THE EFFECT OF PROJECT-BASED LEARNING ON 7TH GRADE STUDENTS' KNOWLEDGE ACQUISITION IN, ATTITUDE TOWARDS AND ACTIVE LEARNING STRATEGIES IN AND LEARNING VALUE OF GEOMETRY WITH DIFFERING COGNITIVE STYLE

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ABSTRACT

THE EFFECT OF PROJECT-BASED LEARNING ON 7TH GRADE STUDENTS' KNOWLEDGE ACQUISITION IN, ATTITUDE TOWARDS AND ACTIVE LEARNING STRATEGIES IN AND LEARNING VALUE OF GEOMETRY WITH DIFFERING COGNITIVE STYLE

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The aim of this study was twofold: (a) to investigate whether seventh grade students' conditional and procedural knowledge acquisition in, attitude towards, active learning strategies in, and learning value of geometry improve differentially for students having different cognitive styles in project-based learning and (b) to examine how project-based learning affects them.

Participants were 97 seventh-grade students in a private school in Ankara. The students were classified into three groups: Field dependent (N=31), field middle (N=35), and field independent (N=31), based on the raw scores of the participants from the Group Embedded Figures Test. Only one treatment (i.e., project-based learning) was conducted for the study, lasting 30 lesson hours. Pre-test and post-test design for the students having three different cognitive styles was utilized.

A mixed methods design integrating both quantitative and qualitative data was used for this study. The data were collected through Conditional and Procedural Knowledge Tests, Active Learning Strategies in and Learning Value of Geometry

Questionnaire, Geometry Attitude Scale, interview responses, and classroom observation field notes.

The quantitative analyses were carried out by using Mixed Design (one between factor and one within factor) Multivariate Analysis of Variance (MANOVA). The results revealed that there is no significant interaction between time and group. There was a substantial main effect for time and follow up analyses for this effect showed that the students achieved large learning gains for all dependent variables. In addition, the main effect of group was not significant.

According to interview responses and classroom observation field notes, those quantitative results were attributable to the influence of contextualizing, visualizing, and collaborating geometry concepts with their peers and teacher during benchmark lessons and developing and sharing artifacts for each of the cognitive style group.

Keywords: Geometry education, project-based learning, cognitive style, conditional knowledge, procedural knowledge, attitude, active learning strategies, and learning value.

ÖZ

PROJE TABANLI ÖĞRENMENİN FARKLI BİLİŞSEL STİLLERE SAHİP 7. SINIF ÖĞRENCİLERİN GEOMETRİ BİLGİ SEVİYESİ, TUTUM VE AKTİF ÖĞRENME STRATEJİLERİ VE ÖĞRENMENİN DEĞERİNE ETKİSİ

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Bu çalışmanın amacı, proje tabanlı öğrenme ortamının farklı bilişsel stillere sahip 7. sınıf öğrencilerinin geometride koşullu bilgi, işlemsel bilgi, tutum, aktif öğrenme stratejileri ve öğrenmenin değerine etkisini ve o etkinin nasıl oluştuğunu araştırmaktır.

Bu çalışmaya Ankara'da bir özel okuldan 97 yedinci sınıf öğrencisi katılmıştır. Öğrenciler Grup Saklı Figürler Testi sonuçlarına göre üç gruba ayrılmıştır: Alandan bağımlı (N = 31), alandan tarafsız (N = 35) ve alandan bağımsız (N=31). Bu çalışmada 30 ders saati süren sadece bir öğretim metodu (proje tabanlı öğrenme) uygulanmıştır. Üç farklı bilişsel stiline sahip öğrenci gruplu öntest-sontest tasarımı uygulanmıştır.

Bu çalışmada nicel ve nitel verileri birleştiren karma araştırma yöntemi uygulanmıştur. Veri toplamak amacıyla koşullu ve işlemsel bilgi sınavları, geometri tutum ölçeği, geometride aktif öğrenme stratejileri ve öğrenmenin değeri anketi, görüşmeler ve gözlemler kullanılmıştır.

Elde edilen nicel veriler karışık desen çoklu varyans analizi ile incelenmiştir. Analiz sonuçlarına göre, üç bilişsel grubunun da ön test ve son test sonuçları eşit miktarda değişim göstermiştir. Tüm bağımlı değişkenler ile ilgili zamana bağlı anlamlı bir fark bulunmuştur. Ayrıca, üç grup arasında anlamlı fark bulunmamıştır.

Bu nicel bulgular üç faklı bilişsel stilden öğrencilerle ilgili sınıf gözlemleri ve öğrenci cevaplarına göre aşağıdaki özelliklerle ilişkilendirilmiştir: Konu anlatımları ve projelerini üretme ve sunma sırasında günlük hayatla ilişkilendirmek, gözünde canlandırmak, akranlarıyla ve öğretmenleriyle işbirliği yapmak.

Anahtar Kelimeler: Geometri eğitimi, proje tabanlı öğrenme, bilişsel stil, koşullu bilgi, işlemsel bilgi, tutum, aktif öğrenme stratejileri ve öğrenmenin değeri.

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LIST OF ABBREVIATIONS

ABBREVIATION	
PBL:	Project-based learning
ConKT:	Conditional Knowledge Test
ProKT:	Procedural Knowledge Test
GAS:	Geometry Attitude Scale
ALSLVGQ:	Active Learning Strategies in and Learning Value of Geometry Questionnaire
ALSGS:	Active Learning Strategies in Geometry Scale
LVGS:	Learning Value of Geometry Scale
GEFT:	Group Embedded Figures Test
PreConKT:	Students' Pretest Scores on Conditional Knowledge Test
PreProKT:	Students' Pretest Scores on Procedural Knowledge Test
PreGAS:	Students' Pretest Scores on Geometry Attitude Scale
PreALSGS:	Students' Pretest Scores on Active Learning Strategies in Geometry Scale
PreLVGS:	Students' Pretest Scores on Learning Value of Geometry Scale
PosConKT:	Students' Posttest Scores on Conditional Knowledge Test
PosProKT:	Students' Posttest Scores on Procedural Knowledge Test
PosGAS:	Students' Posttest Scores on Geometry Attitude Scale
PosALSGS:	Students' Posttest Scores on Active Learning Strategies in Geometry Scale
PosLVGS:	Students' Posttest Scores on Learning Value of Geometry Scale
FDI:	Field Dependence/Independence
FD:	Field dependent
FM:	Field middle
FI:	Field independent

FDs:	Field dependent learners
FMs:	Field middle learners
FIs:	Field independent learners
MANOVA:	Multivariate analysis of variance
Sig:	Significance
df:	Degrees of freedom
N:	Sample size
M:	Mean
SD:	Standard deviation
α:	Significance level
η^2:	Eta squared

CHAPTER 1

INTRODUCTION

Geometry is one of content areas of the mathematics curriculum in every part of K-12 through to college/university. Clements and Battista (1992) express the school geometry as "the study of those spatial objects, relationships, and transformations that have been formalized and the axiomatic mathematical systems that have been constructed to represent them" (p. 420). National Council of Teachers of Mathematics ([NCTM], 2000) also describe geometry as "a natural place for the development of students' reasoning and justification skills" (p. 40).

Geometry plays an important role in other areas of mathematics (numbers, measurement, algebra, probability and statistics), in other disciplines such as art, science, and social studies, in most of the careers such as in art, architecture, and engineering, in everyday language when describing the location of places such as "adjacent to" and "parallel to", in appreciating the beauty of the nature, and in helping students represent and make sense of the world by providing a perspective of analyzing and solving problems and understanding of symbolic interpretation (NCTM, 2000; Sherard, 1981). In spite of the importance of learning geometry from prekindergarten, numerous studies have stated that neither geometrical understanding level of many students nor the methods by which they learn it are satisfactory (Burger & Shaugnessy, 1986; Clements & Battissa, 1992; Fuys 1985; Mitchelmore, 1997; Mullis et al., 2000; NCTM, 1989/2000; OECD, 2004; Prescott, Mitchelmore, & White, 2002; Senk, 1985; Teppo, 1991; Thirumurthy, 2003; Ubuz & Üstün, 2003; Usiskin, 1982). That happens because most students memorize geometrical rules and how to solve problems without understanding relations among concepts that is useful for their everyday lives.

Owing to the nature and importance of geometry, as mentioned earlier, and to prepare students for 21st century, geometry lessons should encourage students to become lifelong learners who increase problem solving, decision making, reasoning, and critical thinking skills; who make connections, applications, and representations; and who improve personal responsibility, collaboration, and interpersonal skills through geometrical tasks that involve and challenge them intellectually (The National Regional Educational Laboratory [NCREL], 2003; NCTM, 2000). Chi, Bassok, Lewis, Reimann, and Glaser (1989) and Dale (1969) show that the percentage of understanding a concept is at the highest level with doing or experiencing it purposefully. Project-based learning (PBL) seems to be one solution to improve geometry education because it focuses on “learning by doing”; it engages students actively in various types of interesting tasks related to within and across the disciplines and real life; and students in project-based learning must represent knowledge and develop all of above skills in a variety of ways to solve authentic questions and to create artifacts by using benchmark lessons, technology, investigation, collaboration, and authentic assessment with the guidance of teacher (Beckett, 2002; Blumenfeld et al., 1991; Blumenfeld, Krajcik, Marx, & Soloway, 1994; Frank & Barzilai, 2004; Frank, Lavy, & Elata, 2003, Helm & Katz, 2001; Katz & Chard, 2000; Krajcik, Blumenfeld, Marx, & Soloway, 1994; Krajcik, Czerniak, & Berger, 1999; Krajcik et al., 1998; Marx et al., 1994; Moursund, 1999; Tal, Dori, & Lazarowitz, 2000).

Research studies on project-based learning in mathematics education are scarce. Some of those studies were related to the effect of PBL on mathematics learning (Aladağ, 2005; Barron et al., 1998; Boaler, 1997; Clanton, 2004; Özdemir, 2006; Wilhelm, Sherrod, & Walters, 2008) and attitude towards mathematics (Aladağ, 2005; Clanton, 2004; Özdemir, 2006; Yurtluk, 2003). Project-based learning takes account of “the acquisition and construction of knowledge” and “the development of desirable feelings”, two of four kinds of learning goals in PBL (Katz & Chard, 2000, p. 54). Active learning strategies and learning value are also important for PBL since PBL focuses on students’ taking an active role in constructing new knowledge derived from their prior understanding and also encourages students to find personal value of what they are doing (Blumenfeld et al., 1991; Frank et al., 2003; Krajcik et al., 1994, 1999; Milner-Bolotin, 2001).

One of the six principles of NCTM (2000) states “excellence in mathematics education requires equity- high expectations and strong support for all students” (p. 12). If what students are good at and how they learn are known, one then easily creates and utilizes a variety of instructional treatments to benefit all types of learners and to accommodate these differences to develop meaningful understanding. Cognitive style is a form of identifying differences describing “an individual’s psychological and educational characteristics” (Saracho, 1997, p. 23). It is “stable attitudes, preferences, or habitual strategies determining a person's typical modes of perceiving, remembering, thinking, and problem solving” (Messick, 1976, p. 5). Cognitive style is potentially useful in education to influence the impact of teaching and learning (Miller, 1987; Saracho, 1997; Shipman & Shipman, 1985).

Field dependence and independence, first introduced by Witkin in the 1940s, is one of the most researched cognitive styles and has wide application to educational practices and problems for how students learn (Bahar & Hansell, 2000; Canino & Cicchelli, 1988; Davis, 1991; Haaken, 1988; Hsu & Dwyer, 2004; Kahtz & Kling, 1999; Luk, 1998; McGregor, Shapiro, & Niemiec, 1988; Saracho, 1991; Witkin, Moore, Goodenough, & Cox, 1977). It is based on individual’s tendency of perception of the surroundings and provides information on cognitive restructuring and social behaviors (Saracho, 2003). A number of studies have shown that more field independent learners (FIs) tend to academically outperform field dependent learners (FDs) in learning mathematics (Berenson, 1985; Carment, 1988; Clark, Ward, & Lapp, 1988; Idris, 1998; Mrosla, 1983; Phuvipadawat, 1984; Roberge & Flexer, 1983; Vaidya & Chansky, 1980). Additionally, Hadfield and Maddux (1988), MacGregor (1988) and Phuvipadawat (1984) have found that FIs have more positive attitudes toward mathematics than FDs. Low level of cognitive and affective outcomes does not essentially demonstrate lack of ability, but rather the unsuitability of the types of instructional materials and the strategies they utilize (Witkin et al., 1977). Project-based learning accommodates the different learning characteristics of students having three different cognitive styles in terms of field dependence-independence to reach an optimal benefit for all students since it requires a variety of styles and intelligences and projects are adaptable to different types of learners and learning situations (Blumenfeld et al., 1991; Frank et al., 2003; Hargrave, 2003).

Literature suggests that the role of student characteristics on gender (Boaler, 1997; Clanton, 2004), different pre-achievement levels (Barron, et al., 1998) and learning styles (Meyer, Turner, & Spencer, 1997) in project-based learning in mathematics education has been investigated. Considering the previous studies, although cognitive style is one of the most important individual differences, as noted before, no study has been encountered on the effect of PBL in mathematics on students having different cognitive styles.

Taking into consideration these facts, the purpose of this study was twofold: (a) to investigate whether seventh grade students' conditional and procedural geometry knowledge acquisition, attitude towards geometry, active learning strategies in geometry, and learning value of geometry improve differentially for students having different cognitive styles in project-based learning and (b) to examine how project-based learning affects students having different cognitive styles on their conditional and procedural knowledge acquisition in, attitude towards, active learning strategies in, and learning value of geometry.

1.1 The Research Questions

The study sought to address the following main research questions:

1. Do seventh grade students' conditional and procedural geometry knowledge acquisition, attitude towards geometry, active learning strategies in geometry, and learning value of geometry with a project-based learning environment improve differentially having dissimilar cognitive styles?

2. How does a project-based learning environment affect seventh grade students having dissimilar cognitive styles on their conditional and procedural geometry knowledge acquisition, attitude towards geometry, active learning strategies in geometry, and learning value of geometry?

1.2 Significance of the Study

There are research studies about the effect of project-based learning on investigating mathematics learning (Aladağ, 2005; Barron et al., 1998; Boaler, 1997; Clanton, 2004; Özdemir, 2006; Wilhelm et al., 2008) and attitude towards mathematics (Aladağ, 2005; Clanton, 2004; Özdemir, 2006; Yurtluk, 2003). Active engagement of students in learning mathematics and valuing of it are also two significant factors for ensuring quality for students (NCTM, 2000). Therefore, examining the effect of PBL on active learning strategies in and learning value of geometry are essential.

For the studies on the effect of PBL on mathematics learning, even though Aladağ (2005) evaluated learning graphs, natural numbers, and fractions and Clanton (2004) analyzed learning algebra, the remaining four studies (Barron et al., 1998; Boaler, 1997; Özdemir, 2006; Wilhelm et al., 2008) investigated learning geometry, focusing on applying concepts of measurement, scale, angles, perimeter, and area of quadrilateral and circular regions, surface area and volume of some solid figures and some higher geometry concepts. The studies on learning geometry found a positive effect of PBL. Although they, except Boaler (1997), have not distinguished the effect of project-based learning for different knowledge types, examining the test questions showed that they examined procedural knowledge (procedural rules), which is related to action sequences such as identifying concepts, how to use cognitive activities, applying rules and algorithms, and solving problems (Schunk, 1996; Smith & Ragan, 1993). Some of those studies explored procedural knowledge acquisition in a real life context.

Analyzing the studies of Barron et al. (1998), Boaler (1997) and Wilhelm et al. (2008) illustrated that they reported procedural knowledge in two different ways: performance or applied assessment and testing. For performance or applied assessment, fifth grade students developed three projects in the study of Barron et al., designing blueprint of a chair and that of a playground individually and a blueprint and two and three dimensional scale models of a playhouse as a small group work considering needs of young children and the builders and geometry concepts of reasonabless of dimensions, the scale, consistency among scale and measurements, perspective, relationship between perimeter and area. Artifacts of the students were evaluated in terms of the scale and the appropriateness and accuracy of measurements to be built. As a result, there was a substantial improvement for the use of realistic measurements and most of the student projects were judged as accurate and safe enough to be built. Boaler (1997) aimed to provide information on high school students' use of mathematics in two applied activities, the architectural and the planning a flat activities in which students developed a plan and a model of a house and a flat by utilizing geometry concepts of measurement, scale, angles, perimeter, area, volume and some other mathematical concepts. While students were making their projects, students were asked accompanying questions that require students to combine and use different areas of mathematics together related to their activities. The same questions were asked to the traditional group. Findings from the study displayed that PBL students gathered higher scores on utilizing concepts of perimeter, area and their estimation of an angle. Wilhelm et al. explored ways that pre-service teachers used their knowledge in higher geometry concepts while they were developing a project in an astronomical context. The researchers analyzed journals of their investigations, narrative responses in online discussions and classroom interactions and artifacts to ascertain the level of their content understanding. The results illustrated that understanding of the students' geometry concepts developed.

Those three studies and Özdemir (2006) investigated procedural knowledge through testing in pretest and posttest fashion. Barron et al. conducted a 'traditional' geometry test covering scale, volume, perimeter, area, units of measurement, and perspective drawing. Students were required to find out the related quantities from figures and to identify correct strategies for deciding these quantities. Boaler (1997) administered a test which was designed to assess procedural knowledge as replication of their textbooks in different numbers and contexts. Wilhelm at al. utilized an inventory regarding an astronomical context to evaluate students' understanding in applying four higher level geometry concepts (periodic patterns, geometric spatial visualization, cardinal directions, and spatial projection). Özdemir (2006) assessed procedural knowledge of applying perimeter and area of quadrilateral and circular closed regions and surface area and volume of cylinders mostly in a real life context. The findings of those four studies indicated that the students made significant gains in above geometry concepts. Additionally, Boaler (1997) examined the effect of PBL for different forms of mathematics knowledge by conducting the national mathematics examination. Two thirds of this test assessed utilizing knowledge for rehearsal of a rule or formula without requiring a great deal of thought for deciding upon a method to adapt the method to fit the demands of the particular situation and one-third of it evaluated using more difficult knowledge which required the use of some thought instead of answering from memory alone. Accordingly, although PBL students did as well as the traditional students in applying knowledge of mathematical facts, rules and procedures directly from memory, PBL students outperformed the traditional students in making use of the knowledge they had in different situations.

Investigating those four studies also revealed that students developed procedural knowledge due to the fact that the following experiences of students with PBL helped them concentrate on the topic, challenge and extend their existing knowledge and explore new concepts: (a) enjoying while developing their own projects; (b) posing a variety of their own questions and seeking the appropriate answers to them, making decisions, developing reasoning skills, and thinking and acting mathematically; (c) collaborating concepts with the teacher, classmates, and others by sharing and discussing when encountered some difficulties related to real-life issues; (d) making connections with life, the future career, and within and across disciplines to learn how and when to use their knowledge; and (e) learning about new mathematical methods and procedures by changing and adapting them to fit the needs of different situations. In addition to investigating the development of procedural geometry knowledge, examining that of conditional knowledge describing the relationship between two or more concepts is also necessary since geometry includes propositions, principles, postulates, axioms and theorems and all students are required to reason relationships among geometry concepts (Burger & Shaugnessy, 1986; NCTM, 2000; Senk, 1985).

Analysis of the studies on the effect of PBL on attitude towards mathematics showed contradictory results. Clanton (2004) regarding perceived usefulness of mathematics and Özdemir (2006) representing interest, enjoyment, confidence and anxiety showed that PBL is effective in increasing attitude. However, Yurtluk (2003) in the sense of liking mathematics and tendency to engage in or avoid mathematical activities and Clanton (2004) related to students' intended career paths and perceived competence in doing mathematics could not find that effect. One reason of these different results may be because of the fact that while the treatment of Aladağ (2005), Yurtluk (2003) and Clanton (2004) were on different topics of mathematics, they studied attitude towards mathematics. For example, Aladağ (2005) utilized PBL on the topics of numbers and graphs, Yurtluk (2003) on some geometry concepts, and Clanton (2004) on algebra, statistics and some geometry concepts. Only Özdemir (2006) conducted PBL in geometry concepts and investigated attitude towards geometry. The researcher showed that having fun with making students' own models, dealing with authentic daily life problems, feeling some confidence with doing something that they could accomplish, working as groups, providing the opportunity for the students to be able to learn more about their future professions attracted students' attention and made them study willingly, which affected their attitudes toward geometry positively. Students may have different attitudes towards some topics, such as geometry, in mathematics. For that reason and because of the importance of geometry, investigating attitudes towards geometry is necessary.

Literature suggests that the role of student characteristics on gender (Boaler, 1997; Clanton, 2004), different pre-achievement levels (Barron et al., 1998) and learning styles (Meyer et al., 1997) in project-based learning in mathematics education has been examined. The participants in the study of Barron, et al. (1998) were partitioned into three groups using their prior mathematics acheivement as low, average and high level students. After conducting project-based learning, as explained earlier, according to the findings of procedural knowledge in terms of both performance assessment and testing, each of the three groups showed statistically significant improvements and lower achieving students benefited from PBL as much as average and high achieving students. Meyer et al. (1997) examined the relationship between students' learning styles of challenge seeking and five dependent variables (academic risk taking, achievement goals, self-efficacy, volition, and affect) in PBL in geometry. They divided small sample of fifth and sixth grade students in one classroom into "challenge seekers" versus "challenge avoiders". During the treatment, the students were solving the driving question, ‘what makes a kite aerodynamic?’, in which they created a kite to understand, integrate, and apply the principles of some geometry concepts (the relationships among measures of angles, the length of sides, and the surface area in polygons) and aerodynamics by building, testing, and evaluating the properties of flying objects. Two students from each of the two learning style groups were chosen to be interviewed about their ongoing decisions related to the challenges and their actions during the project. Although there were some indications that challenge seekers have a higher tolerance for failure, a learning goal orientation and higher than average self-efficacy in math and challenge avoiders have a higher negative affect after failure, a more performance focused goal orientation, a low self-efficacy in math; the small sample of this study reduced the study to an exploratory investigation.

Considering the previous studies, no study has been encountered examining conditional and procedural knowledge acquisition in, attitude towards, active learning strategies in, and learning value of geometry as a function of the interaction of project-based learning environment with field dependence and independence. It is foreseen that this study will have important contributions to the literature in terms of filling this gap.

Additionally, there appeared to be very little research that examined the nature and form of the classroom processes that contributed towards differential knowledge acquisition and attitude. Besides quantitative tools, utilizing qualitative ones can serve complementary functions and can provide a more complete picture of the issue.

This study is also important for developing different and appropriate project-based learning lesson plans, two knowledge acquisition tests in geometry, and adaptation of active learning strategies and learning value questionnaire into geometry, which may be very helpful for mathematics teachers and researchers for both research and instructional purposes. The findings of the present study may have many significant implications for students, teachers, administrators, educators, and curriculum developers to utilize project-based learning for education of K-12 and higher level students having different cognitive styles and that of teachers in learning and teaching mathematics and other disciplines. Both teachers and researchers can make their own decisions and design effective instructional environments for their students by understanding the relationship between learners' field independent/dependent cognitive styles and features of PBL and details of both students' and teacher's descriptions, actions, and reflections. 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. This study may also open the way to conduct more studies about PBL and individual differences. Therefore, this study is worthwhile to conduct.

1.3 Definition of the Important Terms

This section provides brief descriptions and definitions of critical concepts that are used in this study.

Project-based learning: Project-based learning is a comprehensive approach to classroom teaching and learning that "engages students in learning knowledge and skills through an extended inquiry process structured around complex, authentic questions and carefully designed products and tasks" (Markham, Larmer, & Ravitz, 2003, p. 4).

Field dependent, field middle and field independent learner: Field dependent learners have difficulty in separating an item from its context and have superior social skills. In contrast, field independent learners easily break up an organized field and separate relevant information from its context and have greater cognitive structuring skills (Witkin et al., 1977; Witkin & Goodenough, 1981). Field middle learners have no certain tendency toward either style (Dwyer & Moore, 2001).

Conditional and procedural knowledge: Conditional knowledge involves "if-then" or "condition-action" statements and describes the relationship between two or more concepts. Procedural knowledge is the knowledge of how to perform cognitive activities (Smith & Ragan, 1993).

Attitude: Attitude refers to "one's feelings toward a given circumstances and affect one's reaction to a particular situation" (Duatepe-Paksu & Ubuz, 2007, p. 205).

Active learning strategies: Active learning strategies includes "using a variety of strategies to construct new knowledge based on students' previous understanding" by taking an active role (Tuan, Chin, & Shieh, 2005, p. 643).

Learning value: Learning value is "to let students acquire problem-solving competency, experience the inquiry activity, stimulate their own thinking, and find the relevance … with daily life" (Tuan et al., 2005, p. 643).

CHAPTER 2

REVIEW OF RELATED LITERATURE

In this chapter, a review of literature relevant to this research is presented as follows: (1) project-based learning and (2) project-based learning and field dependence-independence.

2.1 Project-Based Learning

An idea of "learning by doing" is not new in education but it has changed noticeably over time. A variety of terms are used interchangeably in the literature for that idea such as project method, project approach, project-oriented approach, project-based science, project-based mathematics, project-based instruction and project-based learning. In this study, the term project-based learning (PBL) will be used to emphasize the importance of learner and the broadest term for education.

Generally speaking, project-based learning includes mainly the following features: (1) Driving question that serve to organize and guide instructional tasks and activities; (2) Engaging students in investigations to answer their questions; (3) Collaboration of students, teachers and members of society on the driving question; (4) Use of technology to access information, investigate, and collaborate; (5) Developing artifacts or products that address the driving question; and (6) authentic assessment (Blumenfeld et al., 1991, 1994; Frank & Barzilai, 2004; Krajcik et al., 1991, 1994, 1999; Marx et al., 1994; Tal et al., 2000). Although each feature can be expressed one by one, in practice features are dependent to each other and orchestration among the features is significant (Blumenfeld et al., 1994). Those features of PBL have its roots in constructivism, a theory about how people learn suggesting that they actively construct their new understandings or knowledge on the basis of their prior knowledge and giving meaning to their experiences (Fosnot, 1996; Frank et al., 2003). Detailed descriptions of those features and relation of them with the theories of proponents of constructivism, Dewey, Kilpatrick, Bruner, Rogers, Piaget, and Vygotsky, are presented in order as follow:

First, the driving question is students' first introduction to the project. A good driving question should be anchored in a real life context; be meaningful and interesting to learners; encompass worthwhile content and process that match curriculum standards; connect the subject-matter to various disciplines and the real life so that students can understand the relations among them; and be broken down into sub-questions (Krajcik et al., 1994, 1998, 1999; Marx et al., 1994; Rivet, 2003). For example, the driving question, "what makes a kite aerodynamic?" (Meyer et al., 1997, p. 507) meets all of the features of a good driving question. Developing a kite is meaningful and interesting for students. They can learn geometry concepts of the relationships among measures of angles, sides and surface area of polygons by connecting those concepts to science and real life by building, testing and evaluating the properties of flying objects. Dewey (1938), Kilpatrick (1918) and Rogers (1969) support that learning takes place by doing and personal involvement in the learning process that is interdisciplinary and concerned on learner's interests and life.

Investigation, the second feature of PBL, is a piece of research that makes students look for answers to the driving question by themselves or in collaboration with others (Katz & Chard, 2000). For above driving question, learners can get information about the properties of flying objects by observing them and interviewing experts such as engineers or by using secondary sources such as books, videos, the Internet, and other sources where information has been prepared by other researchers. The process of investigation may include initially exploring ideas and asking sub-questions; planning and carrying out procedures; finding information and making conclusions; and communicating findings with others (Krajcik et al., 1999). According to Kilpatrick (1918), students learn best when "wholehearted purposeful activity" is present (p. 320). Dewey (1938) and Rogers (1969) also agree that children learn best from planning their own activities in line with pursuing their own purposes and interests and carrying out their own plans.

The third feature of PBL is collaboration and it is a common intellectual effort of students with their peers, their teacher, or community members to investigate the driving question, to examine their conceptions and ideas, to make sense of information, to draw conclusions and present them, and finally to develop understanding (Krajcik et al., 1999). Vygotsky (1978) gives emphasis on learning in the social context and using language and students use language as a tool to express their concepts and ideas, to debate, and to come to resolution in PBL. Collaboration feature of PBL is based on mainly two main principles of Vygotsky, the more knowledgeable other and the zone of proximal development. The more knowledgeable other is someone who has a better understanding or a higher ability level than the learner about a particular task, process, or concept. Vygotsky (1978) described the zone of proximal development as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p. 86). Students are exposed to more zones of proximal development and their cognitive development is promoted when they interact with others who may be a little more knowledgeable or have different viewpoints, strengths, and weaknesses. Scaffolding, a process in which a more knowledgeable other provides support to the learner to help him/her understand or solve the driving question, derives from Vygotsky's the zone of proximal development. In addition, the application of scaffolding in PBL involves teacher roles of coaching, modeling and guiding students. Using Vygotsky's ideas, it is possible to state that collaboration during PBL works most effectively in heterogeneous groups with moderate differences in ability, personality, and previous experience. In addition to Vygotsky, Dewey and Kilpatrick give importance to social activity during group work through interacting with other children. Dewey also supports the guidance of teacher.

As another feature of PBL, technology, such as computers and accompanying software programs, is utilized as a tool to support teaching and learning. Using technology makes the environment more authentic to students since they can use computer to access real data on the Internet, which facilitate communication with knowledgeable others outside the classroom. In addition to gathering data, technology makes it easy to understand key concepts with utilizing visualization tools. It also helps analyze data through the use of electronic spreadsheets and graphing. It allows students to manipulate, construct, and revise their own artifacts easily in several media including text, graphic and video. Moreover, technology can enhance challenge and variety by providing multiple tasks and plays a powerful role in improving student and teacher motivation by actively engaging students in the learning process (Blumenfeld et al., 1991; Krajcik et al., 1994, 1999; Lundeberg, Coballes-Vega, Standiford, Langer, & Dibble, 1997; Salomon, Perkins, & Globerson, 1991).

Project-based learning results in some artifacts or products, which are multiple representations of students' solutions to the driving question and show what they have learned. Since artifacts are concrete and explicit, such as physical models such as a kite, reports, videotapes, multimedia projects, web sites, and computer programs, they are motivating and can be shared and critiqued. Students should demonstrate their knowledge, integrate information, use complex thought and mirror real-world issues in their constructing and sharing of artifacts (Blumenfeld et al., 1991; Marx, Blumenfeld, Krajcik, & Soloway, 1997). In addition to constructivism, this feature of PBL reflects constructionism, both theory of learning and a strategy for education extending the constructivist view of learner's active builder of knowledge by suggesting that people learn the best when they are creating an artifact (Grant, 2002; Han & Kakali, 2001; Kafai & Resnick, 1996; Papert, 1993).

For assessment, the terms "active assessment", "alternative assessment", "authentic assessment", and "performance assessment" are appropriate for PBL. The term "authentic assessment", the sixth feature of PBL, is used for the present study. It assesses learning progress of an individual student, not just the final result and rather than comparing them with others, on the basis of their active performance throughout applying knowledge in artifact development to solve driving question. It measures deep understanding of subject matter knowledge, higher-order thinking skills, and affective outcomes such as attitudes and values with utilizing paper and pencil tests, observations, discussions, interviews, questionnaires, journal writing, rubrics …etc. It involves both students and teachers in the assessment process by helping students monitor their own learning progress in guiding teaching and in evaluating and revising curriculum (Frank & Barzilai, 2004; Krajcik et al., 1999; Tal et al., 2000). Rogers (1969) gives emphasis on self-evaluation rather than being evaluated by others.

In addition to six main features of PBL, as mentioned previously, PBL consists of benchmark lessons, teacher-directed classroom activities based on the curriculum objectives that present certain concepts, principles, skills, and procedures so that students conduct investigation, collaborate, utilize technology, create the project and develop deeper understandings. Students in benchmark lessons are learning the concepts and principles to help them understand and find solutions to the driving question rather than just learning them for the sake of learning. They may include presenting information, giving demonstrations, facilitating discussions, going on field trips, making concept maps and role-playing (Krajcik et al., 1999).

Teachers in project-based learning are considered to have sufficient understanding of content knowledge and they are aware of children's prior knowledge, set clear expectations, create a collaborative learning environment to share information and to appreciate each other's work, overcome challenges, keep referring to the driving question, observe, listen, question, provide feedback, give guidance, offer alternatives, facilitate learning by using benchmark lessons, support inquiry and help children integrate their understandings and strengthen their dispositions (Blumenfeld et al., 1991; Chard, 1998; Katz & Chard, 2000, Krajcik et al., 1999).

The word "learning" in PBL takes account of the learner pointing out student-centered education. The students in PBL have enough prerequisite content knowledge and specific skills; determine how to manage the driving question, what steps to follow, what activities and artifacts to construct, what resources to use, and how to divide up responsibility; gather information; collaborate and consult; practice knowledge and skills through creation of artifacts; keep track of the process to see errors and false steps; improve their work; and judge their own success (Blumenfeld et al., 1991; Chard, 1998). According to Piaget (1977), learning takes place primarily within the individual's mind as a result of internalization and construction of external reality depending on his/her prior knowledge and stage of cognitive development. A general principle derived from Piaget's theory is errors and misconceptions and students are encouraged to examine new ideas through the use of real world problems, authentic materials, and making meaningful connections by linking the new information to their prior knowledge to help students see and correct their errors in PBL. Like the prior education theorists mentioned earlier, Bruner (1961) also agrees that learners should be active in the learning process. The key feature of Bruner's theory is discovery and the discovery learning requires that the student explores examples, concepts and principles and participates in making many of the decisions about what, how, and when something is to be learned.

2.2 Project-Based Learning and Field Dependence and Independence

Educators and psychologists value learners' social and cognitive characteristics, fundamental in field dependence and independence, by viewing from an educational perspective and utilize in their instructional efforts to have better learning outcomes (Davis, 1991; Witkin et al., 1977). Witkin et al. (1977) described educational implications of field dependence and independence by examining social characteristics of learners in terms of "learning of social material" and "the effects of reinforcement" and cognitive characteristics of them as "the use of mediators in learning" and "cue salience" (p. 17). Based on the researchers' four learning areas, the characteristics of field dependent learners (FDs) include (a) being better at concentrating on social aspects of the surrounding and learning and remembering information having social relevance, (b) being more affected by extrinsic goals reinforcements, and motivation, (c) utilizing meditational processes such as analyzing and structuring less effectively and accepting a passive and spectator role in learning, and (d) being more dominated by the most noticeable or salient cues in learning. On the other hand, the characteristics of field independent learners (FIs) comprise (a) having lack of attention to social materials (b) being more influenced by intrinsic goals, reinforcements, and motivation, (c) making better use of meditational processes and accepting an active and hypothesis-testing role in learning, and (d) being less governed by salient cues in learning.

Field dependent learners and field independent learners may respond differentially to the content being presented as well as the learning environment because of the characteristics of them (Witkin et al., 1977). Considering that FDs learn better in a social context and they have great difficulty imposing organization in an unstructured environment they learn, Saracho (1988) and Witkin et al. (1977) point out that the performance of FDs can be equal to that of FIs with social material and when learning materials are highly organized. Bearing in mind the social and cognitive characteristics of FDs and the features of PBL as explained earlier, we may also hypothesize that FDs can make connections between two or more concepts and through engaging physically and cognitively with varied novel elements and authentic and meaningful tasks of well designed PBL, especially solving the driving question related to real-life issues and practices by working collaboratively in heterogeneous groups by interacting with a little more knowledgeable peers and teachers, by utilizing the most significant cues through demonstrations of pictures and objects from other disciplines and real life and those of dynamic geometry software and applets and solving everyday problems in benchmark lessons and constructing artifacts and by being assessed learning progress of an individual student instead of just the final result and rather than comparing him/her with others to solve. Furthermore, since FIs favor mathematics and higher-order tasks and they are more influenced by intrinsic goals (Witkin et al., 1977), they can make relations between two or more concepts while challenging with solving consolidating geometry problems and demonstrations from real life pictures and objects and those of dynamic geometry software and applets. They also have change to make analysis and structures during some higher-order tasks such as making decisions and posing their own questions and pursuing answers to them while orchestrating all features of PBL at the same time, particularly when creating their artifacts. Since PBL encourages responsibility and independent learning (Krajcik et al., 1999), FIs may internalize geometry concepts through all of those processes. For these reasons, it seems reasonable to anticipate that PBL may enhance conditional geometry knowledge acquisition of both FDs and FIs similarly.

PBL promotes students to acquire and apply concepts and principles and to explore why, when, where, and how they learn (Von Kotze & Cooper, 2000). The previous research studies on applying rules and algorithms and solving problems in geometry found a positive effect of PBL (Barron et al., 1998; Boaler, 1997; Özdemir, 2006; Wilhelm et al., 2008). They also gathered that the following experiences of students with PBL affected on that type of knowledge positively: enjoying; posing questions and seeking answers to them; making decisions; developing reasoning skills; thinking and acting mathematically; collaborating concepts with the teacher, class mates, and others; making connections with life, the future career and within and across disciplines to learn how and when to use their knowledge; and learning about new mathematical methods and procedures by adapting them into different situations. Taking into account of the findings of the earlier studies and the characteristics of PBL which have potential to affect conditional knowledge acquisition of FDs and FIs, as emphasized in the previous paragraph, both FDs and FIs can apply geometry concepts in project-based learning environment. Therefore, we can also predict that PBL improve acquisition of procedural geometry knowledge of both FDs and FIs equally.

Like knowledge acquisition, each feature PBL has great potential to foster attitude (Blumenfeld et al., 1991; Branford, 2005; Sidman-Taveau, 2005; Sidman-Taveau & Milner-Bolotin, 2001). Özdemir (2006) found that the following features of PBL affected attitude towards geometry positively: (a) having fun with making students' own models, (b) dealing with authentic daily life problems, (c) feeling some confidence with doing something that they could accomplish, (d) working as groups, (e) providing the opportunity for the students to be able to learn more about their future professions. Different students need different strategies to increase attitude towards geometry because application of any given strategy is likely to increase attitude in some students but decrease it in others. Field dependence and independence dimension of cognitive styles has implications for it (Brophy, 1998). FDs tend to be extrinsically motivated and enjoy learning through working together with others, while FIs tend to be intrinsically motivated and are prone to like individualized learning (Karnasih, 1995; Luk, 1998; Rayner & Riding, 1997; Witkin et al., 1977). Particularly finding the driving question interesting and meaningful, authenticity of the tasks, overcoming obstacles with peer and teacher support, utilizing physical and virtual manipulatives as salient cues, role playing as people from different occupations, and utilizing their thought and wishes in PBL may provide FDs to feel pleasure and confident when dealing with geometry. Moreover, we may also predict that PBL provides high level of attitude of FIs because of the fact that utilizing their imagination in higher-order tasks in solving the driving question and developing artifact help them be intrinsically motivated and feel confident. Within this framework, we may also expect that every feature of well-designed PBL may increase attitude of both FDs and FIs towards geometry similarly.

PBL also requires many features in the process of solving the driving question to enhance active learning strategies and learning value. For instance, discussing on demonstrations of pictures from other disciplines and real life and those of dynamic geometry software and applets and solving everyday problems to understand and consolidate the geometry concepts and collaborating with the group-mates and the teacher on making decisions in line with their own wishes while creating their artifacts provide students to connect previous geometry knowledge and experiences with new knowledge, to value having opportunity to satisfy their curiosity, and to be willing to participate in geometry lesson. Facing with difficulties in these processes and overcoming those obstacles by thinking and collaborating help them value solving problems. The students solve the driving question by investigating through utilizing technology and some other resources such as books, encyclopedias and relatives from different occupations, which provide them to find relevant resources and to value these inquiry activities. Because of those facts, we can anticipate that both FDs and FIs develop active learning strategies and learning value equally in PBL.

CHAPTER 3

METHODS

This chapter explains design, participants, data collection instruments, variables, data collection procedures, development of lesson plans, treatment, treatment verification, and data analysis of the study.

3.1 Design of the Study

The purpose of this study was to investigate whether students' conditional and procedural knowledge in, attitude towards, active learning strategies in, and learning value of geometry improve differentially for students having different cognitive styles in project-based learning.

A mixed methods design, more specifically equivalent status parallel/simultaneous design, integrating both quantitative and qualitative data was used for this study (Cresswell, 2003; Greene, Caracelli, & Graham, 1989; Johnson & Onwuegbuzie, 2004; Tashakkori & Teddlie, 1998; Teddlie & Tashakkori, 2003). This design was utilized to have broader and deeper understanding of the phenomenon by converging both broad quantitative data and the detailed qualitative data and to provide better and stronger inferences that confirm or complement each other. In this design, the quantitative and qualitative data were gathered at the same time. Priority was equal between the two methods. Integration occurred in the interpretation of the overall results.

This is a quasi-experimental study together with extensive interviews and observations of participants. Only one treatment (i.e., PBL) was conducted for the study. Pre-test and post-test design for the students having three different cognitive styles was utilized.

3.2 Participants

The study was conducted with seventh grade students in a private school in Ankara. There were 20 seventh-grade classes in the school and conveniently chosen three of those classes having totally 97 students were included in this study. 90 % of the mothers and 93 % of the fathers graduated from a university. Most of the students had relatives having different occupations such as architects, city planners, and engineers. Majority of them had high socioeconomic status and they had opportunity to utilize computer and Internet at home. This school had computer laboratories and a rich library. The students had opportunity to search from them.

Group Embedded Figures Test (GEFT) developed by Witkin, Oltman, Raskin, and Karp (1971) and translated and validated into Turkish by Cakan (2003) was administered to all students at the beginning of the 2007-2008 academic year as a measure of cognitive style (field dependence and independence). Although Witkin et al. (1971) did not specify a clear cut-off score for grouping field dependent and field independent individuals, Dwyer and Moore (2001) categorized the students into three groups, instead of two groups, to increase differentiation of them according to standard deviation of the total raw scores from the GEFT. Individuals whose raw score fell one half of the standard deviation above the mean were considered to be field independent (FI); those who located one half of the standard deviation below it were classified as field dependent (FD), and those in the middle were classified as field middle (FM) who may said to have no certain tendency toward either style. Frequency, mean (M), standard deviation (SD), and range of the each group of students are presented in Table 3.1. The half of the standard deviation for this study was 2.19. So, mean plus half of the standard deviation was 8.23 + 2.19 = 10.62 and mean minus half of it was 8.23 - 2.19 = 5.84. This showed that subjects who get a raw score from 0 to 5 are considered to be FD, from 6 to 10 to be FM, and from 11 to 18 to be FI. The same range is gathered by the 27 % rule, suggested by Cureton (1957), such that the upper 27 % of the scorers are identified as FI; the lower 27% of the scorers as FD; and individuals whose scores fall between the cut-off values of the upper and lower 27 % as FM.

Table 3.1 The Distribution of Students' Cognitive Styles

Group	N	M	SD	Range
Field dependent	31	2.84	1.81	0-5
Field middle	35	8.03	1.54	6-10
Field independent	31	13.84	2.13	11-18
Total	97	8.23	4.78	0-18

As a result, based on the raw scores of the participants from the GEFT, they were classified into three groups: Field dependent (N=31), field middle (N=35), and field independent (N=31). Each of the three classes had all those three group of students and they all did their learning in the same project-based learning environment. The students were not informed of their cognitive styles. The distribution of the participants in three classes including 34, 30, and 33 students, respectively, in terms of field dependence and independence is given in Table 3.2

Table 3.2 The Distribution of the Participants in Three Intact Classes in Terms of Field Dependence and Independence

Classes	Groups			
	Field Dependents (%)	Field Middles (%)	Field Independents (%)	Total
7A	10 (32.1)	16 (45.7)	8 (25.8)	34 (35.1)
7B	9 (29.0)	8 (22.9)	13 (41.9)	30 (30.9)
7C	12 (38.7)	11 (31.4)	10 (32.1)	33 (34.0)
Total	31 (100)	35 (100)	31 (100)	97 (100)

The distribution of the participants in three cognitive style groups in terms of gender is given in Table 3.3. The average age of all groups of students was 13.

Table 3.3 The Distribution of the Participants in Three Cognitive Style Groups in Terms of Gender

Gender	Groups			
	Field Dependents (%)	Field Middles (%)	Field Independents (%)	Total
Females	18 (58.1)	24 (68.6)	15 ((48.4)	57 (58.8)
Males	13 (41.9)	11 (31.4)	16 (51.6)	40 (41.2)
Total	31 (100)	35 (100)	31 (100)	97 (100)

3.3 Data Collection Instruments

In this study, quantitative and qualitative data collection instruments were utilized for methodological triangulation and a variety of data sources were used for data triangulation. Detailed information about these is stated below.

3.3.1 The Quantitative Data Collection Instruments

In order to gather the quantitative data, six instruments were used in the study: Group Embedded Figures Test, Conditional and Procedural Knowledge Tests, Active Learning Strategies in and Learning Value of Geometry Questionnaire, Geometry Attitude Scale and Lesson Plan Evaluation Scale.

3.3.1.1 Group Embedded Figures Test

Group Embedded Figures Test (GEFT), developed by Witkin, Oltman, Raskin, and Karp (1971) and translated and validated into Turkish by Cakan (2003), was a measure of field dependence/independence and used to assess an individual's perceptual differentiation. In this test, the object is for the individual to find, or disembed, the simple geometric figure within the more complex geometric figure. How a person responds to the GEFT indicates their general tendencies in learning, perceiving and understanding the world. The GEFT score indicates one's ability to locate relevant information within, or separate it from, the overall organizational context. The GEFT has three sections. The first section which is mainly for practice contains seven relatively simple items which must be located and traced in two minutes. This section is designed to determine students' understanding of the GEFT; participants rarely make errors in the first section. The scores from this section are not included in the total scores. The second and third sections each contain nine complex items that are progressively more difficult and have time limits of five minutes each. Scoring is based on the combined number of simple complex figures correctly traced in sections two and three, thus scores may range from 0 (highly field dependent) to 18 (highly field independent). The scores of the second and third sections indicate a learner's ability to perceive a part of a stimulus as discrete from its surroundings through "active and analytic" processes as opposed to "passive and global" processes. Turkish version of the GEFT, which was adapted into Turkish by Cakan (2003), had satisfactory parallel-form reliability and internal consistency for eight graders. The reliability coefficient between the second and third sections was 0.74 and it was 0.85 for the total sample. The Cronbach’s alpha coefficient of the GEFT of the present study for seventh graders was 0.87, which indicate high reliability.

3.3.1.2 Conditional and Procedural Knowledge Tests

In this study, the Conditional Knowledge Test (ConKT) and Procedural Knowledge Test (ProKT) related to the angles and polygons were developed for seventh grade students’ geometry knowledge with the help of the advisor of this study, a mathematics educator at a university. All questions for the two tests were developed by considering the objectives of the National Mathematics Curriculum (MNE, 2005) for the seventh grade geometry and the nature of those two types of knowledge. The researcher consulted the following textbooks and teachers’ resource books for the selection of the questions of ProKT (Aygün et al., 2007; Boyd, Burrill, Cummins, Kanold, & Malloy, 1998; Kalin & Corbitt, 1993; Larson, Boswell, & Stiff, 1995; Önal & Aydın, 2003; Rubenstein & Littell, 2002; Serra, 1997; Şahin, Karakaya, Targil, Mendil, & Katırcı, 1997). Two mathematics teachers, one of them is a doctorate student in educational sciences at the same time, checked the tests for the content validity by comparing the content of the tests with the objectives. Then, the tests were submitted to the advisor to check the appropriateness, relevance, and conciseness of the questions with the nature of mathematical knowledge acquisition and with that of project-based learning. Taking into account their suggestions, some revisions were made on the wordings of questions to make them clear and suitable for the learning outcome being measured.

Draft forms of the ConKT and ProKT were piloted on eight grade students from six public schools in the first semester of 2007-2008 academic year. The aim of the piloting was to check the clarity of the questions, to make sure the adequacy of the test duration, and to check reliability and construct validity of the tests.

Two focused holistic scoring schemes, developed by Lane (1993), reflecting the conceptual framework of conditional and procedural knowledge were utilized for this study for grading the responses for each question in the ConKT and ProKT (see Appendices B and F). For each question of the tests, a five-score level (0-4) was assigned. The highest score of 4 was awarded for responses that the researchers regard as being entirely correct and satisfactory at grade seven geometry level, while the lowest score of 0 was reserved for no answer. The researcher graded the answers on the basis of the question number rather than each student. In other words, the answers given to question 1 were graded by going through each student's answers. Additionally, students' names and cognitive style groups were not taken into account while scoring the tests in order not to be biased.

The reliability analyses were conducted by using Statistical Package for Social Sciences (SPSS) 13.0 for Windows for each test in order to obtain Cronbach alpha reliability coefficients. Construct validity of the draft forms of them were examined in two phases: Exploratory and confirmatory factor analyses. Exploratory factor analyses were conducted by using SPSS 13.0 for Windows and the confirmatory factor analysis was performed by using LISREL (Linear Structural Relations Statistics Package Program) 8.30 for Windows (Jöreskog & Sörbom, 1999).

The exploratory factor analyses were performed to evaluate the factor structures of ConKT and ProKT with regard to the data obtained from Turkish eight grade students. A principal component factor analysis with oblimin rotation was conducted on them. The Kaiser-Meyer-Olkin (KMO) (Kaiser, 1970, 1974) measure of sampling adequacy and Bartlett's Test of Sphericity (BTS) (Bartlett, 1954) were analyzed to ensure that the characteristics of the data were suitable for performing exploratory factor analyses. After the results of KMO exceeded the recommended value of 0.60 and BTS reached statistical significance, a further consideration was to determine the number of factors to be extracted in the subsequent analyses. Pallant (2007) and Thompson and Daniel (1996) suggested three methods to select factors. Accordingly, the present study used: (a) eigenvalue-greater-than-one rule (Kaiser, 1970, 1974), (b) scree tests (Catell, 1966), and (c) parallel analysis (Horn, 1965). To decide which items to retain in each factor, the following rules were used: (a) item loadings have to exceed .30 on at least one factor (Hair, Anderson, Tatham, & Black, 1995) and (b) at least three significant loadings are required to identify a factor (Zwick & Velicer, 1986).

The confirmatory factor analyses were administered to the new samples for each test in order to make sure that selected observed variables with regard to the results of exploratory factor analysis account for the latent variables. Multiple criteria including chi-square (χ^2), normed-chi square (NC), which is the ratio of chi-square and its degrees of freedom), root mean square error of approximation (RMSEA), the root mean square residual (RMR), standardized RMR, goodness-of-fit index (GFI), adjusted-goodness-of-fit index (AGFI), comparative fit index (CFI) were used to test model-data-fit. It is suggested that non-significant chi-square implies that the model fits data and NC index of five or less have been interpreted as a good fit to the data and with χ^2/df ratios of less than 2 indicating overfitting. It is suggested that RMSEA values below 0.10 indicate a good fit to the data and the values below 0.05 indicate a very good fit to the data. The RMSEA index has the advantage of going beyond point estimates to the provision of 90%. Furthermore, by testing whether the value obtained is significantly different from 0.05, LISREL provides a test of the significance of the RMSEA. It is also suggested that RMR and standardized RMR below .05, GFI, AGFI and CFI above .90 as a good fit to the data (Kelloway, 1998; Steiger, 1990). Table 3.4 represents the summary of the criteria of fit indices defined above.

Table 3.4 Criteria for Fit Indices

Fit Index	Criterion
Chi-Square (χ^2)	Non-significant
Normed Chi-Square (NC)	2<NC < 5 (good fit) NC<2 (overfit)
Root Mean Square Error of Approximation (RMSEA)	0.05 < RMSEA < 0.10 (good fit) 0.01<RMSEA < 0.05 (very good fit)
Root Mean Square Residual (RMR)	RMR < 0.05
Standardized Root Mean Square Residual (S-RMR)	S-RMR < 0.05
Goodness of Fit Index (GFI)	GFI> 0.90
Adjusted Goodness of Fit Index (AGFI)	AGFI> 0.90
Comparative Fit Index (CFI)	CFI> 0.90

3.3.1.2.1 Conditional Knowledge Test

The Conditional Knowledge Test (ConKT) involves 10 “if-then” statements in which students were required to describe the relationship between two concepts about angles and polygons (see Appendix A). Objectives of those items are to justify the relationships between the following two concepts: (1) angles when one line intersects two parallel lines at two different points; (2) the angle and side properties of isosceles and equilateral triangles, squares and rectangles, trapezoids and parallelograms, and rhombi and parallelograms; (3) the sum of the measure of angles of polygons and its number of sides; (4) being a regular polygon and its side properties; (5) equal and similar polygons; (6) the being similar polygons and measure of their angles and (7) being similarity of two regular polygons which have the same number of sides. The possible scores of the ConKT range from 0 to 40.

Draft form of the ConKT was piloted on 134 eight grade students for exploratory factor analysis for construct validity of it. As emphasized in section 3.3.1.2, ConKT questions were scored based on the rubric developed by Lane (1993). If we want to give a specific example, grading responses for question 4 (Is the statement “Every trapezoid is a parallelogram” true? Justify your answer) was discussed. As it is seen, the question includes two parts: True/false and justification.

If a student attempted no answer, copied a part of the problem without a solution, used completely irrelevant information or gave false answer by writing down “yes (every trapezoid is a parallelogram)”, he/she got 0 score. If a student answered true/false part correctly by writing down “no (every trapezoid is not a parallelogram)”, he/she got 1 or more points, depending on their explanation on justification part. If a student failed to explain the reasons of why every trapezoid is not a parallelogram or gave unrelated or wrong evidence of the explanation process, the student got 1 point. If he/she identified some of the angle and side properties of trapezoids and parallelograms but could not make connection between them, the student got 2 points. If he/she identified the most important parts, gave a fairly complete response with reasonably clear explanations or descriptions of the relations and statements and presented supporting logically sound arguments which contain some minor gaps such as some of the angle and side properties of those two types of special quadrilaterals, the student got 3 points. If a student showed clear, strong, supporting, logically sound and complete arguments, explanations or descriptions of the relations between angle and side properties of trapezoids and parallelograms, the student got 4 points.

Upon the completion of grading by the researcher, one mathematics teacher, a doctorate student in educational sciences at the same time, scored randomly selected 50 tests. Inter-rater reliability coefficient by means of intra-class correlation (ICC) was computed in order to establish the extent of consensus on the use of the scoring rubric for each of the tests. The ICC value of the ConKT was 0.87, which indicated high reliability and internal consistency of scoring rubric as used by two raters.

For exploratory factor analysis (EFA), 10 questions of the ConKT were subjected to principles component analysis (PCA). Prior to performing PCA, the suitability of data for EFA was assessed. All of inter-item correlations of those questions of the ConKT were .3 or above (see table 3.5). The results of a KMO measure of .91 and a statistically significant BTS measure of 703.83 ($p < .001$, $df = 45$) allowed us to conduct PCA. Subsequent investigations demonstrated the presence of one factor with eigenvalues exceeding 1, explaining 55.74 % of the variance. Table 3.6 presents the eigenvalue, percentage of variance explained by factor and factor loadings for component matrix along with communalities of the questions of Conditional Knowledge Test.

Table 3.5 Correlations Between ConKT Questions

	CON1	CON2	CON3	CON4	CON5	CON6	CON7	CON8	CON9	CON10
CON1	1.00									
CON2	.43	1.00								
CON3	.47	.66	1.00							
CON4	.45	.54	.51	1.00						
CON5	.45	.33	.44	.47	1.00					
CON6	.60	.58	.62	.55	.39	1.00				
CON7	.45	.56	.56	.62	.36	.61	1.00			
CON8	.56	.34	.38	.39	.30	.53	.54	1.00		
CON9	.50	.57	.57	.50	.35	.64	.66	.59	1.00	
CON10	.53	.39	.49	.59	.42	.56	.57	.51	.59	1.00

Table 3.6 Eigenvalue, Percentage of Variance Explained by Factors, and Factor Loadings for Component Matrix Along With Communalities of the Questions of ConKT

Component		Conditional Knowledge of Angles and Polygons	
Eigenvalue		5.57	
% of Variance		55.74	
Question no	Objectives	Factor loadings	Communalities
6	To justify the relationship between sum of interior angles of polygons and their number of sides	.82	.68
9	To justify the relationship between rectangles and similar polygons	.81	.65
7	To justify the relationship between measure of angles and sides of polygons and being a regular polygon	.80	.65
3	To justify the relationship between squares and rectangles	.77	.59
10	To justify the relationship between two regular polygons having the same number of sides and similarity of polygons	.76	.58
4	To justify the relationship between trapezoids and parallelograms	.75	.57
2	To justify the relationship between equilateral triangles and isosceles triangles	.73	.53
1	To justify the relationship between (a) the situation of one line intersects other two parallel lines at two different points and (b) corresponding angles among them	.72	.52
8	To justify the relationship between congruency and similarity of polygons	.68	.47
5	To justify the relationship between rhombi and parallelograms	.58	.34

The component matrix revealed that all ten questions constituted one factor and all factor loadings and communality values were above .30, concurrent with the suggestions of (Hair et al., 1995). The inspection of the screeplot revealed a clear break between the first and second factors. Hence, Catell’s (1966) scree test demonstrated to retain one factor (see Figure 3.1). This was further supported by the results of parallel analysis. To compare the initial eigenvalues obtained in the exploratory factor analysis with the corresponding values of the random eigenvalues, Monte Carlo PCA for Parallel Analysis (Watkins, 2000) was used. The results showed only one factor with eigenvalue of 5.57 exceeding the corresponding values of the random eigenvalues generated for 10 variables, 134 subjects and 100 replications. Therefore, a one-factor solution was selected.

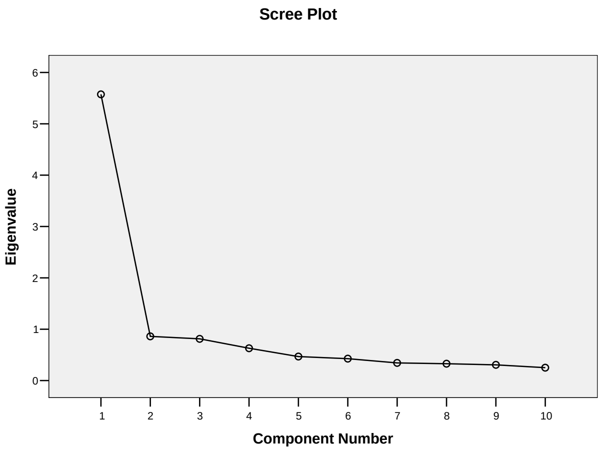


Figure 3.1 Screeplot of ConKT

Regarding the findings of EFA, ConKT was conducted to 259 different eight grade students for CFA to specify ten observed variables (CON1, CON2, CON3, CON4, CON5, CON6, CON7, CON8, CON9, and CON10) which indicate the latent variable of conditional knowledge of angles and polygons. The model was tested and three covariance terms were added to SIMPLIS syntax in order to improve the model considering the modification indices with the highest values. The final SIMPLIS syntax for the CFA of the model is given in Appendix C. LISREL estimates of parameters in ConKT model with coefficients in standardized value and t-values are given in Table 3.7 and Appendix D. The maximum likelihood estimations appeared between .74 and .88 and all t values were significant at $p < .05$. This showed that the factor loadings of each item on the related dimension were at a reasonable size to define ConKT.

Table 3.7 Maximum Likelihood Estimates and t Values of Confirmatory Factor Analysis of ConKT

Item no	ConKT
1	.74 (13.68)
2	.74 (13.59)
3	.84 (16.36)
4	.81 (15.49)
5	.75 (14.03)
6	.87 (17.39)
7	.77 (14.37)
8	.88 (17.61)
9	.78 (14.64)
10	.80 (15.30)

* t values are given in parentheses

Fit statistics of squared multiple correlation (R^2) that equal the proportion of explained variance were displayed in the LISREL output. The values of R^2 for ConKT were presented in Table 3.8.

Table 3.8 Squared Multiple Correlations for ConKT

Observed Variables	R^2
CON1	.55
CON2	.54
CON3	.70
CON4	.65
CON5	.57
CON6	.75
CON7	.59
CON8	.77
CON9	.60
CON10	.64

ConKT was evaluated in terms of the goodness-of-fit-indices which were discussed in detail in section 3.3.1.2. The values of the goodness-of-fit criteria of the model for ConKT are represented in Table 3.9. The model for ConKT demonstrated a significant Chi-Square value of $\chi^2 = 64.00$ with degrees of freedom, df = 31, at a significance level $p < .001$. As known, χ^2 is sensible to sample size. In this sense, this criterion indicates a significant probability level when the sample size increases, generally above 200 (Kelloway, 1998). The sample size in this study was 259, which was large enough to make the test statistically significant. The value of the NC was 2.06 that indicated a good fit to the data with its being less than 5.

The Goodness-of-Fit Index (GFI), the Adjusted Goodness-of-Fit Index (AGFI) and the Comparative Fit Index (CFI) of the model for ConKT was 0.95, 0.92 and .90, respectively. All of those values were higher than 0.90 that indicated a good fit to the data. The Root- Mean-Square Residual (RMR) value of the model was 0.13. It did not support data because it was higher than 0.05.The Standardized-RMR value of the model was equal to 0.024. Since, it was lower than 0.05, it indicated a good fit to the data. The value of Root-Mean-Squared Error of Approximation (RMSEA) of the model was 0.064, which was less than 0.10, indicating a good fit to the data. Additionally, RMSEA of the model was demonstrated to be in the 90 percent confidence interval for RMSEA, which was from 0.042 to 0.087.

Table 3.9 Goodness of Fit Indices of the One Factor Model for ConKT

Fit Index	Value
Chi-Square (χ^2)	64.00 (p= 0.00044)
Normed Chi-Square (NC)	2.06
Root Mean Square Error of Approximation (RMSEA)	0.064
Root Mean Square Residual (RMR)	0.13
Standardized Root Mean Square Residual (S-RMR)	0.024
Goodness of Fit Index (GFI)	0.95
Adjusted Goodness of Fit Index (AGFI)	0.92
Comparative Fit Index (CFI)	0.99

As a result, although RMR was higher than .05 and the relation yielded a significant χ^2, all other fit indices (NC, RMSEA, S-RMR, GFI, AGFI, and CFI) showed a good fit (see Table 3.9). Moreover, the factor loadings of each item on the related dimension were at a reasonable size to define ConKT. As a result, confirmatory factor analysis supported the one-factor solution that emerged from the exploratory factor analysis in the first phase.

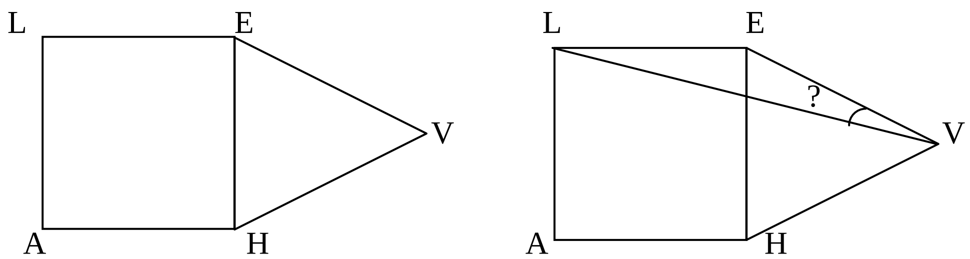
Results of factor structure analysis of ConKT were generally favorable with regard to the validity of scores. Both exploratory and confirmatory factor analysis data yielded Cronbach alpha reliability coefficients of .91 and .93, respectively, which indicate high reliability.

3.3.1.2.2 Procedural Knowledge Test

The Procedural Knowledge Test (ProKT) comprises 14 open-ended questions on angles and polygons, which were prepared to have a deeper understanding of students' computation and application processes (see Appendix E). Questions are posed in the real life context as the focus of the project-based learning is on real life situations. Objectives of the questions are to apply- (1) angles when a line intersects two parallel lines at two different points, (2) the measure of interior angles of a triangle and a rectangle, (3) the measure of interior and exterior angles of a triangle, a pentagon, and a hexagon, (4) the measure of one of the interior angles of a regular octagon, (5) the number of sides of a regular polygon when one of the measures of the interior angle is given, and (6) the side and angle properties of equilateral triangles, parallelograms, rhombi, squares, trapezoids, similar triangles and similar rectangles. The possible scores of the ProKT range from 0 to 56.

Draft form of the ProKT was piloted on 120 eight grade students for EFA for construct validity of ProKT. As emphasized in section 3.3.1.2, ProKT questions were scored based on the rubric developed by Lane (1993). If we want to give a specific example, grading responses for question 12, which aims to apply angles and side properties of a square, an equilateral triangle, and an isosceles triangle in a real life situation, was discussed.

Question 12:



The above signboard consists of LEHA square and EVH equilateral triangle. What is the measure of EVL angle?

If a student attempted no answer, copied a part of the problem without a solution or used completely irrelevant information, he/she got 0 score. If a student reflected just some angle and side properties of a square and an equilateral triangle but then used an inappropriate strategy for solving the problem or the solution process was missing, he/she got 1 point. If a student gave incomplete solution but made significant progress towards completion of the problem and could not see that LEV is an isosceles triangle, he/she got 2 points. If a student executed algorithms, recognized that LEV is an isosceles triangle, used angle and side properties of a square, an equilateral triangle, and an isosceles triangle, computations were generally correct but may contain minor errors, the solution process is nearly complete but could not find measure of EVL angle, he/she got 3 points. If he/she found the measure of EVL angle by executing algorithm and rules and giving evidence of a solution process systematically, completely and correctly, he/she got 4 points.

Upon the completion of grading by the researcher, one mathematics teacher, a doctorate student in educational sciences at the same time, scored randomly selected 50 tests. Inter-rater reliability coefficient by means of intra-class correlation (ICC) was computed in order to establish the extent of consensus on the use of the scoring rubric for each of the tests. The ICC value of the ProKT was 0.96, which indicated high reliability and internal consistency of scoring rubric as used by two raters.

For EFA, 14 questions of the ProKT were subjected to PCA. Prior to performing PCA, the suitability of data for EFA was assessed. All of inter-item correlations of those questions of the ProKT were .3 or above (see Table 3.10). The results of a KMO measure of .94 and a statistically significant BTS measure of 11132.16 ($p < .001$, $df = 91$) allowed us to conduct PCA. Subsequent investigations demonstrated the presence of one factor with eigenvalues exceeding 1, explaining 59.40 % of the variance. Table 3.11 presents the eigenvalue, percentage of variance explained by factor and factor loadings for component matrix along with communalities of the questions of Procedural Knowledge Test.

Table 3.10 Correlations Between ProKT Questions

	PRO1	PRO2	PRO3	PRO4	PRO5	PRO6	PRO7	PRO8	PRO9	PRO10	PRO11	PRO12	PRO13	PRO14
PRO1	1.0													
PRO2	.55	1.0												
PRO3	.50	.49	1.0											
PRO4	.55	.41	.60	1.0										
PRO5	.66	.43	.61	.61	1.0									
PRO6	.60	.57	.61	.58	.63	1.0								
PRO7	.73	.52	.55	.60	.65	.60	1.0							
PRO8	.64	.53	.54	.47	.66	.57	.59	1.0						
PRO9	.55	.57	.48	.45	.51	.65	.50	.55	1.0					
PRO10	.65	.54	.62	.47	.60	.72	.66	.66	.58	1.0				
PRO11	.55	.60	.52	.51	.56	.56	.59	.48	.50	.52	1.0			
PRO12	.60	.52	.52	.51	.56	.62	.55	.58	.64	.55	.51	1.0		
PRO13	.50	.54	.53	.51	.50	.58	.50	.64	.59	.59	.42	.54	1.0	
PRO14	.53	.64	.53	.48	.51	.63	.58	.65	.53	.53	.54	.60	.64	1.0

Table 3.11 Eigenvalue, Percentage of Variance Explained by the Factor, and Factor Loadings for Component Matrix Along With Communalities of the Questions of ProKT

	Component	Procedural Knowledge of Angles and Polygons	
	Eigenvalue	8.32	
	% of Variance	59.40	
Question no	Objectives	Factor loadings	Communalities
6	To apply angles of a triangle and supplementary angles in a real life situation	.83	.69
10	To apply angles and sides of a trapezoid in a real life situation	.81	.65
1	To apply supplementary angles and angles when a line intersects two parallel lines at two different points in a real life situation	.80	.64
7	To apply the measure of angles of a regular octagon in a real life situation	.80	.64
8	To apply one of the measures of the interior angle of a regular polygon to find its the number of sides in a real life situation	.80	.63
5	To apply sum of the measure of the interior angles of a polygon	.79	.62
14	To apply sides of a triangle, similar polygons and proportion in a real life situation	.78	.60
12	To apply angles and sides of a square, an equilateral triangle, and an isosceles triangle in a real life situation	.77	.59
9	To apply angles and sides of a rhombus and an isosceles triangle in a real life situation	.75	.56
13	To apply sides of a rectangle, similar polygons and proportion in a real life situation	.75	.56
3	To apply measure of interior angles of a triangle and a rectangle in a real life situation	.75	.56
2	To apply supplementary angles and angles when a line intersects two parallel lines at two different points in a real life situation	.73	.53
11	To apply angles and sides of a parallelogram, supplementary angles and angles when a line intersects two parallel lines at two different points in a real life situation	.72	.52
4	To apply an exterior and interior angle of a polygon and sum of interior angles of it in a real life situation	.71	.51

The component matrix revealed that four-teen questions constituted one factor and all factor loadings and communality values were above .30, concurrent with the suggestions of (Hair et al., 1995). The inspection of the screeplot revealed a clear break between the first and second factors. Hence, Catell's (1966) scree test showed to retain one factor for subsequent analyses (see Figure 3.2). This was further supported by the results of parallel analysis. To compare the initial eigenvalues obtained in the exploratory factor analysis with the corresponding values of the random eigenvalues, Monte Carlo PCA for Parallel Analysis (Watkins, 2000) was used. The results showed only one factor with eigenvalue of 8.32 exceeding the corresponding values of the random eigenvalues generated for 14 variables, 120 subjects and 100 replications. Therefore, a one-factor solution was selected.

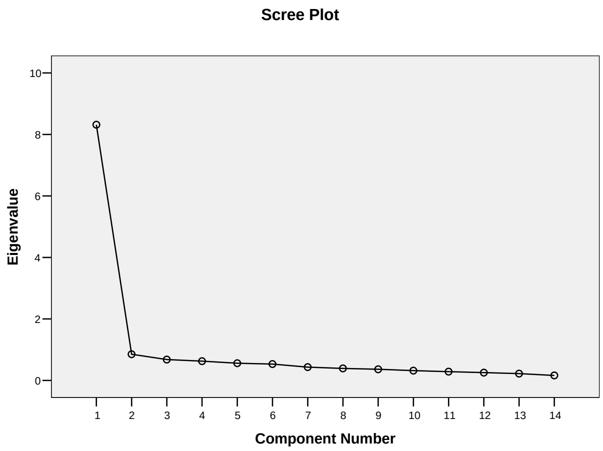


Figure 3.2 Screeplot of ProKT

Regarding the findings of EFA, ProKT was conducted to 192 different eight grade students for CFA to specify four-teen observed variables (PRO1, PRO2, PRO3, PRO4, PRO5, PRO6, PRO7, PRO8, PRO9, PRO10, PRO11, PRO12, PRO13, and PRO14) which indicate the latent variable of procedural knowledge of angles and polygons. The model was tested and twenty-six covariance terms were added to SIMPLIS syntax in order to improve the model considering the modification indices with the highest values. The final SIMPLIS syntax for the CFA of the model is given in Appendix G. LISREL estimates of parameters in ProKT model with coefficients in standardized value and t-values are given in Table 3.12 and Appendix H. The maximum likelihood estimations appeared between 0.80 and 0.97 and all t values were significant at $p < .05$. Table 3.12 presents the standardized estimates and t values for the items of the ProKT. This showed that the factor loadings of each item on the related dimension were at a reasonable size to define ProKT.

Table 3.12 Maximum Likelihood Estimates and t Values of Confirmatory Factor Analysis of ProKT

Item no	ProKT
1	.97 (18.22)
2	.85 (14.74)
3	.82 (13.90)
4	.82 (13.77)
5	.86 (14.84)
6	.91 (16.33)
7	.87 (15.27)
8	.95 (17.58)
9	.88 (15.57)
10	.83 (14.15)
11	.80 (13.34)
12	.90 (16.10)
13	.85 (14.67)
14	.93 (16.95)

* t values are given in parentheses

Fit statistics of squared multiple correlation (R^2) that equal the proportion of explained variance were displayed in the LISREL output. The values of R^2 for ProKT were presented in Table 3.13.

Table 3.13 Squared Multiple Correlations for ProKT

Observed Variables	R^2
PRO1	.93
PRO2	.73
PRO3	.67
PRO4	.67
PRO5	.74
PRO6	.82
PRO7	.76
PRO8	.90
PRO9	.78
PRO10	.69
PRO11	.64
PRO12	.81
PRO13	.72
PRO14	.86

ProKT was evaluated in terms of the goodness-of-fit-indices which were discussed in detail in section 3.3.1.2. The values of the goodness-of-fit criteria of the model for ProKT are represented in Table 3.14. The model for ProKT demonstrated a significant Chi-Square value of $\chi^2 = 125.56$ with degrees of freedom, df = 51, at a significance level $p < .001$. As known, χ^2 is sensible to sample size. In this sense, this criterion indicates a significant probability level when the sample size increases, generally above 200 (Kelloway, 1998). The sample size in this study was 259, which was large enough to make the test statistically significant. The value of the NC was 2.44 that indicated a good fit to the data with its being less than 5.

The Goodness-of-Fit Index (GFI), the Adjusted Goodness-of-Fit Index (AGFI), and the Comparative Fit Index (CFI) of the model for ProKT was 0.91, 0.82, and 0.99, respectively. Although GFI and CFI values were higher than 0.90 that indicated a good fit to the data, AGFI value did not support data. Both of the Root- Mean-Square Residual (RMR) and Standardized RMR values of the model were equal to 0.021. Since, they were lower than 0.05, they indicated a good fit to the data. The value of Root-Mean-Squared Error of Approximation (RMSEA) of the model was 0.087, which was less than 0.10, indicating a good fit to the data. Additionally, RMSEA of the model was demonstrated to be in the 90 percent confidence interval for RMSEA, which was from 0.068 to 0.11.

Table 3.14 Goodness of Fit Indices of the One Factor Model for ProKT

Fit Index	Value
Chi-Square (χ^2)	124.56 (p= 0.00)
Normed Chi-Square (NC)	2.44
Root Mean Square Error of Approximation (RMSEA)	0.087
Root Mean Square Residual (RMR)	0.021
Standardized Root Mean Square Residual (S-RMR)	0.021
Goodness of Fit Index (GFI)	0.91
Adjusted Goodness of Fit Index (AGFI)	0.82
Comparative Fit Index (CFI)	0.99

As a result, although AGFI was little bit lower than 0.90 and the relation yielded a significant χ^2, all other fit indices (NC, RMSEA, RMR, S-RMR, GFI, and CFI) showed a good fit (see Table 3.14). Moreover, the factor loadings of each item on the related dimension were at a reasonable size to define ProKT. As a result, confirmatory factor analysis supported the one-factor solution that emerged from the exploratory factor analysis in the first phase.

Results of factor structure analysis of ProKT were generally favorable with regard to the validity of scores. Both exploratory and confirmatory factor analysis data yielded Cronbach alpha reliability coefficients of .95 and .96, respectively, which indicate high reliability.

3.3.1.3 Active Learning Strategies in and Learning Value of Geometry Questionnaire

Active Learning Strategies in and Learning Value of Geometry Questionnaire (ALSLVGQ) was adapted from the Students' Motivation Toward Science Learning (SMTSL) questionnaire (Tuan et al., 2005; Yılmaz & Huyugüzel-Çavaş, 2007) that measured motivation in six dimensions: Self-efficacy, active learning strategies, science learning value, performance goal, achievement goal, and learning environment stimulation. Of those dimensions, the active learning strategies dimension including 7 items and science learning value dimension with 5 items were taken as a whole questionnaire only changing the word "science" into "geometry" by considering the nature of project-based learning. These two dimensions were taken into consideration in the context of this present study since PBL focuses on students taking an active role in constructing new knowledge derived from their prior understanding and also encourages students to find personal value of what they are doing (Blumenfeld et al., 1991; Frank et al., 2003; Krajcik et al., 1994, 2003; Milner-Bolotin, 2001). Active engagement in learning mathematics and valuing of it are two important factors for ensuring quality for all students (NCTM, 2000).

ALSLVGQ includes statements representing active learning strategies of - (a) attempting to understand new concepts, (b) connecting previous knowledge and experiences with new knowledge, (c) finding relevant resources, (d) discussing with the teacher or the other students, and (e) thinking the reason of mistakes. An example of such items contains: 'During the learning process, I attempt to make connections between the concepts that I learn'. The questionnaire also comprises statements representing learning value of - (a) finding the relevance with daily life, (b) stimulating thinking, (c) acquiring problem solving, (d) experiencing the inquiry activities, and (e) having the opportunity to satisfy their curiosity in geometry. An example of such items of the scale is: 'In geometry, I think it is important to learn to solve problems'. Thus, ALSLVGQ consists of 12 positive items with five-point Likert-type scale. Items on the scale anchor at 1= strongly disagree, 2= disagree; 3= no opinion, 4= agree, 5= strongly agree. The score was the sum of the ratings and the possible scores of the ALSLVGQ range from 12 to 60. Items of the questionnaire are given in Appendix I.

Draft form of the ALSLVGQ including 12 questions was piloted on 188 sixth grade students from a private school for EFA for construct validity of it to understand the underlying structure of them. Principal components analysis (PCA) was carried out for the ALSLVGQ by SPSS 13.0. Prior to performing PCA, the suitability of data for EFA was assessed. Most of inter-item correlations of those items of the ALSLVGQ were above 0.30 (see table 3.15).

Table 3.15 Correlations Between Items of ALSLVGQ

	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12
I1	1.00											
I2	.27	1.00										
I3	.39	.23	1.00									
I4	.39	.24	.33	1.00								
I5	.33	.53	.29	.32	1.00							
I6	.31	.32	.24	.38	.43	1.00						
I7	.35	.25	.35	.39	.51	.38	1.00					
I8	.26	.34	.27	.20	.35	.19	.22	1.00				
I9	.30	.29	.31	.40	.34	.20	.35	.47	1.00			
I10	.33	.30	.24	.21	.26	.29	.22	.40	.50	1.00		
I11	.22	.26	.27	.11	.26	.26	.18	.44	.35	.41	1.00	
I12	.30	.21	.32	.25	.40	.30	.28	.33	.35	.27	.40	1.00

The results of a KMO measure of 0.85 and a statistically significant BTS measure of 632.30 ($p < .001$, $df = 66$) yielded that the data to run PCA was adequate and appropriate. Subsequent investigations demonstrated the presence of two factors with eigenvalues exceeding 1, explaining 37.14 % and 10.74 % of the variance, respectively. The total variance explained by these two factors was 47.87 %. The factor loadings of the first dimension of the items of direct oblimin rotated pattern matrix ranged from .39 to .79. The factor loadings of the second dimension of the items of direct oblimin rotated pattern matrix ranged from .43 to .82. All 12 items had communalities varying from .34 to .58. Therefore, all factor loadings and communality values were above .30, concurrent with the suggestions of Hair et al. (1995). These proposed that all items contributed significantly. Eigenvalues, percentages of variances explained by factors, and factor loadings of pattern matrix and structure matrix along with communalities of the items for the factor analysis of ALSLVGQ were presented in Table 3.16.

Table 3.16 Eigenvalues, Percentages of Variances Explained by Factors, and Factor Loadings of Pattern Matrix and Structure Matrix Along With Communalities of the Items for the Factor Analysis of ALSLVGQ

Components	1		2		
Eigenvalues	4.46		1.29		
% of Variances	37.14		10.74		
	Factor Loadings				
Items	Pattern Matrix	Structure Matrix	Pattern Matrix	Structure Matrix	Communalities
7. Anlamadığım geometri kavramlarıyla karşılaştığımda. yine de bunları anlamak için çaba gösteririm.	**.79**	**.74**	-.11	.27	.56
4. Bir geometri kavramını anlamadığımda. bu kavramı anlayabilmek için öğretmenimle ya da diğer öğrencilerle tartışırım.	**.76**	**.70**	-.13	.23	.51
6. Bir hata yaptığımda. niçin hata yaptığımı bulmaya çalışırım.	**.68**	**.67**	-.02	.30	.45
5. Öğrenme süreci boyunca. öğrendiğim kavramlar arasında bağlantılar kurmaya çalışırım.	**.66**	**.72**	.13	.45	.54
1. Yeni geometri kavramlarını öğrenirken bunları anlamak için çaba gösteririm.	**.59**	**.64**	.10	.38	.41
3. Bir geometri kavramını anlamadığımda bana yardımcı olacak uygun kaynaklar bulurum.	**.50**	**.57**	.16	.39	.35
2. Yeni geometri kavramlarını öğrenirken. bunlarla daha önceki deneyimlerim arasında bağlantılar kurarım.	**.39**	**.52**	.29	.47	.34
11. Geometride araştırmaya yönelik etkinliklere katılmanın önemli olduğunu düşünüyorum.	-.12	.27	**.82**	**.76**	.59
8. Günlük hayatımda kullanabileceğim için geometri öğrenmenin önemli olduğunu düşünüyorum.	-.03	.34	**.78**	**.76**	.58
10. Geometride problem çözmeyi öğrenmenin önemli olduğunu düşünüyorum.	.02	.36	**.72**	**.73**	.53
9. Geometri beni düşünmeye yönelttiği için. geometrinin önemli olduğunu düşünüyorum.	.20	.48	**.61**	**.70**	.52
12. Geometri konularını öğrenirken merakımı giderecek fırsatların olması önemlidir.	.28	.49	**.43**	**.56**	.38

The inspection of screeplot revealed a clear break between the second and third factors, and that first two factors explain the much more of the variance than remaining factors (see Figure 3.3). Hence, it was decided to retain two factors (active learning strategies in geometry and learning value of geometry) for subsequent analyses by using Catell’s (1966) scree test.

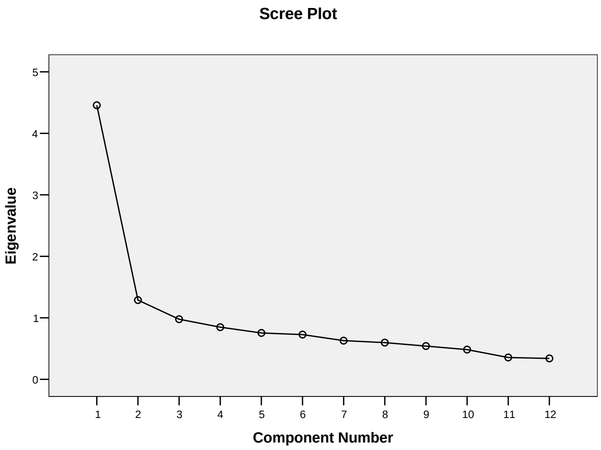


Figure 3.3 Screeplot of ALSLVGQ

This was further checked by the results of parallel analysis. To compare the initial eigenvalues obtained in the first exploratory factor analysis with the corresponding values of the random eigenvalues, Monte Carlo PCA for Parallel Analysis (Watkins, 2000) was used. The results showed only one factor with eigenvalue of 4.66 exceeding the corresponding values of the random eigenvalues generated for 12 variables, 188 subjects and 100 replications. Although the parallel analysis indicated that one factor should be extracted, a second was extracted because its eigenvalue was close to that provided by the second factor extracted from the random data set and the parallel analysis tends to err in the direction of overextraction (O’Connor, 2000).

Regarding the findings of EFA, ALSLVGQ was conducted to 277 different sixth grade students for CFA to specify twelve observed variables (I1, I2, I3, I4, I5, I6, I7, I8, I9, I10, I11, and I12) which indicate three latent variables of active learning strategies in and learning value of geometry. The model was tested and five covariance terms were added to SIMPLIS syntax in order to improve the model considering the modification indices with the highest values. The final SIMPLIS syntax for the CFA of the model is given in Appendix J. LISREL estimates of parameters in ALSLVGQ model with coefficients in standardized value and t-values are given in Table 3.17 and Appendix K. The maximum likelihood estimations of Active Learning Strategies in Geometry Scale (ALSGS) appeared between .60 and .70 and those of Learning Value of Geometry Scale (LVGS) appeared between .59 and .70 and all t values were significant at $p < .05$. This showed that the factor loadings of each item on the related dimension were at a reasonable size to define active learning strategies in and learning value of geometry.

Table 3.17 Maximum Likelihood Estimates and t Values of Confirmatory Factor Analysis of ALSLVGQ

Item no	ALSG	LVG
1	.70 (12.47)	
2	.68 (11.83)	
3	.61 (10.53)	
4	.60 (10.22)	
5	.70 (12.20)	
6	.62 (10.55)	
7	.67 (11.65)	
8		.63 (10.49)
9		.70 (12.05)
10		.63 (10.62)
11		.62 (10.48)
12		.59 (9.78)

* t values are given in parentheses

Fit statistics of squared multiple correlation (R^2) that equal the proportion of explained variance were displayed in the LISREL output. The values of R^2 for ALSLVGQ were presented in Table 3.18.

Table 3.18 Squared Multiple Correlations for ALSLVGQ

Latent Variables	Observed Variables	R^2
ALSG	I1	.49
	I2	.46
	I3	.38
	I4	.36
	I5	.49
	I6	.38
	I7	.45
LVG	I8	.40
	I9	.49
	I10	.39
	I11	.38
	I12	.34

ALSLVGQ was evaluated in terms of the goodness-of-fit-indices which were discussed in detail in section 3.3.1.2. The values of the goodness-of-fit criteria of the model for active learning strategies in and learning value of geometry are represented in Table 3.19. The model demonstrated a significant Chi-Square value of $\chi^2 = 76.10$ with degrees of freedom, df = 48, at a significance level $p < .001$. As known, χ^2 is sensible to sample size. In this sense, this criterion indicates a significant probability level when the sample size increases, generally above 200 (Kelloway, 1998). The sample size in this study was 277, which was large enough to make the test statistically significant. The value of the Normed Chi-Square (NC) in terms of which χ^2/df is displayed, was 1.59 that indicated an overfitting to the data with its being less than 2.

The Goodness-of-Fit Index (GFI), the Adjusted Goodness-of-Fit Index (AGFI), and the Comparative Fit Index (CFI) of the model for ProKT was 0.96, 0.93, and 0.99, respectively. All of those values were higher than 0.90 that indicated a good fit to the data. Although the Root- Mean-Square Residual (RMR) was higher than 0.05, Standardized RMR value of the model was equal to 0.035 and it was lower than 0.05, which indicated a good fit to the data. The value of Root-Mean-Squared Error of Approximation (RMSEA) of the model was 0.046, which was less than 0.10, indicating a good fit to the data. Additionally, RMSEA of the model was demonstrated to be in the 90 percent confidence interval for RMSEA, which was from 0.025 to 0.065.

Table 3.19 Goodness of Fit Indices of the One Factor Model for ALSLVGQ

Fit Index	Value
Chi-Square (χ^2)	76.10 (p= 0.0060)
Normed Chi-Square (NC)	1.59
Root Mean Square Error of Approximation (RMSEA)	0.046
Root Mean Square Residual (RMR)	0.12
Standardized Root Mean Square Residual (S-RMR)	0.035
Goodness of Fit Index (GFI)	0.96
Adjusted Goodness of Fit Index (AGFI)	0.93
Comparative Fit Index (CFI)	0.99

As a result, although the relation yielded a significant χ^2 and RMR was higher than .05, all other fit indices (NC, RMSEA, S-RMR, GFI, AGFI, and CFI) showed a good fit (see Table 3.20). Moreover, the factor loadings of each item on the related dimension were at a reasonable size to define active learning strategies in and learning value of geometry. Thus, confirmatory factor analysis supported the two-factor solution that emerged from the exploratory factor analysis in the first phase.

Results of factor structure analysis were generally favorable with regard to the validity of scores. Both exploratory factor analysis and confirmatory factor analysis data for the entire questionnaire indicated .84 Cronbach alpha reliability estimates, which indicate high reliability. The internal consistency of the two sub-scales of the ALSLVGQ was estimated by the Cronbach alpha coefficient to be generally satisfactory. Those were .78 and .76 for exploratory factor analysis and .78 and .70 for confirmatory factor analysis. The score was the sum of the ratings and the possible scores of the ALSGS range from 7 to 35 and those of the LVGS range from 5 to 25.

3.3.1.4 Geometry Attitude Scale

To determine students' attitudes toward geometry, geometry attitude scale (GAS), developed by Duatepe-Paksu and Ubuz (2007), covering the components of motivation and self-confidence was used (see Appendix L). Seven items representing motivation reflected students' pleasure when dealing with geometry and their eager to continue to think about puzzling ideas outside class. Five items standing for self-confidence involved the behavior of nervousness and tension felt in geometry topics and the students' confidence in their ability to learn and to perform well on examination on geometry. Examples of items related to each component – motivation and self-confidence - include respectively: (a) I do not realize how the time passes when I am studying geometry and (b) I do not feel tension in geometry lessons. This scale consists of 12 Likert type items with five possible alternatives as strongly disagree, disagree, uncertain, agree, and strongly agree. Mainly it included eight indicative and nine contraindicative items. 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. The score was the sum of the ratings. The possible scores of the GAS range from 12 to 60. Both pre and post administration of the GAS generally for the present study yielded Cronbach alpha reliability coefficient of .87, which indicate high reliability.

3.3.1.5 Lesson Plan Evaluation Scale

A lesson plan evaluation scale (see Appendix N) was prepared by the researcher using the criteria (given in section 3.6) to determine to what extent project-based learning was implemented according to the lesson plans. This scale comprises 14 Likert type items with five possible alternatives as strongly disagree, disagree, uncertain, agree, and strongly agree. They were scored as 1, 2, 3, 4 and 5 according to the order of alternatives. Item 1 reflected the driving question, item 2 reflected making investigation, item 3 reflected collaboration of group members, item 4 reflected using technology for both the teacher and the students, item 5 reflected creating an artifact, item 6 reflected authentic assessment, item 7 reflected employing benchmark lessons to supply students with preparatory knowledge for developing an artifact, item 8 reflected the relation of the project with real-life issues, item 9 reflected the students' and teacher's role, item 10 reflected learning by doing, item 11 reflected interdisciplinary opportunities, item 12 reflected making use of higher order thinking skills and the acquired knowledge, item 13 reflected taking students' interest and item 14 reflected orchestration instead of isolation among them.

3.3.2 The Qualitative Data Collection Instruments

In order to gather the qualitative data, two instruments were used in the study: Interview Questions Form and Teacher's Observation Form. Both of them were prepared by the researcher by the help of the advisor. She critiqued and recommended necessary changes to the instruments and the feedback was used to revise organization of the statements and wording of the items.

3.3.2.1 Interview Questions Form

Open-ended interview questions were used in the study (see Appendix P). Exact wording and sequence of questions were determined in advance. They were prepared to get students' having different cognitive styles opinions and experiences of project-based learning in terms of conditional and procedural geometry knowledge acquisition, attitude towards geometry, active learning strategies in, and learning value of geometry. The questions were developed so that students from three different cognitive styles were going to be interviewed at two stage: (a) before artifact development to understand the influence of benchmark lessons and (b) during and upon the creation of the project to see the influence of producing and sharing of the artifact. Interview guide consists of three questions, designed to be asked before development of the artifact, with a focus of assessing the influence of exemplifying geometry concepts from real life on students' procedural knowledge acquisition in, attitude towards, active learning strategies in, and learning value of geometry and utilizing visual tools on their overall and conditional geometry knowledge acquisition. It also includes seven questions to be asked during and after the artifact development which aimed to examine (a) the processes of investigation and choosing polygonal shape of the buildings and (b) the influence of the project on students' overall conditional, and procedural knowledge acquisition in, attitude towards, active learning strategies in, and learning value of geometry. The questions and purpose of assessment are given in detail in Table 3.20.

Table 3.20 Semi-Structured Interview Guide for Analyzing the Learning Process

Time	Interview questions	Purpose of assessment
Before creation of artifact	1. What do you think about demonstrations of some pictures from real life? In what ways?	Assess students' attitude toward exemplifying geometry concepts from real life
	2. What do you think about the usefulness of geometry in other lessons and in real life? In what ways? Prompt: How is geometry useful in other lessons and in real life?	Assess the influence of exemplifying geometry concepts from real life on procedural knowledge acquisition in, active learning strategies in, and learning value of geometry
	3. What do you think about demonstrating some pictures from real life, some concrete materials and using technology are effective in your geometry learning? If yes, in what ways? Prompt: How do they affect your geometry learning?	Assess the influence of utilizing visual tools on students' overall and conditional geometry knowledge acquisition
During and upon creation of artifact	4. How did you make investigation, which references did you find and use?"	Examine the investigation process of the students
	5. How did you place polygons in your project, randomly or purposefully?"	Examine the process of students' choosing polygonal shape of the buildings
	6. Do you like this project? If yes/no, what have you liked/disliked the most? Prompt: Why do you like/dislike?"	Examine students' attitude toward the project
	7. Do you think that you can connect geometrical concepts with each other?" Prompt: If yes, explain how you connect geometrical concepts with each other by giving examples from your project.	Assess the influence of the project on students' conditional geometry knowledge acquisition
	8. Do you think that you can apply geometry concepts in real life? What have you learned? Prompt: If yes, explain how you apply which geometry concepts in real life by giving examples from your project.	Assess the influence of the project on students' procedural geometry knowledge acquisition
	9. Do you like group work? Prompt: Why do you like/dislike group work?	Assess students' attitude toward group work
	10. What difficulties did you face with this project, if any? Prompt: What did you make to overcome those obstacles?	Examine students' reflections about active learning strategies

3.3.2.2 Teacher's Observation Form

Teacher's observation form (see Appendix O) consisting of six main open-ended questions was developed by the researcher to see how project-based learning was implemented in the classroom environment by students having three different cognitive styles and to obtain information about experiences of those three type of students in PBL in terms of five dependent variables of this study by taking into consideration the related literature on the characteristics of them. The first four questions were on the behaviors and reactions of students from three different cognitive groups regarding instructional materials, solving problems, individual and group works, and communication with the teacher and friends. Question five and six reflected how those students show conditional and procedural geometry knowledge, respectively, during benchmark lessons and developing and sharing of the artifact.

3.4 Variables

Four dependent and two independent variables were considered in this study (see Table 3.21). Dependent variables of the study are students' gain scores on the ConKT, ProKT, GAS, ALSGS, and LVGS. The independent variables include between-subject variables and within-subject variables. Time (time1 and time2) was the within-subject factor and cognitive style (FD, FM and FI) was between-subjects factor.

Table 3.21 Variables of the Study

Dependent variables	Independent variables	
Students' gain scores on the ConKT	Within-subject variable	Between-subjects variable
Students' gain scores on the ProKT	Time	Cognitive style
Students' gain scores on the GAS	Time1	FD
Students' gain scores on the ALSGS	Time2	FM
Students' gain scores on the LVGS		FI

3.5 Data Collection Procedures

At the beginning of the study, cognitive styles of the students were tested and they were grouped based on the results from the Group Embedded Figures Test as field dependent, field middle, and field independent and each student was assigned randomly to three or four-member groups, having different cognitive styles, that is, at least one FD, one FM, and one FI student.

The experimental teaching lasted 8 weeks. The teacher explained learning objectives, learning procedures and how to present their artifacts in benchmark lessons to supply them with preparatory knowledge for investigating and preparing their projects. Then, the students worked with their group members to create their artifact. Under the guidance of the teacher, they discussed possible ‘sub-questions’ with their group members and they shared their findings and expressed their own ideas with their group members by making use of the benchmark lessons. After the projects were done, each group manifested and shared the results of their work and process to the class by artifact presentation.

In addition to the GEFT, the other four quantitative instruments (ConKT, ProKT, GAS, and ALSLVGQ) were administered to all cognitive style groups as pre and post test, with an interval of approximately ten weeks between them. During the posttests, only a few students questioned whether they had taken the test before, yet the others did not become aware. ConKT, ProKT, and ALSLVGQ were developed by the researcher and piloted before the study. Details related to the development of these instruments can be seen in sections 3.3.1.2 and 3.3.1.3. The pre-tests were administered prior to the treatment and post-tests were conducted upon the completion of the treatment to examine whether students’ conditional and procedural geometry knowledge acquisition, attitude towards geometry, active learning strategies in geometry, and learning value of geometry improve differentially for students having different cognitive styles in project-based learning.

The time allotted for the administration of each of the ConKT and ProKT was one lesson hour each time. Prior to the administering them, the teacher announced to the students that their scores from these tests would affect their course grade to make them respond questions with serious effort and dedicate the duration to the tests.

The time allotted for conducting the GAS and ALSLVGQ was approximately 5 to 10 minutes each time. Before carrying out them, the teacher declared to the students that their course grade would not be affected from their answers to the items but to reply each item with concentration to show their thoughts.

Qualitative data for this study were gathered by the classroom teacher who is the researcher of this study at the same time because conducting interviews and observations by someone else might have some disadvantages. For example, he/she would not know the characteristics of the students for this study as much as the classroom teacher and students might not feel relaxed when they were observed and interviewed by someone else that they didn’t know. On the other hand, administering them by the classroom teacher had some advantages. For instance, the students behaved naturally in their classroom and the teacher had chance to observe them even during the break. The teacher was not biased to any of the cognitive style groups and the researcher documented all interview answers and observational field notes, even negative ones.

As mentioned earlier, participant observations were used for the study taking into consideration teacher’s observation form (see Appendix O). Whole-class observations were made for each class period. Observational field notes were made of the classroom environment, student-student and teacher-student interactions: how the classroom is structured, what resources were available, what tasks were requirements to students, what value statements were made by the teacher and the students, how students reacted verbally and nonverbally, how certain kinds of questions were answered, how the students made sense of the process, and how they were affected by the method. While collecting data, the nature of students having different cognitive styles, project-based learning, and four dependent variables of this study and the role of the students and the teacher were considered. Observational field notes instead of videotaping were gathered to make the students feel relaxed and behave naturally. While teaching, the teacher took overall notes quickly for everything observed even negative reactions of the students. She wrote them down more in detail after the lesson.

In addition to classroom observations, semi-structured interviews were carried out at two stages: (a) prior to artifact development and (b) during and upon the creation of the project related to the current issues of enactment and to get their opinions and experiences of students with dissimilar cognitive styles in PBL on four dependent variables of the study. Two students from each of the three groups (FD17, FD20, FM20, FM25, FI15, and FI22) were randomly chosen to have the best representative sample to reflect their cognitive style. FD17, FD20, FM20, FM25, FI15, and FI22 got 0, 1, 9, 7, 17, and 18 from the GEFT, respectively. As seen from their GEFT results, FD17 and FD20 are highly field dependent learners and FI15 and FI22 are highly field independent learners. Those six students were interviewed for each interview question. Besides those students, 22 FDs, 31 FMs and 27 FIs were chosen conveniently to ask some of the questions, not all of them, depending on the time limit (see Table 3.22).

Table 3.22 Interview Questions and Interviewed Students

Interview question no	Interviewed students		
	FD	FM	FI
1 and 2	11, 17, 20	14, 20, 25	7,15, 22
3	11, 17, 22	14, 20, 25	3, 7, 15, 20, 22
4	17, 20	2, 14, 20, 25	7, 13, 15, 22
5	16, 17, 20	10, 15, 20, 25	6, 10, 13, 15, 21, 22
6	1, 2, 5, 9, 11, 12, 13, 16, 17, 18, 20, 21, 22, 25, 27, 29, 30	1, 2, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 24, 25, 26, 28, 29, 31, 33, 34	1, 2, 4, 6, 7, 8, 9, 10, 13, 14, 15, 17, 18, 19, 20, 22, 27, 28, 29, 30
7	1, 17, 20	1, 14, 20, 25	1, 10, 15, 22, 30
8	5, 9, 11, 13, 16, 17, 18, 20, 22, 25, 27	1, 2, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 23, 24, 25, 28, 34	1, 2, 6, 7, 9, 10, 13, 14, 15, 17, 19, 20, 22, 27, 28, 29, 30
9	1, 3, 5, 6, 9, 11, 13, 14, 16, 17, 18, 20, 22, 27, 29, 30	1, 2, 4, 5, 8, 9, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 23, 24, 25, 26, 29, 31, 32, 34	2, 3, 6, 7, 9, 10, 12, 13, 14, 15, 16, 17, 19, 20, 21, 22, 23, 24, 27, 28, 30
10	1, 2, 5, 6, 16, 17, 18, 20, 24, 29	1, 2, 4, 8, 11, 13, 15, 20, 21, 25, 26, 30, 34	1, 3, 8, 14, 15, 17, 22, 25

Each interview was conducted individually in an empty classroom during their break times and they were audio-taped. In order to increase the probability of honest responses, the interviewees were informed that they were not graded for their answers and their names and other personal information would be kept confidential and would not be used in anywhere. After the students' explanation, general inquiries were made, such as, "explain," "clarify," or "why" and continue to ask more specific questions, until a response was elicited. This process is repeated for each question in the interviews. The interview tone was amiable and non-threatening, and efforts were made to provide candid responses comfortably. Although interviews were primarily structured, some flexibility was provided by reacting spontaneously to student's explanations to make them clearer. Duration of the interviews varied from 5 to 15 minutes and more than one interview was conducted by the same students different time periods. The researcher wrote a reflective journal for interviews and observations to be aware of issues, biases, and subjectivity.

To sum up, the outline of the main study can be seen from Table 3.23.

Table 3.23 Outline of the Procedure of the Main Study

	Three Groups	Time Schedule
Pretests	Conditional Knowledge Test	11 February 2008
	Procedural Knowledge Test	12 February 2008
	Geometry Attitude Scale	13 February 2008
	Active Learning Strategies in and Learning Value of Geometry Questionnaire	14 February 2008
Treatment	Project-based learning on angles and polygons	10 March – 2 May 2008
Interviews		
Posttest	Conditional Knowledge Test	5 May April 2008
	Procedural Knowledge Test	6 May 2008
	Geometry Attitude Scale	7 May 2008
	Active Learning Strategies in and Learning Value of Geometry Questionnaire	8 April 2008
Interviews		5 May-16 May 2008

3.6 Development of Lesson Plans

In developing the lesson plans, the objectives of the seventh grade geometry suggested by Ministry of National Education (MNE, 2005) were considered to be able to cover each objective. The driving question of 'How is a neighborhood plan designed?' was developed for the subject of angles and polygons in the seventh geometry course as teaching and learning content. Lesson plans were developed by considering the criteria of project-based learning after reviewing the relevant literature (e.g. Beckett, 2002; Blumenfeld et al., 1991, 1994; Carter & Thomas, 1986; Challenge 2000 Multimedia Project, 1999; Chard, 1998; Diffily, 1996, 2003; Erdem, 2002; Erdem & Akkoyunlu, 2002; Helm & Katz, 2001; Katz & Chard, 2000; Kilpatrick, 1918; Krajcik et al., 1994, 1999; Ladewski, Krajcik, & Harvey, 1994; Lundeberg et al., 1997; Marx et al., 1997; Moursund, 1999; Peterson & Thomas, 1986; Reinfried, 1996; Rivet, 2003; Salomon, Perkins, & Globerson, 1991; Stevens, 2000; Tal et al., 2000). The criteria list was as follows: (a) the driving question which integrates interdisciplinary knowledge, reflects real-life issues, takes the students' interest, and makes use of higher order thinking skills and the acquired knowledge; (b) employing benchmark lessons to supply students with preparatory knowledge for developing an artifact; (c) making investigation; (d) using technology for both the teacher and the students (e) collaboration of group members; (f) creating an artifact; (g) authentic assessment; (h) the students' and teacher's role; and (i) orchestration instead of isolation among them.

Eleven lesson plans, four were for benchmark lessons, six were for creating artifact, and one was for presenting artifacts (see Table 3.25) in accordance with the above criteria. Developing a two-dimensional neighborhood plan confronted students with situations related with real life problems and interdisciplinary tasks including mathematics (ratio, proportion, measurement and scale), geometry (angles, polygons), science (plants and green areas), social studies (climate, population, geographic position, economy, industry, etc), art and technology and design (constructing drafts and plans by using protractors and painting plans), religion (religious areas), and Turkish (collaborating on creating artifacts and presenting them and writing a petition). Moreover, teacher's role as a guider was to facilitate exploration, development, imagination, and communication of ideas and concepts. Students are required to be active participants by doing, drawing, researching, measuring, comparing, finding, deciding, discussing, criticizing, imagining, etc. in the process.

Lesson plans and worksheets were formed by the researcher with the help of the advisor. Many modifications were made with her criticisms and suggestions. After establishing the lesson plans and worksheets, one elementary school mathematics teacher, who had an experience of 8 years with teaching mathematics and with project-based learning in geometry, checked the lesson plans in terms of their content, appropriateness of the language used, the grade level of students, and the project-based learning criteria and filled out the lesson plan evaluation scale. She stated that the lesson plans included all criteria of project-based learning. She also pointed out that the students might have difficulty with making meaning of angles and polygons and those lesson plans connecting geometry with their life and making a work related to their desired future occupations would take attention of them and would be helpful for visualizing those concepts. She warned the researcher about investigation stage because the students might not make related research.

The same teacher who checked the lesson plans piloted some of the lesson plans with project-based learning prior to this study on 14 seventh grade students from a private school other than the one used in the main study during the beginning of the second semester of 2007-2008 academic year. The purpose of piloting those lesson plans was to check their applicability in classroom settings, how the classroom settings could be arranged, whether directions given were clear, how classroom management could be accomplished, whether the objectives could be achieved, and whether the lesson plans were attractive to the students. The same mathematics teacher who checked the lesson plans piloted those lesson plans. She grouped the students with three or four students in each group without considering their cognitive styles. She provided the researcher how to use the lesson plans in the classroom effectively. She utilized one of the benchmark lessons including a geometry applet about equal angles when two parallel lines intersect another line and 5 periods making the project. The following conclusions and suggestions were taken in the consideration in order to revise the lesson plans after the pilot study;

• During benchmark lessons, some of the pictures from daily life took lots of time and some of them repeated each other. That’s why eliminate some of them.
• Students had trouble with drafting first the roads or other parts in the neighborhood plan. Students should start first from the roads and than the other parts.
• Students make some mathematical mistakes in the table and teacher needs to give some guidance about the declarative knowledge of angle and sides of polygons.
• Students had trouble with using protractor. Teacher needs to give guidance with using the protractor.

Upon the completion of piloting lesson plans, they were ready to be used (see Appendix M). The aims of each lesson plan are shown in Table 3.24.

Table 3.24 The Aim of the Lesson Plans

# of lesson plan	Time	Aim
1	1x 40’	Introducing the driving question and the project
2	6 x 40’	Presenting the concept of angles among three lines
3	8 x 40’	Presenting the concepts of angles and sides of polygons
4	1 x 40’	Presenting how to collaborate for decision-making and how to use creative thinking skills
5	1 x 40’	Collaborating on the results of their investigations on the driving question and possible sub-questions
6	3 x 40’	Deciding the elements of the neighborhood and the placement of them using social dimension and drawing the draft of the neighborhood plan
7	2 x 40’	Deciding the angle and side measures of the polygons on the plan and in real life
8	3 x 40’	Constructing the plan using social and geometrical dimensions
9	1 x 40’	Checking the projects after teacher feedback
10	2 x 40’	Collaborating the geometrical concepts on the plan
11	2 x 40’	Presenting the artifacts

3.7 Treatment

This experimental study lasted 30 lesson hours (8 weeks) during the second semester of 2007-2008 academic year. Each lesson lasted 40 minutes. In this study, all of the students were conducted project-based learning in mathematics courses. There was no control group.

Project-based learning environment was formed by three main parts: (1) benchmark lessons, (2) creation of artifact, and (3) sharing artifact. The sequence of the treatment is given in Table 3.25. As seen from this table, benchmark lessons lasted 16 hours, developing artifacts went on 12 hours, and 2 hours were allotted to presenting artifacts.

Table 3.25 The Sequence of the Treatment of the Study

Project-based learning with angles and polygons		Lesson	Week
Benchmark lessons	Introducing the driving question and the project	1	1 to 4
	Presenting particular geometrical concepts about angles and polygons	2 to 15	
	Presenting how to collaborate for decision-making and how to use creative thinking skills	16	
Creation of artifacts	Collaborating on the results of their investigations on the driving question and possible sub-questions	17	5 to 7
	Drawing the draft of the neighborhood plan and deciding the angle and side measures of the polygons on the plan	18 and 19	
	Creating artifact (neighborhood plan) using real measurements	20 to 25	
	Checking the projects after teacher feedback	26	
	Collaborating the geometrical concepts on the plan	27 and 28	
Sharing of artifacts	Presenting the artifacts	29 and 30	8

3.7.1 Benchmark Lessons

The purpose of the benchmark lessons for this study was to supply students with preparatory knowledge for developing artifact. At the end of the each of the benchmark lesson, the teacher summarized aim of the lesson both in terms of related geometry concepts and the project. She gave problem solving homework to make the students consolidate the geometry concepts and investigation homework for the next lesson.

During those benchmark lessons, before starting to develop projects, students discussed teacher's questions as a whole class by answering them individually and regular arrangement of the desks was not changed during the benchmark lessons (from 1st lesson to 16th lesson). In other words, students were sitting in the class separately from each of their groups as shown in the figure 3.4.

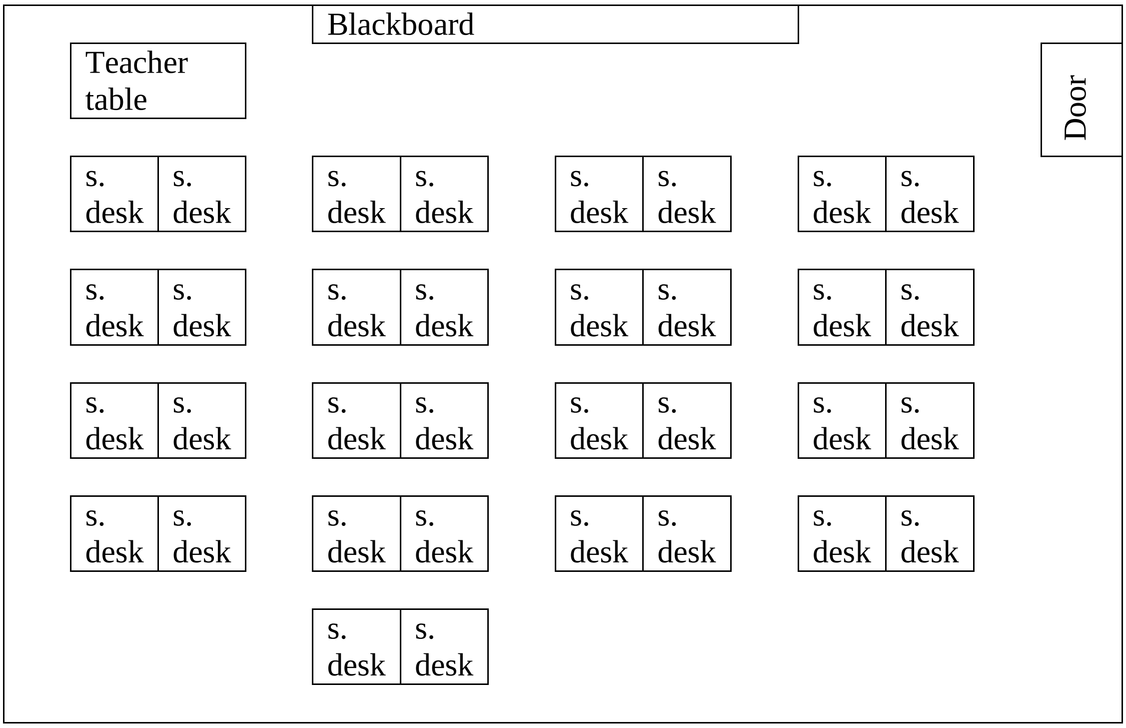


Figure 3.4 The Arrangement of the Classroom in Benchmark Lessons

Students received benchmark lesson to be introduced to the driving question of "how do you design your neighborhood plan?" and the project in the first lesson. The teacher gave a written scenario (project worksheet-1.1) in which they were given a rectangular smooth place and considering the design constraints; they would design a neighborhood as a group of people from different occupations such as engineer, architect, and landscape architect. Some of the design constraints were to (1) design a plan on the white cardboard with the given dimensions; (2) use at least two from each of the isosceles triangles, equilateral triangles, rectangles, squares, parallelograms, rhombi, any other quadrilateral, pentagons, hexagons, regular pentagons, regular hexagons and regular octagons for building grounds; (3) draw roads that (i) intersect at a point, (ii) intersect two by two forming a triangle, (iii) were parallel to each other and (iv) a road intersects two other parallel roads at two different points. The painting of the project was not compulsory. If the group members wanted to paint the plan, they were free to choose colors and types of paint. Some of the other design constraints, such as kinds of buildings which are necessary for residents of a neighborhood and those depending on their wishes and deciding on types of polygons representing those buildings and angle and side measurements of them, would be given after the first group discussion.

The benchmark lesson went on with giving demonstrations of some sample neighborhood plans on acetates to make students understand and visualize the project. The teacher also showed them some bad and mixed neighborhood plans as counter-examples. The teacher asked to explain what they saw in the plans about parts of the plan, the positions of the roads with respect to each other and name of the polygons used in the plans. They told whatever they knew and recognize. Moreover, as an interdisciplinary approach of the project with social studies, students were given investigation homework about the driving question. They were required to make their research individually in three weeks. They were supposed to find a sample neighborhood plan, to investigate people from which occupations were included in a neighborhood plan and what those people did, what were included in a neighborhood plan. They were also needed to decide in what city they wanted to construct a neighborhood and investigate climate of the city, population of the neighborhood and if there were natural, cultural and historical places in the neighborhood… etc. The students were explained about how to make a research on above topics: (i) communicating with knowledgeable individuals such as their neighborhood autonomous, parents or relatives; (ii) using technology such as Internet and (iii) using books and other sources.

After the introduction of the project, the students were given approximately 14 hours of benchmark lessons about geometrical concepts of angles and polygons to create a neighborhood plan. To be more precise, those geometry benchmark lessons were mainly about - (1) angles when two parallel lines are intersected by the third line and (2) angle and side properties polygons, special triangles (isosceles and equilateral triangles), special quadrilaterals (rectangle, square, parallelograms, rhombi, and trapezoids), regular polygons and congruent and similar polygons. The researcher decided to instruct students first on three lines in a plane two draw the roads and then angle and side properties of polygons to draw the ground areas in the plan, respectively. The goals of the benchmark lessons on geometrical concepts were given in Table 3.26.

Table 3.26 Goals of the Benchmark Lessons on Angles and Polygons

Lesson	Goals	Geometry Concept
1	To remind prerequisite knowledge on types of angles (supplementary, complementary, vertically opposite and straight angles and angles at a point)	Three lines in a plane and equal angles when a line intersects two other parallel lines at two different points
2	To describe three lines in a plane	
3	To discover equal angles when a line intersects two other parallel lines at two different points	
4	To discover position of those lines and equal angles on different examples from daily life including sample neighborhood plans	
5	To apply those equal angles	
6	To apply those equal angles	
7	To discover measures of sum of interior angles of a polygon	Angle and side properties of polygons
8	To give examples to usage of polygons in real life and to find measures of exterior angles of a polygon	
9	To describe side and angle properties of regular polygons	
10	To get patterns using regular polygons and to recognize angle and side properties of special quadrilaterals	
11	To describe the relationship between special quadrilaterals	
12	To apply angles and side properties of polygons	
13	To define and use congruent and similar polygons and to describe the relationship between being congruent and similar	
14	To discover polygons, congruent and similar polygons on sample neighborhood plans and to apply congruent and similar polygons	

The benchmark lessons on geometrical concepts included demonstrating pictures from real life and illustrating physical and virtual manipulatives to help the students explore geometrical concepts, to develop geometrical reasoning and to support conceptual understanding. First of all, the teacher demonstrated some pictures from daily life such as pictures of sample neighborhood plans, buildings, bicycles, ornaments, home objects, knot designs, logos and traffic signs, on computer to discover geometrical representations of them on the position of the lines with respect to each other and types of polygons. In addition to those, some pictures were shown from different disciplines such as (i) science: pictures of leaves and flowers, light, reflection, refraction, concave mirrors and parallel linkages to exemplify parallel lines and types of angles; (ii) music: to illustrate parallel and not parallel strings and geometrical shapes of instruments and (iii) art: paintings of some artists who used parallel lines and polygons. Moreover, some pictures were used to exemplify how some people from different occupations, such as designers, building constructers, carpenters, oarsmen, sailors, pilots, architects, meteorologists use those geometry concepts. After discussing geometrical representations of the pictures, the properties of polygons were explained.

Some hands-on materials such as geometry rods, pattern blocks, geo-boards, and tangrams were used to help students visualize the geometry concepts. To be more precise, geometry rods were utilized to show the angle and side properties of polygons and the rigidity of the triangles compared to other polygons; pattern blocks were used to get tessellations of regular polygons; geo-boards were employed to get congruent and similar polygons; and tangrams were used to discuss angle and side properties of polygons.

The students were expected to explore both the relationships among the angles when a line intersected by two other parallel lines by measuring those angles drawn on a paper using a protractor and the formulas to find sum of the measure of the angles of polygons and one of the measure of angles of a regular polygon before they were explicitly stated. The teacher guided the students' thought process by posing a series of guiding questions such as "what is the sum of the measure of the angles of a triangle", "how many triangles can be constructed when the diagonals are drawn from only one edge" and "remember angle properties of regular polygons". After students expressed their findings orally and writing through symbols, the new concept was defined.

Those lessons also comprised consolidating and investigation homework. The students solved problems about angles and polygons, chosen from a daily life context, mostly about designing a plan, to consolidate those geometry concepts. As investigation homework, the students were required to examine some topics such as rigidity of the buildings and the reason for that honeycombs had regular hexagonal shape to help them see application of polygons in real life.

Technology, mainly Internet, was used by students to access information about their investigation homework such as rigidity of the buildings, the reason for that honeycombs had regular hexagonal shape … etc. Moreover, the teacher used computer and acetates to show sample pictures from daily life and sample illustrations using Geometers' Sketchpad, geometry applets and animations to show angle properties when a line intersected by two parallel or not parallel lines and angle and side properties of polygons and the relation among them. To be more precise, the students discussed the relationships among special kinds of quadrilaterals by dragging the figures from their edges as a whole class. For example, they gathered a square by dragging the edges of a rhombus. Therefore, they recognized that every square is a rhombus and explained it orally. As a result of those discussions, they constructed a Venn diagram showing disjoint and intersecting sets and subsets using the sets of parallelograms, rhombi, rectangles, squares and trapezoids. When needed, the teacher reminded prerequisite knowledge of numbers, types of angles, proportion, and first degree equations with one unknown and sets (intersecting and disjoint sets and subsets).

At the end of benchmark lessons on geometrical concepts and before starting artifact development, one more benchmark lesson for decision-making and using their creative thinking skills was given. Students were encouraged to be creative and to develop authentic projects. Benchmark lesson as just-in-time lessons for couple of minutes also went on during development and presentation of artifacts when needed by students such as using the prerequisite knowledge of mathematics concepts of scale, measurements and ratio, using protractor, being creative and collaborating equally in their groups. They will be explained in the artifact development part.

3.7.2 Creation of Artifact

The project-based learning resulted in an artifact, two-dimensional model of neighborhood plan. The purpose of creation of artifacts was to make deepen students' understanding, mainly on the geometrical concepts of angles and polygons, by integrating interdisciplinary knowledge, using complex thought and mirroring real-world issues.

The students worked with their groups having three to four students and at least one of each cognitive style: field dependent, field middle, and field independent. During this stage, arrangement of the desks was changed so that the group members could sit together and discuss their ideas. The arrangement of the desks while they were working with their group members was given in Figure 3.5.

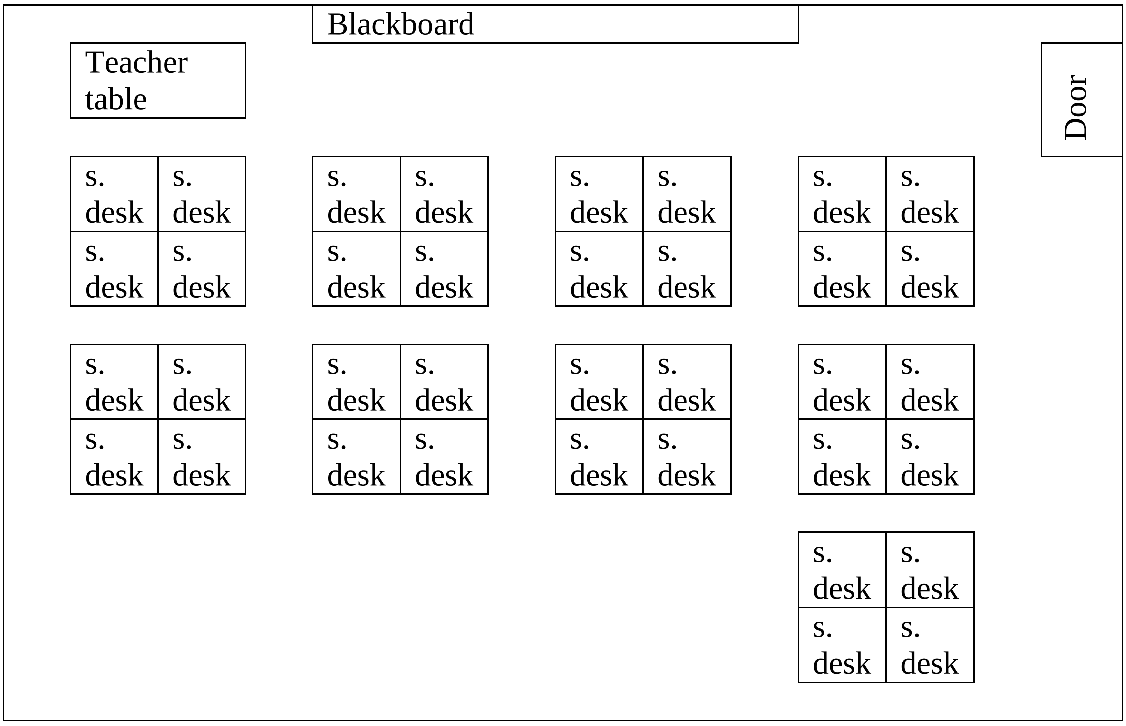


Figure 3.5 The Arrangements of Desks in Group Works

In developing projects, students with their group members collaborated first on the results of their research on the driving question and possible sub-questions. Then, they made the draft of the neighborhood plan on an A4 paper without considering any scale and measurements. In addition the constraints in project worksheet-1 on the parts of the neighborhood, project worksheet-2 was given to the students in which more design constraints existed such as drawing two dimensional representations of schools, village clinic, green areas, etc. Students were free to add to those constraints whatever they wanted. Some of the groups were too slow and wanted to draw the draft in detail like a plan more than needed and the teacher reminded them that were going to draw the plan with respect to real measurements later on and to be careful about the duration of the lesson. While they were drawing their drafts, students couldn't look at their files about their research results in order not to copy whatever they found; instead, they applied in an authentic way whatever they remembered. They collaborated on what real-life issues was the most important for them such as economy, industry, traffic, climate, population, water, plants and green areas, religious areas and the place of the parts on the plan. The projects in general included interdisciplinary approach with (i) social studies while discussing and deciding on real-life issues: economy, industry, climate, population, plants and green areas …etc; (iii) Turkish while presenting and writing a petition; and (iv) art while drawing the drafts and painting the plans. After that, they were required to decide the scale of the plan and using that scale, they completed a table on the side and angle measurements of polygonal representations (isosceles and equilateral triangles, parallelograms, rectangles, squares, rhombi, trapezoids, other quadrilaterals, pentagons, hexagons, and regular pentagons, hexagons and octagons) of the grounds in real life and measurements on the plan. When needed, they used calculators to make calculations. While groups were deciding on angle and side properties of those polygons, they made some changes in their drafts after taking the teacher's approval. When no one could remember such properties in the group, they looked at their notebooks or asked their teacher. She again did not give direct answer but she guided them as "you can ask your group members or look at your notebooks by remembering our benchmark lessons on this topic." When she realized that the groups wrote some impossible measurements, she warned to provide the groups to be aware of that by asking "Isn't it too long for that building to think of a place having such length? Think of that place in real life." This guidance was enough for all of the groups and they found their answers. Afterwards, the teacher examined the tables of the properties of the angle and side properties of polygons and gave feedback to be careful about interior and exterior angles or the number of sides of some polygons. Although some groups did not make any mistake, they were warned to use possible measurements considering real measurements and to use just one couple of equal shape or to finish the table.

Later, students started to draw the two-dimensional plan on a white cardboard with the dimensions of 50 cm by 70 cm, leaving 1 cm from each side, using 30 cm- and 1 m- rulers and protractors. Every material in this project was given to the groups and collected back in each lesson hour to have them make their projects only in the class by themselves. They were advised first to draw the roads and then the ground places. Some groups again used calculator in that stage of the projects. It was very hard for most of the students to draw polygons using protractors because they did not know how to use protractor or even they knew to use it, they had problems on error of measurement. For instance, because of some measurement errors in angles or sides of the polygons, they could not get the real measurement at the last angle or side. Most of them needed the teacher's help and she depicted how to use the protractor to each group. Then, group members showed how to use the protractor to each other and she stated that some simple errors in the measurements could be acceptable in this project. The groups needed to make revisions in their drafts and in the table of measurements. After the students were done with their projects, the teacher checked them and gave feedback to them on the consistency of their measurement table and the measurements on the plan. The feedback included "recheck polygons on your plan, I came up with different measurements than you did for the part of… " and "be sure about the parallel lines by checking equal angles among the roads." After those warnings, the groups improved their plans by checking the measurements.

At the end of creation of artifact phase, they collaborated on the relationship among the geometrical concepts in their plans which included following questions on polygons: Is it possible for calling (i) rectangles in their plans as squares, (ii) parallelograms as rhombi, (iii) trapezoids as parallelograms, (iv) squares as rhombi, (v) equilateral triangles as isosceles triangles, (vi) equal polygons as similar to each other and vice versa for each of them (vii) rectangles as similar, (viii) regular hexagons as similar, (ix) rhombi as regular polygon and (x) rectangle as regular polygon.

The students as a group created their two-dimensional neighborhood plans. They collaborated on how to approach the driving question, what resources to use, what steps to follow. They needed to keep track of the process to see errors and false steps with the help of each others and teacher's feedbacks to improve their work. While collaborating, they consulted the different sources such as using maps and their teachers when they need any help on geometrical concepts, using protractor and the project in general. The students also consulted their teacher when there existed disagreements about the project on where to put what part of the plan, the teacher gave some advises stressing that they would find common answer on that. The teacher carried out benchmark lessons as just-in-time lessons for couple of minutes when needed by students such as using the prerequisite knowledge of scale, measurements, ratio, … etc., using protractor, being creative, participating equally in group discussions, working planned and respecting each other when she saw some conflicts during group discussions . Moreover, during the benchmark lessons, she set clear expectations about the constraints of the project, what and how students were needed to make in every period, to behave in collaborations, to use their creative thinking skills and how to present their projects. In addition, she observed whole class, the groups and the members of the groups in every stage of creating and sharing their artifacts to solve their problems. She participated in the discussions and she was co-learner of the project. She listened to their discussions and their questions about mathematical knowledge, using protractor and the project in general. She guided students by questioning first to understand their opinions, giving feedback to the students when she realized some misconceptions on the mathematical knowledge and on the project, giving demonstrating to use protractor, suggesting alternatives without giving direct answers. The teacher created a collaborative learning environment and warned the members of the groups when she observed that they were not collaborating to each other. When group members were collaborating in a very noisy way, the teacher also reminded them to be careful on that. Throughout projects, she continually made connections to the driving question. When she sensed that students were loosing their interests in the driving question;

she used a benchmark lesson to refocus the students' attention on the goal and value of the project. Besides, she encouraged the students about their work, appreciated and valued each other's work. As a part of authentic assessment, she assessed whole process in addition to the product.

3.7.3 Sharing of Artifact

After the students with their group members created their project, they were required to present it to share their ideas with the other groups and the teacher. As a part of the scenario, each presenter acted as if they were people from different occupations such as an engineer, an architect or a landscape architect who developed the neighborhood plans collaboratively and the teacher acted as if she was an authorized person or a jury from the related municipality. While one group was presenting their project, each of the other groups were sitting together with their group-mates as the same as when producing their artifacts. The presenters as a group were expected to convince the listeners (both the teacher and the other group members) during the four to five minute- presentation on the advantages of their project in terms of attractive appearance of the neighborhood, comfort and safety of the residents and how their project solved some real-life issues such as global warming, drought, air pollution, not having enough green areas, traffic congestion, noise pollution, unplanned urbanization and infrastructure. They also presented why they chose some special position of the roads and some special type of polygons for buildings. Every member of the group was needed to speak in the presentation. They also handed a petition over to the teacher to get permission from the related municipality to apply the project. Some of the groups prepared their presentations using PowerPoint. While one group introducing their neighborhood plan, the other groups listened them carefully and asked some questions to understand the plan and to affect the thought of the teacher.

3.8 Treatment Verification

A mathematics teacher, a doctorate student in educational sciences at the same time who is different from the teachers who conducted the pilot study and the main study, observed three lessons, one lesson from each of the benchmark, artifact development, and sharing artifact parts (lesson plan 3, 8, and 11) and filled out the lesson plan evaluation scale to determine to what extent project-based learning was implemented according to the lesson plans. She graded all three lessons as giving them grade 5. This demonstrated that the implementation by the researcher went as planned. Furthermore, the interview responses of the students were also reckoned as treatment verification.

3.9 Data Analysis

Collected combination of both qualitative and quantitative data were analyzed by utilizing concurrent mixed data analysis, more specifically the parallel mixed analysis model as described by Tashakkori and Teddlie (1998). In this study, both sets of data analyses occurred separately. The quantitative responses were analyzed using descriptive and inferential statistics. The qualitative responses were analyzed using coding and thematic analysis (Bogdan & Biklen, 1992; Tesch, 1990).

In the quantitative part of the study, data included results of Group Embedded Figures Test (GEFT), administered to identify the cognitive styles of each students, and pre- and post results of Conditional Knowledge Test, Procedural Knowledge Test, Geometry Attitude Scale, and Active Learning Strategies in and Learning Value of Geometry Questionnaire. Descriptive statistics comprised of raw scores, percentages, means, medians, standard deviations, skewness and kurtosis to summarize, organize, and simplify the data and to check the assumptions of the inferential statistics. Data analysis for inferential statistics is done by evaluating the results of the tests and scales. Mixed Design (one between factor and one within factor) Multivariate Analysis of Variance (MANOVA) was conducted to examine whether students' conditional and procedural geometry knowledge acquisition, attitude towards geometry, active learning strategies in geometry and learning value of geometry improve for students having different cognitive styles in project-based learning. The independent variables include between-subject variables of time (time1 and time 2) and within-subject variables of cognitive styles (FD, FM, and FI). Statistical analyses are performed at 0.05 significance level using Statistical Package for Social Sciences (SPSS) 13.0.

To gain more insight on the quantitative findings and to give more information about the process as well as product, field notes of participant observation and formal and informal interviews with students included the qualitative data. The qualitative data were transcribed into text and read line by line to get the big picture of them. Then, data coding and grouping were generated considering the data, the nature of project-based learning, field dependence and independence, and four dependent variables of this study (the inductive coding system). It was ongoing processes and recoding and regrouping were conducted whenever necessary. Generally, all types of codes were considered: perspectives of students, students' way of thinking about people and objects, process, activities, strategies and relationships and social structures (Bogdan & Biklen, 1992). Identifying common responses of the students were classified under the same theme. Three main themes were gathered: Influence of contextualizing, visualizing, and collaborating geometry concepts. Each theme was subdivided into three main parts of the treatment of this study: (a) benchmark lessons, (b) creation of artifact, and (c) sharing artifact. Then, the data were analyzed into specific categories of the related task and outcomes pertaining to conditional and procedural geometry knowledge acquisition, attitude towards geometry, active learning strategies in geometry and learning value of geometry for students having three different cognitive styles.

CHAPTER 4

RESULTS

This chapter is divided into two sections. The first section presents quantitative results and the second section deals with qualitative results.

4.1 Quantitative Results

4.1.1 Descriptive Statistics

Descriptive statistics related to students' pretest and posttest scores of ConKT, ProKT, GAS, ALSGS, and LVGS for each of the three groups (FD, FM and FI) are given in Table 4.1.

As shown in Table 4.1, the FD, FM and FI groups showed a mean increase of 23.82, 27.26 and 27.44 from PreConKT to PosConKT; and a mean increase of 38.24, 39.6, and 38.22 from PreProKT to PosProKT, respectively. Similarly, the FD, FM and FI groups showed a mean increase of 9.55, 8.4, and 7.68 from PreGAS to PosGAS, a mean increase of 5.10, 5.05, and 3.07 from PreALSGS to PosALSGS, and a mean increase of 4.29, 3.32, and 2.61 from PreLVGS to PosLVGS, respectively.

Table 4.1 Descriptive Statistics Related to Pretest and Posttest Scores of the ConKT, ProKT, GAS, ALSGS, and LVGS for the FD, FM and FI Groups

	Field Dependent		Field Middle		Field Independent	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Scores on ConKT						
N	31	31	35	35	31	31
Mean	8.12	31.94	8.43	35.69	8.31	35.75
Standard Deviation	4.01	7.20	5.42	3.96	5.20	5.86
Skewness	.36	-.78	.50	-.69	.32	-1.37
Kurtosis	-.27	-.31	-1.02	-.29	-.21	.53
Minimum	1	14	1	26	0	22
Maximum	16	40	19	40	22	40
Scores on ProKT						
N	31	31	35	35	31	31
Mean	4.94	43.18	9.65	49.25	10.03	48.25
Standard Deviation	4.50	11.84	7.04	7.98	7.55	8.16
Skewness	.88	-.75	.92	-1.44	.21	-1.81
Kurtosis	-.22	-.60	.54	1.56	-1.36	3.05
Minimum	0	17	0	25	0	22
Maximum	16	56	28	56	23	56
Scores on GAS						
N	31	31	35	35	31	31
Mean	35.48	45.03	39.00	47.40	38.29	45.97
Standard Deviation	8.27	8.94	8.44	8.47	10.50	9.38
Skewness	-.09	-.20	-.57	-1.16	-.60	-.35
Kurtosis	-.47	-1.04	1.27	1.62	.46	-.72
Minimum	19	29	15	21	11	26
Maximum	53	60	55	60	53	60
Scores on ALSGS						
N	31	31	35	35	31	31
Mean	23.58	28.68	23.46	28.51	24.77	27.84
Standard Deviation	7.40	4.166	6.04	4.579	5.52	5.139
Skewness	-1.09	-.415	-1.01	-.447	-.99	-.241
Kurtosis	1.25	-.385	1.49	-.569	1.27	-1.102
Minimum	2	19	7	19	9	19
Maximum	32	35	33	35	32	35
Scores on LVGS						
N	31	31	35	35	31	31
Mean	15.77	20.06	15.74	19.06	16.68	19.29
Standard Deviation	4.06	3.72	4.20	3.66	4.01	3.64
Skewness	-.11	-.52	-.33	-.32	-.20	-.27
Kurtosis	-.32	.12	-.79	-.77	-.98	-.43
Minimum	7	10	7	11	10	11
Maximum	23	25	22	25	23	25

4.1.2 Inferential Statistics

4.1.2.1 Preliminary Analysis

Since random sampling was not utilized for this study, Multivariate Analysis of Variance (MANOVA) was conducted to investigate whether three cognitive style groups were equal or not according to their pretest scores for five tests as a preliminary analysis. Prior to conducting MANOVA used for comparing the PreConKT, PreProKT, PreGAS and PreALSGS, and PreLVGS for the FD, FM and FI groups, the assumptions of the MANOVA, namely independence of observations, multivariate normality, homogeneity of variance-covariance and absence of multicollinearity were checked.

Independence of observation assumption was met since different groups did not affect from each other when answering the items in the tests used for this study.

Univariate normality was checked through the skewness and kurtosis values of PreDecKT, PreConKT, PreProKT, PreGAS, PreALSGS, and PreLVGS. As seen in Table 4.1, all values were in the acceptable range for a normal distribution.

The homogeneity of covariance matrices was checked by using Box M test. This assumption was satisfied, Box's M = 37.457, $F(30, 27311.813) = 1.152$, $p = .259$ ($p > .05$).

The equality of variance assumption was satisfied by the result of the Levene's test of equality of error variances (Table 4.2). As it is seen from Table 4.2, Levene's test was found to be non-significant for PreConKT, PreGAS, PreALSGS, and PreLVGS and significant for PreProKT. Therefore, while there were not any issues in terms of PreConKT, PreGAS, PreALSGS, and PreLVGS, this assumption was violated for PreProKT but significant result will not cause any problem since the ratio of the largest group size to the smallest group size is less than 1.5 (Hair et al., 1995). Thus, it was assumed that equality of variances assumption was met.

Table 4.2 Levene's Test of Equality of Error Variances for the MANOVA Comparing Pretest Scores

	F	df1	df2	Sig.
PreConKT	2.390	2	94	.097
PreProKT	5.714	2	94	.005
PreGAS	1.145	2	94	.323
PreALSGS	1.473	2	94	.235
PreLVGS	.157	2	94	.855

Since the correlation coefficient between the dependent variables were found to be lower than .80 (Table 4.3), multicollinearity issue was not observed.

Table 4.3 Correlations Between Pretest Scores

	PreConKT	PreProKT	PreGAS	PreALSGS	PreLVGS
PreConKT	1				
PreProKT	.330(*)	1			
PreGAS	.167	.143	1		
PreALSGS	.193	.060	.452(*)	1	
PreLVGS	.106	-.023	.536(*)	.463(*)	1

* Correlation is significant at the 0.05 level (2-tailed).

Table 4.4 presents multivariate test result comparing pretest scores for the three groups. As seen from this table, there was no significant mean difference for PreConKT, PreProKT, PreGAS, PreALSGS, and LVGS of the FD, FM and FI groups at the level p>.05, $F(10, 180) = 1.652$, $p = .084$. It was concluded that three groups were equal according to their conditional and procedural geometry knowledge acquisition, attitude towards geometry, active learning strategies in geometry and learning value of geometry before the treatment. The eta-squared statistics calculated as .08, which indicated large effect size (Cohen 1988 as cited in Pallant, 2007) and showed that if the sample of the study was higher, significant difference could be found.

Table 4.4 Multivariate Test Result Comparing Pretest Scores

Effect	Wilks' Lambda	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Observed Power (a)
Intercept	.038	461.697	5.000	90.000	.000	.962	1.000
GROUP	.839	1.652	10.000	180.000	.095	.084	.783

4.1.2.2 Mixed Design Multivariate Analysis of Variance

A Mixed Design (one between factor and one within factor) Multivariate Analysis of Variance was conducted to test the first research question: Does a project-based learning environment affect conditional and procedural knowledge acqusition in, attitude towards, active learning strategies in geometry and learning value of geometry students in geometry differentially with dissimilar cognitive styles? Prior to the analysis, data were examined in terms of missing values, outliers and assumptions of Mixed Design MANOVA.

4.1.2.2.1 Missing Data Analysis

There were no missing data in all pretests and posttests. When a student was absent during application of any test, the researcher, who was also the class teacher, utilized the test as soon as possible after he/she came back to school. This was main factor in achieving a result with no missing data.

Approximately the same number of students from each of the three cognitive style groups was absent when conducting the tests. For instance, two FDs, one FM and one FI were not present as administering PosProKT. Therefore, it is not considered as limitation of the study.

4.1.2.2.2 Outliers

Since MANOVA is quite sensitive to the outliers, both univariate and multivariate outliers should be checked. Standardized z scores, Cook’s Distance and Leverage values were checked for univariate outliers. Since there were not any cases observed standardized z scores exceeding the range between -3.29 and +3.29, the Cook's Distance values greater than 1 and Leverage values higher than 5 (Tabachnick & Fidell, 2001), no univariate outliers were found. It was concluded that no univariate and multivariate outliers were found and excluded from the data.

4.1.2.2.3 Assumptions of the Mixed Design Multivariate Analysis of Variance

Independency of observations, multivariate normality, homogeneity of variance-covariance matrices between groups and absence of multicollinearity assumptions of Mixed Design MANOVA were checked.

Independency of observations 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. Moreover, there was no significant mean difference for all pretests among the three groups (Table 4.4).

For the normality assumption, skewness and kurtosis values of the scores should be checked. The values between –2 and +2 can be assumed as approximately normal for skewness and kurtosis (Pallant, 2007). As it is seen in Table 4.1, all of the skewness and kurtosis values were in the acceptable range for a normal distribution.

Homogeneity of covariance matrices, that is, the observed covariance matrices of the dependent variables are equal across the groups, was examined through Box's test of equality of covariance matrices. The F-test from Box's test, Box's M = 156.186, $F(110, 23352.538) = 1.203$, $p = .073$, indicated no significance at the level $p > .05$, and this assumption was met.

Equality of variances was tested by using Levene's test of equality of error variances. As it is seen from Table 4.5, Levene's test was found to be non-significant for PreConKT, PreGAS, PosGAS, PreALSGS, PosALSGS, PreLVGS, and PosLVGS at the level $p > .05$, $F(2, 94) = 2.390$, $p = .097$; $F(2, 94) = 1.145$, $p = .323$; $F(2, 94) = .495$, $p = .611$; $F(2, 94) = 1.473$, $p = .235$; $F(2, 94) = 1.104$, $p = .336$; $F(2, 94) = .157$, $p = .855$; $F(2, 94) = .027$, $p = .973$, respectively, and significant for PosConKT, PreProKT, and PosProKT at the level $p < .05$, $F(2, 94) = 5.046$, $p = .008$; $F(2, 94) = 5.714$, $p = .005$; and $F(2, 94) = 5.199$, $p = .007$, respectively. Therefore, while there were not any issues in terms of PreConKT, PreGAS PosGAS, PreALSGS, PosALSGS, PreLVGS, and PosLVGS, this assumption was violated for PosConKT, PreProKT, and PosProKT. However, significant result will not cause any problem since the ratio of the largest group size to the smallest group size is less than 1.5 (Hair et al., 1995). Thus, it was assumed that equality of variances assumption was met.

Table 4.5 Levene's Test of Equality of Error Variances for the Mixed Design MANOVA

	F	df1	df2	Sig.
PreConKT	2.390	2	94	.097
PosConKT	5.046	2	94	.008
PreProKT	5.714	2	94	.005
PosProKT	5.199	2	94	.007
PreGAS	1.145	2	94	.323
PosGAS	.495	2	94	.611
PreALSGS	1.473	2	94	.235
PosALSGS	1.104	2	94	.336
PreLVGS	.157	2	94	.855
PosLVGS	.027	2	94	.973

In order to check the multicollinearity assumption, bivariate correlation between dependent variables were analyzed via Pearson product moment correlation method. Since the correlation coefficient between the dependent variables were found to be lower than .80 (Table 4.6), multicollinearity issue was not observed.

Table 4.6 Correlations Between Dependent Variables

	PosConKT	PosProKT	PosGAS	PosALSGS	PosLVGS
PosConKT	1				
PosProKT	.427(*)	1			
PosGAS	.361(*)	.285(*)	1		
PosALSGS	.188	.212(*)	.334(*)	1	
PosLVGS	.262(*)	.097	.437(*)	.602(*)	1

* Correlation is significant at the 0.05 level (2-tailed).

4.1.2.2.4 Mixed Design Multivariate Analysis of Variance Results

Mixed Design Multivariate Analysis of Variance (MANOVA) was conducted to examine whether students' conditional and procedural knowledge acquisition in, attitude towards, active learning strategies in, and learning value of geometry improve differentially for students having different cognitive styles in a project-based learning environment. The independent variables include between-subject variables and within-subject variables. Time (time1 and time2) was the within-subject factor, cognitive style (FD, FM and FI) was between-subject factor and students' gain scores on ConKT, ProKT, GAS, ALSGS, and LVGS were the dependent variables.

Table 4.7 Multivariate Test Results for the Mixed Design MANOVA

Effect	Wilks' Lambda	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Observed Power(a)
Group	.835	1.695	10.000	180.000	.085	.086	.796
Time	.029	596.237	5.000	90.000	.000	.971	1.000
Time* Group	.867	1.337	10.000	180.000	.214	.069	.671

As shown in Table 4.7, Mixed Design (one between factor and one within factor) MANOVA indicated no significant interaction between time and group, Wilks' λ = .867, $F(10, 180) = 1.337$, $p = .214$, $\eta^2 = .069$, suggesting there was the same change in scores over time from pretests to posttests for three cognitive style groups. There was a substantial main effect of time, Wilks' λ = .029, $F(5, 90) = 596.237$, $p < .001$, $\eta^2 = .971$. The main effect of group was not significant, Wilks' λ = .835, $F(10, 180) = 1.695$, $p = .085$, $\eta^2 = .086$ at the level $p>.05$, suggesting no significant difference in the effectiveness of three types of cognitive styles.

Since there was a significant main effect found for time, in order to test the effect of time on students' pretest and posttest scores on the ConKT, ProKT, GAS, ALSGS, and LVGS, Mixed Design (one within subject factor and one between subject factor) Analysis of Variance (ANOVA) was conducted as follow up tests of

Mixed Design MANOVA. The results of tests of within-subjects contrasts and descriptive statistics for the tests can be seen in Table 4.8 and Table 4.9, respectively.

Table 4.8 Tests of Within-Subjects Contrasts

Source	Measure	time	df	F	Sig.	Partial Eta Squared	Observed Power(a)
TIME	ConKT	Level 1 vs. Level 2	1	1582.895	.000	.944	1.000
	ProKT	Level 1 vs. Level 2	1	1615.637	.000	.945	1.000
	GAS	Level 1 vs. Level 2	1	86.582	.000	.479	1.000
	ALSGS	Level 1 vs. Level 2	1	60.086	.000	.390	1.000
	LVGS	Level 1 vs. Level 2	1	93.352	.000	.498	1.000
Error (TIME)	ConKT	Level 1 vs. Level 2	94				
	ProKT	Level 1 vs. Level 2	94				
	GAS	Level 1 vs. Level 2	94				
	ALSGS	Level 1 vs. Level 2	94				
	LVGS	Level 1 vs. Level 2	94				

Table 4.9 Descriptive Statistics for the Tests

		Mean	N	Standard. Deviation	Std. Error Mean
Pair 1	PosConKT	34.51	97	5.967	.606
	PreConKT	8.29	97	4.886	.496
Pair 2	PosProKT	46.99	97	9.712	.986
	PreProKT	8.27	97	6.854	.696
Pair 3	PosGAS	46.19	97	8.880	.902
	PreGAS	37.65	97	9.132	.927
Pair 4	PosALSGS	28.35	97	4.608	.468
	PreALSGS	23.92	97	6.317	.641
Pair5	PosLVGS	19.45	97	3.663	.372
	PreLVGS	16.05	97	4.078	.414

Table 4.8 and Table 4.9 showed there was a statistically significant increase in ConKT scores from PreConKT (M = 8.29, SD = 4.886) to PosConKT (M = 34.51, SD = 5.967), $F(1, 94) = 1582.895$, $p < .001$, $\eta^2 = .944$. The eta-squared statistics calculated as .94 which indicated large effect size (Cohen 1988 as cited in Pallant, 2007) and 94 % of the gain in conditional geometry knowledge acquisition can be attributed to project-based learning.

Similarly, there was a statistically significant increase in ProKT scores from PreProKT (M = 8.27, SD = 6.854) to PosProKT (M = 46.99, SD = 9.712), F(1, 94) = 1615.637, $p < .001$, , $\eta^2 = .95$. The eta-squared statistics calculated as .95 which indicated large effect size (Cohen, 1988 as cited in Pallant, 2007) and 95 % of the gain in procedural geometry knowledge acquisition can be attributed to PBL.

There was also a statistically significant increase in GAS scores from PreGAS (M = 37.65, SD = 9.132) to PosGAS (M = 46.19, SD = 8.880), $F(1, 94) = 14.887$, $p < 0.001$, , $\eta^2 = .48$. The eta-squared statistics calculated as .48 which indicated large effect size (Cohen, 1988 as cited in Pallant, 2007) and 48 % of the gain in attitude towards geometry can be attributed to PBL.

There was a statistically significant increase in ALSGS scores from PreALSGS (M = 23.92, SD = 6.317) to PosALSGS (M = 28.35, SD = 6.317), $F(1, 94) = 60.086$, $p < .001$. The eta-squared statistics calculated as .39 high indicated large effect size (Cohen, 1988 as cited in Pallant, 2007) and 39 % of the gain in active learning strategies in geometry can be attributed to PBL.

In the same way, there was a statistically significant increase in LVGS scores from PreLVGS (M = 19.45, SD = 3.663) to PosLVGS (M = 16.05, SD = 4.078), $F(1, 94) = 93.352$, $p < .001$. The eta-squared statistics calculated as .50 which indicated large effect size (Cohen, 1988 as cited in Pallant, 2007) and 50 % of the gain in learning value of geometry can be attributed to PBL.

Therefore, the students achieved large learning gains for conditional and procedural knowledge in, attitude towards, active learning strategies in, and learning value of geometry.

4.2 Qualitative Results

In order to determine how a project-based learning environment affects students having dissimilar cognitive styles with respect to conditional and procedural geometry knowledge acquisition, attitude towards geometry, active learning strategies in, and learning value of geometry, their reactions during classroom interactions based on field notes of observations and by means of interview responses were examined in terms of influence of contextualizing, visualizing, and collaborating geometry concepts. The following excerpts from the interview responses and observation field notes can be seen in Turkish in the Appendices S and P, respectively. They can be followed with codes, involving a letter and two letters followed by a number. For example, in the codes INT-FD2 and OBS-FD2, INT and OBS were used to indicate the interview response and observation field note excerpt, respectively, and FD2 indicated the quote of the second field dependent student.

4.2.1 Influence of Contextualizing Geometry Concepts

Students worked contextually in geometry and made connections to geometry and real-life in authentic environments during benchmark lessons and developing and sharing of artifacts as the characteristics of project-based learning.

4.2.1.1 Influence of Contextualizing in Benchmark Lessons

Contextualizing elements in benchmark lessons to supply students with preparatory knowledge for artifact development involved introducing the driving question; exemplifying geometry concepts from real life; and solving geometry problems in a real-life context.

4.2.1.1.1 Influence of Introducing Driving Question

Classroom observations showed that introducing the driving question, ‘how do you design your neighborhood plan’, captured students’ attention and they posed questions to understand whether each group member only make the work of a person having an occupation and whether they can (a) design the neighborhood anywhere such as abroad, (b) make a (three-dimensional) model, (c) use computer programs to design their plans and (d) get information from their relatives or people around them related to their occupations. The teacher explained all of the students’ questions saying, “This project is going to be only two dimensional, not three dimensional. That is to say, you are going to construct birds’ eye views of the neighborhood on a carton. You are free to choose the neighborhood anywhere and to add whatever you want in keeping with the design constraints. Remember that people from different occupations share their knowledge and experiences with each other in real life to create a common product. Like that, you as a whole group are going to produce one artifact in the classroom, not at home. You can benefit from your relatives to get information on their occupation but it is not allowed to have your relative make the project. I am going to see the work of each group member. Don’t worry”.

In addition to asking the above questions to comprehend the driving question, some of them were worried about the difficulty of the project since they had not become accustomed to making such a project. Some of them, especially FIs, were also unhappy with their group members and wanted to change them because they thought that some of them would be given more responsibilities.

> What is that? (OBS-FD10)
>
> This project is too difficult for us, it is many dimensional. (OBS-FI27)

Although many of the students from three cognitive styles could not connect the project with geometrical concepts in the beginning of the project and in spite of some students’ worries about the difficulty of the project, introducing the driving question increased some of their curiosity and some of them showed their excitement in different ways. For example, FM16 and FI20 drew their draft designs immediately and showed them to their teacher with enthusiasm and some groups decided their group leaders straight away after the lesson. Moreover, some of them made connections with their future plans.

> I liked the idea of designing a neighborhood. (OBS-FD12)
>
> It seems very enjoyable (OBS-FM10)
>
> I already want to be an architect so this project is going to be helpful for me. (OBS-FM11)

4.2.1.1.2 Influence of Exemplifying Geometry Concepts from Real-life

After the introduction of the driving question, some real objects such as a matryoshka doll and a ball to play football were demonstrated to help students understand geometrical concepts. Students were also displayed a matryoshka doll, a set of five or more wooden dolls of decreasing sizes placed one inside the other, which provided students intuition of similar figures. They were shown a ball with which football was played and its picture which allowed students to differentiate two and three-dimensions. They explained that there was not any pentagonal or hexagonal shape on the ball but there were those shapes on its picture.

> They (the figures on the ball) are not pentagon or hexagon because they are not on a plane; it (the ball) is not smooth. (OBS-FD16, OBS-FM2 and OBS-FM29)

The teacher also showed some pictures from daily life such as sample neighborhood designs to support students to comprehend the driving question; pictures of leaves, buildings, iron table, reflection and refraction of a light from science to exemplify types of angles; pictures of sample logos, bicycle wheels, flags, spider web, house, mosaics, shelf, stairs, traffics signs, musical instruments, meridians, parking areas, parallel linkages, devices used by pilots, sailors, oarsman, carpenters, and designers, symbols used by meteorologists, etc related to the position of three lines in a plane and equal angles among them; pictures of bicycles and some popular buildings to show the rigidity of triangles; pictures of traffic signs, ornaments, home objects, knot designs, and flowers to represent different types of polygons, especially quadrilaterals; pictures of Turkey taken from different distances in space and those of a person with the same and different sizes and with proportional and non-proportional lengths to help them make sense of similar figures. Most of the students from three cognitive style groups, even the ones who had not participated in the lessons before project-based learning environment such as FD10, FD21, FD24, FM9, FM16, FM31, FI22, FI25, and FI26 raised their hands excitedly to give their opinions and show what they recognized on geometric representations of the pictures.

To give more precise examples, demonstrations and class discussions on the pictures of a traffic sign representing a triangle, a table for a quadrilateral, a ball with which football was played for a pentagon and a hexagon, a frame for a hexagon, and a stop sign for an octagon activated their prior knowledge of the sum of the measure of angles of a triangle and pushed them to discover the sum of the measure of interior angles of polygons with respect to the number of their sides. As another specific example, students were given an illustration of the teacher's own rectangular shaped photograph and proportional and non-proportional photocopies of it with the same and different lengths to allow students to make meaning of concepts of congruent and similar polygons in their minds. Students found the ratio of the sides of two similar photographs by using a ruler and a calculator. They also recognized that the similarity ratio of congruent polygons was 1. Students realized the expression of the person on her face didn't change in two similar photographs but it altered in the photograph having non-proportional sides with the other photographs and that was very amazing for the students and they smiled and laughed. It was interesting to observe that one FD and one FM student realized non-similarity of the rectangles by concentrating on changing the expression on the face of the person and one FI student by recognizing non-proportional sides of them. Those pictures make the students, especially FIs at the beginning; ask some bridging questions to find connections between the concepts. They answered their own questions by thinking about some salient cues such as the person's face and the rectangles' side lengths. This activity helped all types of students learn the conditional knowledge that rectangles might not be similar if their sides were not proportional.

They are not similar because the expression on the face has changed. (OBS-FD1)

You look longer in this photograph; they are not similar. (OBS-FM3)

The sides of those photographs are not proportional and they are not similar. (OBS-FI3)

Are two rectangles similar to each other if we double one side and take half of the other side? (OBS-FI12)

Showing such pictures activated all kinds of students' previous experience in real-world settings and provided them a topic with which to talk about those experiences and to pose additional questions from real life to create a correlation between geometrical and everyday meaning.

(While discussing the pictures representing congruent and similar figures) Are the two pictures of a mountain having the top and side views similar to each other? (OBS-FD2)

I have a set of Matryoshka dolls at home, I can bring them tomorrow if you want. (OBS-FD18)

(While showing pictures of a person, formed by using pieces of a tangram) That resembles the pictures to a person who was wrestling. (OBS-FM2)

That resembles the logo of a bank. (OBS-FM4)

I have never thought of a stop sign being in the shape of an octagon before. (OBS-FM5)

(After showing and experiencing that triangles are the most rigid polygons with the help of geometry rods) Are pyramids more rigid than other buildings because they consisted of triangles? (OBS-FM12)

I like those pictures of instruments because I play them. (OBS-FM17)

(While showing the pictures of snowflakes which represented a regular hexagon) How are snowflakes examined without being melted on a microscope? (OBS-FI4)

(While showing a temple in the shape of a trapezoid) Maya Temple. (OBS-FI6)

> (While discussing the activity of the rigidity of polygons) Triangles are used in the buildings for rigidity. I watched the documentary of the construction of a building in Hong Hong. It was so interesting to me. (OBS-FI28)

Both the classroom observations and interview responses to interview questions 1 and 2 about what they think about demonstrations of some pictures from real life and about the usefulness of geometry in other lessons and in real life, revealed that presenting geometry concepts connecting with elements of daily life; asking their own questions remembering their earlier knowledge and experiences and pursuing solutions to them; and participating in the activities helped all types of students understand why they need to know the concept and when and how to use their knowledge. These situations were meaningful, interesting and enjoyable and they had fun with them. As a result, they had higher active learning strategies, appreciation, and attitude towards learning of geometry concepts. In addition, in this way, they recalled simple facts and rules and make connections among the concepts and learning became less abstract and more connected to their own lives and experiences and they developed usable understandings of geometry concepts. For that reason, the conditional and procedural knowledge levels of all kinds of students were enhanced.

> I could not concentrate on mathematics before since it was too difficult for me. However, examples from real life and discussing them caused me to pay attention. (INT-FD11)
>
> I learned rectangles might be non-similar by remembering your picture on which your face has changed. (INT-FD17)
>
> I connect mathematics with what I see in our life. We were involved in the activities and participated more. I found whether two of your photographs (in the shape of rectangles) were similar using a calculator. That caused me to understand geometry more. (INT-FD20)
>
> We understood more because of being given examples from daily life. (INT-FM14)

I learned geometry is used in buildings. While discussing pictures on buildings, we saw when to use triangles and why we learn triangles. (INT-FM20)

Now, I say that this is related to that geometry subject when I see an object outside. They eased my understanding. (INT-FI7)

I realized that geometry is related to real life because people from different occupations use it. We learned the reasons for everything. That is why we learned better. (INT-FI22)

4.2.1.1.3 Influence of Solving Geometry Problems in a Real-Life Context

In addition to exemplifying geometrical concepts, questions assessing conditional and mostly procedural knowledge situated in a real life context were solved by students. Those questions included the hour-hand and minute-hand of a clock, elbow movements, skiing, seesaw and using scissors for applying types of angles; pictures of traffic signs, home objects, a ball, and any type of design to use representations of polygons and their interior and exterior angles; and designing a plan to utilize three lines in a plane and angles among them, the measures of interior and exterior angles of polygons, regular polygons, congruent and similar polygons. Some of those questions were discussed in the class and some others were given as consolidating homework assignment. Solving everyday life geometry questions activated students' previous experience, as stated in the previous section.

(For the question related to complementary angles which was situated in the context of moving the arms of a person whose arms were broken) I have never thought of angles while moving my arms. (OBS-FD2)

(For the question related to supplementary angles which was situated in the context of skiing) I ski. I haven't thought of skiing and supplementary angles together. (OBS-FM9 and OBS-FM23)

Classroom observations showed that most of the students had difficulty with solving procedural knowledge type of questions at first. "We didn't solve this kind of questions before" said OBS-FD2. To give an example of a difficulty in solving geometry question in a real life context, they had a trouble with solving the question, what is the number of sides of a signboard whose sum of measures of interior angles is 2160 degrees.' To solve it, they remembered their knowledge of finding the measure of the sum of interior angles of a polygon and constructing a proportion. OBS-FM3 and OBS-FM34 related this question with the first question they had just solved and said "We know from the first question that the sum of the measures of interior angles of an octagon is 1080 degrees. So, if twice that is 2160, the number of sides is 16 (two times 8)." They made wrong generalizations. The teacher asked "does the sum of measures of a polygon also double if the number of the sides doubles?" to help them recognize their misconception. OBS-FI6 recalled the knowledge of angles of a triangle and any other polygon with respect to its sides and answered with enthusiasm, "For example, a polygon with three sides has sum of interior angles of 180 degrees. A polygon having four sides has 4 minus 2 times 180, 360 degrees. There is no relation of doubling". The students realized that there was no direct variation between the number of sides of a polygon and the sum of the measures of its interior angles. They also utilized other mathematical concepts such as first degree equations with one unknown to solve the questions. They also started to connect procedural types of questions with other contexts such as angles in any design. Those questions became easier after they were encouraged to utilize their active learning strategies. "Solving such kinds of questions is very good, (because) they remain in my mind longer this way" said OBS-FD2. By answering them more, students had opportunities to engage in thinking and reasoning in discussions, to reflect on their own understanding and to refine their existing knowledge, which helped the three types of students increase conditional and procedural knowledge acquisition.

In addition, solving geometry problems including pictures from real-life showed the features of students having different cognitive styles. For example, a field dependent student (OBS-FD2) could not select a hexagon on a design of wallpaper, in which it was embedded and said "I could not see any hexagon in this picture, where is it?" His desk friend, a field independent student separated the hexagon from the whole design and displayed it to OBS-FD2.

4.2.1.2 Influence of Contextualizing in Artifact Development

Besides benchmark lessons, creating an artifact involved three elements for contextualization in solving the driving question process: investigating, making decisions, and constructing blueprints and plans.

4.2.1.2.1 Influence of Investigation

The students investigated from different sources in order to find a place of a neighborhood. Classroom observations in this process and interview responses to question 4, 'how did you make investigation related to neighborhood design and what references did you find and use?', showed that they investigated from an atlas to gather information on the geographic position of a neighborhood in which they wanted to design their project. Moreover, they found sample plans, sample projects and articles on designing a place, on what people from different occupations do, and on the geographic position, history, population, climate, plants, cultural, natural, and historical places of the neighborhood from the Internet, encyclopedias, and with the help of their relatives. They realized there was much information on designing a place. They prepared a summary on their findings. As a result of their investigations, they discovered meaning through inquiry, they understood the world around them and they realized all details were important in real life. Since they did research from different references, those investigations helped all types of students increase their active learning strategies and value of those inquiry activities. Some of them mentioned their investigation process and the benefits of them as follows:

> I found information from the Internet easily by selecting appropriate keywords. I have learned the duties of a city planner, an architect, an engineer, a landscape architect. We are going to choose black pine (for green areas) because we have learned that it produces more oxygen compared to other types of trees. (INT-FD17)
>
> I searched the web sites you gave us. I did not have any difficulty with that. I saw that one mistake may demolish everything if architects are not careful with their drawings. (INT-FD20)

> We decided what neighborhood to design by looking for the place of it in an atlas. We got information on the geographic position of Edirne and occupations such as architecture and landscape architecture. (INT-FM14)
>
> Our prime minister lives in our neighborhood. That's why finding information on that neighborhood was easy related to climate, geographic position, population, history, cultural places and the parts of that neighborhood. There was lots of information and selecting appropriate information was difficult. My father, older sister and brother are engineers. I got help from them. I found sample plans and information on occupations. I also found newspaper articles from the Internet and I prepared a summary of my findings. (INT-FM25)
>
> I searched the Internet but there was so much information. I found information on what a city planner does, sample plans and the geographic position and population of a place. I also researched in encyclopedias but I could not find any information. (INT-FI7)
>
> I benefited from Internet and Google. I increased my information on engineering, architecture, and constructing a place. (INT-FI22)

4.2.1.2.2 Influence of Making Decisions

Following the investigations, students needed to make decisions on two issues: the social and geometrical dimensions of the project.

4.2.1.2.2.1 Influence of Making Decisions on Social Dimension

The social dimension included four anchoring events or experiences that all students shared, for which students used their findings of investigations, summary of them, and their social studies knowledge which they associated with their previous experiences on their life. The first was deciding on what occupation each member of the group wanted to be, as a result of gathering information from their investigations and in line with their wishes. Classroom observations indicated that students chose to be people from different occupations, mostly different types of engineering and architecture and city planning. Most of the students who wanted to be different types of engineering are FDs and then FIs and FMs, respectively. Generally FMs and then FIs and FDs in order preferred to be architects and city planners. One FD, one FM and two FIs wished to be different ministers. One FI decided be a head doctor and one FM wanted to a lawyer. It was interesting to observe that one FD desired to be a sociologist and another FD selected to be an assistant of an engineer. Groups also decided their group leader. It was observed that approximately half of the group leaders were FMs, a quarter of them were FIs and only three of them were FDs. Only a few groups did not have their group leaders.

The second anchoring event was deciding on a common place in the neighborhood. Different groups decided to design a neighborhood in different places most of them in Turkey and a few abroad. Some of them were in big cities; some others were in small towns. Some of them were in a seaside, on an island, or in the places where industry has been developed. After deciding a place for the neighborhood, groups also discussed population, geographic position, history, cultural and natural beauties, climate, and plants of the neighborhood. They had problems about estimating population of a neighborhood. They also asked other questions related to social studies. Some of the students from three types of students looked at a Turkish map for position of any place they wanted in the class.

> I did not know that they were living in a neighborhood. (OBS-FD4)
>
> Where (what city) does Bodrum belong to? (OBS-FD23)
>
> We investigated places from different cities; we are going to decide on one city. (OBS-FM8)
>
> Is there a steppe climate? (OBS-FM13)
>
> We used our investigations to choose the place of the neighborhood. (OBS-FM15)
>
> What can be the population of a neighborhood, can it be one thousand? (OBS-FM23, OBS-FM35 and OBS-FI1)
>
> Do you know where the stadium of … is? (OBS-FM35)

The third anchoring event was determining elements of the neighborhood considering the current and future needs of inhabitants on health (village clinic, hospital, pharmacy), education (preschool, kindergarten, primary school, high school, university), shopping (supermarket, bazaar, shopping center), entertainment (theatre, cinema, disco), sport (football, volleyball, basketball, tennis, ice-skating areas), recreation (forest, greenness, areas to picnic, park, playgrounds for kids, botany, tea garden, beach, zoo), religion (church, mosque, synagogue), residence (houses), administration (bank, mukhtar's office, fire department, police office, post office, law court), transportation (airport, bicycle routes, bus station, harbor, parking lot, petrol station, roads, taxi rank, train station, subway metro station), eating-out (restaurant, bakery), and other needs (animal shelter, dormitory, rest house, hotel, dormitory, water tank, museum, cemetery, recycling factory, place of a course for women). The most interesting part during observing was they were respectful to people from different religions. For example, they thought to make a church and a synagogue in addition to a mosque. They thought to protect existing historical and cultural places and natural beauties in the neighborhood and restore them if needed. Depending on the position of the neighborhood, some groups thought the development of the neighborhood at industry and tourism.

The fourth anchoring event was determining the placement of those elements in the neighborhood plan. It was observed that some students had trouble with that. For example, when OBS-FM3 said "the police station should be on the side (of the neighborhood)", her group friend OBS-FI6 said "no, it should be in the center to catch up with thieves easily". OBS-FD5 from the same group said "FI6 wants to make a playground for children to close to the road; it should not be like that". Moreover, OBS-FD1 from another group said "we could not agree with where to put this building of a course". They found a common place for the elements of the neighborhood by taking into account the comfort and safety of the residents and attractive appearance of the neighborhood. Classroom observations demonstrated that they thought to construct buildings for shopping, education, and administration in the center of the neighborhood to access them easily by walking from homes. Moreover, they put forest, fire department, and a water tank nearby in case of any fire and village clinic and pharmacy close to each other to acquire a medicine easily. They also paid attention to solve the current issues of global warming, drought, air pollution, not having enough green areas, traffic congestion, noise pollution, unplanned urbanization, and infrastructure. The students also designed that were aesthetically pleasing and architecturally sound neighborhoods.

By means of those anchoring events, all students from three different cognitive style groups realized the world around them by bringing in their personal experience of their own life-especially their neighborhood-by discussing them reasonably. They stated that they learned how to design a place and the reasons behind the places of each element in their neighborhood where they lived. Since they were given freedom about what they wanted to do, they were more involved in developing the project, which increased their active learning strategies and learning value. Here are some examples from students' statements of their decisions from classroom observations on the third and fourth anchoring events:

> We put entertainment places in different regions in the neighborhood for everyone to be close to them. I have learned how to design a place while developing this project (OBS-FD1)
>
> There is a water tank to solve the water problem of the region, a police station close to houses, and a cemetery in case of any need. There are parallel roads to make their appearance proper (OBS-FD2)
>
> We did not change historical places and we did not construct just a mosque for religious buildings. There is a mosque, synagogue, and church since we think that there should be religious freedom. We put a train station to ease the transportation issue. (OBS-FD3)
>
> We wanted people to pay attention to global warming (OBS-FD11)
>
> We tried to make some places, which were used commonly more, bigger and some others, utilized less, smaller (OBS-FD13)
>
> We tried to design green areas as large as possible. (OBS-FD18)
>
> We made the fire department close to green areas so arrival would be easyt in case of fire. We did not change historical places such as a historical church and Greek houses. We placed fish restaurants due to the fact that this region is a touristic place. We put a church thinking that some Greeks might live in the neighborhood. We placed a mosque near the houses. We put some places such as a village clinic, pharmacy, and fire department in the center of the

neighborhood. We put pharmacy near to the village clinic. We made cycle track, not available for other vehicles (OBS-FM1)

I have learned the logic behind the place of the elements (of neighborhood) (OBS-FM3)

We put a water tank because of the water problem, nowadays. (OBS-FM4)

We wanted to have a decent and beautiful neighborhood. We did not want to have too maby concrete roads. (OBS-FM9)

(While developing our project) I tried to remember the places that I went and travelled before. We designed crossing roads by thinking of traffic. (OBS-FM15)

We decided what we need in our neighborhood. To do that, I think our own neighborhood (where my family lives). (OBS-FM20)

I understood why markets, mosques, and some other buildings are close to apartments. Shortly, I have learned city planning (OBS-FM25)

There is infrastructure problem and we gave importance to that issue. We took a great care not to have unplanned urbanization (OBS-FM26)

We paid attention to noise pollution. We made a condition of not having buildings that are too high. (OBS-FM34)

The reason that we chose this neighborhood was its unplanned urbanization. We tried to give importance to the esthetic (appearance of the neighborhood). We gave importance also to industry. There is a hospital, a village clinic, etc to meet the health service needs, the pharmacy and the school are close to each other to find medicine when there is health problem. There are parking areas not to have any parking problem. We placed subway metro-train stations in order to ease transportation. (OBS-FI3)

Having parallel roads provided planned urbanization and decreases traffic and traffic accidents. We gave importance to greenness and we included many green areas in our neighborhood to meet the needs of enough clean air for the people in the city. We put the school near to the apartment complexes. We placed some building such as village clinic and police office in the center of the neighborhood to arrive them easily. (OBS-FI6)

> We used some strategies which we saw in computer games before. For example, there should be enough distance among buildings for soldiers to cross. (OBS-FI12)
>
> This neighborhood became a place where so many people wanted to live. We placed a mosque, the building of social and cultural facilities and a sports center in line with the wishes of people in our neighborhood. We tried to put apartment complexes near to each other. (OBS-FI16)

Both classroom observations and interview responses to question 6 about their thoughts on the reason for their enjoyment of the project revealed that students had fun with feeling a sense of ownership of the project and deciding elements of the neighborhood and placement of them by utilizing their thought, wishes, imagination, and creativity. They also enjoyed acting as people from different occupations do, in particular an architect. They helped all kinds of students' attitude level go up. They mentioned about their thoughts on the reason of their enjoyment as follows:

> I liked the most designing the city because both it becomes funny and we designed the city (the neighborhood) ourselves. For example, there is a disco nearby the rest home (in our design), it was enjoyable for me. We also designed a new place. Everything of the design belongs to us. We put whatever we wanted. Being everything in ourselves' power is very nice. (INT-FD2)
>
> We really liked the project because it is very enjoyable and entertaining and you show your imagination (INT-FD13)
>
> I liked this project since I am interested in and enjoy designing and creating places. I was very interested in imagining myself as an architect and designing a place. (INT-FD27)
>
> I liked it. I had fun doing it and I enjoyed deciding the position of some places. (INT-FM5)
>
> I liked it because I think that our creativity and imagination has developed. (INT-FM9)

I liked this project because you can show your imagination with the project. I think that I placed the elements of the neighborhood in the right places. (INT-FM13)

I liked it because (the project was) entertaining and good. Finding a place was the most interesting part for me. (INT-FM21)

(With her eyes lighting up) I liked the project and it was very pleasant for me because I like to design things very much. (INT-FM24)

(With her eyes lighting up) The reasons of where and how elements were placed attracted my attention (INT-FM25)

I liked the project very much because it was designing a neighborhood only based on our imagination. Generally, it was an easy and entertaining project. (INT-FM29)

I liked the project because we could make whatever we wanted. We decided the place of the elements (of the neighborhood). I liked it the most. (INT-FM31)

Since we envisaged something, I liked it. We planned a neighborhood It was also entertaining for me. (INT-FI1)

I liked the whole project very much. I had the best time when deciding the placement of elements of the neighborhood. (INT-FI13)

It was pleasant to form and design our own neighborhood based on our wishes. I think that we did the design well. (INT-FI14)

I liked it. In my opinion, it was a fun project and we placed the buildings to the proper places. (INT-FI18)

The most interesting part for me was deciding the places of the school, homes, and the shopping center to construct the neighborhood. (INT-FI27)

4.2.1.2.2.2 Influence of Making Decisions on Geometrical Dimension

The geometrical dimension of making decisions comprised three anchoring events. First was deciding positions of roads with respect to each other using positions of three lines in a plane and angles among them. As design constraints, roads should have been drawn according to the following positions: (a) intersecting at a point, (b) intersecting two by two forming a triangle, (c) being parallel to each other, (d) a road intersecting two other non-parallel roads, (e) a road intersecting two other parallel roads at two different points with 90 degrees and other than 90 degrees. The students related those constraints to each other and asked some bridging questions showing that they thought more critically. This event made students relate and utilize positions of three lines in a plane.

> Can parallel roads be vertical (instead of horizontal)? OBS-FM11
>
> Can we draw roads by including more than one constraint at a time? (OBS-FD23, OBS-FM11, OBS-FI1 and OBS-FI10)
>
> We demonstrated (the positions of) three parallel roads and a road which intersects two other parallel roads with 90 degrees at the same time. We already draw a road which is intersected by two other non-parallel roads when we draw roads forming a triangle. Aren't they the same? (OBS-FI1 and OBS-FI10)

The second anchoring event of geometrical dimension in the project development was deciding on polygonal shape of each building. Classroom observations and interview responses to question 5, 'How did you place polygons in your project, randomly or purposefully?' demonstrated that they chose the polygonal shape of the buildings with respect to different criteria. For example, INT-FD16, INT-FD20, INT-FI15 decided to use some polygons such as rectangles for a football field and administration buildings and squares for apartment by remembering their shape in real life. INT-FI6 and INT-FI21 chose some shapes for well appearance and for good architectural style such as apartments in the shape of squares which were symmetrical to each other and a cinema saloon in the shape of hexagon. INT-FI10 and INT-FI15 selected a triangle for small places such as a museum and a bus station. Moreover, INT-FD17, INT-FM10, INT-FM15, INT-FI10, INT-FI13, INT-FI15, and INT-FI21 decided some polygons should have more than three sides to have a larger area and to take some buildings together and nest them such as harbor in the shape of rectangle; an airport in the shape of pentagon; and a hotel, religious buildings, shopping center, and schools in the shape of hexagons. INT-FD16, INT-

FM20, INT-FM25, and INT-FI10 chose trapezoids, parallelograms, and rhombi for buildings which had narrower and wider parts. INT-FI15 and INT-FI21 chose the shapes of a rectangle and an octagon considering the position of the roads. INT-FI21 and INT-FI22 thought also whether the polygon they decided fit into the carton and made changes in the shapes, if not. Deciding on polygonal shape of the buildings helped three types of students increase knowledge of simple facts and rules of identifying polygons.

The third anchoring event of geometrical dimension was deciding interior and exterior angle and side measurements of polygonal shapes of buildings in real life and in the plan considering the scale together. It was observed that they determined the scale of the plan by thinking about the dimensions in the plan (carton), 48 cm by 68 cm, and those in real life, 1200 m by 1700 m. In this stage, students used their prerequisite knowledge on measurements of lengths and changes among them such as changing from meter to centimeter and they found the scale to be 1:2500. Students were given two tables in project worksheet 6.1 to be filled out, which included two from each of the isosceles triangles, equilateral triangles, parallelograms, rectangles, squares, rhombi, trapezoids, any other type of quadrilaterals, regular pentagons, regular hexagons, regular octagons, irregular pentagons having equal sides, and any other irregular hexagons and irregular pentagons for the buildings. In one table, the students decided interior and exterior angle and side measurements of the buildings in real life. In the other table, they decided those of the same buildings in the plan having 1:2500 scale. Students were required to choose only two of those polygons as congruent, not others in order to make them utilize angle and side properties of similar polygons. When they began to work finding measurements on the tables, each group was given a calculator to find the results of the operations easily. Students started to activate their prior knowledge of geometrical facts and relationships pertaining to angle and side properties of above special polygons from the benchmark lessons and anchor and utilize them in order to decide measures of interior and exterior angles and side lengths of the polygons. They looked at their notes of benchmark lessons from their notebooks when none of the group members remembered the related knowledge. Some of the students such as OBS-FD25, OBS-FM14, and OBS-FI14 worked while their notebooks and textbooks were open. They gave meaning to the relations among those concepts by active engagement in completing the table. To do that, they looked at a Venn diagram showing the relationships among special quadrilaterals they had prepared in the benchmark lessons. This event helped all types of learners build their own representations of the concepts of angle and side measurements of polygons.

Classroom observations and interview responses to question 10, ‘What kind of difficulties were you faced with, if any?’ indicated that all kinds of students encountered four main difficulties in computations of finding angle and side measurements of polygons on those two tables. First, they faced a problem related to interior and exterior angle relationships of a polygonal shape of a building on the plan and that in real life. Some of them could not realize that those two polygons are similar and they have congruent angles. For example, OBS-FD29 said, “We must multiply every (angle) measure (of an isosceles triangle) on the plan by 2500 (scale) in order to find (angle) measurement of it in real life.” When she remembered the previous knowledge of the fact that the sum of interior angles of a triangle is always 180 degrees, she understood her mistake and said, “Yes… They (angle measurements of polygons) must be the same (both in the plan and in real life)”. The second difficulty was estimating the lengths of the buildings in real-life. For example, OBS-FD23 asked, “Is the width of this class 25 meter-long? I want to picture how long 25 m is in my mind.” The teacher let her and her group friend OBS-FI25 measure the length of the classroom using a 1 meter ruler and they found it to be approximately 8 meters. In this way, they visualized what an eight meters-length means. Thirdly, the students had difficulty with considering the scale and the lengths of a building both in the plan and in real life and the usability of that length in real life simultaneously. For instance, OBS-FI21 said, “One side of a post office in the plan is 10 cm.” Her mind was challenged when thinking of its dimension as 250 m in real life which was too long for a post office. They as a group wrote down a shorter length for that building. This happened in many groups. Fourth, they had difficulty with time limits. The speed of the groups in deciding all measurements in those two tables was different. Some group-members got stressed because of not finishing the tables and they were rude to their peers. For instance, OBS-FI23 to his group friend OBS-FM25, OBS-FM28 to his group friend OBS-FD24, OBS-FI31 to his group friend OBS-FD29 said some rude expressions like "Take this and finish it in the break".

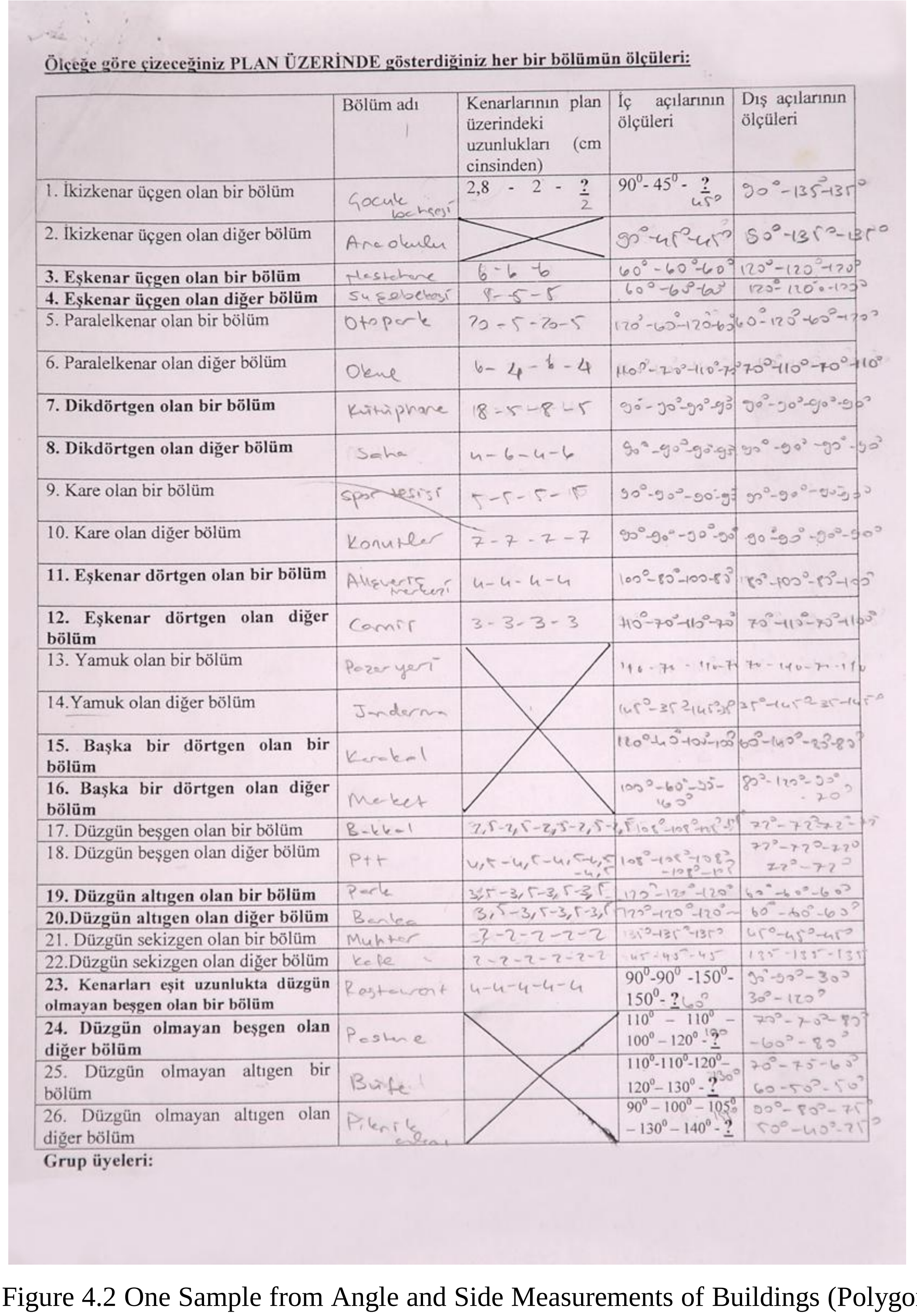
After they were done with those two tables, the teacher checked and found some mistakes with them. For example, even though there was not any geometrical mistake in some of the tables, some groups did not complete some parts in the tables and some groups did not choose any congruent polygons; some others chose congruent polygons more than needed; and some of the lengths of polygons were useless for real life, such as a parallelogram with 20, 5, 20, 5 cm-lengths representing a post office on the 1:2500 scale-plan. In some others, there were some geometrical mistakes: (a) wrong angle or side measures for the polygons such as 2, 2, 3, 1, 1 cm lengths for a irregular pentagon with equal sides; (b) mistake with the number of sides of a polygons such as six interior angles for a trapezoid; and (c) confusion with interior and exterior angles of a polygon such as 60 and 120 degrees for interior and exterior angles of a regular hexagon, respectively. The teacher warned the students by writing guiding expressions. For example, "You haven't decided measurements in this part", "You should complete each part (of the tables)", and "Be careful with the angle and side measurements of that polygon by remembering the related properties." Samples from the students' work on those two tables are given in Figures 4.1 and 4.2. Other examples can be seen in Appendix S.

Taslak Kroki üzerinde gösterdiğiniz her bir bölümün GERÇEK ölçüleri:

	Bölüm adı	Kenarlarının gerçek uzunlukları (m)	İç açılarının ölçüleri	Dış açılarının ölçüleri
1. İkizkenar üçgen olan bir bölüm	Çocuk bahçesi	70 - 50 - 50	90°-45°-45°	90°-135°-135°
2. İkizkenar üçgen olan diğer bölüm	Anaokulu		90°-45°-45°	90°-135°-135°
3. Eşkenar üçgen olan bir bölüm	Hastane	150 - 150-150	60°-60°-60	120°-120°-120°
4. Eşkenar üçgen olan diğer bölüm	Su şebekesi	175-175-175	60°-60°-60°	120°-120°-120°
5. Paralelkenar olan bir bölüm	Otopark	500- 125-500-125	120°-60°-120°-60	60°-120°-60°-120°
6. Paralelkenar olan diğer bölüm	Okul	150 -100-150-100	110°-70°-110°-70	70°-110°-70°-110°
7. Dikdörtgen olan bir bölüm	Kütüphane	200-125-200-125	90°-90°-90°-90°	90°-90°-90°-90°
8. Dikdörtgen olan diğer bölüm	Sah	100 - 150 -100-150	90°-90°-90°-90°	90°-90°-90°-90°
9. Kare olan bir bölüm	Spor tesisi	125 -125-125-125	90°-90°-90°-90°	90°-90°-90°-90°
10. Kare olan diğer bölüm	Konutlar	175-175-175-175	90°-90°-90°-90°	90°-90°-90°-90
11. Eşkenar dörtgen olan bir bölüm	Alışveriş Merkezi	100 - 100-100-100	100-80°-100°-80°	80°-100°-80°-100°
12. Eşkenar dörtgen olan diğer bölüm	Camii	75 - 75 - 75 - 75	110°-70°-110°-70	70°-110°-70°-110°
13. Yamuk olan bir bölüm	Pazar yeri		110 - 70 - 110 - 70	70 - 110-70 -110
14. Yamuk olan diğer bölüm	Jandarma		145°-35°-145°-35	145-35°-145°-35°
15. Başka bir dörtgen olan bir bölüm	karakol		120°-40°-100°-100°	60°-140°-80°-80°
16.Başka bir dörtgen olan diğer bölüm	market		100°-60° -90°-110°	80°-120°-90°-70°
17. Düzgün beşgen olan bir bölüm	Bakkal	67,5-67,5-67,5-	108°-108°-108°	72°-72°-72°-
18. Düzgün beşgen olan diğer bölüm	PTT	112,5- 112,5 -112,5-112,5 -112,5	108°-108°-108 108°-108°	72°-72°-72° 72° 72
19.Düzgün altıgen olan bir bölüm	Park	87,5-87,5-87,5	120°-120°-120°	60°-60°-60°
20. Düzgün altıgen olan diğer bölüm	Banka	87,5-87,5-87,5 87,5-87,5-87,5	120°-120°-120° 120°-120°	60°-60°-60° 60°-60°
21. Düzgün sekizgen olan bir bölüm	Muhtar	50-50- 50-50	135°-135°-135°	45°-45°-45°
22. Düzgün sekizgen olan diğer bölüm	Kafe	50 - 50 - 50 - 50 50 - 50 - 50	45 - 45 -45 45 - 45 - 45	135 - 135- 135 135 - 135
23. Kenarları eşit uzunlukta düzgün olmayan beşgen olan bir bölüm	Restaurant	100-100-100- 100 - 100	90°-90°-150° 150°-60°	90°-90°-30° 30°-120°
24.Düzgün olmayan beşgen olan diğer bölüm	Postahane		110°-110°-100° 120°-100°	70°-70°-80 -60°-80°
25.Düzgün olmayan altıgen bir bölüm	Büfe		110°-110°-110° 120°-130°	70°-70°-60° 60°-70°-50°
26.Düzgün olmayan altıgen olan diğer bölüm	Piknik alanı		90°-100°-105° -130°-140°	90°-80°-75° 50°-40°-85°

Not: Yukarıdaki sadece iki çokgeni birbirine eş seçin. Diğer çokgenlerin kenar uzunlukları birbirinden farklı olsun.

Figure 4.1 One Sample from Angle and Side Measurements of Buildings (Polygons) in Real Life


Ölçeğe göre çizeceğiniz PLAN ÜZERİNDE gösterdiğiniz her bir bölümün ölçüleri:

	Bölüm adı	Kenarlarının plan üzerindeki uzunlukları (cm cinsinden)	İç açılarının ölçüleri	Dış açılarının ölçüleri
1. İkizkenar üçgen olan bir bölüm	Çocuk bahçesi	2,8 - 2 - ? 2	90° - 45° - ? 45°	90° - 135 - 135°
2. İkizkenar üçgen olan diğer bölüm	Anaokulu		90° - 45° - 45°	90° - 135° - 135°
3. Eşkenar üçgen olan bir bölüm	Hastahane	6 - 6 - 6	60° - 60° - 60°	120° - 120° - 120°
4. Eşkenar üçgen olan diğer bölüm	Su şebekesi	5 - 5 - 5	60° - 60° - 60°	120° - 120° - 120°
5. Paralelkenar olan bir bölüm	Otopark	20 - 5 - 20 - 5	120° - 60° - 120° - 60°	60° - 120° - 60° - 120°
6. Paralelkenar olan diğer bölüm	Okul	6 - 4 - 6 - 4	110° - 70° - 110° - 70°	70° - 110° - 70° - 110°
7. Dikdörtgen olan bir bölüm	Kütüphane	8 - 5 - 8 - 5	90° - 90° - 90° - 90°	90° - 90° - 90° - 90°
8. Dikdörtgen olan diğer bölüm	Saha	4 - 6 - 4 - 6	90° - 90° - 90° - 90°	90° - 90° - 90° - 90°
9. Kare olan bir bölüm	Spor tesisi	5 - 5 - 5 - 5	90° - 90° - 90° - 90°	90° - 90° - 90° - 90°
10. Kare olan diğer bölüm	Konutlar	7 - 7 - 7 - 7	90° - 90° - 90° - 90°	90° - 90° - 90° - 90°
11. Eşkenar dörtgen olan bir bölüm	Alışveriş merkezi	4 - 4 - 4 - 4	100° - 80° - 100 - 80°	80° - 100° - 80° - 100°
12. Eşkenar dörtgen olan diğer bölüm	Camii	3 - 3 - 3 - 3	110° - 70° - 110° - 70°	70° - 110° - 70° - 110°
13. Yamuk olan bir bölüm	Pazar yeri		110 - 70 - 110 - 70	70 - 110 - 70 - 110
14. Yamuk olan diğer bölüm	Jandarma		145° - 35° - 145° - 35°	35° - 145° - 35° - 145°
15. Başka bir dörtgen olan bir bölüm	Karakol		120° - 40° - 100° - 100°	60° - 140° - 80° - 80°
16. Başka bir dörtgen olan diğer bölüm	Market		100° - 60° - 90° - 110°	80° - 120° - 90° - 70°
17. Düzgün beşgen olan bir bölüm	Bakkal	2,5 - 2,5 - 2,5 - 2,5 - 2,5	108° - 108° - 108° - ...	72° - 72° - 72° - 72°
18. Düzgün beşgen olan diğer bölüm	Ptt	4,5 - 4,5 - 4,5 - 4,5 - 4,5	108° - 108° - 108° - 108° - 108°	72° - 72° - 72° 72° - 72°
19. Düzgün altıgen olan bir bölüm	Park	3,5 - 3,5 - 3,5 - 3,5	120° - 120° - 120°	60° - 60° - 60°
20.Düzgün altıgen olan diğer bölüm	Banka	3,5 - 3,5 - 3,5 - 3,5	120° - 120° - 120° -	60° - 60° - 60°
21. Düzgün sekizgen olan bir bölüm	Muhtar	2 - 2 - 2 - 2 - 2	135° - 135° - 135°	45° - 45° - 45°
22.Düzgün sekizgen olan diğer bölüm	Kafe	2 - 2 - 2 - 2 - 2 - 2	45 - 45 - 45	135 - 135 - 135
23. Kenarları eşit uzunlukta düzgün olmayan beşgen olan bir bölüm	Restorant	4 - 4 - 4 - 4 - 4	90^0-90^0 -150^0- 150^0- ? 60°	90° - 90° - 30° 30° - 120°
24. Düzgün olmayan beşgen olan diğer bölüm	Pastane		110^0 – 110^0 – 100^0 – 120^0 - ? 100°	70° - 70° - 80° - 60° - 80°
25. Düzgün olmayan altıgen bir bölüm	Büfe		110^0-110^0-120^0– 120^0– 130^0 - ? 130°	70° - 75 - 60° 60 - 50° - 50°
26. Düzgün olmayan altıgen olan diğer bölüm	Piknik alanı		90^0 – 100^0 – 105^0 – 130^0 – 140^0 - ? 155°	90° - 80° - 75° 50° - 40° - 25°

Grup üyeleri:

Figure 4.2 One Sample from Angle and Side Measurements of Buildings (Polygons) in the Plan

The fourth anchoring event of geometrical dimension was deciding the width and length of the roads on the plan. The teacher asked the students to find the width of a road on the plan in terms of cm whose width was 10 m in real life. They found it as 0.4 cm using the scale. Then, the teacher advised them to decide to have roads whose width was approximately 0.5 cm-long in the plan. The above discussion was not enough for some students to make sense of it and they found 0.5 cm too small for the width of the road on the plan. Then, the teacher asked them to compare it with the length of any building such as a post office having 4 cm length they found in the third anchoring event to help them see viability of that width in real life. In addition to width, they also have to decide the length of a road on the plan. It was so interesting to observe that they developed their own strategies in this stage. They measured the length of A4 paper and that of the carton, used for their blueprints and plans, respectively. They got a ratio between those two lengths and constructed a proportion to find the length of the road on the carton. They asked for a calculator to find the results of operations they discovered.

> We found the ratio of 7 to 3 (between the lengths of A4 paper and the road) in our blueprint. We magnified and constructed the road on the plan in the same ratio of seven to three (between the lengths of the carton and the road). (OBS-FM21)
>
> If the length of A4 paper is 28 cm and that of the road on it is 7.5 cm, what would be the length of the road on the plan if that of the carton is 68 cm? (OBS-FI15)

Classroom observations revealed that after making decisions on geometric dimension and although some of them were very upset at first with the difficulty of the project, they smiled and joined the activity well after they understood the driving question and the project more in detail. In addition, interview responses to question 6, "Did you like the project, why?" illustrated that making decisions on geometric dimension was more enjoyable for all types of students. Some students such as INT-FD5, INT-FD11, INT-FD27, INT-FM1, INT-FM19, INT-FM23, and INT-FM28 had fun with using geometry concepts and learning how geometry is utilized in real life. INT-FD13, INT-FD17, INT-FM4, INT-FM13, INT-FM15, INT-FM22, INT-FM24, INT-FI1, INT-FI4, INT-FI6, INT-FI10, INT-FI13, INT-FI19, INT-FI20 and INT-FI27 thought the project is interesting because it is different from other projects that they used to as solving just ordinary questions. Designing neighborhoods had varied elements such as deciding polygonal shape of the buildings, computing angle and side measurements of the polygons in the plan and in real life using calculators and designing and producing a neighborhood plan by thinking, combining their imagination with mathematics and utilizing geometry concepts. In addition to above reasons, interview responses of some FMs and FIs (INT-FM14, INT-FI10, INT-FI13 and INT-FI30) showed that they liked the project because they liked geometry in general. INT-FI10 also wanted to make its three-dimensional model. As a result, although some of the students had some difficulties in the process of deciding geometrical dimensions of the project, they were happy and gained confidence when they overcame those obstacles. Because of those reasons, attitude level of the students with different cognitive styles increased.

> It was hard but we think that we accomplished it. (INT-FM18)
>
> Most of the students generally said, ‘What is that’ at first; we though that there was nothing related to mathematics in the project but then it was beneficial for me. (INT-FI15)
>
> I thought, ‘What is the relationship of this project with mathematics?’ when you first introduced it but I realized its connection later. (INT-FI20)

All types of students participated in challenging tasks and solved the difficulties in a mathematical manner related to (a) positions of the roads, (b) their width and length measurements and (c) angle and side measurements of polygons with the help of their peers and teacher and using a calculator. They also utilized those concepts in their life by connecting them with their previous knowledge and real life experience and by satisfying their curiosity. Those reasons helped all kinds of students increase their active learning strategies and appreciate learning geometry more.

Deciding on the angle and side properties of special polygons (given in Figres 4.1 and 4.2) with the help of peer discussions and teacher guidance enabled them to justify the relationships between (a) the measure of angles and sides of polygons and being a regular polygon, (b) the sum of interior angles of polygons and their number of sides, (c) equilateral triangles and isosceles triangles, and (d) special quadrilaterals. For instance, OBS-FI8 saw on the tables that they wrote down all angle measures of a parallelogram as 90 degrees. She said, “There is a mistake here. Angles of parallelogram can’t be 90 degrees.” Then, the teacher asked her to remember angle properties of a parallelogram. After she told the properties as “It has opposite equal angles”, the teacher posed, “Does a parallelogram have opposite equal angles if it has all 90 degrees?” The student understood that angles of a parallelogram can be 90 degrees, which are the angles of a rectangle at the same time. As a result of those discussions based on imagining those polygons as buildings of the neighborhood boosted conditional knowledge.

Additionally, three types of students utilized interior and exterior angles and sides of an isosceles triangle, an equilateral triangle, a parallelogram, a rhombus, a rectangle, a square, regular and irregular polygons and congruent and similar polygons in the context of neighborhood design. This made them acquire a high level of procedural knowledge.

4.2.1.2.3 Influence of Constructing Blueprints and Plans

While students were working on making decisions on social and geometrical dimension, as mentioned previously, they also constructed their blueprints without taking into consideration the scale and without drawing exact polygonal shapes of the buildings. Students were free to construct any geometrical shape in addition to given polygons in project worksheet 6.1. For example, they added some circles and more number of polygons. There were some observed problems in this stage, too. Some groups started to construct a detailed blueprint more than needed. Some of them wanted to construct two different blueprints by dividing their groups into two sub-groups, having a field independent and field middle pairs and a field independent and field middle pairs in each one. Some of them did not consider some positions of the roads such as roads constituting a triangle. They made some changes in their blueprints after the teacher’s feedback on these points. One sample from the students’ blueprints is given in Figure 4.3. Other examples can be seen in Appendix S.

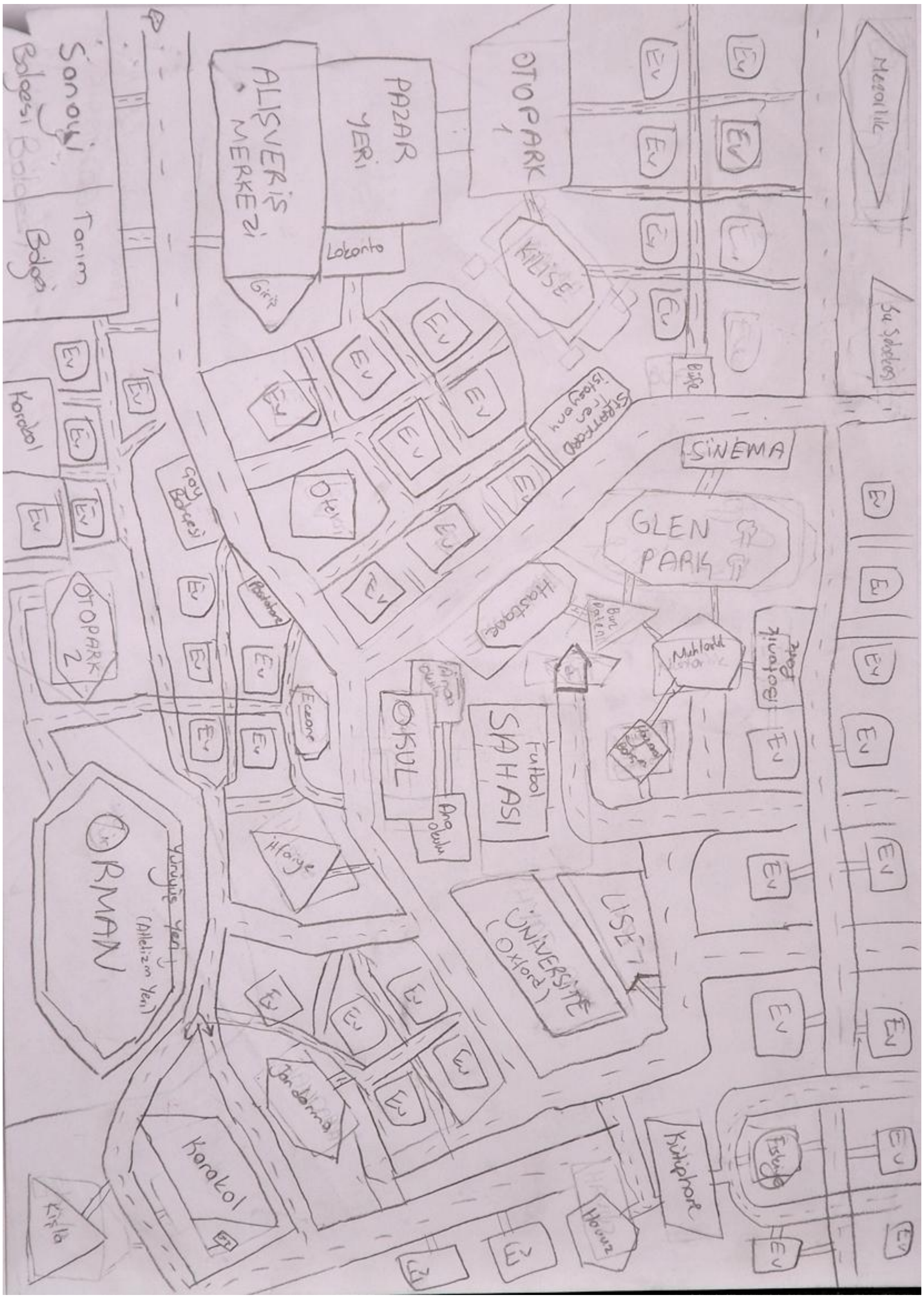


Figure 4.3 One Sample from the Students' Blueprints

Then, the students started to construct their plan by using their decisions on social and geometrical dimensions of the project and their blueprints. Classroom observations and interview responses to question 10 regarding the difficulties they faced showed that they had seven main troubles in constructing the plan: (a) using protractors, (b) error of measurement in constructing polygons considering their angle and side measurements, (c) constructing polygons and roads at the same time because of the nature of some of their design, (d) having some polygons which did not fit into the plan, (e) having more empty space than planned, (f) giving importance to adornment before finishing constructions of roads and polygons, and (g) time issue. First, it was observed that students needed the help of the teacher and asked some questions about constructing an angle and a polygon in their plan by using a protractor individually representing his/her group and as a group for using a protractor. All of those students concentrated on the teacher's demonstration of using a protractor and they tried to apply it. Some of them realized that they did not understand it exactly after the first trial of application. They asked for the same demonstration again. As a result of this trial and error process, they understood it since they needed to utilize it within the context of designing a neighborhood. Another problem with using a protractor was constructing polygons with small sides of lengths such as one centimeter-long side.

> How do we construct 90 degrees? Could you please show me how to draw an angle? (OBS-FD23)
>
> We could not construct a parallelogram with 100 and 80 degrees of angles, could you help us? (OBS-FM4)
>
> We don't know how to draw this irregular hexagon, could you give an idea? (OBS-FM8)
>
> I could not construct the irregular pentagon which has equal sides. Could you help me. (OBS-FI2)
>
> I could not construct regular octagon, I haven't constructed one before. (OBS-FI6)
>
> How do we construct an angle with 100 degrees? Could you please show us? (OBS-FI23)
>
> We could not construct a regular pentagon. (OBS-FI31)
>
> We could not construct the triangle with 2.8, 2 and 2 cm-lengths and 90, 45 and 45 degrees of angles, could you show us? (The group of OBS-FD3, OBS-FM4, OBS-FI9 and OBS-FI10)

> We don't know how to construct this shape, could you demonstrate it to us? (The group of OBS-FD10, OBS-FM9 and OBS-FI14)

Second, although the students understood using a protractor, they had also difficulty with error of measurement in constructing polygons considering their angle and side measurements. The teacher checked each construction and gave feedback immediately if she realized any mistake. For instance, she said, "You constructed this angle having 115 degrees for this regular octagon. What is measure of one of the angles of it. Think about it and construct again." If she realized error of measurement, she explained, "Every construction by hand might include error in your measurements. If you make a mistake of one or two degrees when constructing an angle of a polygon, it causes the last angle to be different than its real measurement. As long as you are aware of the angle and side measurements of them, it is acceptable for this project."

> We tried to construct a regular hexagon whose sides are 2.5 cm long. We were careful with its angles but the sixth length became 3 cm instead of 2.5 cm. (OBS-FI4)
>
> We tried (the construction of this regular octagon) again but we could not make it. All of its sides must be 1-cm long but the last side became smaller. (OBS-FI6)
>
> For constructing the irregular hexagon with its 90, 100, 105, 130, 140, and 155 degrees of angles, the last angle became 140 degrees-different from 155 degrees-as we decided although we constructed the other angles carefully. (OBS-FI8)
>
> We could not construct the isosceles (right-angled) triangle. We constructed an angle with 90 degrees and equal sides but the other two angles became 40 and 50 degrees instead of 45 and 45 degrees. (the group of OBS-FD16, OBS-FM12, OBS-FM13 and OBS-FI19)
>
> We planned to construct a regular hexagon here but its side and angle measurements were different. That is to say, it was not a regular hexagon. How can we improve it? (The group of OBS-FD11, OBS-FM10, OBS-FM11 and OBS-FI18)

Another difficulty was with constructing roads. The students stated that they solved that problem with deciding to construct polygons before roads. Despite their decisions on the width of the roads, some students constructed roads whose width was so bigger than 0.5 cm which caused students to have trouble with making polygons fit into the plan. Because of that difficulty some of the groups wanted to change the angle and side measurements in the plan. Besides this, some of the groups had to construct roads and polygons together because of the nature of their design. For example, roads and polygons were nested for some blueprints. That's why those groups had to think about both length and direction of roads and polygons at the same time. Moreover, the students needed to utilize equal angles when one road intersected the other two parallel roads. Some of them also had much space in the plan after they constructed roads. They added some more parts to the plan or changed their blueprints and the angle and side measurements of the buildings in the plan.

> Something we planned in the blueprint did not fit into the plan since there was not enough space. (INT-FM14)
>
> We thought this of element of the neighborhood as a parallelogram but it did not fit into the plan. We changed this parallelogram into a trapezoid. (OBS-FM20)

Some groups gave importance to adornment before finishing constructions of polygons. Some students, such as FM35, wanted to construct three-dimensional representations of the buildings instead of two-dimensional. Since some of the groups constructed the plan very detailed, they had problem with time issue. To solve that obstacle, they worked during lunch breaks and they divided their labor of construction in their group and constructed different polygons at the same time to finish the constructions quicker.

At the end of constructing the plans, they checked the angle and side measurements using a protractor and a ruler. This was the last stage of artifact development. It was observed that mostly FIs checked the measurements and FMs and FDs made needed changes. Sample neighborhood plan of a group can be seen in Figure 4.4. Other examples can be seen in Appendix S.

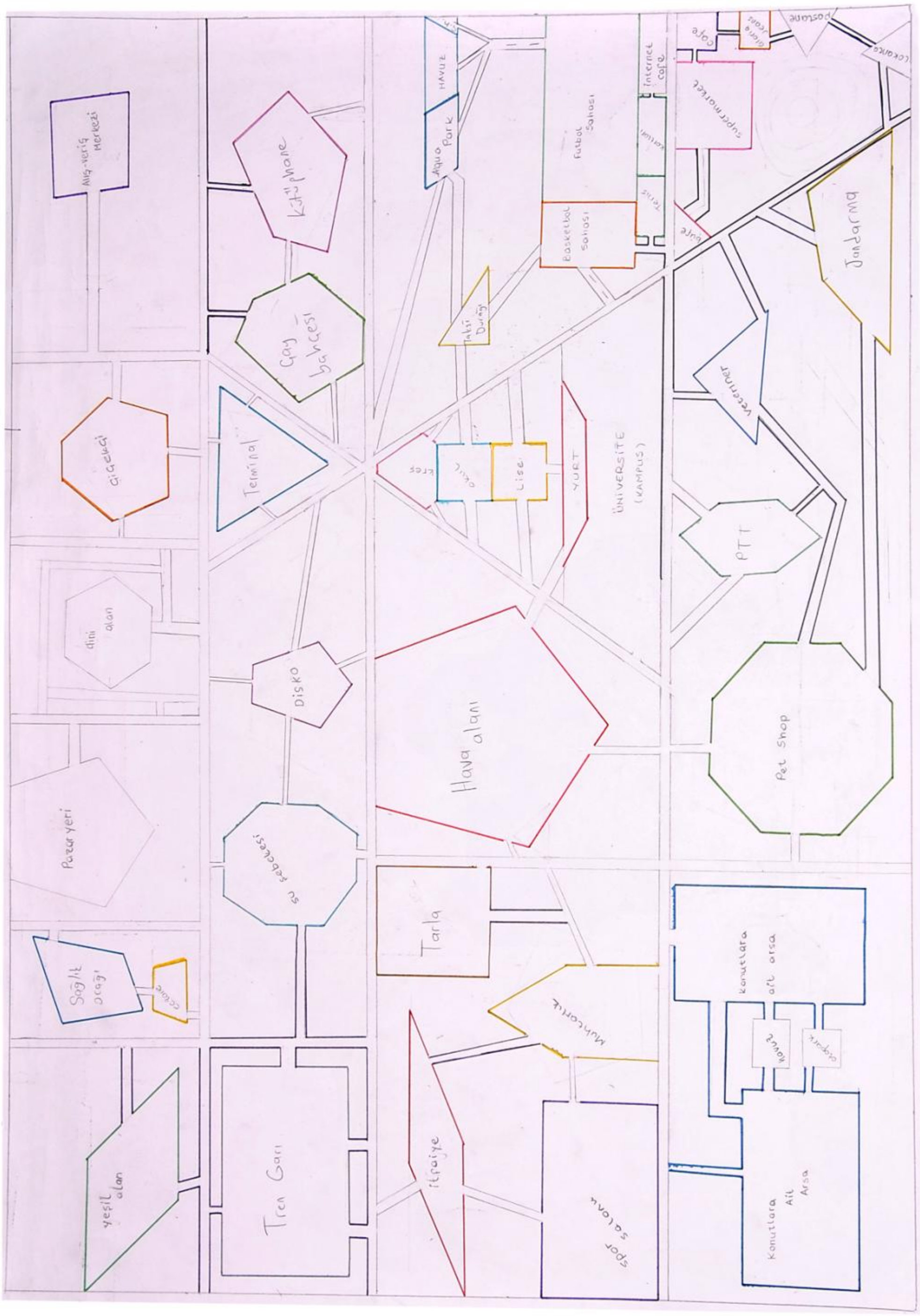


Figure 4.4 One Sample Neighborhood Plan

Then, they collaborated on the following relationships between the polygons (buildings) in their plan: (a) isosceles triangles and equilateral triangles, (b) parallelograms and rhombi, (c) parallelograms and squares, (d) rectangles and squares, (e) rhombi and squares, (f) trapezoids and parallelograms, (g) congruent and similar polygons, (h) rectangles and similarity, (i) regular polygons and similarity, (j) rhombi and regular polygons, and (k) rectangles and regular polygons with respect to their angle and side properties by explaining their reasons. They also discussed the relationship between parallel lines and equal angles (corresponding, interior alternate and exterior alternate angles). Furthermore, three FDs, four FMs and five FIs were asked the seventh interview question, ‘Do you think that you have connected geometrical concepts with each other? If yes, give examples from your project’, to get students’ opinions related to the effect of artifact development on conditional knowledge acquisition. They answered this interview question while they were looking at their projects in front of them. Both classroom observations and interview responses to this question illustrated that all types of students could make those relations easily by remembering all phases of the project and benchmark lessons. They formed connections among the above geometrical concepts by interacting with geometry and interpreting and developing meaning in everyday life situations in their neighborhood design. They stated that the excitement they felt during the activities and facing with and solving challenging events in making decision on geometric dimension of the project took their attention and provided them to associate geometry concepts better. They mentioned their opinions on their conditional knowledge acquisition as follows:

> Yes, I have learned since I remember what we did in the project. The calculator was useful for us. The measure of one of angles of this hexagon is 120 degrees. This is a regular hexagon. We found a total angle with 180 times n-2. We divided it by n to find (the measure of) one of its angles. These regular hexagons are similar to each other because they have equal angles and equal sides and their sides are proportional. Opposite angles are equal in this parallelogram, but only these two sides are parallel in this trapezoid. What else…, those regular pentagons having the same sides and angles are congruent. There are many similar polygons such as those two regular hexagons. The angles of those

rectangles are 90 degrees. Those two rectangles are not similar because their sides are not proportional. Those squares representing houses are congruent figures. They are also similar if they are congruent but the opposite is false. This pentagon has equal sides but it is not a regular polygon. Its angles have to be the same to be a regular polygon. All angles in this equilateral triangle are the same. Two angles in this isosceles triangle are the same. If three angles are equal, any two of them are equal. For that reason, every equilateral triangle is an isosceles triangle. The opposite is not true, of course. I had never thought of those relationships before. While we were making our projects, we were aware of what we were doing. (INT-FD20)

Yes, for example, these congruent shapes are similar because their measures are the same but all similar shapes are not congruent. Those regular hexagons are similar. Their angles are the same. Only their sides are different but they (sides) have to be proportional. That's why, they are similar. We used three congruent shapes here. Restaurants… They are similar, too because every congruent figure is similar at the same time but every similar figure is not congruent. We can not call this rhombus a square because the sides and angles of a square are equal. This village clinic is in the shape of a square and we can call it as a rhombus. The angles of a rhombus can be the same or different. Bases are parallel but not the other opposite sides in this trapezoid. This (trapezoid) is not a parallelogram since all opposite sides are parallel in a parallelogram. (INT-FM20)

Yes, for example, we made this post office (in the shape of) a parallelogram. This parallelogram is not a trapezoid because all (opposite) sides are parallel (in parallelogram). Only two of the sides are parallel in a trapezoid. This village clinic is (in the shape of) a rhombus. A square is also called a rhombus because all sides are equal in a rhombus. (If it is a square) its angles are 90 degrees, additionally. This square is a parallelogram because those two (opposite) sides are parallel and the other two sides are also parallel. Opposite sides are equal. We can also call this equilateral triangle an isosceles triangle since it includes the properties of an isosceles triangle; at least two sides are equal. This mukhtar's office (a pentagon with equal sides and unequal angles) is not a regular polygon

> because its angles are different. Those equal octagons are similar because every side and the angles are the same. (INT-FI1)

All types of students needed to utilize geometry concepts of (a) angle and side properties of polygons (isosceles triangles, equilateral triangles, parallelograms, rectangles, rhombi, squares, trapezoids and congruent, similar, regular, and irregular polygons) and (b) equal angles when a line intersects two other parallel lines to create and reflect on their own neighborhood plans. 11 FDs, 23 FMs and 17 FIs were also asked the eight interview question, ‘Do you think that you have applied any geometry concepts in your projects? If yes, give examples from your project.’ to get students’ opinions related to the effect of artifact development on procedural knowledge acquisition. Both classroom observations and interview responses to the eight question displayed that all types of students gained or consolidated applying the above geometry concepts in daily life as a result of developing their projects with enjoyment, investigating, computing, using a calculator, utilizing angle and side properties and constructing. They constructed and reconstructed usable understanding on above geometry concepts by engaging both physically and cognitively in seeing, discovering, reasoning, interpreting, applying and doing ideas through all cycles of enactment and revision processes in the context of designing a neighborhood plan. They were able to perceive and integrate different situations and develop meaning from them; to select appropriate procedures; and to adapt and change procedures to fit new situation. They expressed their opinions on their procedural knowledge acquisition as follows:

> I learned this subject (angles and polygons) better by making geometry enjoyable and entertaining. For example, those angles are corresponding angles. This is a regular hexagon and (total) measure of its angles is 720 degrees. We find it as n-2 times 180. Then, we divide it by n to find one of them. All sides and angles are equal in a regular polygon. This twin towers and football field (rectangles) are similar because their lengths and widths are three times those of the other. They are interior and exterior angles in this triangle. (The shapes of) the water tank and post office are congruent. This kindergarten, school, and parking area are (in the shape of) a parallelogram. When I forgot rules I looked

at my notebook to remember them and we used them to complete the table. I can utilize angles of some polygons and some other subjects that I learned easily. (INT-FD17)

I have learned utilizing facts. For example, vertically opposite angles, they have equal measures. The sum of those two angles (interior angles among parallel lines) is 180 degrees. Those two angles are corresponding angles. We find the measure of total angles: 180 times 8-2, and divide it by 8 to find (the measure of one of) angles of this regular octagon. When you asked the rules, I remembered our project. I did not memorize the rules. Now, those are meaningful for me. (INT-FM1)

I learned utilizing simple facts. For example, the sum of (measure of) those two (interior) angles is 180 degrees. If those (parallel) roads continued like that, those two angles, corresponding angles, would have the same angles. This is an exterior angle of the triangle. It supplements (the interior angle) to 180 degrees. This square is a regular polygon. We find (the measure of) one of its angles by n-2 times 180 divided by n. Those homes (octagons) are congruent. They have equal angles and equal sides. Those rectangles are similar since the ratio (of its sides) is equal. For example, if (lengths of) sides are 4 to 8, those of the others are 3 to 6. Those rectangles are not similar. They have to have the same ratio between their sides to be similar. We used simple facts related to angles and side properties. We decided on the sides and angles of polygons and completed a table. (INT-FI1)

In addition to learning those new geometry concepts, students from three cognitive styles stated that they have consolidated their previous knowledge of plan and scale and shrinking in a given ratio and learned the following: (a) where geometry is used in real life, especially in architectural designs, and the importance and value of it in real life, (b) designing a place, (c) details about different occupations, (d) using a protractor to construct geometrical shapes and (e) challenges and difficulties on that and how to overcome those obstacles. All of those opportunities helped them to enhance procedural knowledge of three types of students.

In addition to conditional and procedural acquisition, both classroom observations and interview responses to question 6, “Did you like the project, why?” displayed that all types of students gave a varied picture of their enjoyment with all stimulating experiences in artifact development. The students were happy to make their own projects with their own effort and worked with enthusiasm even at the lunch break and in the counseling hour since they wished to do so. They also showed their desire by discussing their projects with the other groups of students in the breaks. The interview responses showed that all FDs out of 17, all FMs out of 26 and 17 FIs out of 20 felt that creating artifacts were pleasant and entertaining. Three of the FIs (INT-FI7, INT-FI8, and INT-FI22) revealed that they didn’t like the project because they thought the project was difficult, boring and taking time, although they expressed their excitement with some parts of the project. For instance, INT-FI7 said that he liked deciding angles and sides of polygons and he also said, “It gets more enjoyable (every period)” on his own while working on the project. His group friend OBS-FI8 articulated, “I was good at deciding the place of the elements of the neighborhood. I am proud of myself (when I overcome obstacles).” INT-FI22, whose group had one more field independent student, mentioned her enjoyment with constructions in the project and her group finished the project first in the class.

All of the other students’ replies to the interview question gave the impression that they were genuinely interested in dealing with authentic situations which were more interesting and familiar to them due to several reasons. Some students from three types of cognitive style groups such as INT-FD9, INT-FD17, INT-FD18, INT-FD25, INT-FM21, INT-FM24, INT-FI1, INT-FI9, INT-FI15, INT-FI17, and INT-FI22 found the whole project enjoyable. 10 FDs, 18 FMs and 12 FIs stated that they liked the project because of constructions. They had fun creating neighborhood design by utilizing hand skills; combining their imagination with geometry; acquiring geometry concepts; and learning the reason behind them by seeing, feeling, and doing. The students such as OBS-FD1, OBS-FM6, OBS-FM24, OBS-FI7 and OBS-FI26 showed their excitement and enjoyment with the project by expressing their feelings directly to their group members while working on their projects. Because of that, some of them (INT-FM9, INT-FM25, INT-FM26, OBS-

FI8, OBS-FI16, OBS-FI28, INT-FI28, INT-FI29) decided they want to be an architect. Some of them started to act as if they were architects. For example, they needed to stand up while using one-meter rulers and put their pencils in back of their ears. Moreover, INT-FD13, INT-FM12-INT-FM13, INT-FI9, INT-FI17, INT-FI18, and INT-FI22 expressed that they liked paintings. In interviews, the students from three cognitive styles reported that overcoming the challenges they were confronted with helped them feel happy and be confident. All of those reasons contributed three types of students to have higher level attitude towards geometry.

Students valued the importance of geometrical and mathematical processes in building their products. The level of their active learning strategies went up because they needed to find information from different sources, to choose their own methods and plan routes through the task to overcome obstacles and to combine different areas of mathematical content. They understood both the importance of geometry in architecture and the kinds of difficulties architects were faced with during construction. For instance, INT-FD20 said, "I realized construction is not an easy work." This allowed them to develop active learning strategies in and learning value of geometry.

4.2.1.3 Influence of Contextualizing in Sharing Artifacts

The last contextualizing feature was sharing and presenting their projects to the teacher and their class friends by acting as if they were people from different occupations and as if the listeners were from the related municipality to convince them on the advantages of their project. In addition to the neighborhood plan, some of the groups prepared their presentations using PowerPoint. While one group was presenting their project, the other groups listened to them carefully. Interview responses to question 6 about their thoughts on the reason of their enjoyment of the project also showed that some students such as INT-FD21, INT-FM26, INT-FM33, and INT-FI13 liked the presentations. The students, both presenters and listeners, also showed their excitement during the presentation of their projects. The listening groups got excited and compared their project with the presenters' and asked some questions to affect the thought of the teacher who acted as if an authorized person or a jury.

What is the meaning of a sociologist? (OBS-FD1)

What are the historical places? OBS-FD5)

Is there a coiffeur? (OBS-FM1)

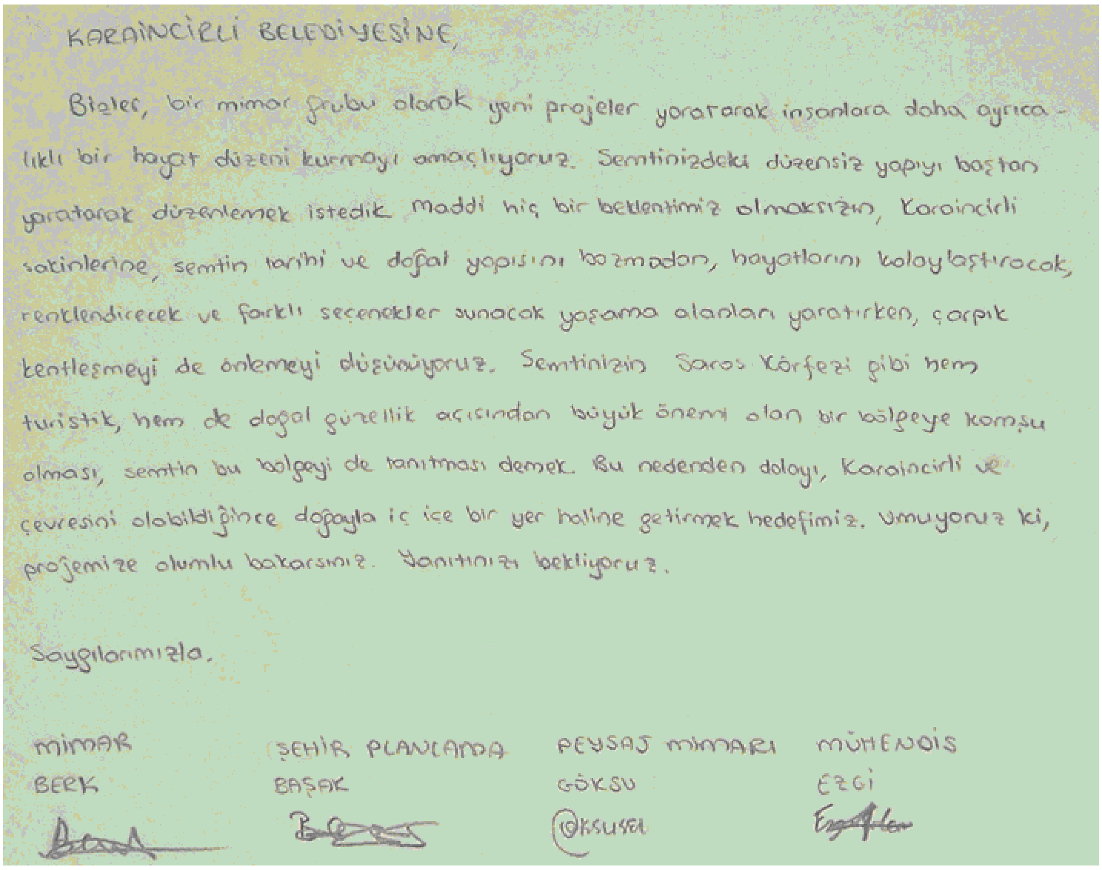
Why didn't you give importance to naturalness? (OBS-FM3)

What kind of entertainment places did you have? Isn't there noise? (OBS-FM30)

Why didn't you show water pipes in your project? (OBS-FI28)

Moreover, after the students observed the presentation of the other groups, they emphasized the difference between their projects and others. For example, OBS-FM18 said "there is no petrol station in other projects as we listened carefully. We put it because we thought it was necessary." All listeners applauded the presenters when they finished their presentation although the teacher did not emphasize that. Those reasons enabled all types of students to have a higher level of attitude.

All students made connection with Turkish while presenting and writing a petition to get permission from the related municipality to apply the project. A sample petition of them can be seen in Figure 4.5. Other examples can be seen in Appendix S.



KARAINCIRLI BELEDIYESINE,

Bizler, bir mimar grubu olarak yeni projeler yaratarak insanlara daha ayrıcalıklı bir hayat düzeni kurmayı amaçlıyoruz. Semtinizdeki düzensiz yapıyı baştan yaratarak düzenlemek istedik. Maddi hiç bir beklentimiz olmaksızın, Karaincirli sakinlerine, semtin tarihi ve doğal yapısını bozmadan, hayatlarını kolaylaştıracak, renklendirecek ve farklı seçenekler sunacak yaşama alanları yaratırken, çarpık kentleşmeyi de önlemeyi düşünüyoruz. Semtinizin Saros Körfezi gibi hem turistik, hem de doğal güzellik açısından büyük önemi olan bir bölgeye komşu olması, semtin bu bölgeyi de tanıtması demek. Bu nedenden dolayı, Karaincirli ve çevresini olabildiğince doğayla iç içe bir yer haline getirmek hedefimiz. Umuyoruz ki, projemize olumlu bakarsınız. Yanıtınızı bekliyoruz.

Saygılarımızla,

MIMAR	ŞEHIR PLANLAMA	PEYSAJ MIMARI	MÜHENDIS
BERK	BAŞAK	GÖKSU	EZGI

Figure 4.5 One Sample Petition

4.2.2 Influence of Visualizing Geometry Concepts

In addition to contextualizing geometry concepts, students visualized them during benchmark lessons and creating and sharing artifacts. The students developed mental images of the geometrical concepts through constructing their plans. They activated those images when needed by remembering the process of constructions and the geometrical shapes on their plan. Visualizing the two-dimensional neighborhood plans during their presentations got the attention of all students and they listened to the presentations carefully. Detailed description on the influence of visualization in benchmark lessons is presented below:

The influence of visualizing geometry concepts in benchmark lessons were investigated through exemplifying geometry concepts using visual tools. Concepts were demonstrated with visual tools such as (a) lined paper, (b) physical manipulatives (e.g., pattern blocks, geo-boards, geometry rods, and tangrams), (c) virtual manipulatives (e.g., Geometers' Sketchpad, geometry applets, and animations on the computer), (d) real objects (e.g., a ball and Russian matrushka dolls), (e) rulers, (f) protractors, (g) calculators, (h) Venn diagrams and (i) pictures from real-life and related to other disciplines, as mentioned in the contextualizing section. The experiences of the students with them helped all types of students form geometry concepts of equal angles when a line intersects two other parallel lines and angle and side properties of polygons, regular polygons, congruent and similar polygons, and special quadrilaterals and the relation among them.

Students folded a lined paper in such a way that a line intersected two other parallel lines. They measured the angles among the lines with a protractor and discovered equal angles without identifying their names. Corresponding angles were likened to the letter of F and vertically opposite angles to that of Z. They also realized the sum of the measures of the interior angles of a triangle was 180 degrees by cutting out each angle of a paper in any type of triangular shape and arranging the angles to form three adjacent supplementary angles. Especially, some FD students had trouble with completing these experiments and the teacher or their desk friend helped them. Working on those visual materials caused FI students to think more critically and make connections between geometry concepts. For example, OBS-FI12 on his own, made a squared shaped paper and cut out from its angles and he put them together in order to get four adjacent angles to see whether they constitute 360 degrees.

Students also experienced physical manipulatives such as pattern blocks, geo-boards, geometry rods and tangrams to visualize geometrical concepts. After the benchmark lessons on finding each angle of a regular polygon, they tried to get regular tessellations in the context of making a quilt design using pattern blocks of equilateral triangles, squares, regular pentagons and regular hexagons. Having an empty space when only using regular pentagons but not when using others challenged the students' minds and made them think about its reason. The students found its reason by considering one of the measures of the interior angles of those regular polygons and its divisibility by 360 degrees.

> A regular hexagon consists of six equal equilateral triangles. That's why, we can get a hexagon with using equilateral triangles. (OBS-FM10)
>
> One of the interior angles of an equilateral triangle, a square and a regular hexagon are 60, 90 and 120 degrees (respectively). 360 can be obtained with all of them (they are divisible by 360). However, one of the interior angles of a regular pentagon is 108 and 360 can't be obtained using 108 (360 is not divisible by 108). (OBS-FM13)

Moreover, students were given double-sided geo-boards, including a pin isometric array on one side and a square grid of pegs on the other side, and different colored rubber bands to help students visualize congruent and similar polygons. The students, mostly FI students, examined the positions of pegs on geo-boards with curiosity. They were encouraged to place rubber bands around the isometric pegs to form four congruent equilateral triangles nearby. Students also set up rectangles, having proportional and non-proportional sides on the square grid side of the geo-board. They experienced the relation between angles and side properties of congruent and similar polygons with class discussion. Students realized that a polygon with equal angles such as rectangles having sides of 1 by 2 and 2 by 5 did not have to be similar if its sides were not proportional.

Congruent and similar polygons were also visualized on tangrams, a puzzle that consists of a square cut into seven pieces including a small square, a parallelogram, two small congruent triangles, two large congruent triangles, and a medium-size triangle. After discussing the history of tangrams, students were given all those seven pieces and they formed tangrams. Some FD students had difficulty on that and the teacher helped them. Then, the class discussed the type of those polygons and their angle and side properties. The students made connections with previous geometry concepts of equal angles among three parallel lines. After that, the congruent and similar polygons of those pieces were explored. It was interesting to see some FD students put some polygonal pieces of the tangram above each other and observed whether the shapes covered exactly the other to check the congruence of them. Working with those hands-on materials provoked their curiosity and made abstract geometry concepts more concrete and they convinced the students that what they had learned was true. When the teacher asked them to discuss congruency and similarity of the seven pieces of the tangram, it was also interesting to observe that some FI students expressed their complex thinking in such a way that they thought also congruency and similarity of the polygons which were made up of two or more of those seven pieces.

As another manipulative, geometry rods were utilized to show the rigidity of the triangles compared to other polygons. Students constructed a triangle, a quadrilateral, a pentagon and a hexagon using those geometry rods. They were very excited when they noticed the triangle did not move but others did. The expression on the students' face changed and they concentrated more on the lesson. Some of them were challenged when they saw a square is moving and it is not rigid. OBS-FM21 brought his own material called GeoMac another day and said, "I tried (the rigidity of polygons) with GeoMac and triangles are more rigid compared to other polygons".

In addition to physical manipulatives, virtual manipulatives such as Geometers' Sketchpad, geometry applets, and animations on computer were demonstrated to empower to see, to consolidate and to create visual image in students' minds, and to make meaning of the geometry concepts. In Geometers' Sketchpad, polygons, regular polygons, congruent and similar polygons and special quadrilaterals were illustrated to help them visualize angle and side properties of them and the relation of them. Besides vertical and horizontal directions as the students used to, those polygons were shown in other directions as well by dragging the figures. It was interesting to observe that OBS-FD16 wanted to see the demonstration again and some of the FI students wanted to see what would happen if the teacher manipulated, dragged and moved the edges. The teacher provided students to make connections on different geometrical concepts by asking guiding questions. For instance, she questioned, "Is every parallelogram called as a rectangle?", "What are the relations between a rectangle and a square, between a rhombus and a parallelogram, and between a rhombus and a rectangle?", "What is it called if the measure of all angles of a rhombus is 90 degrees" and "What is the relationship between a trapezoid and a parallelogram?" By recalling the angle and side properties of special quadrilaterals, students as a class discussed the relations among them with guidance of the teacher. Such kind of technology either made the students realize the relationship among them intuitively or caused them, even FDs, to think more critically and to pose more relational questions. For example, after showing a parallelogram on computer screen, OBS-FD2, OBS-FD4, and OBS-FD13 asked whether a rectangle or a square could be obtained from the parallelogram by moving its edges, OBS-FI2 asked whether a square could be gathered from a rhombus, OBS-FI6 asked whether a square can be got from a rectangle, and OBS-FI23 asked the relation among a rhombus, rectangle and a square.

During the discussions, if a student made wrong relationships on special quadrilaterals, the teacher asked them to verbalize why they thought in that way and emphasized to them that they should revise their knowledge of simple facts and rules. While discussing more relationships between the concepts, the students started to realize those relationships more easily. After the discussion on each of the above relational questions came to end, the teacher demonstrated them on the computer screen. To allow them to connect their relations among special quadrilaterals more deeply, the students created Venn diagrams showing those relations using disjoint sets, intersecting sets, and subsets. Even though most of the students had trouble with connecting quadrilaterals with each other in the beginning of the lesson, the number of students who made those connections increased with visualizing them.

In addition to showing special quadrilaterals, the students were displayed a sample logo design in the shape of a star (having ten sides), which made the students smile, to make them visualize that the shape and angles of similar figures except its dimensions remained the same even if its direction was changed. Additionally, students were shown three animations on a computer screen related to congruency and similarity. The first animation was a scenario, in which an expert in NASA wanted to work on a satellite but it was too hard with that large of an object. The teacher asked for the solution to that and students said to make its (three dimensional) model. They realized the dimensions of the original satellite and its model had to be proportional and they found the scale by being careful in changing between units of length. Another animation was a demonstration of drawing similar triangles to help them visualize how to construct their neighborhood plan. The teacher explained that there might be error in their measurement while they were drawing their plan using a protractor and a ruler. The last animation was in similarity of rectangles. The class discussed whether it was enough to compare only one pair of sides of two rectangles for similarity. The students again realized that all dimensions of similar rectangles had the same ratio.

As another virtual manipulative, they saw equal angles (corresponding angles, interior alternate angles, and exterior alternate angles) among three lines when one of them intersected two other parallel lines using a geometry applet.

Some misconceptions such as defining the part of the bicycle wheel as a triangle; thinking all rectangles were similar, all rectangles have two small and two tall sides, and all rectangles are made up of two equal squares; confusing the concepts of congruent polygons and regular polygons came into being after those demonstrations. Moreover, students had trouble with if-then statements. For example, some students thought (a) if all sides of a quadrilateral have equal length, its opposite sides had different lengths; (b) if the measure of all angles were the same, its opposite angles had different measure; and (c) if only one pair of sides were parallel, so would the other pairs be. Even if some of those students knew related simple facts and rules, they could not connect the relation among them. Instead of saying the right answers directly, the teacher reminded them of what they already knew and made them engaged in argumentation and reflection so they could realize and correct the misconceptions and to refine their existing knowledge.

Besides these classroom observations, interview responses to question 3 concerning the effect of demonstrating visual tools on knowledge acquisition revealed that all students from three cognitive style groups learned geometry concepts especially the relations among them, better with the help of virtual manipulatives because they were very interesting and enjoyable for them. Moreover, using such materials was visual for them and caused them to concentrate on the details of the lesson. Four FDs, one FM and two FIs stated what they saw on the demonstration on the computer. They expressed gathering some types of quadrilaterals from others or not by dragging the edges of them such as obtaining a square from a parallelogram. Three FDs pointed out the superiority of this type of learning over traditional learning. One FD, two FMs and two FIs thought that seeing things on computer makes learning more permanent. Additionally, one FD student stated that she experienced the rigidity of triangles.

As a result, the experience of all types of students in this active learning environment with all of the above visual tools by seeing, touching, doing, posing and answering more critical questions, engaging mentally in discussions, verbalizing their geometrical thinking, creating a visual picture of the concepts and constructing meaning had a positive influence on conditional and procedural geometry knowledge. The students were more comfortable with those visual tools which boosted their self-confidence. They were reluctant to participate in the activities and to visualize the concepts, which provided them to have a higher level of attitude.

4.2.3 Influence of Collaborating Geometry Concepts

As one of the features of project-based learning, the students collaborated with their teacher and classmates in whole class discussions during the benchmark lessons; with the community members, their teacher, and their peers in heterogeneous small-groups having the students from three different cognitive styles during artifact development; and with their teachers and within and between groups during presentations to investigate the driving question and to build understanding of the geometry concepts.

4.2.3.1 Influence of Collaborating in Benchmark Lessons

As mentioned earlier in the contextualizing and visualizing sections, the students interacted with their teacher and discussed the knowledge, experiences, and ideas as a whole class to understand the driving question in detail, to exemplify the concepts, and to apply them in real-life geometry problems. The teacher related each activity of the benchmark lessons with the driving question. She challenged their minds with demonstrations and by asking questions such as “Is it enough to know one of the measure of eight angles to find that of the other seven angles when one line intersects the other two parallel lines?”; “What is the special name for a rhombus having all 90 degrees angles?”; and “Why are honey combs in the shape of regular hexagons? Have you ever thought on that?" While solving those kinds of questions and geometry problems, the teacher helped them activate related preexisting mental structures and apply them to the new situation. For example, she enabled them to remember the prerequisite knowledge of angles at a point, first degree equations with one unknown and finding the measure of angles of regular polygons to discover the reason of getting regular tessellations using regular triangles, quadrilaterals, and hexagons, but not using regular pentagons. When some field dependent students had difficulty with the class activities, such as cutting out a triangular shaped paper to get adjacent supplementary angles and forming a tangram using its seven pieces, the teacher helped them. The students also communicated with the teacher and with their classmates on the activities during the breaks.

Those interactions with the teacher made the students connect and utilize the concepts, stimulate thinking, and wish for participating challenging activities. They enabled the higher level of all kinds of students' attitude towards, active learning strategies in, and learning value of geometry. In this way, their knowledge acquisition level also increased.

4.2.3.2 Influence of Collaborating in Artifact Development

As seen earlier, the students collaborated with their parents and relatives to get information on different occupations and with a mukhtar, an administrator of a neighborhood, to get a sample neighborhood plan; with their teacher and group members to make decisions on social and geometrical dimensions and to construct their blueprints and plans during artifact development.

The teacher facilitated learning by orchestrating the instructional events; reminding them of benchmark lessons; setting clear expectations; giving guidance; resolving small-group conflicts as soon as they arose; maintaining control of certain classroom events and appropriate behavior; keeping the students on task; and creating a learning environment in which students could feel comfortable with making decisions, discussing knowledge and ideas, asking questions, making experiments, posing solutions, revising and changing their work.

The students worked equally together with their group members on creating a neighborhood plan without dividing any labor except in constructing different parts in the plan by consulting their peers or teacher when needed. They used language to express, debate, and explain knowledge and ideas and to come to a resolution and consensus regarding the ideas and concepts.

In collaboration in the heterogeneous group of students, strengths, weaknesses, and different viewpoints among children's views promoted deeper understanding. Students learned from their more knowledgeable group members a lot. All of the students from three different cognitive style groups talked about their ideas on collaborating investigation results, making decisions on social dimension, constructing blueprints and plans. Mostly FIs and some FMs in the groups were decision makers for the geometrical dimension of the project. They decided what operations to make for the angle and side measurements of buildings, which showed cognitive restructuring skills of the FIs, by reminding the properties of polygons to their group members and mostly FDs found the results using calculators. FIs found some short ways to find the real side measurements of the buildings. For example, OBS-FI28 explained that "if you multiply it with 25 without changing from centimeter into meter, it will provide easiness to find real lengths" to his group members. Each other enabled them to be aware of their mistakes. For instance, OBS-FM28 warned his group friend OBS-FI26 with his mistake on construction and said, "Be careful, the angle you constructed is 35 degrees instead of 45 degrees."

The collaboration between the groups existed also during the breaks and the students, mostly FIs and some FMs but not generally FDs, examined the other groups' blueprints and plans and compared them with theirs. They explained what they were doing in their projects to the other groups. The next day, some FI students such as OBS-FI4 and OBS-FI5 did not like what they did compared to others and erased what they had constructed on the previous day and said ,"Other groups constructed better than us. That's why, we erased (our constructions)." Moreover, OBS-FM7 from the same group said "our project is not as good as the others." The teacher talked to them and the whole class and said "you should not compare what you did with other groups. Every group creates their own project. You should do your best. I don't compare among the projects of the groups. You are working well."

Some FDs talked to the teacher and wanted motivation from the teacher by asking the opinion of the teacher related only to their project. Since they were sensitive to criticism, they were happy to hear positive comments on their projects. These examples showed that FIs liked a competitive atmosphere but not FDs.

Students had challenges on social and geometrical dimensions of the project as seen in the contextualizing section. When the group members could not reach an agreement on making decisions on social dimension such as on the placement of the elements in the neighborhood plan, they wanted guidance from the teacher. After she listened to them and emphasized to them to think about the validity of their responses and suggested alternatives, she left them to make their own decisions. They also had trouble with geometrical dimension such as imagining the availability of dimensions of a building in real life. Instead of talking about the answers directly, she helped them see the unavailability of the dimensions they thought by asking guiding questions. For example, she said, "You determined the dimensions of the post office on the plan as 10 cm. Think about its real dimension". After peer collaboration, they found its real dimension to be 250 m and the teacher said, "Don't you think this dimension is too long for a post office if you think of a post office in real life?" The teacher also recognized that some groups had a problem remembering angle and side properties of some polygons. If no one in their group had remembered related geometry concepts, she posed guiding expressions. For instance, "Remember how the measure of an interior angle of a regular polygon is found" and reviewed the discussions during benchmark lessons and advised them to look at their notebook.

Moreover, the teacher caused students to recognize and overcome misconceptions they had stated in the visualizing section. She enabled the students who had a misconception to verbalize their previous knowledge on that concept and have them utilize their angle and side properties. She also warned the students with their plan constructions when she saw any mistake of angle or side measures of polygons. For example, she said, "You constructed 115 degrees for one of the angles of this regular octagon. What is the measure of it? You should think about it and construct it again." In addition, the students collaborated on the difficulty of constructing equal angles among the roads. To do that, they reminded each other of these concepts. After she checked the work of each group at the end of each stage, she warned them by giving written and oral feedback before going on the next stage, as mentioned in the contextualizing section.

Classroom observations and interview responses to question 10 on the difficulties they faced revealed that conflicts arose when they participated with their peers. Some of the students had difficulty getting used to each other, refused to work together, and did not involve each other in developing the artifact. Some students, especially some FDs, such as OBS-FD7, OBS-FD8, OBS-FD10, OBS-FD11, OBS-FD15, OBS-FD17, OBS-FD18, were passive and did not join the group discussions at first. Some of the students also had other misbehaviors such as not controlling their level and tone of voice and hitting each other by using one meter-rulers, and critiquing by offending others. The speed of the groups was different and some students were rude to their group members, such as OFI23 to OBS-FM25, OBS-FI31 to OBS-FD24, and OBS-FM28 to OFD24, because of getting stressed on being behind other groups. Conflicts also arose in some groups having two FI students such as FI1 and FI2, FI7 and FI8, and FI22 and FI23 in the same group. Mostly, some FIs resisted having their group members accept their ideas.

When the students disagree with their peers' ideas, the teacher motivated the students to join discussions and she told them to listen carefully to what others are saying to learn to understand the point of view of others, to criticize ideas other than their peers, and to appreciate each others' differences. When the students had a discrepancy on their ideas, the teacher helped them by asking guiding questions such as "How can you use all ideas and can you come up with a compromise?" The students needed to be open to criticism from their peers and to learn to compromise. It was observed that the students having disagreements with their peers started to work well when they were motivated, understood the project, and were physically and cognitively engaged in designing a neighborhood plan. This could be seen in the statement of OBS-FI7 as, "Our group members were not in accordance with each other (at first)but now we are working more harmoniously." Classroom observations and interview responses showed that they found their own ways to resolve conflicts and differences in opinion amicably. For example, they made drawing, balloted, applied what the majority wanted, reached a common ground instead of insisting on their ideas, and got help from the teacher or their peers for any challenge. Sample interview responses on the influence of collaboration of students with the teacher and their peers on solving difficulties can be seen as follows:

> I overcame difficulties with the help of my friends. (INT-FD5)
>
> My group friends taught me to use a protractor and construct polygons. (INT-FD16)
>
> We could not come to an agreement in where to place this course first but then, we voted on that and placed (the remaining polygons) on the empty spaces. (INT-FD17)
>
> I had difficulty with getting used to the project and my group mates at first but everything was resolved with the help of my friends. (INT-FD18)
>
> We mentioned our difficulties to our teacher and she explained them in very appropriate language. (INT-FD24)

> We made others in the group responsible for the constructions that we could not do. Then, a volunteer constructed them. Our group friends FI1 and FI2 had difficulty with having disagreements choosing the polygons to construct. Then, they solved it by constructing in order. (INT-FM1)
>
> We learned constructing by asking questions and getting help from our teacher. (INT-FM4)
>
> My group mates helped with constructing. My friends and I had difficulties constructing taking into consideration the measurement of angles and sides but we solved that problem by getting help from our teacher and solidarity with our friends. (INT-FM13)
>
> We had discrepancies in our ideas but we did what most of us wanted to do. (INT-FM15)
>
> We experienced difficulty with arranging both real life measurements and those on the plan but calculators and our group friend FI15 helped us. (INT-FM20)
>
> My group mates enabled me to make anything that I could not do. I also helped them (when they needed it) and we did not have any trouble. (INT-FM25)
>
> We got help from our teacher and constructed the trapezoid according to the degrees of its angles. (INT-FM34)

> I asked questions to my teacher (when I had any difficulty) and I got help from her. (INT-FI8)
>
> We tried to correct the mistakes by helping each other. (INT-FI22)
>
> My friends and I had different ideas. I did not insist on my opinion so that we would not be late. (INT-FI25)

Facing the disagreements and resolving them helped the students enhance their problem-solving skills. They used some strategies that enabled them to form more detailed and thorough understanding when they discussed concepts, defended their views, debate ideas, and explained concept to others as well as to the teacher. In this way, their active learning strategies were boosted.

The teacher sometimes reflected on the involvement of the students individually and on the progress of their project as a group. She motivated the groups' work by using gestures and with encouraging expressions such as "Good job, your project looks nice." and "All of you are working in accordance with your peers, contributing to the project with a proper tone of voice." Those groups went on working with enthusiasm after being encouraged. In this way, the students gained self-esteem because they felt needed for developing the projects and saw that their ideas were valued. During a break some students from three different cognitive style groups stated that they liked the project. Interview responses to question 9, 'Do you like group work? Why do you like/dislike group work?' also showed that all FDs out of 16, all FMs out of 25, and 19 FIs out of 21 stated that they liked collaborating with their group members. Although two FIs (INT-FI20 and INT-FI22) pointed out that they disliked the group work because of disagreements in the groups, they stated that they liked sharing ideas and work during classroom observations. The others stated different reasons for liking group work. 8 FDs, 12 FMs and 8 FIs pointed out that the group work was more enjoyable and they overcame difficulties and finished the work easily and faster when working with others in comparison to individual work. 5 FDs, 9 FMs and 6 FIs enjoyed sharing and discussing different and creative ideas and knowledge. 4 FDs, 6 FMs and one FI student liked supporting each other, solidarity and increasing friendship. Some FIs liked group work also because of guiding their friends. Additionally, although INT-FI6 stressed that he liked group work, he wished to choose his own group friends. Those situations enabled the students to have a higher attitude toward geometry.

As seen in the contextualizing and visualizing sections, it was observed that social interaction of the students with their teachers and peers contributed to the knowledge acquisition of all type of students. It suited FDs because they were provided guidance and it suited FIs since it encouraged using their cognitive restructuring skills. Knowledgeable others helped the students learn new ideas and skills that they could not learn on their own. The collaborative environment promoted their own active learning as well as the learning of others. The students brought multiple perspectives to the classroom with diverse backgrounds and aspirations. They shared their discoveries with their peers and reviewed what they had learned through explaining it to them. Discussions promoted an exchange and reflection on different views. Suggestions, seeing others' behaviors, receiving different ideas, and understanding others' points of views during discussions provided students with opportunities to solve any problem, to improve their work and to acquire knowledge. They were aware of what they were studying. The feedback from the teacher their peers and involving both socially and intellectually led to better understanding of geometry.

In addition to geometry knowledge acquisition, interview responses to question 9 revealed that some students from all three types emphasized that they learned interpersonal skills such as working as a team, comprehending and developing team spirit, the importance of group work, being and working together, helping each other, becoming close friends with their classmates, respecting others' decisions, increasing communication, and creating a product together.

CHAPTER 5

DISCUSSION, CONCLUSIONS AND IMPLICATIONS

This chapter includes three sections. First section presents the discussion of the results. Implications and recommendations for further studies are given in the second and third sections, respectively.

5.1 Discussion

The aim of this study was twofold: (a) to investigate whether seventh grade students' conditional and procedural geometry knowledge acquisition, attitude towards geometry, active learning strategies in geometry, and learning value of geometry improve differentially for students having different cognitive styles in project-based learning and (b) to examine how project-based learning affects students having different cognitive styles on their conditional and procedural knowledge acquisition in, attitude towards, active learning strategies in, and learning value of geometry.

It was hypothesized that engaging with varied novel elements and authentic and meaningful tasks of well-designed project-based learning might improve conditional and procedural geometry knowledge acquisition, attitude towards geometry, active learning strategies in geometry, and learning value of geometry of both FDs and FIs similarly. The hypotheses of this study were supported by both quantitative and qualitative data. Quantitative results showed that three types of students achieved similar improvements for conditional and procedural knowledge in, attitude towards, active learning strategies in, and learning value of geometry. In addition, there was a substantial main effect of time and no significant difference in the effectiveness of three types of cognitive styles.

5.1.1 Conditional and Procedural Geometry Knowledge Acquisition

According to the quantitative results, field dependent, field middle, and field independent groups showed a similar mean increase of 23.82, 27.26 and 27.44 from PreConKT to PosConKT, respectively. The calculated very large effect size (.944) for time effect of conditional knowledge claims the practical significance of this result. The findings on conditional knowledge were verified by the qualitative results. All students from three different cognitive styles were demonstrated some pictures from daily life in benchmark lessons and developed two dimensional neighborhood plans as a group by deciding on angle and side measurements of different types of buildings in the shape of different polygons (regular and irregular polygons, congruent and similar polygons and special quadrilaterals) and constructing those plans by utilizing the measurements.

They caused all types of students to represent and make sense of different types of angles, the position of three lines in a plane, equal angles when one line intersected two parallel lines and different types of polygons. They made all kinds of students, even FDs, remember their earlier knowledge and experiences and pose some bridging questions to find connections between the angle and side properties of polygons. They pursued solutions to their own questions by thinking about some salient cues such as the person's face in a picture and constructions using rulers and protractors, by thinking and reasoning in discussions, by reflecting on their own understanding, and by refining their existing knowledge. In this way, they recalled simple facts and rules and formed connections among above geometry concepts by interacting with geometry and interpreting and developing meaning in everyday life situations in their neighborhood design.

Learning became less abstract and more connected to their own lives and experiences. In this way, the students understood why they need to know the concept and when and how to use their knowledge, which supports the idea of Von Kotze and Cooper (2000). These situations were meaningful, interesting and enjoyable and they had fun with them. The students stated that the excitement they felt during the activities and facing with and solving challenging events in making decision on geometric dimension of the project took their attention and provided them to associate geometry concepts better. Those findings were concurrent with Dewey (1938), Kilpatrick (1918) and Rogers (1969), who support that learning takes place by doing and personal involvement in the learning process that is interdisciplinary and concerned on learner’s interests and life. The results of this study are also consistent with Bruner (1961), who states that learners explore examples, concepts and principles and participate in making many of the decisions about what, how, and when something is to be learned.

Experiences of all types of students in this active learning environment with all of the visual tools by seeing, touching, doing, posing and answering more critical questions, engaging mentally in discussions, verbalizing their geometrical thinking, creating a visual picture of the concepts and constructing meaning had a positive impact on conditional geometry knowledge.

The significant mean increase of three types of students in conditional knowledge acquisition in this study was partly attributable to social interaction of the students with knowledgeable others (the teacher and peers). It helped each type of students learn new ideas and skills that they couldn’t learn on their own. All of the students having three different cognitive styles talked about their ideas on collaborating investigation results, making decisions on social and geometrical dimensions, constructing blueprints and plans. In collaboration in the heterogeneous group of students, strengths, weaknesses and different viewpoints among children’s views promoted deeper understanding as stated by Vygotsky (1978). They shared their discoveries with their peers and reviewed what they have learned through explaining it to them. Suggestions, seeing others’ behaviors, receiving different ideas, and understanding others’ points of views during discussions provided children with opportunities to solve any problem and to improve their work and to acquire knowledge. Mostly FIs and some FMs in the groups were decision makers for geometrical dimension of the project and found some short ways to find the real side measurements of the buildings. They decided what operations to make for the angle and side measurements of buildings, which showed cognitive restructuring skills of the FIs, by reminding the properties of polygons to their group members and mostly FDs found the results using calculators. That’s why, collaboration feature of PBL suited FDs because they were provided guidance and it suited FIs since it encouraged using their cognitive restructuring skills.

According to the results of procedural knowledge, FD, FM, and FI groups showed a similar mean increase of 38.24, 39.6, and 38.22 from PreProKT to PosProKT, respectively. The calculated very large effect size (.945) for time effect of procedural knowledge claims the practical significance of this result. Significant improvements related with procedural knowledge acquisition supports the findings of Barron et al., which provided evidence that each of the three different pre-achievement level groups showed statistically significant improvements and lower achieving students benefited from PBL as much as average and high achieving students. Findings of the present study are concurrent with other previous studies (Boaler, 1997; Özdemir, 2006; Wilhelm et al., 2008) which provided a positive effect of PBL on applying rules and algorithms and solving problems in geometry. Those studies also found that the following experiences of students with PBL affected procedural knowledge positively: enjoying; posing questions and seeking answers to them; making decisions; developing reasoning skills; thinking and acting mathematically; collaborating concepts with the teacher, class mates, and others; making connections with life, the future career and within and across disciplines to learn how and when to use their knowledge; and learning about new mathematical methods and procedures by adapting them into different situations.

Like those experiences, several other reasons may account for positive effect of PBL on procedural knowledge. Both the classroom observations and interview responses showed that exemplifying geometrical concepts and solving procedural questions situated in a real life context activated students' previous experience and knowledge and to engage in thinking and reasoning in discussions, to reflect on their own understanding and to refine their existing knowledge. Additionally, three types of students utilized the geometrical concepts in the context of neighborhood design by engaging both physically and cognitively in seeing, discovering, reasoning, interpreting, applying and doing ideas through all cycles of enactment and revision processes. They gained and consolidated applying the geometrical concepts with enjoyment, investigating, computing, using a calculator, utilizing angle and side properties and constructing. They were able to perceive and integrate different situations and develop meaning from them; to select appropriate procedures; and to adapt and change procedures to fit new situation. In addition to contextualizing geometrical concepts, visualizing and collaborating them had a positive effect on procedural knowledge, as stated in conditional knowledge.

5.1.2 Attitude Towards Geometry

According to the results of attitude towards geometry, the FD, FM and FI groups showed a similar mean increase of 9.55, 8.4, and 7.68 from PreGAS to PosGAS, respectively. The calculated very large effect size (.479) for time effect of attitude claims the practical significance of this result. Like knowledge acquisition, each feature PBL has great potential to foster attitude, as the previous studies stated (Blumenfeld et al., 1991; Branford, 2005; Sidman-Taveau, 2005; Sidman-Taveau & Milner-Bolotin, 2001).

Although some of the students were very upset at first with the difficulty of the project, they smiled and joined the activity well after they understood the driving question and the project more in detail. All types of students were engaged in meaningful, interesting, and enjoyable activities, as mentioned above. They thought the project is interesting because it is different from other projects that they used to as solving just ordinary questions. Designing a neighborhood had varied elements such as deciding elements of the neighborhood and placement of them, polygonal shape of the buildings, computing angle and side measurements of the polygons in the plan and in real life using calculators and designing, producing and sharing a neighborhood plan by thinking, utilizing their hads skills, combining their imagination and creativity with geometry and mathematics geometry concepts in line with their wishes. They had fun with feeling sense of ownership of the project and all of those activities. They liked learning the reason behind geometrical concepts by seeing, feeling, and doing. They also enjoyed acting as people from different occupations do, in particular an architect. After achieving some difficulties in the process of deciding geometrical dimensions of the project, they were happy and gained confidence.

The students were more comfortable with the visual tools which boosted their self-confidence. They were reluctant to participate in the activities and to visualize the concepts.

Another reason for the positive effect on attitude can be stemmed from the teacher's reflection on the involvement of the students individually and on the progress of their project by using gestures and with encouraging expressions as a group. In this way, the students gained self-esteem because they felt needed for developing the projects and saw that their ideas were valued. They stated they liked the project as a whole or some parts such as sharing ideas and work, group work, sharing and discussing different and creative ideas and knowledge, supporting each other, solidarity and increasing friendship. Some FIs liked group work also because of guiding their friends. Each of those situations enabled three types of students to have a higher attitude toward geometry. Those results were concurrent with Özdemir (2006), who found that the following features of PBL affected attitude towards geometry positively: (a) having fun with making students' own models, (b) dealing with authentic daily life problems, (c) feeling some confidence with doing something that they could accomplish, (d) working as groups, (e) providing the opportunity for the students to be able to learn more about their future professions.

As hypothesized, since field dependent students tend to be extrinsically motivated and enjoy learning through working together with others (Karnasih, 1995; Luk, 1998; Rayner & Riding, 1997; Witkin et al., 1977), finding the driving question interesting and meaningful, authenticity of the tasks, overcoming obstacles with peer and teacher support, utilizing physical and virtual manipulatives as salient cues, role playing as people from different occupations, and utilizing their thought and wishes in PBL provided FDs to feel pleasure and confident when dealing with geometry. Furthermore, since field independent students tend to be intrinsically motivated and are prone to like individualized learning, PBL provided high level of attitude of FIs because of the fact that utilizing their imagination in higher-order tasks in solving the driving question and developing artifact help them be intrinsically motivated and feel confident. Therefore, they had higher level of attitude.

5.1.3 Active Learning Strategies in and Learning Value of Geometry

According to the results of active learning strategies in and learning value of geometry, the FD, FM and FI groups showed a similar mean increase of 5.10, 5.05, and 3.07 from PreALSGS to PosALSGS and a similar mean increase of 4.29, 3.32, and 2.61 from PreLVGS to PosLVGS, respectively. All types of students showed statistically significant improvements both in active learning strategies in and learning value of geometry. The students had higher active learning strategies and appreciation of geometry concepts with discussing on demonstrations of some pictures from other disciplines and real life and those of dynamic geometry software and applets, finding information from different sources, choosing their own methods and plan routes through the task to overcome obstacles and to combine different areas of mathematical content, understanding the importance of geometry in architecture and the kinds of difficulties architects were faced with during constructions, being given freedom about what they wanted to do and being involved in both benchmark lessons, developing neighborhood plan and presentations. All types of students participated in challenging tasks and solved the difficulties in a mathematical manner related to the geometrical concepts with the help of their peers and teacher and using a calculator.

They also utilized those concepts in their life by connecting them with their previous knowledge and real life experiences and by satisfying their curiosity. Those interactions with the teacher made the students connect and utilize the concepts, stimulate thinking, and wished for participating challenging activities. Facing with the disagreements and resolving them helped the students enhance their problem-solving skills. They used some strategies that enabled them to form more detailed and thorough mental understanding, when they discussed concepts, defended their views, debate ideas, and explain concept to others as well as to the teacher. In these ways, their active learning strategies and learning value were boosted.

5.2 Implications

In this study, the students having three different cognitive styles created a neighborhood plan by using benchmark lessons, technology, investigation, collaboration with the teacher, peers, and others and authentic assessment related to angles and polygons, within and across the disciplines, and real life. The results of this study showed that project-based learning caused three types of students to have significant improvements equally for conditional and procedural knowledge in, attitude towards, active learning strategies in, and learning value of geometry. These results suggest that project-based lessons should be utilized in other topics of geometry and mathematics.

This study shows several challenges and tendencies that three types of students encountered. Field dependents usually faced with problems related to using their cognitive restructuring skills such as making decisions on dimensions of the buildings (polygons) in the plan and in real life. Field independents had difficulties with social interactions. Teachers should be aware of the cognitive styles of students and make efforts to design teaching activities considering their characteristics in order to maximize the benefits for all types of students.

Witkin et al. (1977) described field dependent learners as accepting a passive and spectator role in learning and field independent learners as accepting an active and hypothesis-testing role in learning. It was observed that most of the group leaders while developing their artifacts as a group were field middle students. This suggests that the students chose neither a passive nor an active characteristic as a group leader. That's why teachers should form heterogeneous small-groups having field middle students in addition to field dependent and field independent students.

One further implication can be suggested for the mathematics textbooks and other teaching materials. The mathematics textbooks are lacking activities for students having dissimilar cognitive styles. Authors of mathematics education books should include concrete activities for them.

In order to use project-based learning in the mathematics, pre-service and classroom teachers should be given a chance to improve their understanding and implementation of project-based learning. National Ministry of Education should provide in-service training for teachers. Project-based lesson plans of this study for the geometry topics of angles and polygons can be taught effectively in the specified period of time given in the curriculum.

Generally, tests or examinations consist of few conditional knowledge questions that ask students to make justifications. Even though the tests include procedural knowledge, few of them explore connecting geometrical concepts with a real life context. Teachers may prepare guidelines and ask students to reason about the relations between concept definitions and theorems to accustom students with such tasks. Teachers can also assess procedural knowledge to enable students to apply geometrical concepts in a daily life context.

This study was conducted in the school having computer laboratories and a rich library. The participants of this study had opportunity to utilize computer and Internet both in the school and at home to make a search easily. Most of the students had relatives having different occupations such as architects, city planners, and engineers. Both the school and outside school contexts should provide students opportunities to gather information whatever they need.

5.3 Recommendations for Further Studies

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

• This study illustrated that several aspects of project-based learning have an effect on students having three different cognitive styles with respect to conditional and procedural knowledge in, attitude towards, active learning strategies in, and learning value of geometry. More mixed methods studies combining both quantitative and qualitative data should be conducted to provide a deep understanding about the effects of project-based learning and how it can be helpful in different geometry and mathematics concepts and different variables.

• Other kinds of individual differences such as different pre-achievement levels, multiple intelligences, thinking styles, learning styles, and other dimensions of cognitive styles in addition to field dependence and independence can be taken into consideration. A study to determine effects of project-based learning on the students with different characteristics would be fruitful.

• Replication of this study on higher sample size, different grade levels and other mathematics topics are recommended to provide more in-depth results. This would help to determine whether project-based learning is an effective method for a wider range of age groups and regardless of the concepts being taught.

• Complete randomization if provided in a replication of this study would allow researcher to generalize over a wider samples.

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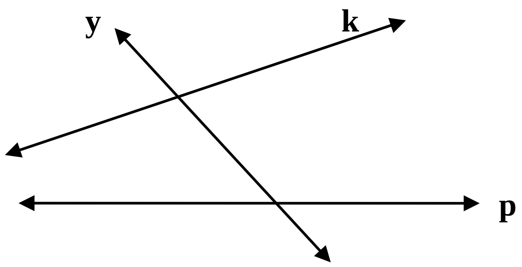
APPENDIX A

CONDITIONAL KNOWLEDGE TEST

Adı Soyadı: Sınıfı:

Bu sınav, 7. sınıfta öğrendiğiniz bazı geometri konuları ile ilgili 10 sorudan oluşmaktadır. Her soruda açıklama yapmanız beklenmektedir. Lütfen bildiğiniz tüm soruları cevaplamaya çalışınız. Sınav süresi 40 dakikadır. Başarılar…

1)



Yandaki şekilde **y** doğrusu, **k** ve **p** doğrularını birer noktada kesmektedir. "**k** ve **p** doğruları birbirine paralel değil ise kesişen noktalarda oluşan açı çiftlerinden yöndeş açıların ölçüleri birbirine eşittir" ifadesi doğru mudur? Cevabınızı nedenleriyle açıklayınız.

2) "Her eşkenar üçgen, bir ikizkenar üçgendir" ifadesi doğru mudur? Cevabınızı nedenleriyle açıklayınız.

3) "Her kare bir dikdörtgendir" ifadesi doğru mudur? Cevabınızı nedenleriyle açıklayınız.

4) "Her yamuk bir paralelkenardır." ifadesi doğru mudur? Cevabınızı nedenleriyle açıklayınız.

5) “Her eşkenar dörtgen bir paralelkenardır.” ifadesi doğru mudur? Cevabınızı nedenleriyle açıklayınız.

6) “Bir çokgenin kenar sayısı 6 artarsa, iç açılarının ölçüleri toplamı 6 derece artar” ifadesi doğru mudur? Cevabınızı nedenleriyle açıklayınız.

7) “Bir çokgenin tüm kenarları eşit uzunlukta ise bu çokgen bir düzgün çokgendir” ifadesi doğru mudur? Cevabınızı nedenleriyle açıklayınız.

8) “Birbirine eş olan çokgenler aynı zamanda benzerdir” ifadesi doğru mudur? Cevabınızı nedenleriyle açıklayınız.

9) “Dikdörtgenlerin tüm açıları eşit ölçüde oldukları için dikdörtgenler birbirine benzerdir” ifadesi doğru mudur? Cevabınızı nedenleriyle açıklayınız.

10) “Düzgün sekizgenler birbirine benzerdir” ifadesi doğru mudur? Cevabınızı nedenleriyle açıklayınız.

APPENDIX B

SCORING RUBRIC FOR
CONDITIONAL KNOWLEDGE TEST QUESTIONS

Visual Skills: interpreting statements.
Verbal Skills: correct use of terminology, accurate communication in describing relationships.
Drawing Skills: appropriate use of symbols and notations.
Logical Skills: formulating and testing hypothesis, making inferences, using counter-explanations, develop mathematical arguments about geometric relationships

Score	Description
0	* No answer attempted. * Copies parts of the problem without attempting a solution. * Uses irrelevant information. * Includes conditional knowledge which completely misrepresent the problem situation.
1	* Shows very limited explaining of the principles, theorems, relations, and statements. * Fails to identify the important parts when expressing the “if-then” statements. * Gives incomplete evidence of the explanation process. * Places too much emphasis on unimportant relations when expressing the “if-then” statements.
2	* Shows some of the limited explaining of the principles, theorems, relations, and statements. * Identifies some important parts when expressing the “if-then” statements. * The relations expressed in the “if-then” statement is difficult to interpret and the arguments given are incomplete and logically unsound.
3	* Shows nearly complete explaining of the principles, theorems, relations, and statements. * Identifies the most important parts when expressing the “if-then” statements. * Shows general understanding of the relations in the “if-then” statements. * Gives a fairly complete response with reasonably clear explanations or descriptions. * Presents supporting logically sound arguments which may contain some minor gaps.

4	* Shows explaining of the principles, theorems, relations, and statements. * Identifies all the important parts when expressing the "if-then" statements. * Shows understanding of the relations in the "if-then" statements. * Gives a complete response with a clear, unambiguous explanation or description. * Presents strong, supporting, logically sound and complete arguments which may include counter-explanations or different aspects.

APPENDIX C

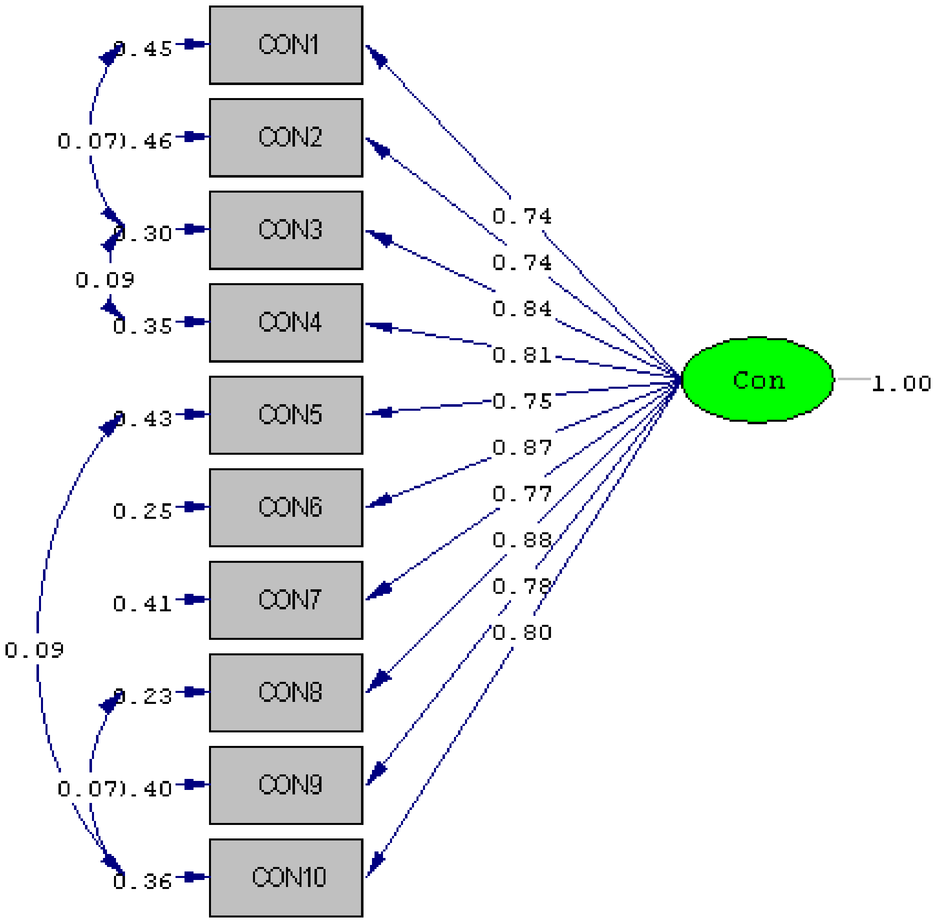
THE SIMPLIS SYNTAX FOR THE CONDITIONAL KNOWLEDGE TEST MODEL

```
Real Data Set
Observed Variables
CON1 CON2 CON3 CON4 CON5 CON6 CON7 CON8 CON9 CON10

Covariance matrix from File: con.cov
Sample Size = 259
Latent Variables
Con
Relationships

CON3 CON6 CON8 CON10 CON4 CON7 CON5 CON9 CON1 CON2 = Con

Set error Covariance Between CON4 and CON3 Free
Set error Covariance Between CON10 and CON8 Free
Set error Covariance Between CON10 and CON5 Free

Path Diagram
Admissibility Check = 1000
Iterations = 5000
End of problem
```

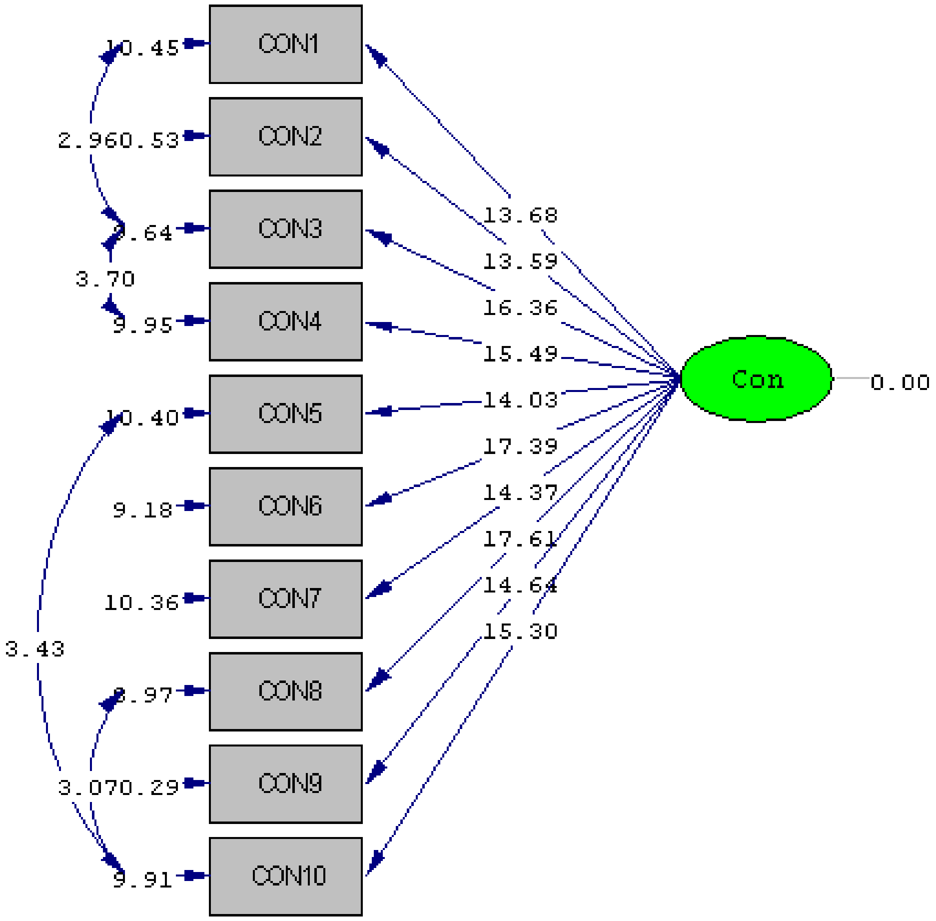
APPENDIX D

LISREL ESTIMATES of PARAMETERS in CONDITIONAL KNOWLEDGE TEST MODEL (COEFFICIENTS in STANDARDIZED VALUE and t-VALUES)

COEFFICIENTS IN STANDARDIZED VALUE



COEFFICIENTS IN t-VALUES



APPENDIX E

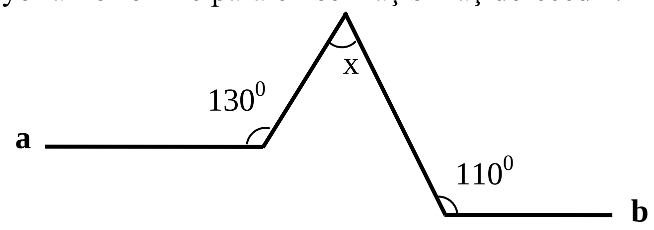
PROCEDURAL KNOWLEDGE TEST

Adı Soyadı: Sınıfı:

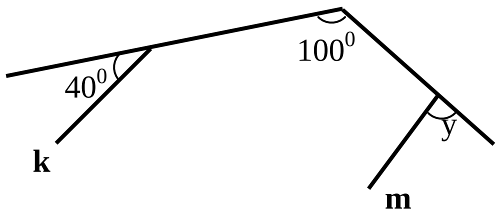
Bu sınav, 7. sınıfta öğrendiğiniz bazı geometri konuları ile ilgili 14 sorudan oluşmaktadır. Tüm sorularda açıklamalar yapmanız veya işlemlerinizi göstermeniz beklenmektedir. Lütfen bildiğiniz tüm soruları cevaplamaya çalışınız. Sınav süresi 40 dakikadır. Başarılar…

Aşağıdaki 1. ve 2. sorudaki şekiller farklı otoyollardaki bazı yolların birbirlerine göre durumlarını gösteren iki plandan alınmıştır. Yollar arasındaki bilinen açılar aşağıda verilmiştir.

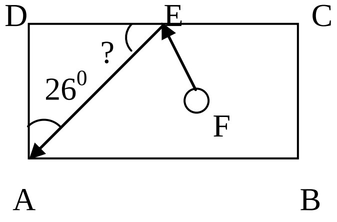
1) a ve **b** yolları birbirine paralel ise x açısı kaç derecedir?



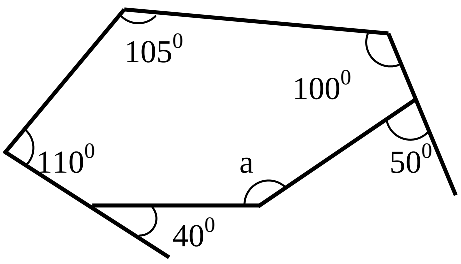
2) k ve **m** yolları birbirine paralel ise y açısı kaç derecedir?



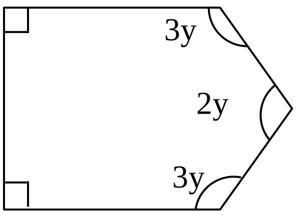
3) Dikdörtgensel bölge şeklindeki bilardo masasında F noktasından E noktasından atılan top aynı açıyla geri döner. Bilardo topu 26^0'lik açı yapacak şekilde A köşesine girerse $s(D\hat{E}A) = ?$



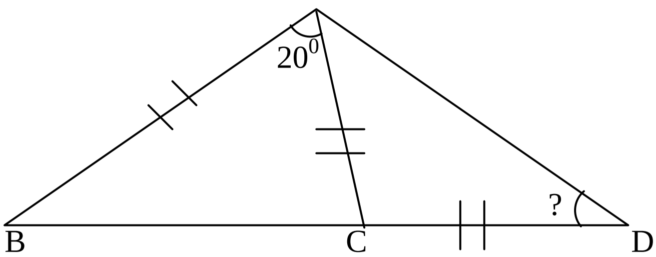
4) Altıgen şeklindeki bir arsanın çevrelediği duvar köşelerinin birbirleriyle yaptığı iç ve dış açıların ölçüleri, şekildeki gibi çizilen bir planda verilmiştir. Bu şekilde **a** iç açısının ölçüsü kaç derecedir?



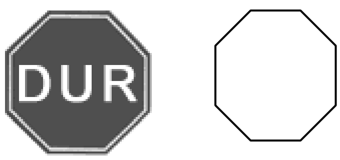
5) Beysbolda kale işareti olan levha beşgen şeklindedir ve iç açılarının ölçüleri 90, 90, 3y, 2y, ve 3y derece ise bu levhanın en büyük açısı kaç derecedir?



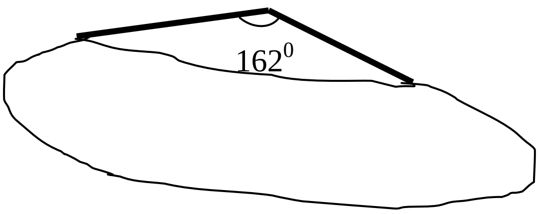
6) Aşağıdaki şekil birbirine komşu üçgensel bölge şeklindeki iki arsanın planından alınmıştır. Bu planda $s(\widehat{BAC}) = 20^0$ ve $|AB| = |AC| = |CD|$ ise D açısı kaç derecedir?



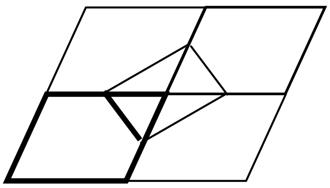
7) Bir usta, bir parça metalden <u>düzgün sekizgen</u> keserek 'DUR' işaretine ait levha yapmak istiyor. Bu levhanın her bir iç açısı kaçar derece olmalıdır?

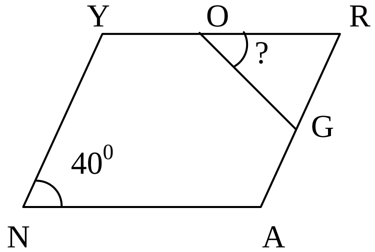


8) Düzgün çokgen şeklindeki bir levhanın üstü kısmen bir örtüyle kapatılmıştır. Açık olan bir köşesine ait iç açısının ölçüsü 162^0 olan bu levha kaç kenarlıdır?



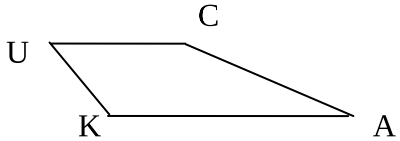
9) Bir yorgan deseni, şekildeki gibi birbirine eş olan eşkenar dörtgenlerden ve eşkenar dörtgenlerin birleştiği yerde üçgenlerden oluşmaktadır.



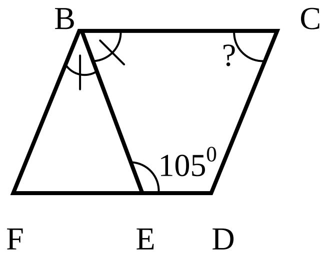


Yukarıdaki O ve G noktaları, YRAN eşkenar dörtgenin kenarlarının orta noktaları ve N açısının ölçüsü 40^0 ise GOR açısının ölçüsü kaç derecedir?

10) Bir uçağın arka kanadı aşağıdaki şekildeki gibi yamuk biçiminde tasarlanmıştır. UCAK yamuğunda, [UC] // [KA] ve K açısının ölçüsü, U açısının ölçüsünden 30^0 daha fazladır. Buna göre, K açısının ölçüsü kaç derecedir?

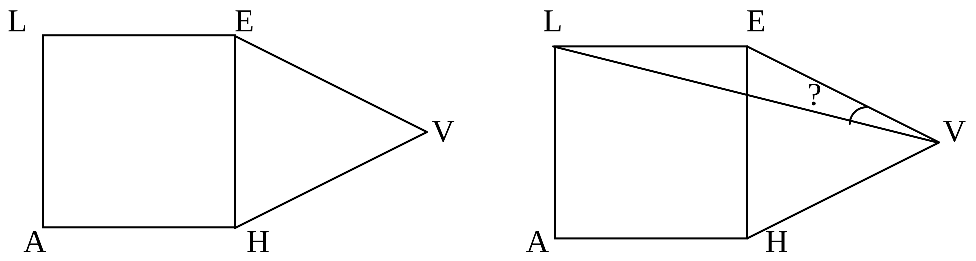


11) Aşağıdaki şekil, bir firmanın logosunun bir bölümünü göstermektedir.



BCDF paralelkenarında, E noktası FD doğru parçası üzerindedir. FBE ve EBC açılarının ölçüleri eşittir. BED açısının ölçüsü 105^0 ise C açısının ölçüsü kaç derecedir?

12)



Yukarıdaki yönü gösteren işaret levhası LEHA karesi ve EVH eşkenar üçgeninden oluşmaktadır. Buna göre EVL açısının ölçüsü kaç derecedir?

13) Ahmet 5 cm x 8 cm boyutlarında çektirdiği fotoğrafını büyülterek elindeki uzun kenarı 20 cm olan çerçevelerden birine yerleştirmek istiyor. Fotoğrafını kesmeden ve şeklini değiştirmeden kısa kenarı kaç santimetre olan bir çerçeve seçmelidir?

14)

Bir orman mühendisi kuruyan ağaçları kesmeden önce uzunluklarını hesaplamak istemektedir. Bir mühendisin gölgesi 8 dm ve boyu 18 dm ise gölgesi 96 dm olan bir ağacın yüksekliği kaç desimetredir?

APPENDIX F

SCORING RUBRIC FOR
PROCEDURAL KNOWLEDGE TEST QUESTIONS

Visual Skills: imaging
Verbal Skills: correct use of terminology
Drawing Skills: appropriate use of symbols and notations, accurate application of the algorithm.
Logical Skills: classification, recognition of essential properties of a geometrical
concept, formulating and testing hypothesis, making inferences, using counter-explanations,
appropriate use of the procedures, use visualization and spatial reasoning to solve problems.

Score	Description
0	* No answer attempted. * Copies parts of the problem without attempting a solution. * Uses irrelevant information. * Includes procedural knowledge which completely misrepresent the problem situation.
1	* Makes major computational errors when employing the algorithms and rules. * Reflects an inappropriate strategy for solving the problem. * Gives incomplete evidence of a solution process. * The solution process is missing, difficult to identify or completely unsystematic.
2	* Makes serious computational errors when employing the algorithms and rules. * Gives some evidence of the solution process. * The solution process is incomplete or somewhat unsystematic. * Makes significant progress towards completion of the problem but the algorithm is unclear.
3	* Executes algorithms and rules completely. * Computations are generally correct but may contain minor errors. * Gives clear evidence of a solution process. * The solution process is nearly complete and systematic.
4	* Executes algorithm and rules completely and correctly. * Reflects an appropriate and systematic strategy for solving the problem. * Gives evidence of a solution process. * The solution process is complete and systematic.

APPENDIX G

The SIMPLIS SYNTAX for the
PROCEDURAL KNOWLEDGE TEST MODEL

Real Data Set
Observed Variables
PRO1 PRO2 PRO3 PRO4 PRO5 PRO6 PRO7
PRO8 PRO9 PRO10 PRO11 PRO12 PRO13 PRO14

Covariance matrix from File: pro.cov
Sample Size = 192
Latent Variables
Pro
Relationships

PRO8 PRO14 PRO6 PRO12 PRO5 PRO1 PRO11 PRO7 PRO10 PRO4 PRO2 PRO13 PRO9 PRO3 = Pro
Set Error Covariance Between PRO14 and PRO1 Free
Set Error Covariance Between PRO8 and PRO6 Free
Set Error Covariance Between PRO14 and PRO13 Free
Set Error Covariance Between PRO10 and PRO8 Free
Set Error Covariance Between PRO10 and PRO6 Free
Set Error Covariance Between PRO4 and PRO3 Free
Set Error Covariance Between PRO8 and PRO5 Free
Set Error Covariance Between PRO14 and PRO5 Free
Set Error Covariance Between PRO10 and PRO3 Free
Set Error Covariance Between PRO12 and PRO9 Free
Set Error Covariance Between PRO11 and PRO7 Free
Set Error Covariance Between PRO13 and PRO7 Free
Set Error Covariance Between PRO7 and PRO1 Free
Set Error Covariance Between PRO14 and PRO11 Free
Set Error Covariance Between PRO5 and PRO4 Free
Set Error Covariance Between PRO9 and PRO7 Free
Set Error Covariance Between PRO13 and PRO2 Free
Set Error Covariance Between PRO11 and PRO1 Free
Set Error Covariance Between PRO12 and PRO7 Free
Set Error Covariance Between PRO12 and PRO10 Free
Set Error Covariance Between PRO13 and PRO11 Free

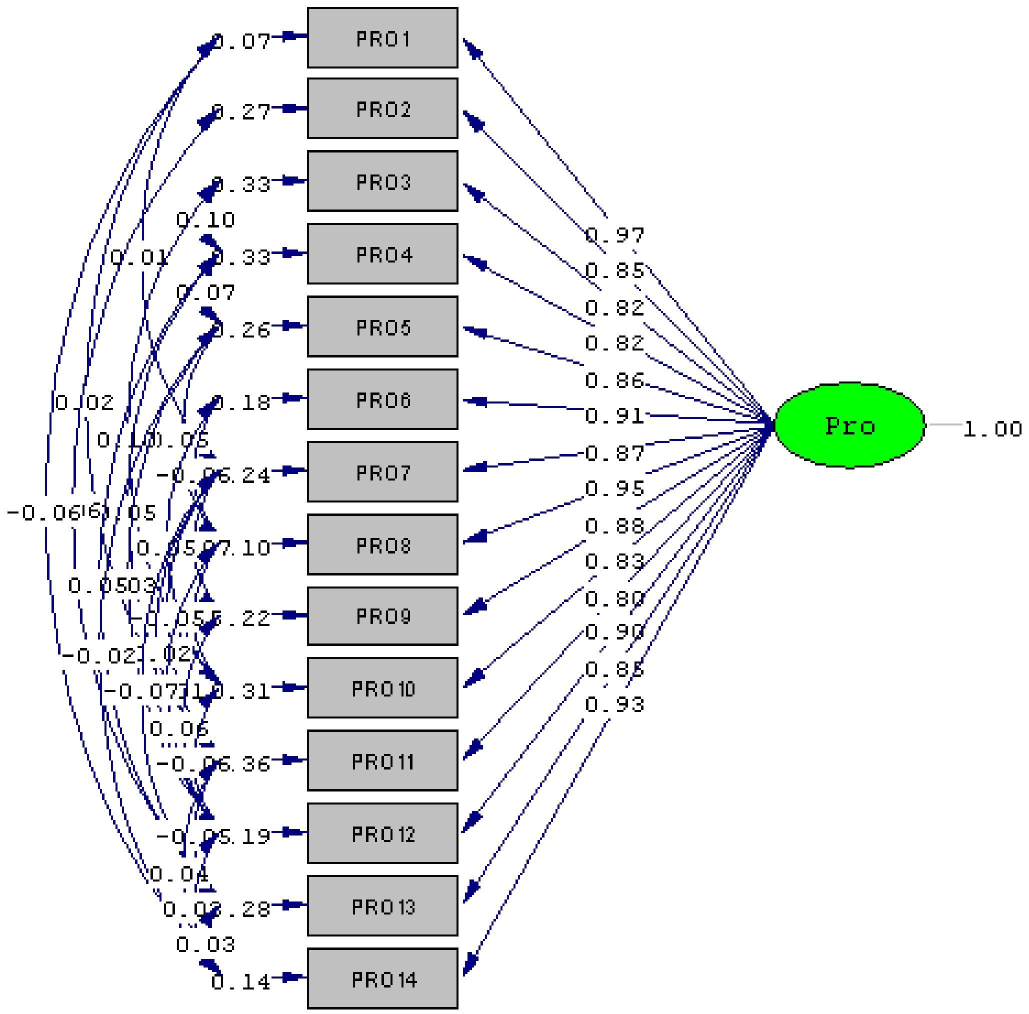
Set Error Covariance Between PRO12 and PRO8 Free
Set Error Covariance Between PRO13 and PRO4 Free
Set Error Covariance Between PRO14 and PRO12 Free
Set Error Covariance Between PRO11 and PRO4 Free
Set Error Covariance Between PRO12 and PRO5 Free

Path Diagram
Admissibility Check = 1000
Iterations = 5000
End of problem

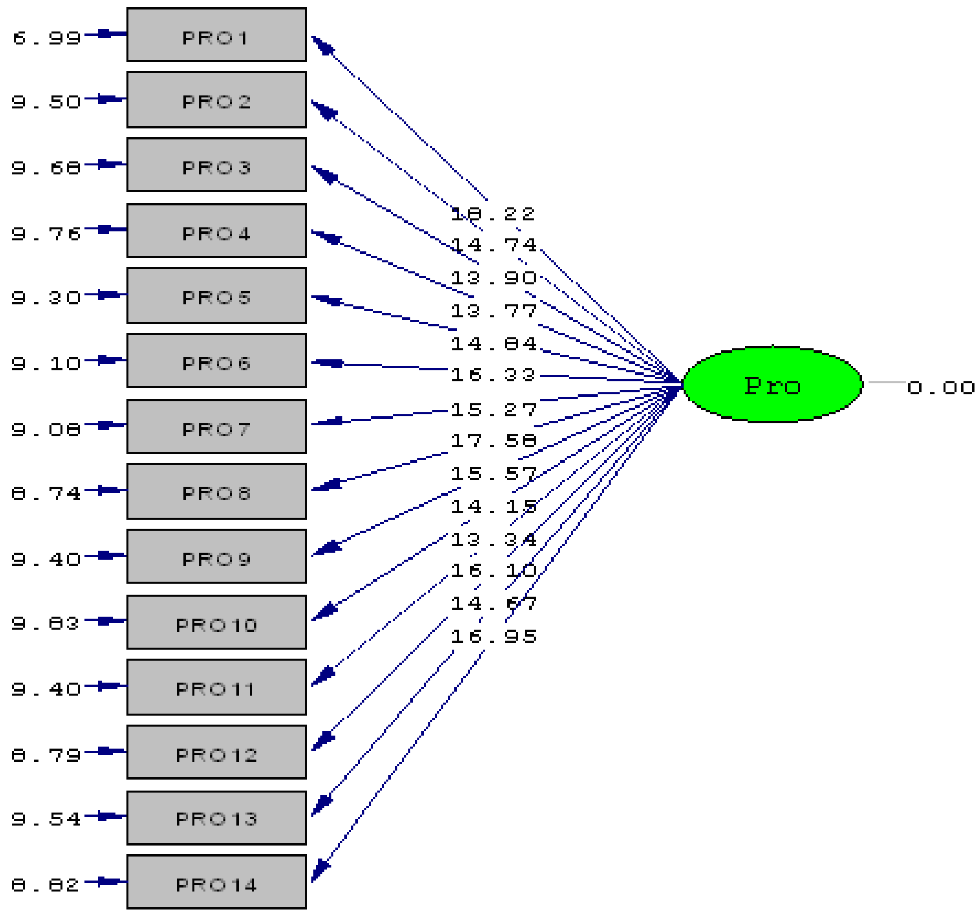
APPENDIX H

LISREL ESTIMATES of PARAMETERS in PROCEDURAL KNOWLEDGE TEST MODEL (COEFFICIENTS in STANDARDIZED VALUE and t-VALUES)

COEFFICIENTS IN STANDARDIZED VALUE



COEFFICIENTS IN t-VALUES



APPENDIX I

ACTIVE LEARNING STRATEGIES in and LEARNING VALUE of GEOMETRY QUESTIONNAIRE

GEOMETRİDE AKTİF ÖĞRENME STRATEJİLERİ ve ÖĞRENMENİN DEĞERİ ANKETİ

Aşağıdaki sorular 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 işaretleyiniz.

Adı Soyadı:________________________________ Sınıf:_____

	Hiç Uygun Değildir	Uygun Değildir	Kararsızım	Uygundur	Tamamen Uygundur
1. Yeni geometri kavramlarını öğrenirken bunları anlamak için çaba gösteririm.					
2. Yeni geometri kavramlarını öğrenirken, bunlarla daha önceki deneyimlerim arasında bağlantılar kurarım.					
3. Bir geometri kavramını anlamadığımda bana yardımcı olacak uygun kaynaklar bulurum.					
4. Bir geometri kavramını anlamadığımda, bu kavramı anlayabilmek için öğretmenimle ya da diğer öğrencilerle tartışırım.					
5. Öğrenme süreci boyunca, öğrendiğim kavramlar arasında bağlantılar kurmaya çalışırım.					

6. Bir hata yaptığımda, niçin hata yaptığımı bulmaya çalışırım.					
7. Anlamadığım geometri kavramlarıyla karşılaştığımda, yine de bunları anlamak için çaba gösteririm.					
8. Günlük hayatımda kullanabileceğim için geometri öğrenmenin önemli olduğunu düşünüyorum.					
9. Geometri beni düşünmeye yönelttiği için, geometrinin önemli olduğunu düşünüyorum.					
10. Geometride problem çözmeyi öğrenmenin önemli olduğunu düşünüyorum.					
11. Geometride araştırmaya yönelik etkinliklere katılmanın önemli olduğunu düşünüyorum.					
12. Geometri konularını öğrenirken merakımı giderecek fırsatların olması önemlidir.					

APPENDIX J

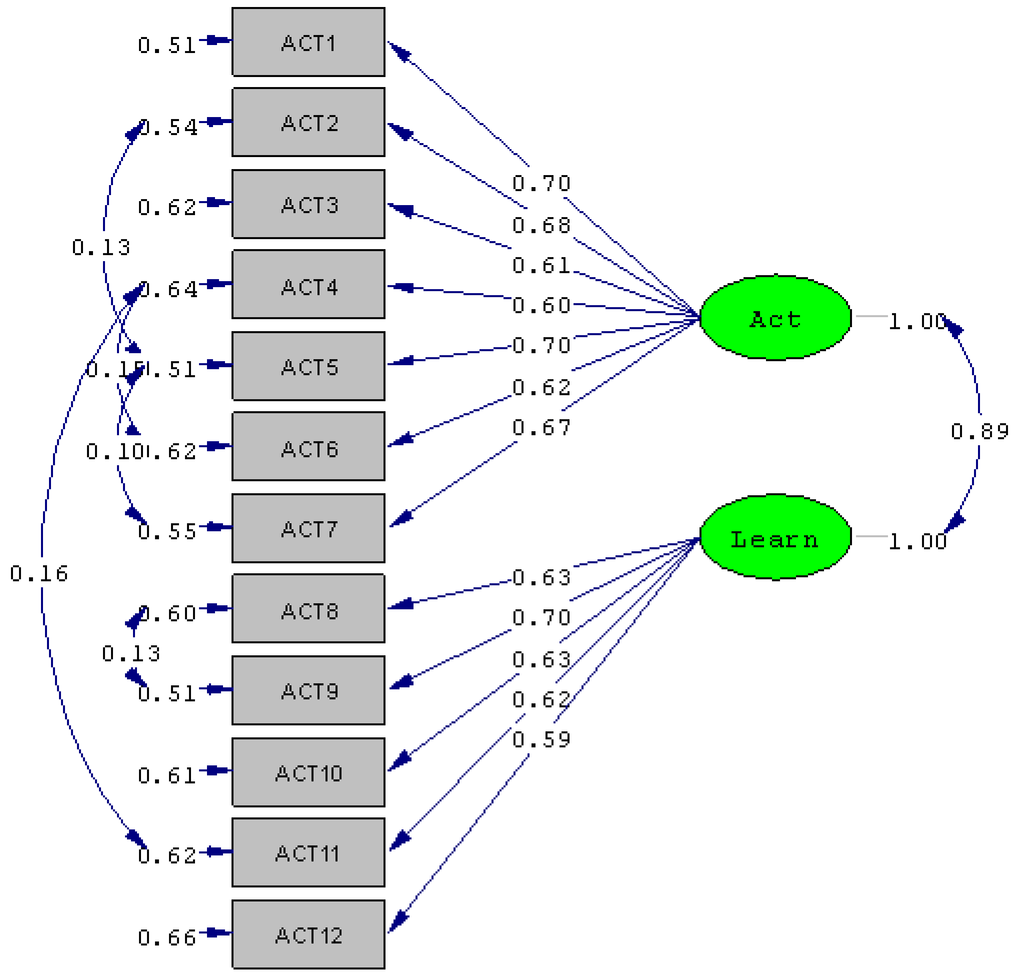
The SIMPLIS SYNTAX for the ACTIVE LEARNING STRATEGIES and LEARNING VALUE of GEOMETRY QUESTIONNAIRE

```
Real Data Set
Observed Variables
ACT1 ACT2 ACT3 ACT4 ACT5 ACT6 ACT7 ACT8 ACT9 ACT10 ACT11
ACT12
Covariance matrix from File: actsecond.cov
Sample Size = 277
Latent Variables
Act Learn
Relationships

ACT3 ACT6 ACT4 ACT5 ACT7 ACT2 ACT1 = Act
ACT8 ACT9 ACT11 ACT10 ACT12 = Learn

Set Error Covariance Between ACT11 and ACT4 Free
Set Error Covariance Between ACT6 and ACT4 Free
Set Error Covariance Between ACT5 and ACT2 Free
Set Error Covariance Between ACT9 and ACT8 Free
Set Error Covariance Between ACT7 and ACT5 Free

Path Diagram
Admissibility Check = 1000
Iterations = 5000
End of problem
```

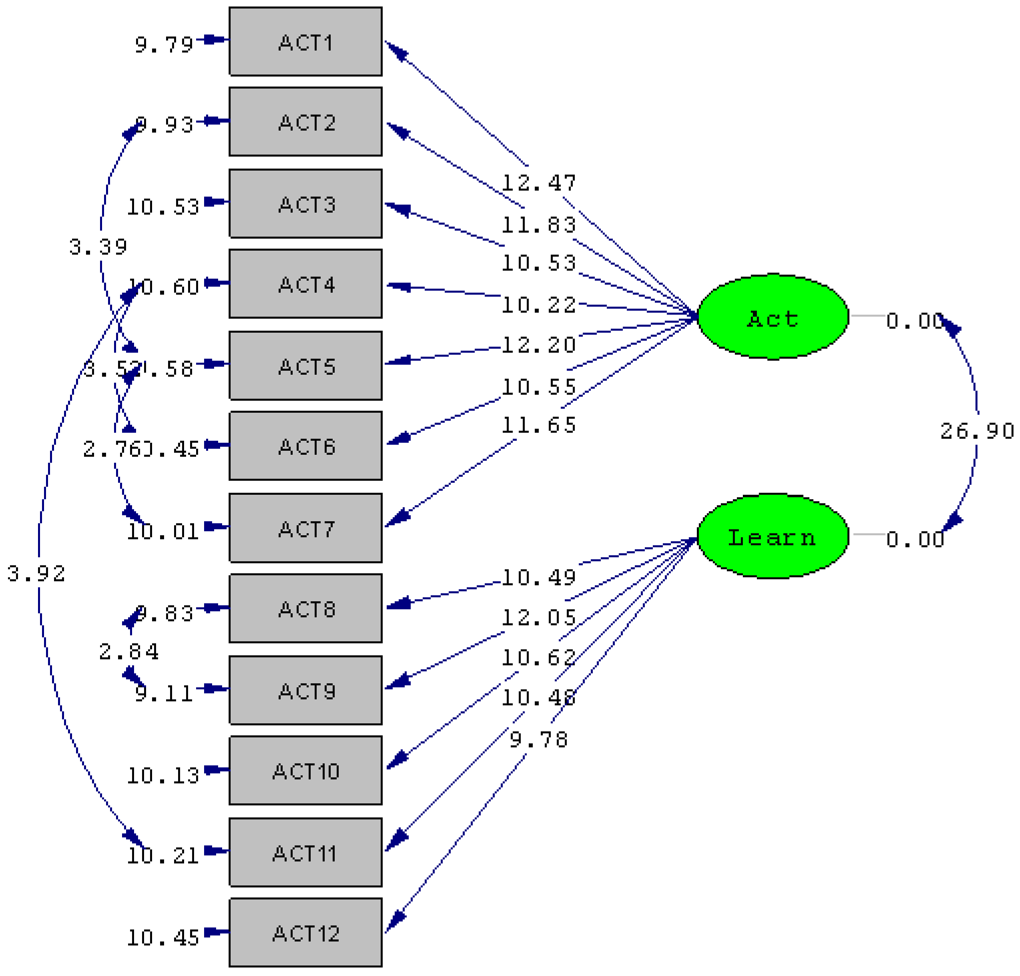
APPENDIX K

LISREL ESTIMATES of PARAMETERS in ACTIVE LEARNING STRATEGIES and LEARNING VALUE of GEOMETRY QUESTIONNAIRE MODEL (COEFFICIENTS in STANDARDIZED VALUE and t-VALUES)

COEFFICIENTS IN STANDARDIZED VALUE



COEFFICIENTS IN t-VALUES



APPENDIX L

GEOMETRY ATTITUDE SCALE

GEOMETRİYE KARŞI TUTUM ÖLÇEĞİ

Aşağıdaki sorular 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 işaretleyiniz.

Adı Soyadı:_________________________________ Sınıf:_____

	Tamamen 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.					

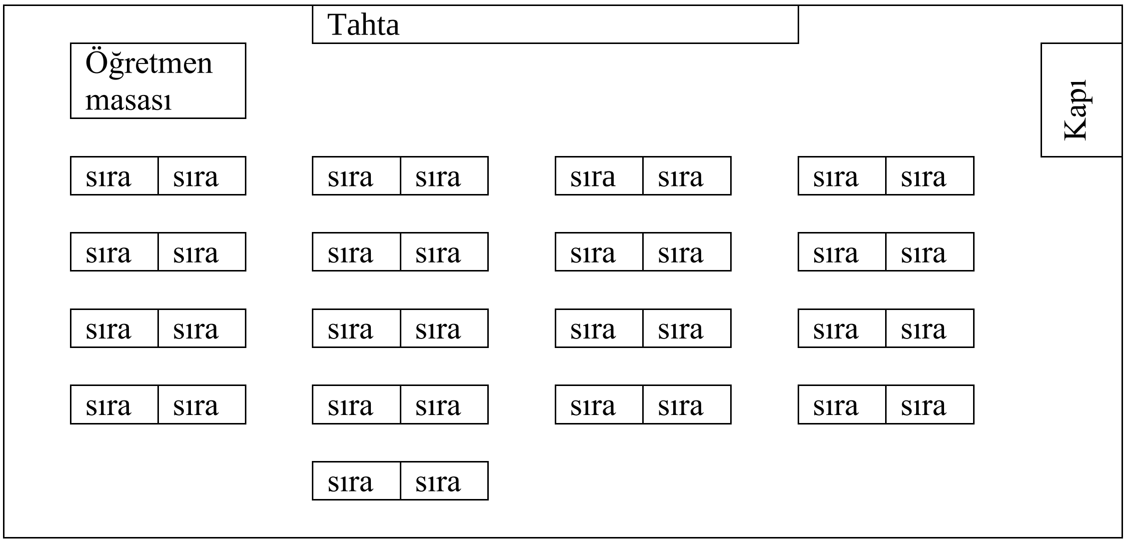
7. Geometriyi seviyorum.					
8. Geometri dersinde kendimi huzursuz hissediyorum.					
9. Geometri sorularını çözmekten zevk almam.					
10. Geometri çalışırken vaktin nasıl geçtiğini anlamıyorum.					
11. Matematiğin en zevkli kısmı geometridir.					
12. Geometri dersi sınavından çekinmem.					

APPENDIX M

LESSON PLANS

PART 1: BENCHMARK LESSONS (Ders Planı 1-4)

Öğrenciler projelerini oluşturmaya başlamadan önce bireysel çalışacaklardır ve sınıf yerleşim planı aşağıdaki gibi olacaktır.



DERS PLANI 1

YARARLANILAN DİSİPLİNLER: Matematik, Sosyal Bilgiler
TARİH:
SINIF: 7
SÜRE: 1 ders saati
KAZANIMLAR:
1) Sürükleyici soruyu (driving question) ve projeyi anlar.

YÖNTEM VE TEKNİKLER: Proje Tabanlı Öğrenme, Araştırma
KULLANILAN EĞİTİM TEKNOLOJİLERİ: Bilgisayar, Internet
ARAÇ ve GEREÇ: Sınıf içi araç gereçler, tepegöz, örnek planlar, proje çalışma yağrağı-1.1

DERSİN İŞLENİŞİ

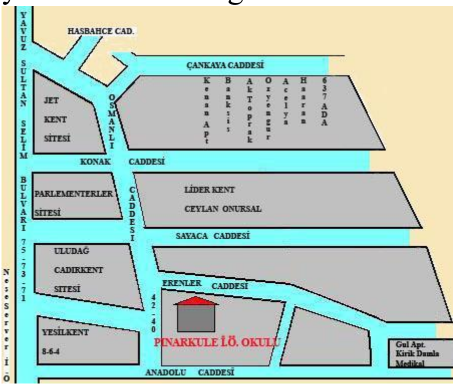
Sürükleyici Soru (Driving Question) ve Projeyle Tanışma ve Sosyal Bilgiler Dersi ve Günlük Yaşamla Bağlantı

1. Öğretmen projeyi öğrencilere tanıtmak için şu hikayeyi açıklar: "Diyelim ki bir şehirdeki bir mahalle gecekondulardan oluşuyor ve gecekondular yıkılıp o mahalle Kentsel Dönüşüm Projesiyle yeniden yapılandırılmak isteniyor. 'Hayalinizdeki mahalleyi nasıl tasarlarsınız?' konulu bir mahalle tasarım proje yarışması düzenleniyor. Sizler de farklı mesleklerden kişiler olarak bazı arkadaşlarınızla projeye katılacaksınız. Bir mahalle tasarımı için neler gerektiğini ve matematikle bağlantısını kurarak projenizi tamamlayacaksınız."

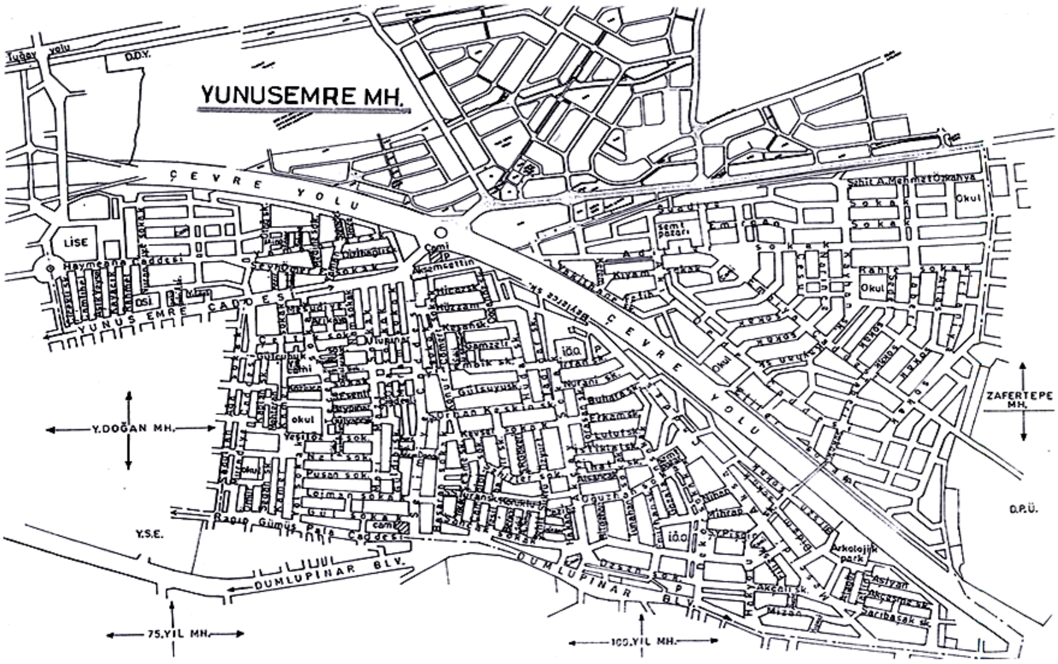
2. Öğretmen mahalle tasarımına geçince birlikte çalışacakları grup arkadaşlarını belirler. Bunun için her çalışma grubunda en az birer tane alandan bağımlı (field dependent), alandan tarafsız (field middle) ve alandan bağımsız (field independent) öğrenci olacak şekilde üç ya da dört öğrenci olacaktır. Öğretmen oluşturduğu grupları öğrencilere söyler. Bilişsel stillerine göre gruplandırıldıklarından söz etmeden bu grupların rastgele seçildiklerini söyler.

3. Öğretmen, öğrencilerin proje konusunu daha iyi anlamaları için şu soruları sorar: "Bir şehir hangi bölümlerden oluşur? Bir kişinin mesela postacının aradığı bir yeri bulabilmek için o yere ait neleri bilmesi gerekir?" Öğrencilerden "Şehir, ilçe, semt, mahalle, cadde ve sokak isimlerinin önemli olduğunu bilmemiz gerekir" yanıtı beklenir. Sosyal Bilgiler dersinde gördükleri 'Yakın çevremiz, sokak, cadde, mahalle, semt, köyümüzü tanıyalım' konusu hatırlatılarak burada öğrencilerin mahalle kavramına ulaşmaları beklenir. Öğrencilere mahalle kavramından bahsedilir: "Şehirdeki en küçük yerleşim birimleri mahallelerdir. Bir adresteki yeri belirlemek için önce mahallelerdeki yeri belirleriz. Daha sonra caddeyi kesen sokaklardan, aradığımız sokağı buluruz." Öğrencilere kendi mahalleleriyle ilgili şu sorular sorulur: "Sizin mahallenizde hangi bölümler var; caddeler birbirini nasıl kesiyor; ev veya apartmanların dışında hangi bölümler var?"

4. Öğretmen projeyi ve ne yapacaklarını iyi anlasınlar diye tepegözle asetatta aşağıdaki gibi bazı örnek mahalle planlarını öğrencilere gösterir. Bu planlar http://pinarkule.meb.k12.tr/ ve http://www.karaman.bel.tr/karaman-rehberi/mahalle-krokileri.aspx internet adresinden elde edilmiştir. Öğrenciler, krokilerde yer alan yolların birbirine göre durumlarını ve gördükleri çokgen çeşitlerini tartışırlar.



5. Yukarıdaki krokilere ek olarak, çok karışık olan krokilere de dikkat çekilir ve http://www.kutahyagundem.com/mahalle-krokileri internet adresinden alınan aşağıdaki gibi örnekler verilir.



Araştırma Ödevi

1. Öğrencilere proje çalışma yaprağı-1.1 dağıtılır. Bu yönergeyi öğrencilerin araştırmaları için yardımcı fikirler, projenin sınırlılıkları, projede öğrencilerin alacakları roller… vb konular içermektedir. Tüm öğrencilerden bireysel olarak şunları araştırmaları beklenir:

a) Kendi mahallenizin veya başka bir mahallenin planını,
b) bir mahallenin tasarımı için hangi mesleklerden kişilerin görev alacağını,
c) bu meslekteki kişilerin yaptıkları işlerin neleri içerdiğini ve
d) mahalle krokisi çizimindeki standartların neler olduğunu.

2. Araştıracakları bu konuları mahalle muhtarı, internet, aileniz, çevrenizdeki başka kişiler veya başka kaynaklardan, örneğin şehir bölge planlama mezunu bir tanıdıklarından, bulabilecekleri belirtilir.

3. Araştırma yapmaları için yaklaşık üç hafta verilecektir. Bu süre sonunda araştırmalarında elde ettikleri bilgileri sınıfa getirmeleri beklenir.

4. Dersin sonuna doğru projeyle ilgili öğrencilerden gelen sorular yanıtlanır.

PROJE ÇALIŞMA YAPRAĞI -1.1

2007-2008 Eğitim-Öğretim Yılı 2. Dönem 7. Sınıf Matematik Dersi
HAYALİMDEKİ MAHALLE PLANI TASARIMI PROJESİ

Çalışmaya Katılan Grup Üyelerinin İsimleri:

Diyelim ki bir şehirdeki bir mahalle gecekondulardan oluşuyor ve gecekondular yıkılıp o mahalle Kentsel Dönüşüm Projesiyle yeniden yapılandırılmak isteniyor. Bu amaçla HAYALİMDEKİ MAHALLE konulu bir mahalle tasarım proje yarışması düzenleniyor. Şehir bölge planlama uzmanı, mimar, mühendis ve peysaj mimarı gibi mesleklerden oluşan grubunuzun da bu projeye katılması beklenmektedir. Bir mahalle planı tasarımı için gerekenleri araştırıp, matematikle bağlantısını kurarak projenizi tamamlayacaksınız. Bu projede istenilenler aşağıda sıralanmıştır:

1) Projenize başlamadan önce mahalle planı hazırlamanıza yardımcı olması için aşağıdakileri araştırınız:
a) Bir mahalle planı tasarımında hangi meslekteki kişilerin görev aldığını ve bu meslekteki kişilerin yaptıkları işlerin neleri içerdiğini araştırınız. Bu konu ile ilgili belediyedeki yetkililerle veya o meslekten olan bir yakınınızla konuşup bilgi, belge, çizim, kroki, fotoğraflar vb. bir araya getiriniz. Mahalle planı çizimindeki standartların neler olduğunu da araştırınız. Mahalle muhtarınıza giderek veya ansiklopedi, kitap veya internet gibi diğer kaynaklardan bir örnek mahalle planı bularak bu planı sınıfa getiriniz. İncelemeniz önerilen web sayfaları şunlardır: www.tmmob.org.tr www.spo.org.tr www.planlama.org www.kentli.org www.kentselyenileme.org
b) Hangi şehirde bu mahalleyi kurmak istediğinize ve bu mahallenin coğrafî konumuna grup olarak karar veriniz. Bu şehrin iklim koşullarını ve bu iklim koşullarına göre hangi tip bitki örtüsünün bulunduğunu araştırınız. Belirleyeceğiniz ilin iklimine uygun bitki ve ağaç çeşitlerini araştırmak için sosyal bilgiler dersi öğretmeninize danışabilir veya Orman Bakanlığının internet sayfasından yararlanabilirsiniz.
c) Bu mahallenin arazisi içinde tarihî ve kültürel yapılar veya doğal alanların olup olmadığını araştırınız ve varsa o yapılara veya bölgelere zarar vermeden tasarımınızı yapınız. (Örneğin o arsada hazır camii, köprü… vb tarihî eser olan yapılar olabilir.)
d) Bir mahalle planında yer alan bölümleri araştırınız. Tasarlayacağınız mahallenin nüfusuna karar vererek bu mahallede yaşayan tüm bireylerin her türlü gereksinimlerini unutmadan, eski yaşam koşullarını daha iyiye götürerek ve çevresel etkileri de dikkate alarak mahallede mutlaka olması gerekenleri ve eklemek istediklerinizi listeleyiniz. Bu projede yer alan mahalle planında mutlaka olması gereken ve önerilen bölümler sınıf tartışmasından sonra sizlere belirtilecektir.

2) Bu projede aşağıdaki matematiksel kavramları uygulamanız beklenmektedir:

a) Kurulması planlanan mahalle dümdüz bir alan üzerinde ve 1200metre x 1700metre boyutlarındaki bir dikdörtgensel bölge şeklindedir. Hayalinizdeki mahallenin planını çizmeniz için 50cm x 70cm boyutlarındaki bir düz beyaz karton kullanmanız gerekiyor. Bu mahallenin planını çizmeniz için hangi ölçeği kullanmanız gerektiğine karar veriniz.

b) Projenizde yer alan bölümlere ait arsaların çizilebilmesi için aşağıdaki her bir bölümdeki geometrik şekilleri <u>en az ikişer kez</u> kullanmanız beklenmektedir:

* Üçgenlerden ikizkenar üçgen ve eşkenar üçgen,
* Dörtgenlerden paralelkenar, dikdörtgen, kare, eşkenar dörtgen, yamuk ve bu özelliklere sahip olmayan bir dörtgen,
* Düzgün beşgen, altıgen ve sekizgen
* Düzgün olmayan beşgen ve altıgen,
* Tüm açıları eşit ölçüde olup düzgün olmayan bir çokgen,
* Tüm kenarları eşit uzunlukta olup düzgün olmayan bir çokgen,
* Birbirine eş olan iki çokgen,
* Birbirine benzer olup eş olmayan iki çokgen şeklindeki arsalar olmalıdır.

Bunlara ek olarak projenizde yer alan cadde ve sokakların birbirlerine göre durumları aşağıdakiler olmalıdır:

* Bir noktada kesişen yollar,
* Üçgen oluşturan yollar,
* Birbirine paralel olan, paralel caddeleri dik kesen ve başka ölçüdeki açılarla kesen yollar,
* Birbirine paralel olmayan yollar olmalıdır.

c) Bir A4 kağıdı üzerinde ölçeksiz (gerçek ölçülere uymadan) bir kroki yapınız.

d) Grup üyeleri olarak taslak plan üzerinde gösterdiğiniz her bir bölümün geometrik şekline, gerçek kenar uzunluklarına, oluşan iç ve dış açıların ölçülerine ve her farklı bölümün arasındaki uzaklıklara karar veriniz. Bununla ilgili bir tablo hazırlayınız.

e) Gerçek boyutlarına karar verdiğiniz her bir bölüme ait geometrik şeklin, a şıkkında belirlediğiniz ölçeğe göre küçülteceğiniz mahalle planı üzerindeki kenar uzunluklarına, oluşan iç ve dış açıların ölçülerine ve her farklı bölüm arasındaki uzaklıklara karar veriniz. Bununla ilgili de bir tablo hazırlayınız.

3) Gerekli malzemeleri edininiz. (Açıölçer, cetvel, boya kalemi, grup için ve bireysel ayrı iki dosya, A4 kağıdı ve karton)

4) Mahalle tasarımı için ilgili belediyeden izin almanız gerekmektedir. Bunun için belediyeye bir dilekçe yazınız. Dilekçe yazmak için Türkçe öğretmeninize danışabilirsiniz.

5) Mahalle planında yer alan bölümleri istediğiniz renklerde boyayabilirsiniz.

6) Grubunuza bir isim bulunuz. Plan oluşturmak üzere aranızdan birini başkan seçiniz. Bulduğunuz tüm kaynakları, tüm yazılarınızı, çizimlerinizi… vb dosyanızda saklayınız ve aranızdan bir kişiyi bu iş için görevlendiriniz. Projenizi yaparken grubunuzdaki her bir öğrenci eşit görev alacaktır (tartışma ortamında, kaynak araştırırken, projeyi tasarlarken,…vb). Bazı durumlarda aranızda görev dağılımı da yapabilirsiniz ama projeye her öğrencinin eşit katılması beklenmektedir.

7) Sınıftaki her öğrenci, projenin başlangıcından bitimine kadar her hafta yapılan çalışmayı, okuduklarınızı, kullandığınız tüm kaynakları, gözlemlerinizi, karşılaşılan zorlukları ve bu zorlukları nasıl çözdüğünüzü vb not edecektir. Bu yazdıklarınızı ve belgelerinizi bir dosyanızda saklayınız. Projeyi tamamladıktan sonra genel bir rapor yazınız. Bu rapor içinde en çok ilginizi çekenleri, projede hoşlanmadıklarınızı, projeyi hazırlarken kullandığınız yöntemleri, projede en iyi yaptığınız ve zorlandığınız bölümleri, projeden neler öğrendiğinizi yazınız. Proje çalışması bitiminde her öğrenci bireysel dosyasını teslim edecektir.
8) Proje bitiminde grup olarak hazırlayacağınız iki boyutlu mahalle planı ve grubunuzun sunum raporu da teslim edilecektir.
9) Grup olarak tasarladığınız mahallenin planını ilgili belediyedeki uzmanlara sunum yoluyla tanıtmanız ve avantajlarını kabul ettirmeniz beklenmektedir. Sunumunuzda grubunuzdaki her bir öğrenci görev alacaktır. Sunumunuz en fazla 5 dakika sürmelidir. Sunum bitiminde mahalle tasarımınızı uygulamaya geçirmek için ilgili belediyeden izin almanız gerektiğini düşünerek bir dilekçe yazınız. Grup olarak yazdığınız dilekçeyi sunum sonunda teslim ediniz.

DERS PLANI 2

YARARLANILAN DİSİPLİNLER: Beden Eğitimi, Fen ve Teknoloji, Matematik, Müzik, Sosyal Bilgiler, Resim, Trafik, Türkçe.
TARİH:
SINIF: 7
Süre: SÜRE: 6 ders saati
ÜNİTE: Tam Sayılardan Rasyonel Sayılara
ÖĞRENME ALANI: Geometri-Ölçme
ALT ÖĞRENME ALANI: Doğrular ve Açılar-Açıları Ölçme
BÖLÜM: Aynı Düzlemdeki Üç Doğru
KAZANIMLAR:
1) Aynı düzlemde olan üç doğrunun birbirine göre durumlarını belirler ve inşa eder.
2) Yöndeş, iç, iç ters, dış ters açıları belirleyerek isimlendirir.
3) Paralel iki doğrunun bir kesenle yaptığı açıların eş olanlarını ve bütünler olanlarını belirler.
4) Paralel iki doğrunun bir kesenle yaptığı açıların ölçüleri ile ilgili hesaplamalar yapar.
DERS İÇİ İLİŞKİLENDİRME: Birinci dereceden bir bilinmeyenli denklemler, oran, kümeler (kümelerde kesişim ve boş küme), açılar (açıları isimlendirme, açıların iç ve dış bölgesi ve açı çeşitleri: dar açı, dik açı, geniş açı, doğru açı, tam açı, tümler açılar, bütünler açılar, ters açılar), doğru, doğru parçası, düzlem, diklik ve paralellik.
YÖNTEM VE TEKNİKLER: Proje Tabanlı Öğrenme, Araştırma, Keşfetme, Soru-Cevap
KULLANILAN EĞİTİM TEKNOLOJİLERİ: Bilgisayar, Internet
ARAÇ ve GEREÇ: Sınıf içi araç gereçler, düz çizgili A4 kağıdı, cetvel, geometri tahtası, geometri şeritleri, paket lastiği, açıölçer, noktalı ve izometrik kağıt, kareli kağıt, boya kalemleri, tepegöz, örnek fotoğraflar ve planlar, pekiştirici çalışma yaprakları 2.1 ve 2.2

DERSİN İŞLENİŞİ

<u>1. ders</u>

Sürükleyici Soru ve Sosyal Bilgiler Dersiyle Bağlantı

1. Öğretmen öğrencilere geometrinin hangi ihtiyaçtan dolayı ortaya çıktığını sorar. Öğrenci yorumlarından sonra öğrencilere geometrinin hangi ihtiyaçtan dolayı ortaya çıktığı anlatılır: "İnsanoğlu topraktan yararlanmaya ve ona sahip olmaya başladığı zaman ilk medeniyetin beşiği sayılan Nil Vadisi'nde yaz aylarında Nil Nehri taşar ve arazi hudutları silinirmiş. Ardından araziyi işlemek isteyenler arasında o arazinin kime ait olduğu ile ilgili kavgalar olurmuş çünkü arazi sınırlarının tekrar belirlenmesi gerekirmiş. Sonunda bu probleme kalıcı bir çözüm bulmuşlar ve gökyüzündeki yıldızların oluşturduğu üçgen, dörtgen, gibi şekiller arazi üzerine çizilmiş ve bunların sahipleri tespit edilmiş. Böylece ilk geometri konuları ortaya çıkmış. Sizler de bu örneğe benzer olarak bir yeri belirlemek amacıyla geometri bilgilerinizi kullanarak mahalle planınızı çizeceksiniz. Geometrinin başlangıç

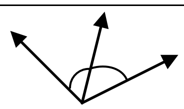
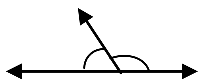
noktası olarak arazi çizimleri olduğu gibi günümüzde de bir yerin planının çiziminde de geometrik şekiller çok kullanılır.”

2. Öğrencilere, projelerini (hayallerindeki mahallenin tasarımı) doğru bir şekilde çizebilmeleri için gerekli olan geometri bilgisini bu süre içinde hep birlikte tartışarak ve araştırarak öğrenecekleri belirtilir. Kendi mahallelerinde yer alan cadde veya sokakların durumlarının nasıl olduğuna evlerine gittiklerinde yollardan geçerken dikkat etmeleri istenir.

Ders İçi, Diğer Derslerle ve Günlük Hayatla İlişkilendirme ve Teknoloji Kullanımı

1. Öğrencilere “Doğru açı nedir, tümler açılar nedir?” gibi sorular sorularak daha önceki yıllarda yer alan açılar konusunu (açıları isimlendirme, açıların iç ve dış bölgesi) ve açı çeşitlerini (dar açı dik açı, geniş açı, doğru açı, tam açı, tümler açılar, bütünler açılar, ters açılar) hatırlamaları beklenir.

2. Açı çeşitleri ile ilgili günlük hayattan aşağıdaki gibi fotoğraflar tepegöz yardımıyla gösterilir: Tümler ve bütünler açılar için yaprak fotoğrafları ve ters açılar için bina ve ütü masası fotoğrafları. Bu resimler http://images.google.com.tr/ internet adresinden alınmıştır. Öğrencilere bu fotoğraflarda gördükleri açı çeşitleri sorulur.

Tümler açılar için	Bütünler açılar için	Ters açılar için
		Hong Hong’daki Bank of China Binası  
		

3. Öğrencilerden gelen yanıtlardan sonra “Bütünler açıların ölçüleri toplamının 180^{o}”, “Tümler açıların ölçüleri toplamının 90^{o}” ve “İki doğru arasında ve zıt yönde olan açıların ters açılar ve ölçülerinin eşit” olduğu hatırlatılır. Yukarıdaki gösterimleri tahtaya çizilir.

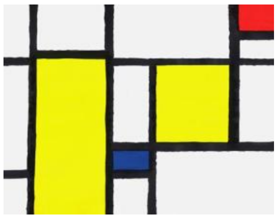
4. Öğrencilerden kendilerinin diğer derslerinde ve genel olarak günlük hayattan tümler, bütünler ve ters açılarla ilgili örnekler vermeleri istenir.

5. Öğrenci yorumlarından sonra açıların kullanımına örnek olarak http://images.google.com.tr/ internet adresinden alınan aşağıdaki fotoğraflar ve resimler gösterilir.

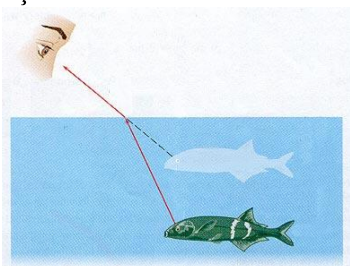
(a) Doğada örneğin yukarıdaki gibi yapraklarda,

(b) Bazı mesleklerde örneğin pilotlar, askerler, denizcilerin yönlerine karar vermek için magnetik pusula kullanımı ve tasarımcıların 30-60-90 ve 45-45-90 derece açılar ölçen T cetveli kullanımı ve ünlü ressamların örneğin Piet Mondrian ve Wassily Kandinsky'nin resimlerinden örnekler






c) Diğer derslerde örneğin Teknoloji ve Tasarım dersinde T cetveli kullanımı ve Fen ve Teknoloji dersinden kırılma ve gelen ışığın düz aynada yansımasıyla oluşan açılar



Pekiştirici Ödev

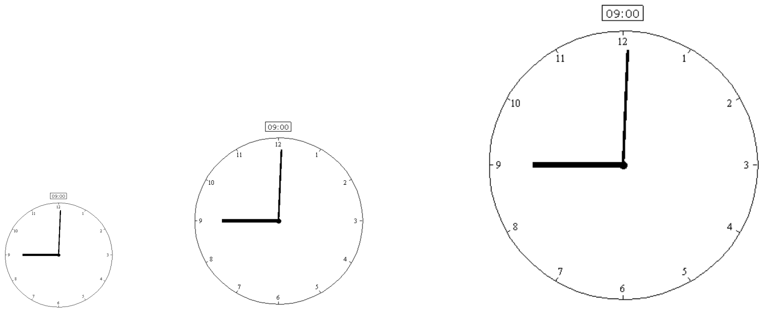
1. Öğrencilere, doğru açı, dik açı, tümler, bütünler ve ters açılarla ilgili pekiştirici çalışma Yaprağı-2.1 dağıtılır. Çalışma yaprağındaki tüm sorular günlük hayattan bir durum içinde hazırlanmış sorulardır.

PEKİŞTİRİCİ ÇALIŞMA YAPRAĞI-2.1

DOĞRU AÇI, DİK AÇI, TÜMLER, BÜTÜNLER VE TERS AÇILAR

1) SAAT

Aşağıda üç farklı büyüklükte saat vardır ve hepsi saat 9:00'ı göstermektedir.



a)Yukarıdaki saatlerde akrep ve yelkovan arasındaki açılar kaçar derecedir? Bu açı şekil üzerinde nasıl gösterilir? Bu hangi açı çeşidine eşittir?

b) Saatin büyüklüğü ile akrep ve yelkovan arasındaki açının ölçüsü değişir mi? Neden?

c) Saatlerin hepsinde saat 9:37 olsaydı akrep ve yelkovanlar arasındaki açıların ölçüleri farklı olur muydu? Neden?

2) DİRSEK HAREKETLERİ

İrem'in geçirdiği kazadan dolayı alçıya alınan kol dirseği açılınca dirseğini hiç hareket ettiremiyordu ve fizik tedaviye başladı. İlk alçı açılınca İrem'in alçılı dirseği en fazla 35^0 açılabiliyordu. Doktor, İrem'in bileklerini önce 90^0, sonra da 180^0 döndürmesi için egzersizler verdi. Egzersizleri yapan İrem her gün bileklerini kaç derece döndürdüğünü ve geriye kaç derecelik açısı kaldığını hesaplıyordu.

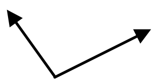
1. gün İrem bileğini <u>18^0 daha</u> döndürmüştür.

a) İrem dirseğini toplam kaç derece açabilmektedir?

b) Dik olarak tutması için dirseğini kaç derece daha açması gerekmektedir?

c) İrem'in dirseğini açabildiği açı ile dik döndürebilmesi için kalan açı hangi açı türüne örnektir? Neden? Bu durumu şekil üzerinde gösteriniz.

2. gün bileğini dik tutmayı başarmıştır**.** Kolu şekildeki gibi gösterilirse aradaki açı hangi sembolle gösterilir?



3. gün <u>55^0 daha</u> hareket ettirirse 180^0 döndürmesi için kaç derecelik açısı kalmıştır? İrem'in dirseğini döndürebildiği açı ile 180^0 döndürebilmesi için kalan açı hangi açı türüne örnektir? Neden? Bu durumu şekil üzerinde gösteriniz.

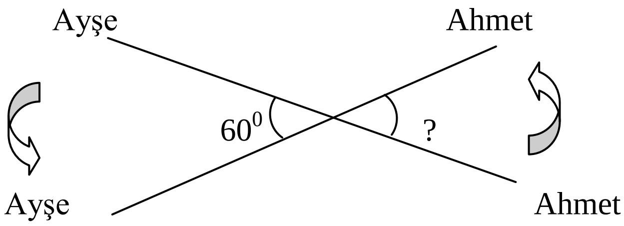
İrem 4. gün toplam 180^0 döndürmeyi başarmıştır.

3) KAYAK ATLAYICISI

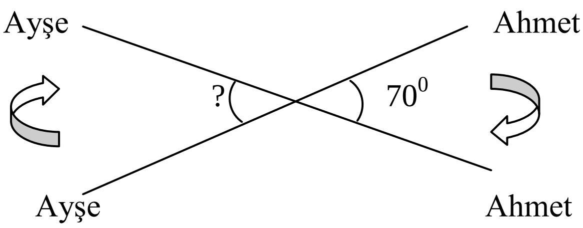
Olimpik kayak atlayıcısı olabildiğince uzağa atlayabilmesi için kendi vücudu ve kayak önü arasında olabildiğince az açı yapmak ister. Önünde 20^0 açı varsa bu yarışçının arka tarafıyla yaptığı açı kaç derecedir? Bu iki açı hangi açı çeşidine örnektir? Bu durumu şekil üzerinde gösteriniz.

4) TAHTEREVALLİ

İki kardeş (Ayşe ve Ahmet) şekildeki gibi tahterevalliye binmektedir. Ayşe tahterevallide 60^0 aşağı inerse Ahmet kaç derece yukarı çıkar? Bu hareket hangi açılara örnektir?



Ahmet tahterevallide 70^0 aşağı inerse Ayşe kaç derece yukarı çıkar? Bu hareket hangi açılara örnektir?



5) TERZİ

Bir terzi kumaş kesmek için makasını 48^0 açmıştır. Makasını tamamen kapatması için kaç derecelik açı yapması gerekir? Bu hangi açılara örnektir?

2. ders

Proje ve Sosyal Bilgiler Dersiyle Bağlantı

1. Hazırlayacakları mahalle krokisinde caddelerin birbirlerine göre durumlarını inceleyebilmeleri için bir düzlemdeki üç farklı doğrunun birbirlerine göre durumlarını inceleyecekleri belirtilir.

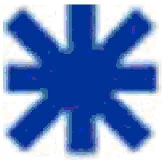
Ders İçi İlişkilendirme

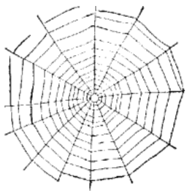
1. Öğrencilere daha önceki yıllarda gördükleri şu kavramlar ve sembolleri sınıf ortamında bulunan örneklerle hatırlatılır: Nokta, doğrular, paralel doğrular, düzlem, boş küme ve kümelerde kesişim. Örneğin düzlem için tahta düzlemi gibi. Öğrencilere bir düzlem üzerindeki üç farklı doğrunun birbirlerine göre durumlarının neler olabileceği sorulur. Öğrencilerden kendi fikirlerini geometri çubukları veya cetveller yardımıyla göstererek açıklamaları beklenir.

Günlük Hayatla İlişkilendirme ve Teknoloji Kullanımı

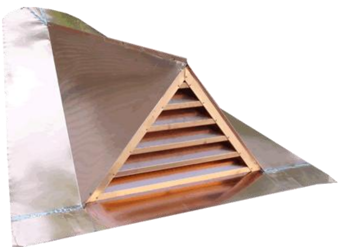
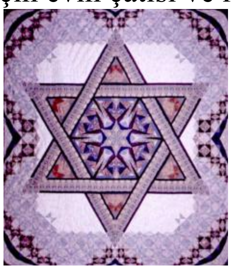
1. Bir düzlemde üç farklı doğrunun birbirine göre durumları, geometri tahtası, geometri çubukları ve cetveller kullanılarak ve tepegöz üzerinde http://images.google.com.tr/ internet adresinden alınan günlük hayattan örnek fotoğraflar gösterilerek öğrencilere keşfettirilir:

a) Bir noktada kesişen doğrular için logo, tekerlek, direksiyon, örümcek ağı, bisiklet, yaprak, farklı ülkelerin bayrakları,



b) üçgen oluşturan yollar için evin çatısı ve mozaik;


c) birbirine paralel olan üç doğru için Anıtkabir, resmi tören, raf, merdiven, ev, gemi, müzik aletleri, olimpiyat yarışı, farklı ülkelerin bayrakları, trafik işaretleri ve ışığın düz ve çukur aynada yansıması



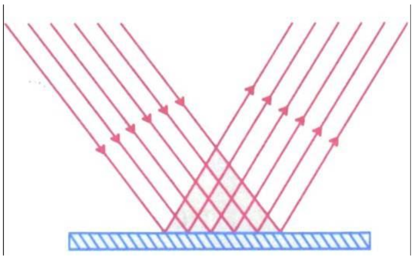
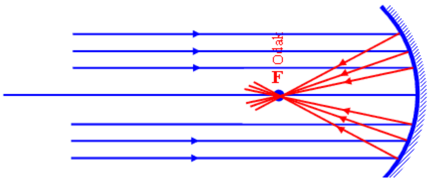




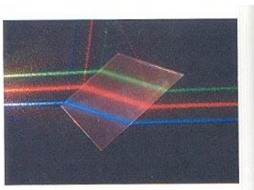
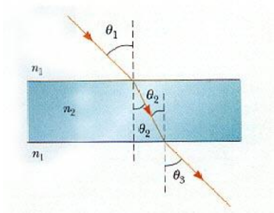


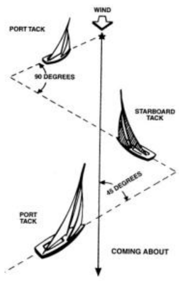


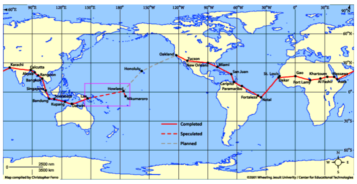


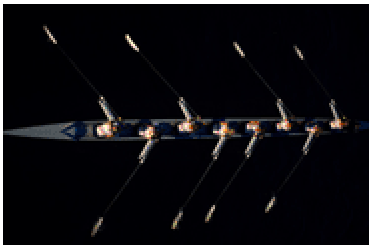
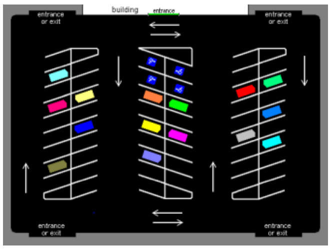
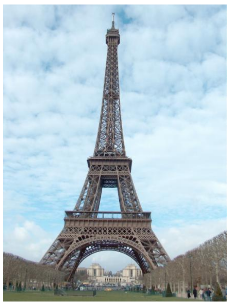
d) paralel olan iki doğruyu kesen bir doğru için ışığın kırılması, gemi, gemi güzergâhı, paralel ve meridyenler, bayraklar, trafik işaretleri, kürek çeken sporcular, park yerindeki çizgiler, Eiffel Kulesi, binaların dış görüntüleri, eğrelti otu ve zigzaglı cetvel.



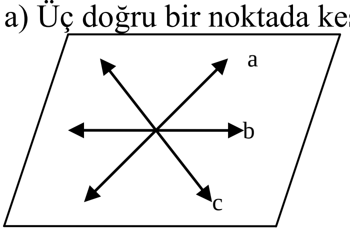
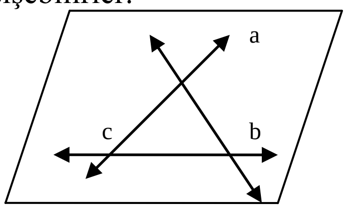
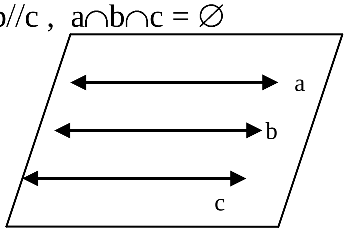
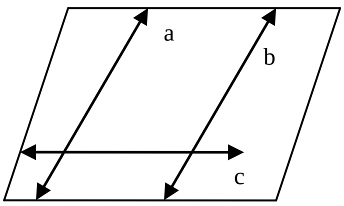




2. DERS PLANI 1'de gösterildiği gibi örnek mahalle planları tekrar gösterilir. Öğrenciler bu planlarda gördükleri yolların birbirine göre durumlarını tartışırlar.

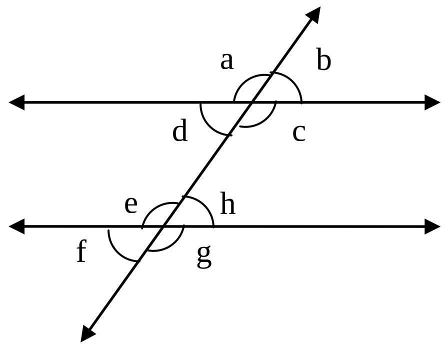
3. Bir düzlemde üç doğrunun birbirine göre durumlarını gösteren şekilleri ve sembolleri tahtaya çizilir.

<table>
<tr>
<td>a) Üç doğru bir noktada kesişebilir.
</td>
<td>b) Birbiriyle ikişer ikişer farklı noktalarda kesişebilirler.
</td>
</tr>
<tr>
<td>c) Üçü de birbirine paralel olabilir. Bu doğruların kesişimleri boş küme olur. $a//b//c$, $a \cap b \cap c = \varnothing$
</td>
<td>d) İkisi paralel, üçüncüsü diğer ikisini birer noktada kesebilir. $a//b$
</td>
</tr>
</table>

Son madde için şu tanım yazılır: “Paralel olan iki doğrunun her birini farklı bir noktada kesen üçüncü bir doğru, bu iki doğrunun ‘keseni’ olarak adlandırılır.”

3. Ders

1. Öğrencilere iki paralel doğruyu üçüncü bir doğrunun kesmesine örnek olarak düz çizgili bir A4 kağıdı verilir. Paralel çizgilere aşağıdaki şekildeki gibi bir doğru parçası çizer. Oluşan açılar şekildeki gibi isimlendirilir. Açıölçer yardımıyla öğrenciler kendi kağıtlarında oluşan sekiz açının ölçüsünü bulurlar. Açılar arasındaki eş ölçüde olanlar öğrencilere keşfettirilir.



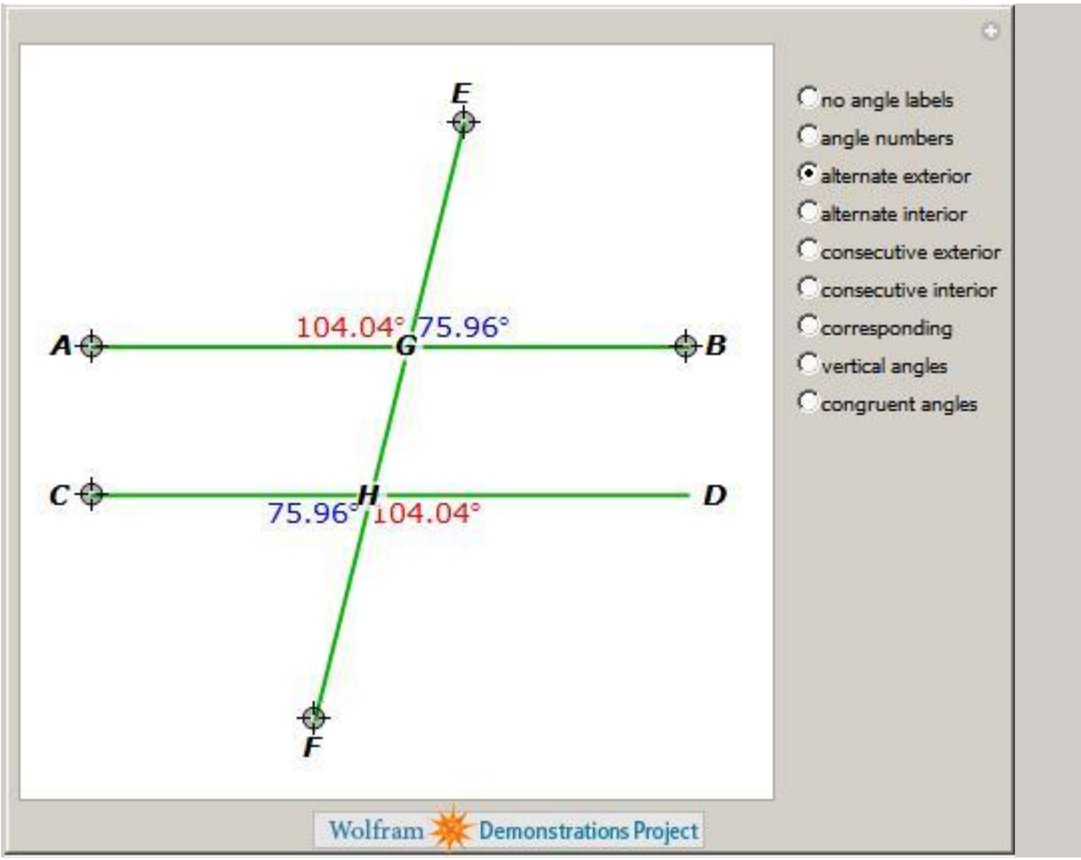
2. Paralel doğruların bir kesenle kesilmesi durumunda yöndeş, içters ve dışters açıların ölçülerinin eşit olduğu keşfettirilir ve bu tahtaya yazılır. Görsel öğrenen öğrenciler için yöndeş açılar F harfine ve iç ters açılar Z harfine benzetilir.

Yöndeş açılar	İçters açılar	Dış ters açılar
a ve e d ve f b ve h c ve g	c ve e d ve h	a ve g b ve f

3. “Oluşan sekiz açıdan (a, b, c, d, e, f, g, h), bir açının ölçüsünün bilinmesi diğer yedi açının ölçülerinin bulunmasını sağlar mı?” sorusu öğrencilerle tartışılır.

Teknoloji Kullanımı

1. Öğrencilere
http://demonstrations.wolfram.com/ParallelLinesAnglesWithATransversal/
adresinden indirilen dinamik geometri yazılımı gösterilir. Bu yazılım, paralel iki doğruyu kesen üçüncü bir doğru olması durumunda oluşan açıları içerir. Bu üç doğrudan biri hareket ettirilse bile AB ve CD doğrularının paralelliği değişmediği için oluşan sekiz açıyla ilgili yöndeş, iç ters ve dış ters açıların ölçülerinin eşitliği değişmez.



4. Ders

Günlük Hayat ve Diğer Derslerle İlişkilendirme

1. Öğrencilerden günlük hayattan bir düzlemdeki üç doğruya, özellikle paralel iki doğruyu kesen üçüncü bir doğrunun olması durumuna örnek vermeleri istenir.

2. Öğrencilerden gelen cevaplara göre DERS PLANI 2'deki 1. ve 2. derste gösterilen örnek fotoğraflar üzerinde bazı mesleklerin bu açı çeşitlerini nasıl kullandıkları ile ilgili örnekler tartışılır. Örneğin öğretmen şu açıklamaları yapar ve soruları sorar:

a) Millî bayramlarda Hava Kuvvetleri uçakları gösteri yaparlar. Neden birbirine çarpmadan uçarlar?

b) Bazı gemiler rüzgârdan dolayı ulaşmak istedikleri yere doğrudan doğrusal olarak gidemezler. Bunun yerine gemiyi 45^0, 90^0 şeklinde çevirerek zigzag çizerler.

c) Kürekçiler daha hızlı olmak için aynı anda birbirine paralel kürek çekerler.

d) Marangozlar birbirine paralel doğruları ve kesenleri çok kullanırlar.

e) Hava durumu sembollerinde birçok geometrik şekil kullanılmaktadır.

f) Otoparktaki çizgiler neden birbirine paraleldir? Farklı otoparklarda çizgiler farklı ölçülerdeki açılardan oluşmaktadır. 30, 45, 60 ve 90 derece gibi. Neden farklı açılar kullanılmış?

g) Tasarımcılar 30-60-90 ve 45-45-90 derece açılar ölçen T cetveli kullanırlar. Her türlü tasarımda örneğin logo tasarımında kullanılır.

h) Yol, köprü ve tünel gibi yapıları inşa ederken mimar, mühendis, şehir plancısı neyi düşünmelidir? Paralel doğruları kesen doğruları ve bu durumda oluşan açıları neden kullanıyorlar?

3. Öğrencilere diğer derslerinde şimdiye kadar gördükleri hangi konuların bir düzlemdeki üç doğruya özellikle paralel iki doğruyu kesen üçüncü bir doğrunun olması durumuna örnek verilebileceği sorulur. Öğrencilerden gelen cevaplara göre aşağıdakiler vurgulanır:

a) Fen ve Teknoloji dersinden, çukur aynalara gelen açılar paralel yansır. Yansıma olayında, düzlem ayna kullanılarak gelme ve yansıma açıları birbirine eşittir. Eski lokomotif trenlerde ve araba cam sileceklerinde paralel bağlantılar kullanılırmış. Işık ışınları, saydam bir ortamdan farklı bir ortama geçerken kırılır ve doğrultuları değişir. Paralel gelen ışık demetleri paralel yansır.

b) Paralel doğrular ve kesene müzik aletlerinden örnekler verilir.

Projeyle İlişkilendirme

1. DERS PLANI 1'deki gibi örnek planlar tekrar gösterilir. Bu planlar üzerinde öğrencilere,

a) birbirine paralel iki caddenin üçüncü bir cadde tarafından kesen durumun olduğu caddeler ve oluşan açılar ve

b) bir yerin planını elle çizenlerin iki caddenin birbirine göre tam paralel olup olmadığını neye göre karar verdikleri sorulur.

<u>5. ve 6. Ders</u>

1. Öğrencilere üç doğrunun birbirine göre durumu ve oluşan açıların ölçüleriyle ilgili pekiştirici çalışma yaprağı-2.2 verilir. Bu çalışma yaprağı daha çok bir yerin planının çizilmesiyle ilgili aşağıdaki kavramları içermektedir:

a) Bir düzlemde üç doğrunun birbirine göre durumları,

b) paralel iki doğruyu üçüncü bir doğru kesmesi durumunda oluşan eş açılar ve

c) paralel olmayan iki doğruyu üçüncü bir doğru kesmesi durumunda oluşan açılar.

.

2. Öğrenciler önce sıra arkadaşlarıyla sonra sınıfta çalışma yaprağı sorularını tartışırlar. Öğretmen kendi görüşünü söylemeden sınıfta "Farklı düşünenler var mı?" diye sorar. Cevap veren kişinin söylediği doğru ve sınıfta da aksi cevap gelmezse soru geçilir.

3. Öğrencilerin her birinden ertesi gün için herhangi bir üçgen getirmeleri istenir.

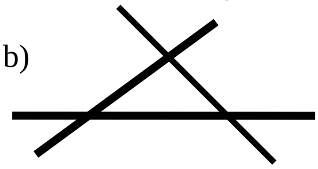
PEKİŞTİRİCİ ÇALIŞMA YAPRAĞI-2.2

ÜÇ DOĞRUNUN ARKADAŞLIĞI

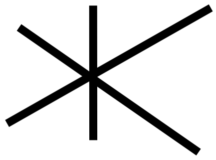
1) Aşağıdaki 3 caddenin birbirine göre durumlarını belirleyiniz.

a) 

…………………

b) 

……………………………

c) 

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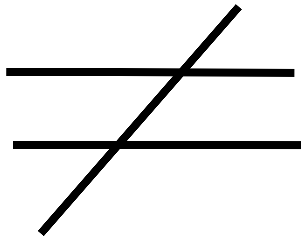
d) 

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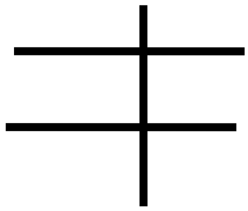
e) 

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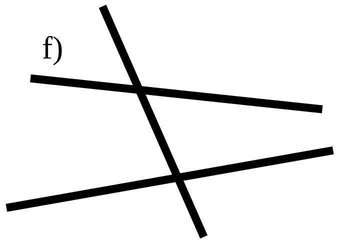
f) 

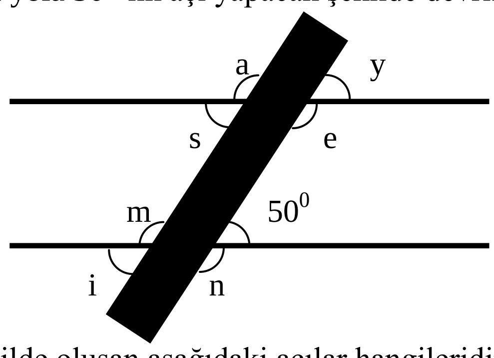
……………………………

2) 1. sorunun **d** şıkkında yer alan açıların ölçülerini açıölçer yardımıyla bulunuz. Burada eş ölçüdeki açıları belirtiniz.

3) 1. sorunun **e** şıkkındaki açıların ölçülerini açıölçer yardımıyla bulunuz.

4) 1. sorunun **f** şıkkındaki açıların ölçülerini açıölçer yardımıyla bulunuz. Burada eş ölçüdeki açılar (varsa) nelerdir? Bu üç doğrudan birbirine paralel olanlar var mıdır? Neden?

5) Aşırı rüzgârdan dolayı yolun bir kenarındaki uzunca bir kavak ağacı şekildeki gibi yola 50$^{0'}$ lik açı yapacak şekilde devrilmiş ve yolu trafiğe kapatmıştır.



Ağacı kaldırmak için iki vinç, ağacın yolun iki yanını kestiği noktalarda beklemektedir. Ağacı kaldırabilmeleri için aynı anda hareket etmeleri gerekmektedir. Bunun için de diğer yedi açının ölçülerini bilmeleri gerekmektedir.

Şekilde oluşan aşağıdaki açılar hangileridir? Tüm olasılıkları yazınız.

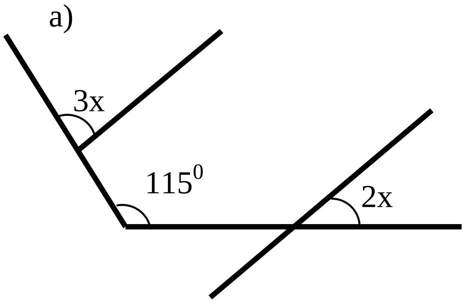
Yöndeş açılar	İç ters açılar	Dış ters açılar	Komşu bütünler açılar	Ters açılar

Burada oluşan açıların hangileri eşittir?

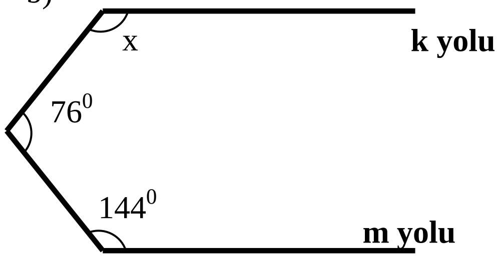
Şekilde oluşan diğer yedi açının ölçüsü (y, a, s, e, m, i, n) nedir?

6) Aşağıda bazı yolların krokileri ve bu yolların kaçar derecelik açılar oluşturduğu verilmiştir. Hepsinde **k** ve **m** yolları paralel ise aşağıda x açıları kaç derecedir? (Her bir kroki birbirinden farklı yerlerin krokisini göstermektedir.)

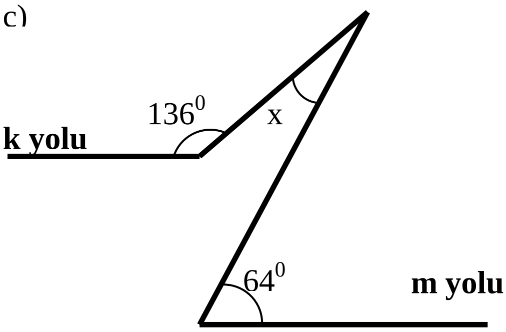
a)



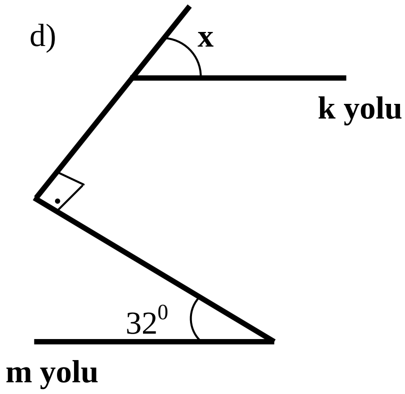
b)



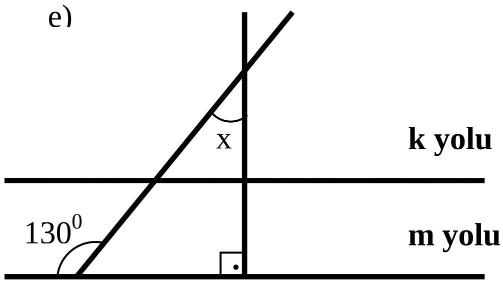
c)



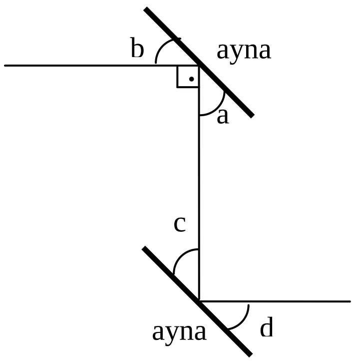
d)



e)



7) Bir periskop aşağıdaki gibidir. Aynalar paraleldir ve gelen açı ile yansıyan açı eşit ölçüdedir. Şekilde d açısı kaç derecedir?



DERS PLANI 3

YARARLANILAN DİSİPLİNLER: Beden Eğitimi, Fen ve Teknoloji, Matematik, Müzik, Sosyal Bilgiler, Resim, Trafik, Türkçe.
TARİH:
SINIF: 7
Süre: SÜRE: 8 ders saati
ÜNİTE: Orantıdan Çıktık Yola
ÖĞRENME ALANI: Geometri-Ölçme
ALT ÖĞRENME ALANI: Çokgenler-Açıları Ölçme
BÖLÜM: Çokgenler

KAZANIMLAR:
1) Çokgenlerin köşegenlerini, iç ve dış açılarını belirler.
2) Çokgenlerin iç ve dış açılarının ölçülerini belirler.
3) Dörtgenlerin kenar, açı ve köşegen özelliklerini belirler.
4) Düzgün çokgenleri inşa eder ve çizer.
5) Çokgenleri karşılaştırarak eş veya benzer olup olmadıklarını belirler ve bir çokgene eş ve benzer çokgenler oluşturur.

DERS İÇİ İLİŞKİLENDİRME: Kümeler (alt kümeler, ayrık kümeler, kümelerde kesişim ve birleşim), öteleme, öteleme ve örüntü ile süsleme, ondalık sayılar, üçgen çeşitleri, açı çeşitleri, çarpanlara ayırma, oran ve orantı, ölçek, cebirsel ifadeler, birinci dereceden bir bilinmeyenler, paralel doğrular arasında kalan eş açılar

YÖNTEM VE TEKNİKLER: Proje Tabanlı Öğrenme, Araştırma, Keşfetme

KULLANILAN EĞİTİM TEKNOLOJİLERİ: Bilgisayar, Internet
ARAÇ ve GEREÇ: Sınıf içi araç gereçler, A4 kağıdı, cetvel, geometri tahtası, geometri şeritleri, paket lastiği, örüntü blokları, tangram blokları, açıölçer, hesap makinesi, noktalı ve izometrik kağıt, kareli kağıt, boya kalemleri, tepegöz, makas, futbol topu, ahşap oyuncak bebekler, üçgen şeklinde kesilmiş kağıt, çokgenlerin ve düzgün çokgenlerin iç açılarıyla ilgili tablolar, pekiştirici çalışma yaprakları 3.1, 3.2, 3.3 ve 3.4

DERSİN İŞLENİŞİ

1. ders

Öğretmen, "Tasarlayacağınız mahalle planı üzerinde yer alacak olan çokgenleri çizebilmeniz için çokgenler konusuna geçeceğiz." der.

Diğer Derslerle İlişkilendirme

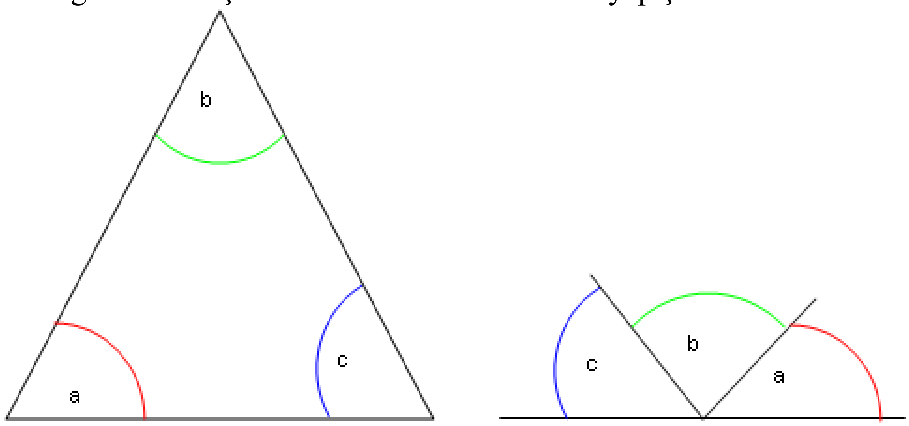
1. Daha önceki yıllardan çokgenler konusunda neler bildikleri öğrencilere sorulur ve çokgenler hatırlatılır. Çevremizde bazı şeyleri nasıl gruplandırılıyorsak (örneğin organlarımızı) çokgenleri de kenar sayısına veya açılarına göre sınıflandırıldığı ve herkesin, her canlının ve nesnenin bir ismi olduğu gibi her çokgenin de üçgen, dörtgen, beşgen, altıgen, yedigen, sekizgen gibi isimlendirildiği belirtilir.

Çokgenlere örnekler, geometri çubuklarıyla ve geometri tahtası üzerinde lastiklerle gösterilir.

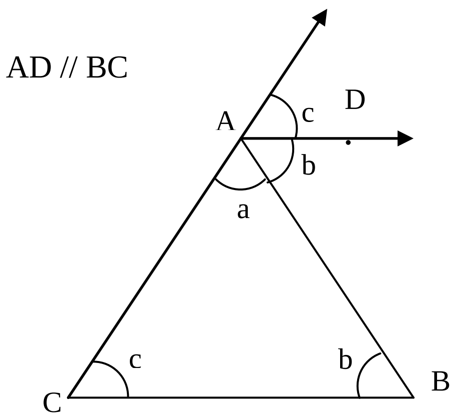
Ders İçi İlişkilendirme ve Teknoloji Kullanımı

1. Bir üçgenin iç açılarının ölçüleri toplamının 180^0 ve bunun nedeni üç örnekle hatırlatılır.

a) Öğrencilerin getirdiği üçgenlerin üç köşesini kesip köşelerini bir noktada yan yana birleştirmeleri istenir. Böylece bu üç açının birlikte doğru açıyı oluşturduğunu öğrenciler keşfederler ve bunu defterlerine yapıştırırlar.



b) Öğrenciler iki paralel doğru arasında kalan eş açılardan yöndeş ve iç ters açıları kullanarak üçgenin iç açıları toplamının 180^0 olduğunu ispatlarlar.



c) Yukarıdaki iki yöntemle şekildeki gibi b ve c açılarının, a açısının yanında doğru açıyı oluşturduğunu thevisualclassroom.com internet adresinden alınan dinamik geometri yazılım programı olan "Geometer's Sketchpad" yardımıyla da görürler. Böylece üçgenin iç açılarının toplamının 180 derece olduğu teknolojiyi kullanarak da kanıtlanır.

2. Öğrencilere aşağıdaki tablo dağıtılır. Öğrenciler, bu tabloda çokgenlerin iç açıları toplamını, üçgenin iç açıları toplamından yararlanarak keşfederler.

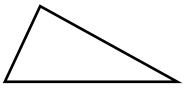
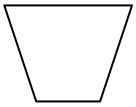
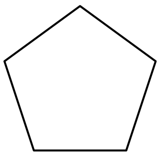
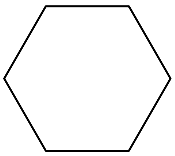
a) Üçgen, dörtgen, beşgen ve altıgenin bir köşesinden karşı köşelere köşegenler çizerler.

b) Bu köşegenler çizildiğinde oluşan üçgen sayısını bulurlar.

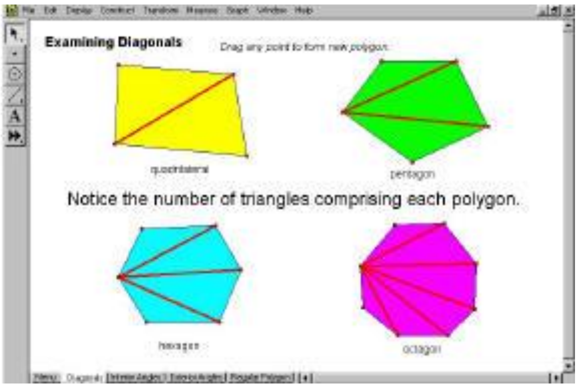
c) Çokgenin bir köşesinden diğer köşelere köşegenler çizildiğinde oluşan üçgen sayısı ve o çokgenin kenar sayısı arasındaki bağlantıyı bulurlar.

d) Üçgenin iç açılarını kullanarak bunu 180'le çarparlar.

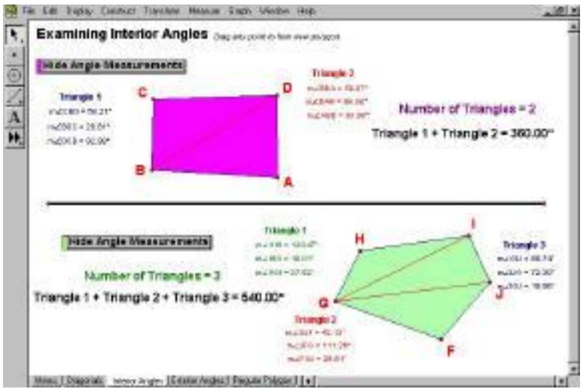
e) n kenarlı bir çokgenin iç açılarının ölçüleri toplamının (n-2)x180 olduğunu keşfederler.

Çokgenin ismi ve şekli	Kenar Sayısı	Çokgenin bir köşesinden diğer köşelere köşegenler çizildiğinde oluşan üçgen sayısı	İç Açılarının Ölçüleri Toplamı
 Üçgen	3	1	1.180 = 180
 Dörtgen			
 Beşgen			
 Altıgen			
…	…	…	…
n-gen			

3. http://mathbits.com/MathBits/GSP/Polygons.htm internet adresinden indirilen "Geometer's Skecthpad" dinamik geometri yazılımında çokgenlerin bir köşesinden çizilen köşegenleri gösterilir.



4. Ayrıca, aynı adresten alınan üçgen, dörtgen, beşgen ve altıgenin köşelerinden çekildiğinde çokgenin kenar sayısı değişmeden, iç açılarının her birinin ölçüsü değişse bile ölçüleri toplamının değişmediği gösterilir.



5. Öğretmen çokgenler konusunu öğrencilerin hazırlayacakları projeleriyle ilişkilendirerek gerekli hatırlatmaları yapar.

Araştırma Ödevi

1. Ödev olarak "Bir dağ bisikletinin ve birçok yapının daha sağlam olması için hangi çokgen daha çok kullanılmaktadır? Neden?" sorusunu öğrencilerden araştırmaları istenir.

2. ders

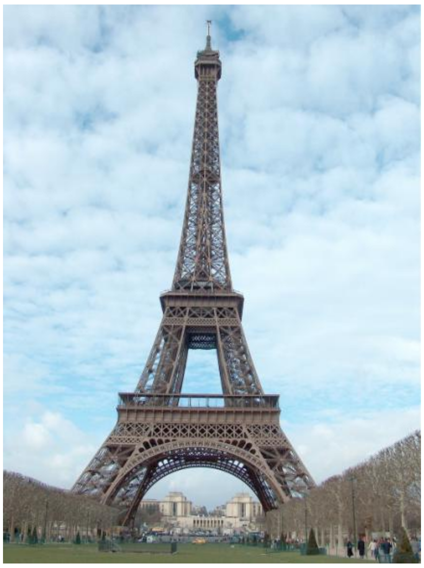
Günlük Hayatla İlişkilendirme

Aşağıdaki fotoğraflar http://images.google.com.tr/ internet adresinden alınmıştır.

1. Aşağıdaki fotoğraflarda yer alan bisiklet ve Eiffel Kulesi gibi bina fotoğrafları gösterilir. Geometri çubuklarıyla üçgen, dörtgen, beşgen ve altıgen şekiller elde edilir ve içlerinde en sağlam olanı tartışılır. Bunun sonunda öğrenciler üçgenin, çokgenler içinde en bükülmez ve en sağlam olduğunu deneyerek keşfederler.

Bundan dolayı bisikletin ve yapıların daha sağlam olmaları için üçgen şeklinin daha çok kullanıldığı örnek fotoğraflarla gösterilir.

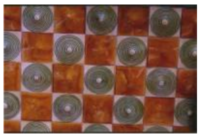
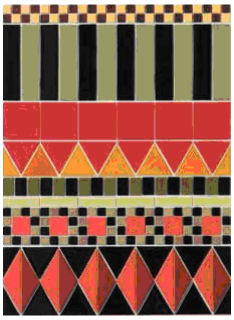
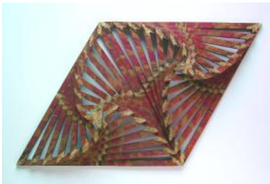


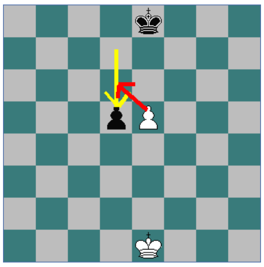



2. Üçgen, dörtgen, beşgen, altıgen, yedigen ve sekizgene örnek resimler gösterilir: Mozaikler, bisiklet, Bermuda Şeytan Üçgeni, takılar, yapılar, çatı, logolar, trafik işaretleri, yorgan desenleri, satranç tahtası, doğadan çiçekler, beyzbol sahası, ev eşyası, binaların süslemeleri, masa, kutu, bal peteği ve kar tanesi resimleri ve Picasso ve Juan Gris gibi bazı ünlü ressamların resimleri… Özellikle "alandan bağımlı" (field dependent) öğrenciler düşünülerek bu örnekler çokgenin kenar sayısına göre sıralı gösterilir.


O KARDEŞLİK M BİRLİĞİ K DÜNYA MEVLANA



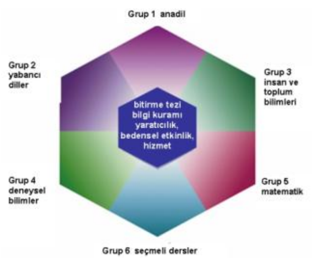








beşgen
Ofis Mobilyaları

Roche



THE SIGILLUM DEI ÆMETH, A PANTACLE MADE BY DR. JOHN DEE.
Figure V

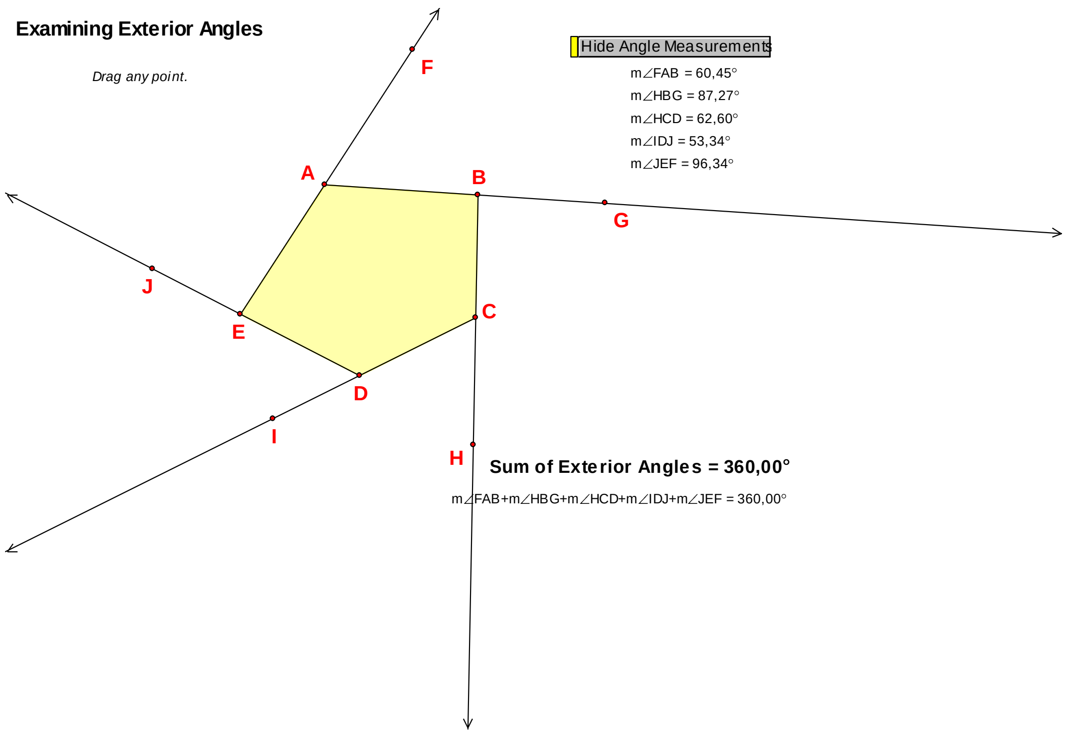







Teknoloji Kullanımı

1. Öğretmen, “Şimdi projenizi (mahalle planınızı) çizmek için dış açıları öğreneceğiz” der. Sonra “Bir çokgende bir dış açı, o köşeye ait bir iç açıyı bütünleyen açıdır” tanımı yapılır. Dış açı ile ilgili http://mathbits.com/MathBits/GSP/Polygons.htm internet adresinden indirilen “Geometer’s Skechpad” dinamik geometri yazılımı yardımıyla çokgenlerin bir köşesindeki iç ve dış açılarının ölçüleri toplamının 180 derece ve bir çokgenin dış açılarının ölçüleri toplamının 360 derece olduğu gösterilir.



Günlük Hayatla İlişkilendirme

1. Çokgenler ve açılarıyla ilgili pekiştirici çalışma yaprağı-3.1 dağıtılır ve sorular sınıfta çözülür.

PEKİŞTİRİCİ ÇALIŞMA YAPRAĞI-3.1

ÇOKGENLER VE AÇILARI-I

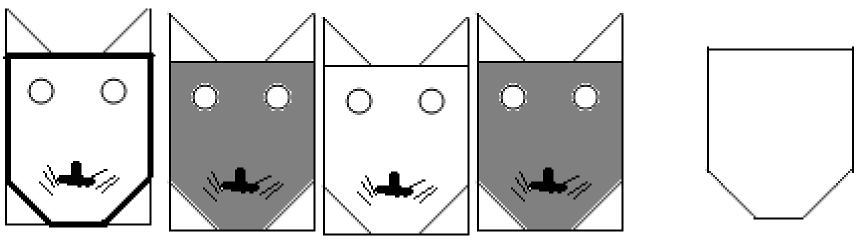
1. Günlük hayattan aşağıdaki fotoğraflar hangi çokgen çeşidine örnektir? Her birinin şeklini altlarına iki boyutlu çiziniz ve her birinin iç açılarının ölçüleri toplamını bulunuz.

	Trafik levhası	Şekildeki masanın üstü	Futbol topu fotoğrafındaki siyah şekiller	Fotoğraf çerçevesi	DUR işareti levhası
					
Çokgenin ismi					
Çokgenin şekli					
Çokgenin iç açıları ölçüleri toplamı					

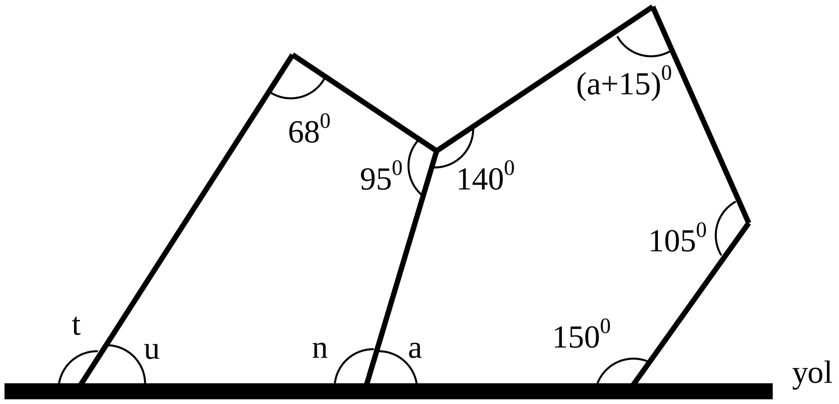
2. Çokgenlerin kenarları arttıkça iç açılarının ölçülerinin toplamının nasıl değiştiğini tartışınız.

3. İç açılarının ölçüleri toplamı 2160^0 olan çokgen şeklindeki levha kaç kenarlıdır?

4. Aşağıdaki şekiller bir duvar kağıdı deseninden alınmıştır. Aşağıdaki altıgenlerin iç açıları (sol üstten saat yönü tersine doğru) **90, x + 10, x, x, x + 10 ve 90** derece ise bu altıgendeki her bir iç açının ölçüsünü bulunuz.



5. Elif Hanım'ın beşgen şeklindeki arsası ve Tuna Bey'in dörtgen şeklindeki arsası belli bir ölçekle küçültülen aşağıdaki plandaki gibi birbirine komşudur. Ayrıca, bu iki arsanın bir kenarları da doğrusal bir yola komşudur. Plan üzerinde, bu iki arsanın köşelerinin birbiriyle yaptığı açıların ölçüleri aşağıdaki gibi verilmiştir.



a) Beşgensel bölge ve dörtgensel bölge şeklindeki arsaların iç açıları kaçar derecedir?

b) Şekilde gösterilenlerden hangisi **u** açısının bir dış açısıdır?

c) Beşgendeki **a** açısının dış açısı hangi açıdır?

d) Beşgendeki **a** açısının dış açısı olan açı hangi şeklin iç açısıdır?

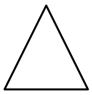
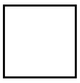
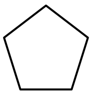
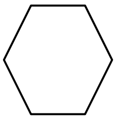
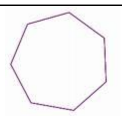
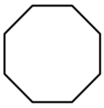
3. ders

1. Düzgün çokgenleri bir önceki seneden biraz gördükleri için öğrencilere neler hatırladıkları sorulur. "Tüm iç açıları aynı ölçüde ve tüm kenarları aynı uzunlukta olan çokgenlere düzgün çokgen denir" tanımı hatırlatılır. Tanımda '**ve**' kelimesine dikkat çekilir. "Sadece tüm iç açılarının eşit olması ya da tüm kenarlarının aynı uzunlukta olması düzgün çokgen olmasına yeterli midir?" sorusu öğrencilere sorulur ve örnekler vererek açıklamaları istenir.

Günlük Hayatla Bağlantı

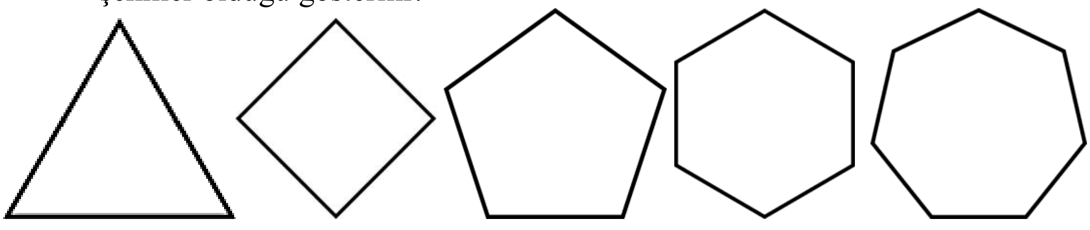
1. Düzgün üçgen, dörtgen, beşgen, altıgen, yedigen ve sekizgene 2. derste gösterilen bazı fotoğraflar tekrar gösterilir. Düzgün üçgenin eşkenar üçgen olduğu ve düzgün dörtgenin kare olduğu öğrencilere keşfettirilir. Düzgün çokgenlerin bir iç açısının ölçüsünü bulmak için hazırlanan aşağıdaki tablo öğrencilere asetatla gösterilir ve birer kağıt öğrencilere dağıtılır. Bu tabloda öğrenciler hesap makinesi kullanmadan

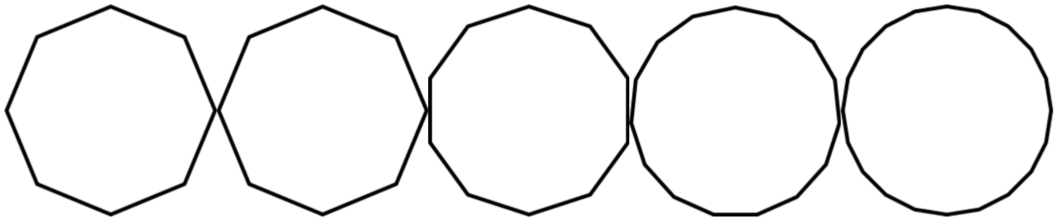
düzgün çokgenlerin kenar sayısı ve bir iç açısının ölçüsü arasındaki bağıntıyı keşfederler.

Kenar sayısı	İç açı sayısı	Çokgenin İsmi	Şekli	İç açılarının ölçüleri toplamı	Bir iç açısının ölçüsü
3	3	Eşkenar üçgen			
4	4	Kare			
5	5	Düzgün beşgen			
6	6	Düzgün altıgen			
7	7	Düzgün yedigen			
8	8	Düzgün sekizgen			
…	…	…	…	…	…
n	n	Düzgün n-gen			

Teknoloji Kullanımı

1. Bilgisayarda düzgün çokgenlerin kenar sayısı arttıkça çembere daha yakın şekiller olduğu gösterilir.





Araştırma Ödevi

1. Öğrencilerden "Bal petekleri hangi düzgün çokgen şeklindedir? Neden?" sorusunu araştırmaları istenir. Ayrıca, "Çokgenler günlük hayatta nerelerde kullanılıyor? Onunla ilgili poster…vb hazırlayın." denir.

<u>4. ve 5. ders</u>

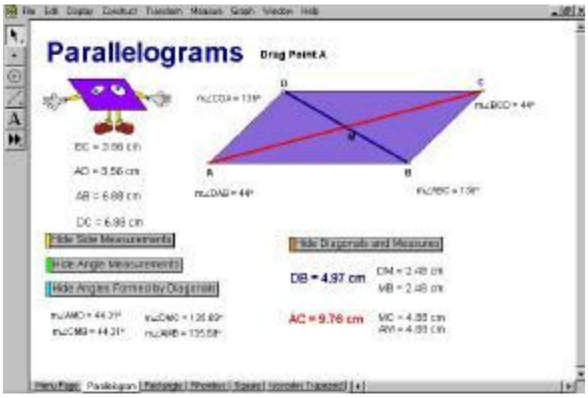
Günlük Hayatla Bağlantı

1. Düzgün çokgenlerin uygulaması ile ilgili öğretmen şu soruyu sorar: "Bir terzi birbirine eş olan sadece düzgün üçgenler, kareler, düzgün beşgenler veya düzgün altıgenlerden oluşan kumaş parçalarını köşeleri yan yana gelecek ve hiç boşluk kalmayacak şekilde birleşirse bir yorgan deseni elde edebilir mi?" Öğrencilere birbirine eş olan eşkenar üçgen, kare, düzgün beşgen ve düzgün altıgenler şeklinde örüntü blokları verilir. Öğretmen 6. sınıf bölünebilme konusunu hatırlatır. Öğrenciler, bu düzgün çokgenlerin bir iç açılarının ölçülerini kullanarak altı eşkenar üçgeni (60^0 x 6 $=360^0$), dört kareyi (90^0 x 4 $= 360^0$) ve üç düzgün altıgeni (120^0 x 3 $= 360^0$) yan yana koyarak bir süsleme oluşturabileceklerini keşfederler. Buna karşın, bir düzgün beşgenin bir iç açısının 108^0 ve 108 sayısının 360'ın çarpanlarından biri olmayacağı için düzgün beşgenler yan yana gelince boşluk kalacağını ve süsleme yapılamayacağını keşfederler. Bu süslemeleri örüntü blokları kullanarak da elde ederler.

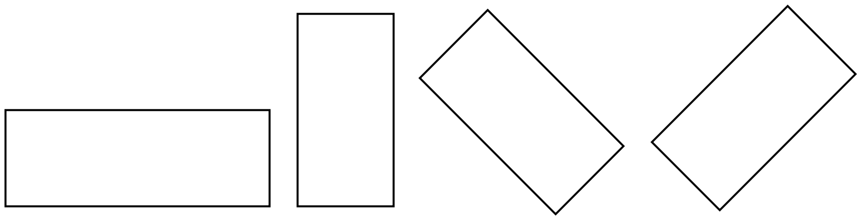
Teknoloji Kullanımı

1. Kümelerde alt küme, ayrık kümeler, kesişim ve birleşim kavramı hatırlatılır ve dörtgenlerin de kendi içinde açılarına ve kenarlarına göre sınıflandırılabileceği söylenir. Öğrencilere şimdiye kadar duydukları dörtgen isimleri sorulur.

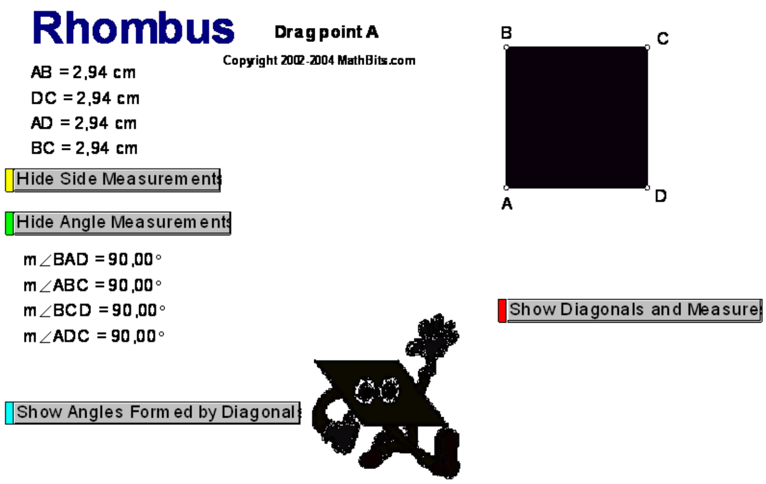
2. Özel dörtgenlerin (paralelkenar, dikdörtgen, eşkenar dörtgen, kare ve yamuk) açı ve kenar özellikleri, http://mathbits.com/MathBits/GSP/Quadrilaterals.htm internet adresinden alınan "Geometers' Sketchpad" dinamik geometri yazılımı yardımıyla öğrencilere gösterilir. Bu yazılımda verilen özel dörtgenlerin köşelerinden hareket ettirip açı ölçüleri ve kenar uzunlukları değişse de o dörtgenin açı ve kenar özelliklerini sabit kalacağı gösterilir. Örneğin paralelkenarın karşılıklı açılarının eşit ölçüde ve karşılıklı kenarlarının aynı uzunlukta olduğunu öğrenciler fark ederler.

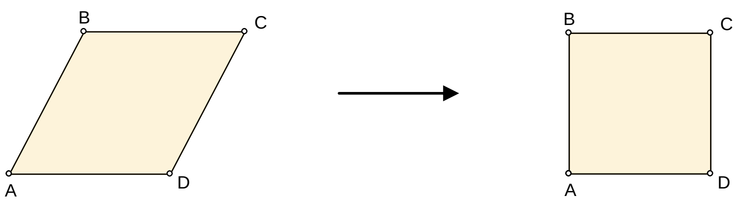


3.Öğrenciler bu dörtgenleri alışık oldukları gibi sadece yatay şekilde görmezler. Aşağıdaki dikdörtgenler gibi farklı yönlerden de görürler.



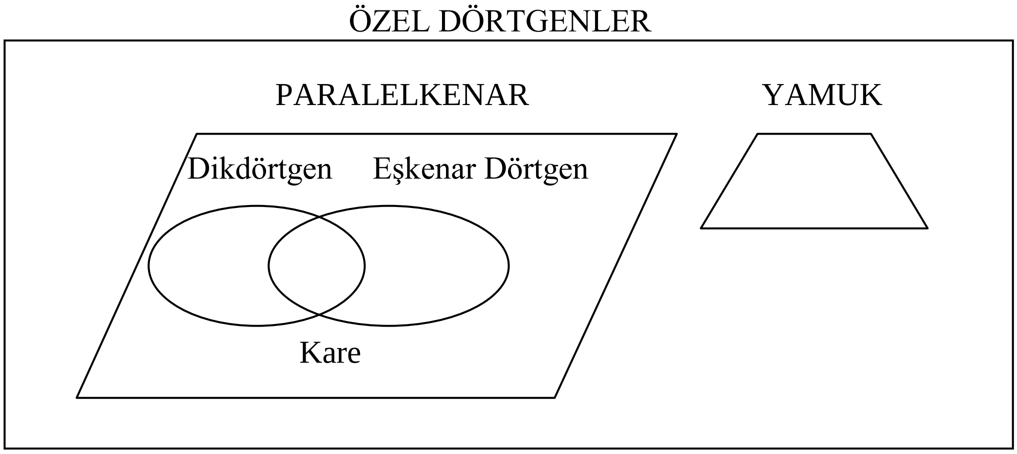
4. Özel dörtgenlerin özelliklerini kullanarak birbiriyle bağlantıları da tartışılır. Örneğin, öğrencilere eşkenar dörtgen gösterilirken “Burada kare elde edebilir miyiz” sorusu sorulur. Eşkenar dörtgenin köşelerini hareket ettirerek açıları 90 derece ve tüm kenarlarının uzunlukları aynı olan dörtgen, yani kare elde edilir.





5. Yamuk gösterilirken köşelerini hareket ettirerek paralelkenar elde edilemeyeceğini öğrenciler görürler.

6. Bu tür tartışmalarla ve öğrenciler görerek özel dörtgenlerden ayrık, kesişen, birbirinin alt kümesi olan kümeleri tartışırlar. Sonra aşağıdaki Venn şemasıyla gösterilen kümeler öğrencilerle birlikte çizilir.



<u>6. ders</u>

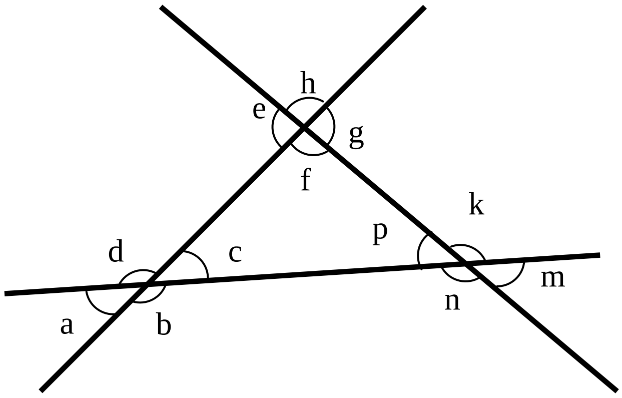
1. Çokgenler ve açılarıyla ilgili pekiştirici çalışma yaprağı-3.2 dağıtılır. Bu çalışma yaprağı aşağıdaki kavramlarla ilgili günlük hayattan bir durum içeren sorulardan oluşur:
   a) Üçgende dış açı,
   b) çokgenlerin iç açıları ve
   c) bir çokgen ve o çokgenin belli bir oranda küçültürken oluşan yeni şeklindeki açılarının birbiriyle bağlantısı.

2. Dörtgenlerle ilgili pekiştirici çalışma yaprağı-3.3 dağıtılır. Bu çalışma yaprakları aşağıda verilmiştir. Pekiştirici Çalışma Yaprağı-3.2’deki 3. soru ve 3.3’teki 1. soru öğretmenin yönlendirmesiyle sınıfta çözülür. Geri kalan sorular ödev olarak verilir.

PEKİŞTİRİCİ ÇALIŞMA YAPRAĞI-3.2

ÇOKGENLER VE AÇILARI-II

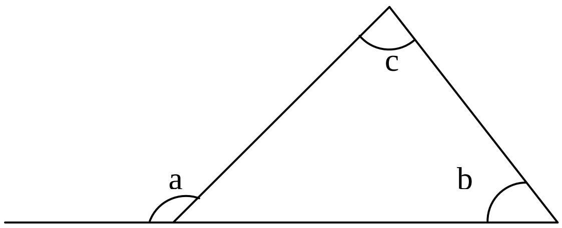
1.



Yandaki üç farklı yol ikişer ikişer kesişerek ortada üçgensel bölge şeklinde bir arsa oluşturuyorlar. Yukarıda oluşan açılardan hangileri üçgensel bölgenin iç açılarına ait dış açılardır?

c açısının dış açıları	**f** açısının dış açıları	**p** açısının dış açıları

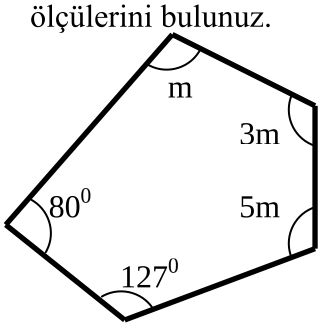
2. Bankalarda, marketlerde… vb hiç güvenlik kamerası gördünüz mü? Bunlar belli aralıklarla, belli açılarla dönerler ve bu çerçevede çekim yaparlar. Şekildeki gibi üçgensel bölge şeklindeki bir arazinin iç ve dış bölgelerine yerleştirilen a,b,c güvenlik kameraları vardır.



Yandaki gibi b ve c iç bölgesindeki kameralar 55^0 ve 64^0 lik açılarla dönmektedir. Buna göre a kamerası kaç derecelik açıyla döner?

3.Bir plancı aşağıdaki gibi bir bahçenin planını çizmek istemiştir. Planı belli bir ölçekle küçültüp çizmek için bahçenin etrafındaki köşelerin birbiriyle yaptığı açıları ölçmesi gerekmektedir. Buna göre

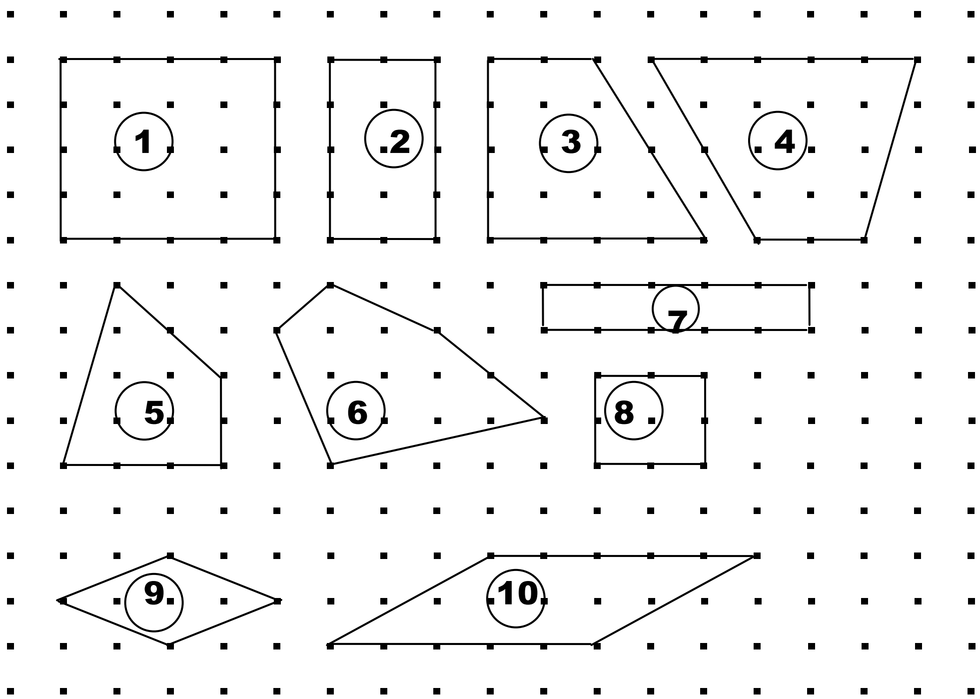
a) Bu bahçedeki köşelerin birbiriyle yaptıkları açıların ölçüleri ile plandaki açıların ölçüleri hakkında ne söylenebilir? Yani bahçenin gerçek açı ölçüleri ve plandaki açı ölçüleri arasında nasıl bir bağlantı olur?
b) Planı çizdikten sonra bulduğu açılar aşağıdaki gibiyse bilinmeyen açıların ölçülerini bulunuz.



PEKİŞTİRİCİ ÇALIŞMA YAPRAĞI-3.3

DÖRTGENLER

1.Aşağıdaki noktalı kağıt üzerine çizilen çokgenler numaralandırılmıştır.



a) Dörtgen olanların numaralarının kümesini liste yöntemiyle göstererek yazınız.

b) Paralelkenar olanların numaralarının kümesini **P** ile göstererek liste yöntemiyle gösteriniz. Neden bu numaralı şekilleri seçtiğinizi yazınız.

c) Dikdörtgen olanların numaralarının kümesini **D** ile göstererek liste yöntemiyle gösteriniz. Neden bu numaralı şekilleri seçtiğinizi yazınız.

d) Eşkenar dörtgen olanların numaralarının kümesini **E** ile göstererek liste yöntemiyle gösteriniz. Neden bu numaralı şekilleri seçtiğinizi yazınız.

e) Kare olanların numaralarının kümesini **K** ile göstererek liste yöntemiyle gösteriniz. Neden bu numaralı şekilleri seçtiğinizi yazınız.

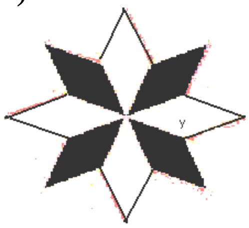
f) Yukarıdaki **P, D, E ve K** kümelerini aynı Venn Şeması üzerinde gösteriniz.

g) Yukarıdaki paralelkenar, dikdörtgen, eşkenar dörtgen ve kare oluşturan **P, D, E ve K** kümelerinden birbirini kapsayan, birbirinin alt kümesi olanlar varsa hangileridir?

h) Yukarıdaki şekillerden yamuk olanların numaralarının kümesini **Y** ile göstererek liste yöntemiyle gösteriniz. Neden bu numaralı şekilleri seçtiğinizi yazınız.

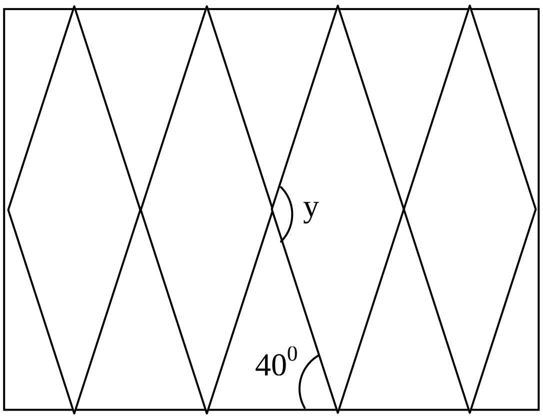
ı) Paralelkenar ve yamuk şekillerinin oluşturduğu **P ve Y** kümeleri nasıl kümelerdir? **P, D, E, K ve Y** kümelerini aynı Venn Şeması üzerinde gösteriniz.

2)



Birbirine eş sekiz eşkenar dörtgenden oluşan yukarıdaki desen aynı köşede birleştirilerek yorgan yapmak için çiziliyor. Bu eşkenar dörtgenlerden bir tanesinin her bir iç açısı kaç derecedir?

3)

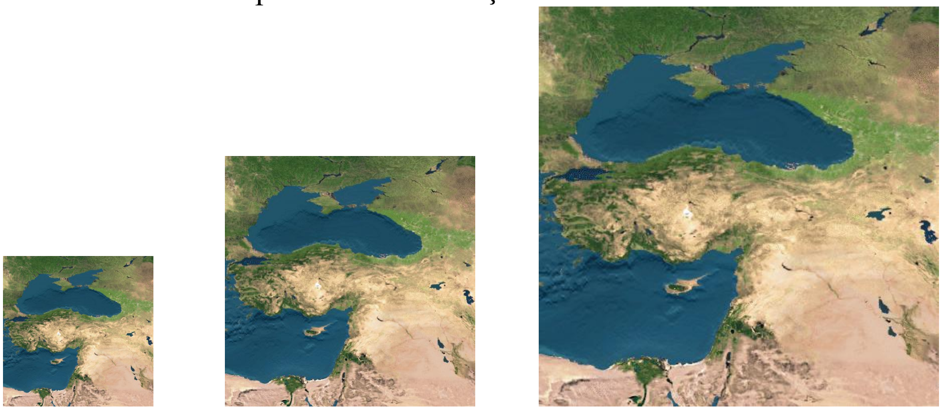


Yukarıdaki dikdörtgensel bölge üzerine çizilen halı deseni birbirine paralel çizgilerden oluşur. Buna göre y kaç derecedir?

7. ders

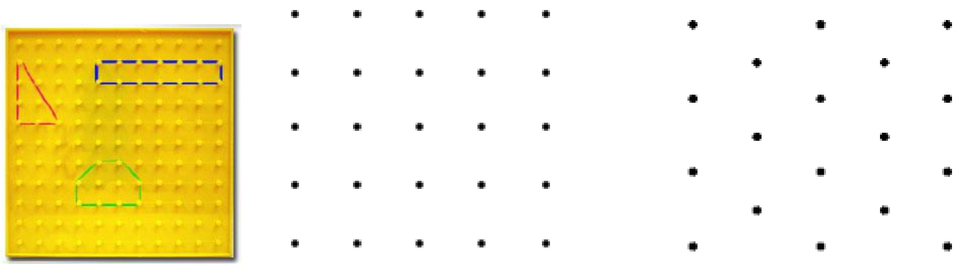
Günlük Hayatla Bağlantı

1. Öğrencilerin projelerini oluşturabilmeleri için son konu olan çokgenlerde benzerlik konusuna geçilir. Öğretmen, öğrencilere çokgenlerin eşliği ve benzerliği ile ilgili daha önceden ne hatırladıklarını sorar. Aşağıda verilen Türkiye'nin uzayda farklı uzaklıklardan çekilen uydu fotoğraflarını öğrenciler inceler. Bu fotoğrafların birbirine benzer olup olmadıkları tartışılır.



2. Öğrencilere aşağıda verilen ahşap oyuncak bebekler gösterilir ve bu bebeklerin birbiriyle benzerliği tartışılır.

3. Öğrencilere birer tane, bir yüzünde noktalı kağıt diğer yüzünde izometrik kağıt üzerindeki noktaların yer aldığı geometri tahtası ve farklı renkteki lastikler verilir.



Öğretmen izometrik ve noktalı kağıt özelliklerini anlatır. Öğrenciler önlerindeki geometri tahtasını inceler. İzometrik noktaların yer aldığı bölümde öğrenciler lastikler yardımıyla birbirine eş ve benzer olan eşkenar üçgenleri (birbirine eş yan yana dört eşkenar üçgen ve bu üçgenlerin oluşturduğu daha büyük boyuttaki eşkenar üçgen) elde ederler. Noktalı kağıttaki noktaların yer aldığı yüzde, boyutları 1-2, 2-5, 3-6 ve 5-10 olan dört dikdörtgeni elde ederler. Buradaki benzer olan ve olmayan dikdörtgenler tartışılır. Açı ölçülerini ve kenar uzunluklarını hatırlayarak tüm dikdörtgenlerin birbirine benzer olup olmadıkları tartışılır.

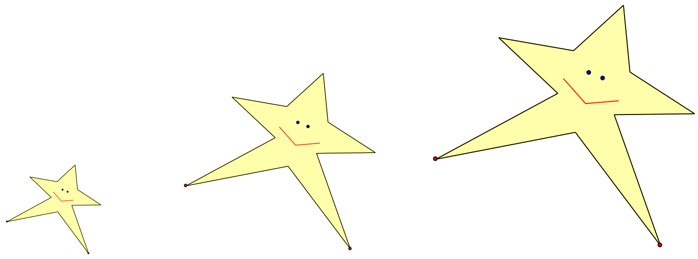
4. Öğretmen, eşlik ve benzerlik kavramlarını anlatmak için kendi fotoğraflarını gösterir: Bu üç fotoğraftan ilk ikisi birbirine eştir. Üçüncüsü ise diğer fotoğraftan orantılı büyütülmüştür. Öğrenciler bu fotoğrafların kenar uzunluklarını cetvel yardımıyla bulurlar. Kısa ve uzun kenarların uzunluklarının birbirine oranlarını hesap makinesiyle hesaplarlar.

5. Öğretmen dikdörtgenlerin birbirine benzer olamayabileceğini göstermek için yukarıdaki ilk fotoğrafın kısa ve uzun kenarlarının orantılı şekilde büyütülmediği ve küçültülmediği iki fotoğraf daha gösterir. Görünüşü değişen bu fotoğrafların diğer fotoğraflarla benzer olup olmadığı tartışılır.

6. Eşlik ve benzerliğin tanımı tartışılır. "Karşılıklı kenar uzunluklarının oranı birbirine eşit olan çokgenler, benzer çokgenlerdir" tanımı yapılır. Bu oran "benzerlik oranı"dır. Eş çokgenlerde benzerlik oranı 1'dir."

Teknoloji Kullanımı

1. www.dynamicgeometry.com internet adresinden alınan "Geometer's Sketchpad" dinamik geometri yazılımında hazırlanan yıldız şeklinde logo gösterilir. Logonun köşelerinden çekip aynı oranda büyütülen ya da küçültülen farklı ölçülerdeki bu logoların benzerliği tartışılır.

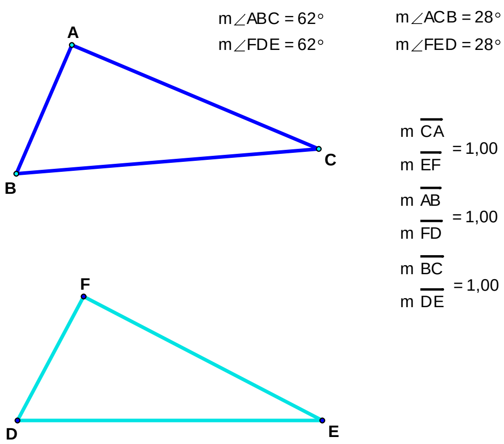


2. http://www.saskschools.ca/curr_content/byersjmath/geometry/teachers/polygon/scalesnd.swf internet adresinden alınan bir animasyonda senaryo gereği NASA'da görevli bir kişi bir uzay mekiğiyle çalışmak ister ama bu kadar büyük bir nesneyle çalışması çok zordur. Çözüm önerileri (uzay mekiğinin maketinin yapılması gibi) ve uzay mekiğinin maketinin hazırlanması için dikkat edilmesi gerekenler tartışılır. Burada öğrencilerden uzay mekiğinin tüm boyutlarının orantılı şekilde küçültülmesi gerektiğini görmeleri beklenir. Aynı animasyonda belli bir oranda küçültülen maket gösterilir. Mekiğin gerçek boyutları metre cinsinden ve maketinin boyutları santimetre cinsinden verilir. Öğrenciler maketin küçültülme oranını bulurlar.

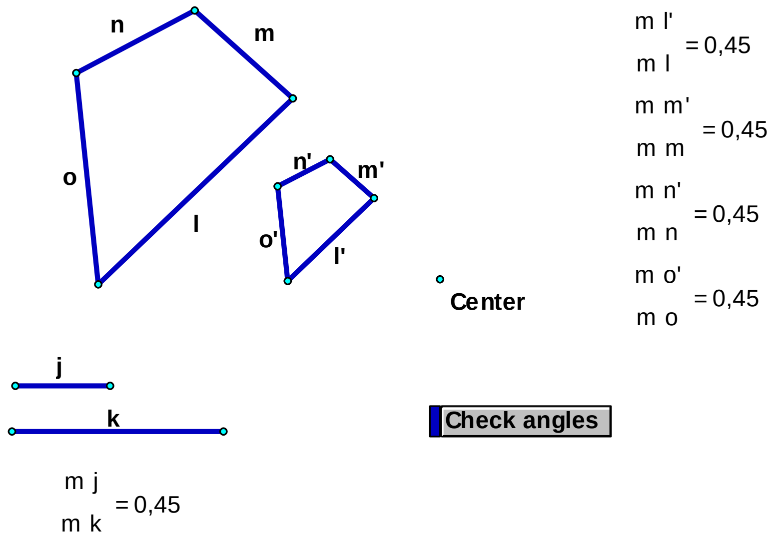
3. Aynı adresten alınan başka bir animasyonda 1:3 oranında küçültülerek bir üçgene benzer üçgen çizme gösterilir ve öğretmen, "Mahalle planınızı çizerken bunu kullanacaksınız." der. Öğrencilere projeleri hatırlatılarak kendi çizimlerinde hata payı olabileceği belirtilir. Animasyonda üçgenin kenarları cetvel yardımıyla ve açıları açıölçer yardımıyla ölçülür. Üçgenin bir açısının ölçüsü 72 derece bulunur. Burada öğretmen, "Bunu gerçekte çizerken ölçümünüzde 1-2 derece hata payı olabilir ama yine de siz projenizi çizerken olabildiğince dikkatli çizin." der.

4. Aynı adresten alınan başka bir animasyonda iki dikdörtgenin benzerliği tartışılır. Öğrenciler animasyondaki cetveli hareket ettirerek dikdörtgenlerin kenar uzunluklarını bulurlar ve kenarlarının oranından benzer olup olmadıklarına karar verirler.

5. Öğrenciler, hh.harpethhall.org internet adresinden alınan birbirine eş iki üçgenin açı ve kenar ölçülerinin aynı ve benzerlik oranının 1 olduğunu görürler.

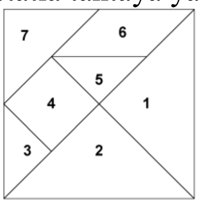


g. hh.harpethhall.org internet adresinden indirilen “Geometer’s Sketchpad” dinamik geometri yazılımında, hareket ettirilebilen bir yamuğun köşelerinden çekerek farklı yamuklar gösterilir. Programda kenar ve açı özellikleri de verilir ve eş veya benzer yamuklar elde edilir.



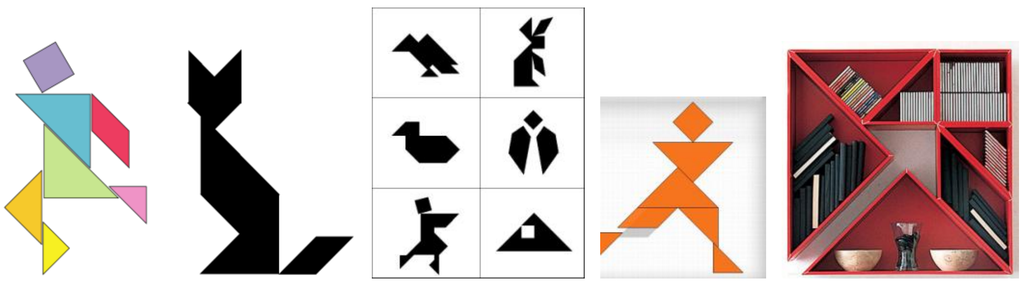
8. ders

1. Öğrencilere tangramı oluşturan parçalar dağıtılır. Tangramın bir örneği aşağıdaki gibi asetatla tahtaya yansıtılır.



Öğrenciler kendileri asetata bakıp parçaları birleştirip tangramı oluştururlar. Parçaların (üçgenler, kare, paralelkenar, eşkenar dörtgen) kenar ve açı özellikleri ve eş ve benzer olanları tartışılır.

2. Tangram parçalarından elde edilen aşağıdaki fotoğraflar öğrencilere gösterilir.



3. Çokgenlerde eşlik ve benzerlikle ilgili pekiştirici çalışma yaprağı-3.4 sınıfta çözülür.

PEKİŞTİRİCİ ÇALIŞMA YAPRAĞI-3.4

ÇOKGENLERDE EŞLİK VE BENZERLİK

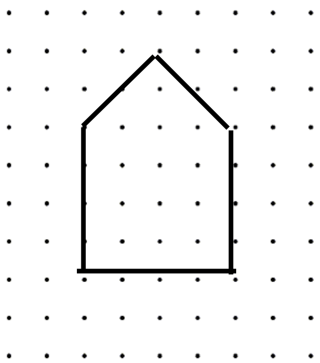
1) Fotokopi makineleri, şekilleri istenilen oranda küçülterek ya da büyüterek çoğaltabilir. Zehra, boyutları 40 cm ve 24 cm olan bir resmi çoğaltmak istiyor.
a) Resimlerin % 50 küçültülerek çoğaltılması durumunda boyutlarını bulunuz.

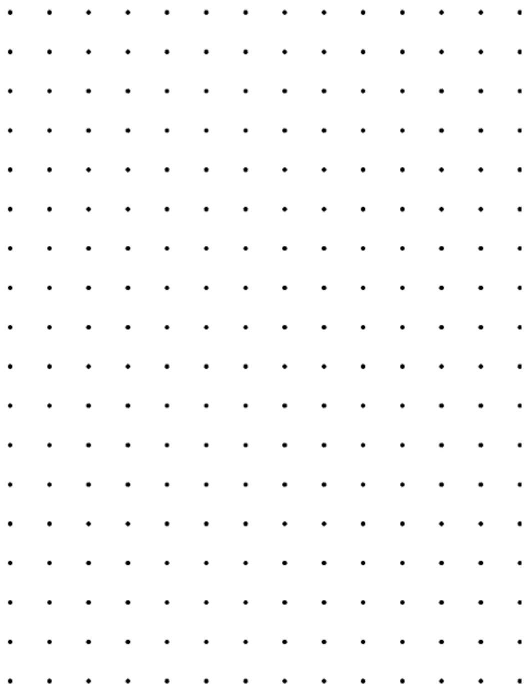
b) Resimlerin % 50 büyültülerek çoğaltılması durumunda boyutlarını bulunuz.

c) b ve c şıklarında elde edilen resimler eş midir? Benzer midir?

2) Benzerlik oranı 1/3 olan iki üçgenin açıları ölçüleri arasındaki oran da 1/3 olur mu?

3) Aşağıdaki noktalı bölüme, yandaki noktalı bölümdeki şeklin benzerlerini ½ ve 2 oranlarını kullanarak çiziniz.





Günlük Yaşamla Bağlantı

DERS PLANI 1'deki gibi asetatla yansıtılan örnek bir mahalle planında çokgen çeşitleri, dörtgen çeşitleri, eş ve benzer çokgenler tartışılır.

DERS PLANI 4

YARARLANILAN DİSİPLİNLER: Matematik, Müzik, Sosyal Bilgiler.
TARİH:
SINIF: 7
Süre: SÜRE: 1 ders saati
ÖĞRENME ALANI: Geometri-Ölçme
ALT ÖĞRENME ALANI: Çokgenler- Doğrular ve Açılar-Açıları Ölçme
BÖLÜM: Aynı Düzlemdeki Üç Doğru - Çokgenler

KAZANIMLAR:
1) Bir konuda karar verme ile ilgili nasıl işbirliği yapılacağını ve yaratıcılığın nasıl kullanılacağını anlar.

YÖNTEM VE TEKNİKLER: Proje Tabanlı Öğrenme, Araştırma

DERSİN İŞLENİŞİ

Günlük Yaşamla Bağlantı

Projelerin özgün olması gerektiğinden ve yaratıcılıktan bahsedilir. Şu örnek verilir: Üç kişi düşünelim:

1. kişinin nota bilgisi vardır ve çok güzel bir eser besteler.

2. kişinin nota bilgisi vardır ve bir şarkı bestelerken başka beğendiği bir şarkının bir bölümünü kullanarak kendi şarkısına uyarlar ama kaynağını da kasetinde belirtir.

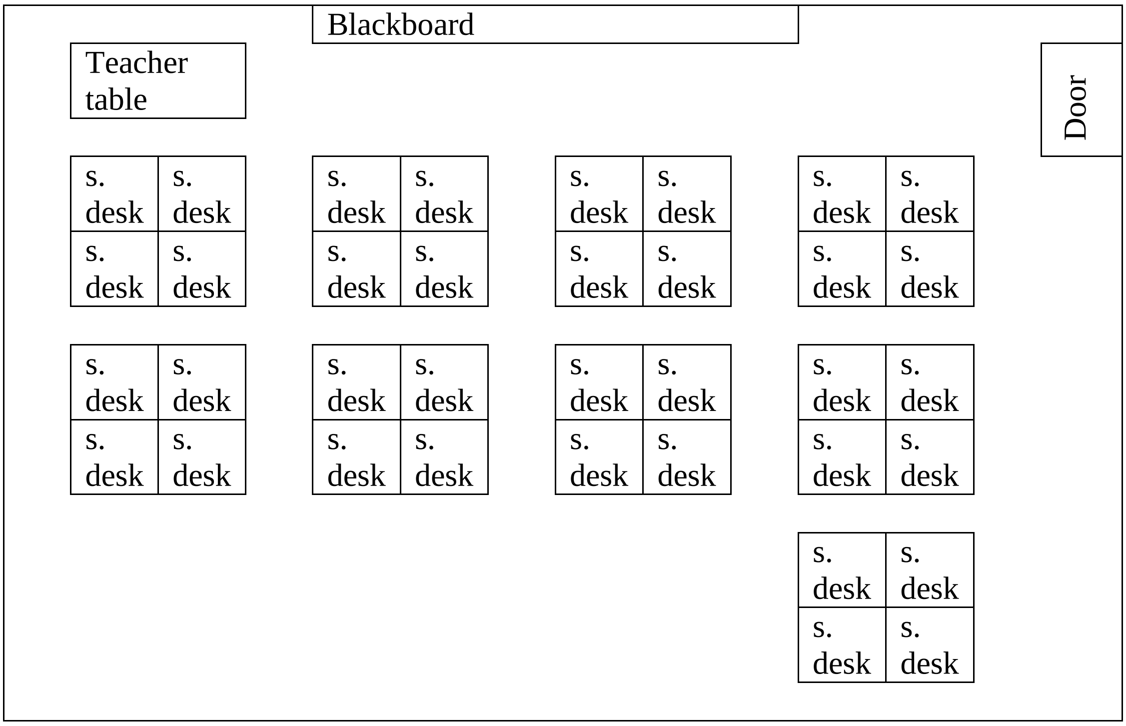
3. kişinin nota bilgisi vardır ve daha önceden beğenilen bir şarkının birkaç veya çoğu bölümünü aynen alır ve kendi bestelediği şarkı gibi göstermeye çalışır.

Bu üç kişinin yaptıkları konuşulur ve yaratıcılık tartışılır.

Bazı konular ve kavramlar sınıfça ve grup içinde tartışılırken nasıl davranılmasının uygun olacağı ile ilgili gereken zamanda açıklamalar yapılır.

PART 2: CREATION OF ARTIFACT (Lesson Plan 5-10)

Öğrenciler projelerini oluştururken DERS PLANI 1'de belirlenen grup arkadaşlarıyla yan yana oturarak çalışacaklardır ve sınıf yerleşim planı aşağıdaki gibi olacaktır.



DERS PLANI 5

YARARLANILAN DİSİPLİNLER: Matematik, Sosyal Bilgiler.
TARİH:
SINIF: 7
Süre: SÜRE: 1 ders saati
ÖĞRENME ALANI: Geometri-Ölçme
ALT ÖĞRENME ALANI: Çokgenler- Doğrular ve Açılar-Açıları Ölçme
BÖLÜM: Aynı Düzlemdeki Üç Doğru - Çokgenler

KAZANIMLAR:
1) Projeleriyle ilgili yaptıkları araştırmaları grup olarak tartışırlar.

YÖNTEM VE TEKNİKLER: Proje Tabanlı Öğrenme, Araştırma

KULLANILAN EĞİTİM TEKNOLOJİLERİ: Bilgisayar, Internet
ARAÇ ve GEREÇ: Sınıf içi araç gereçler, A4 kağıdı, cetvel

DERSİN İŞLENİŞİ

1. Öğrenciler bireysel yaptıkları araştırmalar sonunda elde ettikleri bilgileri grup olarak birbirleriyle paylaşırlar ve hazırlayacakları mahalle planı ile ilgili aşağıdakilere karar verirler:

(a) başkanlarına,
(b) gruptaki her kişinin mesleğine,
(c) tasarlayacakları mahallenin hangi şehirde olduğuna
(d) iklimine,
(e) coğrafî özelliklerine,
(f) varsa bitki örtüsüne,
(g) nüfusuna,
(h) varsa tarihî ve kültürel eserlerine ve
(i) mahalle planlarında olmasını istedikleri bölümlere.

2. Grup üyeleri, tartışmalarına rağmen karar veremedikleri ya da anlaşamadıkları konularda öğretmenlerine danışırlar. Öğretmen, cevabı doğrudan vermek yerine öğrencilerin projeyi detaylı anlamaları için aşağıdaki gibi bazı yönlendirici sorular sorar veya açıklamalar yapar:

a) Bir mahalle nüfusu ne olabilir?
b) Mahallenizi düşünün, neler var evinizin etrafında?
c) Siz bu projede il ya da ilçe değil bir mahalle tasarlayacaksınız.

3. Öğrenciler getirdikleri örnek krokilerde cadde ve sokakların birbirine göre durumları ve gördükleri geometrik şekilleri ve özelliklerini tartıştılar.

DERS PLANI 6

YARARLANILAN DİSİPLİNLER: Fen ve Teknoloji, Matematik, Müzik, Sosyal Bilgiler, Resim, Trafik, Türkçe.
TARİH:
SINIF: 7
SÜRE: 3 ders saati

ÖĞRENME ALANI: Geometri-Ölçme
ALT ÖĞRENME ALANI: Çokgenler- Doğrular ve Açılar-Açıları Ölçme
BÖLÜM: Aynı Düzlemdeki Üç Doğru - Çokgenler

KAZANIMLAR:
1) Mahallelerinde yer alan bölümlere (binalara ve yollara) ve bu bölümlerin mahallelerindeki yerlerine sosyal yaşamı da düşünerek karar verirler.
2) Binaların geometrik şekillerine karar verirler.
3) Bunlara uygun mahallelerinin krokilerini (taslak planlarını) ölçülere ve geometrik şekillere uymaksızın çizerler.

DERS İÇİ İLİŞKİLENDİRME: Uzunluk ölçüleri, ölçek, oran ve orantı
YÖNTEM VE TEKNİKLER: Proje Tabanlı Öğrenme, Araştırma, Keşfetme

KULLANILAN EĞİTİM TEKNOLOJİLERİ: Bilgisayar, Internet
ARAÇ ve GEREÇ: Sınıf içi araç gereçler, A4 kağıdı, cetvel, proje çalışma yaprağı-6.1.

DERSİN İŞLENİŞİ

<u>1., 2. ve 3. Ders</u>

Günlük Yaşamla Bağlantı ve Proje Hazırlama

1. Öğrencilere Hayalimdeki Mahalle projesi hatırlatılır ve Proje Çalışma Yaprağı-6.1 ve boş bir A4 kağıdı dağıtılır. Öğretmen şu açıklamayı yapar:
"Projenizi ölçülere uygun karton üzerinde çizmeden ön bir hazırlık yapacaksınız. Tasarlayacağınız mahallede mutlaka olması gereken binaların çeşitleri ve yolların birbirlerine göre durumları verilmiştir. Bunlar dışında sizler de istekleriniz doğrultusunda bu bölümlere eklemeler yapabilirsiniz. Binaları size tabloda verilen çokgen çeşitlerine uygun şekilde seçiniz. Bu arada ölçülere dikkat etmeden hangi bölüm mahallenin neresinde taslak olarak belirtmek için boş A4 üzerinde kroki yani taslak plan çizeceksiniz. Krokiye önce yolları yerleştirip sonra binaları yerleştirebilirsiniz. Tam tersini de yapabilirsiniz ya da ikisini birlikte de çizebilirsiniz. Önce yolları çizseniz sizin için daha kolay olabilir."

2. Öğrenciler, daha önceden yaptıkları araştırma sonuçlarına ve binalar için çalışma yaprağında ilk sayfada yer alan listeye göre projelerinde mutlaka olması gereken ve eklemek istedikleri binalara karar verirler.

3. Çalışma yaprağı ikinci sayfada yer alan çokgen çeşitlerine göre bu binaların şekline karar verirler. Bu çokgen çeşitleri, bir tane kenarları eşit uzunlukta olan düzgün olmayan beşgen, başka bir tane düzgün olmayan beşgen ve her birinden ikişer tane olan

a) ikizkenar üçgen,
b) eşkenar üçgen,
c) paralelkenar,
d) dikdörtgen,
e) kare,
f) eşkenar dörtgen,
g) yamuk,
h) başka bir dörtgen,
i) düzgün beşgen,
j) düzgün altıgen,
k) düzgün sekizgen,
l) düzgün olmayan altıgen içermektedir.

4. Çalışma yaprağının ilk sayfasında planda çizecekleri yolların birbirine göre durumlarına örnek yollar çizmeleri için de açıklama vardır. Projelerinde yer alan yollar ve caddeler için aşağıdakileri düşünürler:

a) üçü birbirine paralel olan,
b)ikisi paralel ve üçüncüsü diğer ikisini birer noktada dik ve başka bir açıyla kesen,
c) üçgen oluşturulan ve
d) paralel olmayan iki yolu üçüncü bir yolu kesen yollar ve caddeler.

5. Bir önceki üç maddede verdikleri kararlar doğrultusunda A4 kağıdına krokilerini (taslak planlarını) ölçülere ve geometrik şekillere uymaksızın çizerler.
6. Öğretmen krokilerin çizimleri bitince kontrol eder ve öğrencilerin yönergede yer alıp unuttukları konuları hatırlatır.

7. Öğrenciler, öğretmenin yorumları doğrultusunda gereken yerlerde düzeltmeler yaparlar.

PROJE ÇALIŞMA YAPRAĞI-6.1

Grup üyeleri:

Tasarlayacağınız Mahallede Olması Gereken Bölümler:

1) Yerleşme alanları: Konutlara ait arsalar
2) Eğitim kurumları: Mahalle içinde yürünebilir uzaklıkta en az bir anaokulu ve bir ilköğretim okulu
3) Okul öncesi ve okul çağı yaş grubu için çocuk bahçeleri
4) Sağlık alanı: Sağlık ocağı.
5) Sosyal ve kültürel faaliyetler için bir binalar.
6) Alışveriş merkezi.
7) Spor alanları: Futbol sahası.
8) Dinlenme ve eğlence alanları: Lokanta, büfe, çay bahçesi, pastane.
9) Ulaşım: Genişliği 7m-15m arasında olan yerel yollar, cadde ve sokaklar.
10) Otopark yeri
11) Pazaryeri
12) Yönetim donanımları: PTT, jandarma (polis karakolu), muhtar, itfaiye, su şebekesi.
13) Yeşil alanlar: Dinlenme, gezinti, piknik eğlence, yürüyüş amaçlı yeşil alanlar.
14) Dini alanlar: camii, …vb.

Tasarlayacağınız Mahallede İsteğe Bağlı Olabilecek Bölümler:

Yukarıda belirtilen bölümlerin her birinin sayısını grup üyelerin ortak isteğine bağlı arttırabilirsiniz. Örneğin birden fazla ilköğretim okulu olabilir. Bunlara ek olarak aşağıdaki bölümler veya başka eklemek istediğiniz bölümler olabilir:

Lise, üniversite, planladığınız bölgede bulunan tarihi eser (camii ve kilise gibi), kültürel eser, doğal yapı (orman, sulak bölge ve dere gibi) veya o bölgenin ekonomik kaynakları (tarım, hayvancılık, ulaşım, turizm, el sanatları, ticaret, madenler, sanayi ve enerji kaynakları gibi), hastane ve kaplıca gibi sağlık merkezleri, yüzme, atletizm, buz pateni… açık ve kapalı tesisler, botanik, hayvanat bahçesi ve yardım kurumları.

Zorunlu olan yukarıdaki 14 maddeye ekledikleriniz:

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Çizeceğiniz Yollar:

1. Herhangi üçü paralel olsun.
2. İkisi paralel olsun, üçüncüsü diğer iki paralel yolu dik kessin.
3. İkisi paralel olsun, üçüncüsü diğer iki paralel yolu başka bir açıyla kessin.
4. Paralel olmayan iki yolu, üçüncü bir yol kessin.
5. Üçgen oluşturan üç yol olsun.

Taslak Kroki üzerinde gösterdiğiniz her bir bölümün GERÇEK ölçüleri:

	Bölüm adı	Kenarlarının gerçek uzunlukları (m)	İç açılarının ölçüleri	Dış açılarının ölçüleri
1. İkizkenar üçgen olan bir bölüm				
2. İkizkenar üçgen olan diğer bölüm				
3. Eşkenar üçgen olan bir bölüm				
4. Eşkenar üçgen olan diğer bölüm				
5. Paralelkenar olan bir bölüm				
6. Paralelkenar olan diğer bölüm				
7. Dikdörtgen olan bir bölüm				
8. Dikdörtgen olan diğer bölüm				
9. Kare olan bir bölüm				
10. Kare olan diğer bölüm				
11. Eşkenar dörtgen olan bir bölüm				
12. Eşkenar dörtgen olan diğer bölüm				
13. Yamuk olan bir bölüm				
14. Yamuk olan diğer bölüm				
15. Başka bir dörtgen olan bir bölüm				
16.Başka bir dörtgen olan diğer bölüm				
17. Düzgün beşgen olan bir bölüm				
18. Düzgün beşgen olan diğer bölüm				
19.Düzgün altıgen olan bir bölüm				
20. Düzgün altıgen olan diğer bölüm				
21. Düzgün sekizgen olan bir bölüm				
22. Düzgün sekizgen olan diğer bölüm				
23. Kenarları eşit uzunlukta düzgün olmayan beşgen olan bir bölüm				
24.Düzgün olmayan beşgen olan diğer bölüm				
25.Düzgün olmayan altıgen bir bölüm				
26.Düzgün olmayan altıgen olan diğer bölüm				

<u>Not:</u> Yukarıdaki sadece iki çokgeni birbirine eş seçin. Diğer çokgenlerin kenar

uzunlukları birbirinden farklı olsun.

Ölçeğe göre çizeceğiniz PLAN ÜZERİNDE gösterdiğiniz her bir bölümün ölçüleri:

	Bölüm adı	Kenarlarının plan üzerindeki uzunlukları (cm cinsinden)	İç açılarının ölçüleri	Dış açılarının ölçüleri
1. İkizkenar üçgen olan bir bölüm		2,8-2 - ?	90^0-?- ?	
2. İkizkenar üçgen olan diğer bölüm				
3. Eşkenar üçgen olan bir bölüm				
4. Eşkenar üçgen olan diğer bölüm				
5. Paralelkenar olan bir bölüm				
6. Paralelkenar olan diğer bölüm				
7. Dikdörtgen olan bir bölüm				
8. Dikdörtgen olan diğer bölüm				
9. Kare olan bir bölüm				
10. Kare olan diğer bölüm				
11. Eşkenar dörtgen olan bir bölüm				
12. Eşkenar dörtgen olan diğer bölüm				
13. Yamuk olan bir bölüm				
14.Yamuk olan diğer bölüm				
15. Başka bir dörtgen olan bir bölüm				
16. Başka bir dörtgen olan diğer bölüm				
17. Düzgün beşgen olan bir bölüm				
18. Düzgün beşgen olan diğer bölüm				
19. Düzgün altıgen olan bir bölüm				
20.Düzgün altıgen olan diğer bölüm				
21. Düzgün sekizgen olan bir bölüm				
22.Düzgün sekizgen olan diğer bölüm				
23. Kenarları eşit uzunlukta düzgün olmayan beşgen olan bir bölüm			90^0-90^0 -150^0-150^0- ?	
24. Düzgün olmayan beşgen olan diğer bölüm			110^0-110^0 –100^0–120^0-?	
25. Düzgün olmayan altıgen bir bölüm			110^0-110^0-120^0–120^0– 130^0 - ?	
26. Düzgün olmayan altıgen olan diğer bölüm			90^0–100^0– 105^0–130^0– 140^0 - ?	

DERS PLANI 7

YARARLANILAN DİSİPLİNLER: Fen ve Teknoloji, Matematik, Müzik, Sosyal Bilgiler, Resim, Trafik, Türkçe.
TARİH:
SINIF: 7
SÜRE: 2 ders saati

ÖĞRENME ALANI: Geometri-Ölçme
ALT ÖĞRENME ALANI: Çokgenler- Doğrular ve Açılar-Açıları Ölçme
BÖLÜM: Aynı Düzlemdeki Üç Doğru - Çokgenler

KAZANIMLAR:
1) Mahallelerinde yer alan binaların (çokgenlerin) gerçekte ve plan üzerindeki açı ve kenar ölçülerine karar verirler.

DERS İÇİ İLİŞKİLENDİRME: Uzunluk ölçüleri, ölçek, oran ve orantı
YÖNTEM VE TEKNİKLER: Proje Tabanlı Öğrenme, Araştırma, Keşfetme

KULLANILAN EĞİTİM TEKNOLOJİLERİ: Bilgisayar, Internet
ARAÇ ve GEREÇ: Sınıf içi araç gereçler, A4 kağıdı, cetvel, proje çalışma yaprağı-6.1, hesap makinesi.

DERSİN İŞLENİŞİ

<u>1. ve 2. Ders</u>

Günlük Yaşamla Bağlantı ve Proje Hazırlama

1. Sosyal Bilgiler ve matematik dersinde bir önceki yılda öğrendikleri ölçek konusu hatırlatılır. "Yeryüzünün tamamı veya bir kısmını kağıt üzerine aynı ölçülerde göstermek mümkün müdür? Aynı ölçülerle çizilse kullanışlı olur mu? Neden? Harita yaparken uzunluklar neden küçültülür? Küçültme nasıl yapılır?" soruları yöneltilir. Öğrencilerin "Küçültme belli oranda olur." yanıtını vermeleri ölçek konusunu hatırlamaları beklenir. Ölçeğin neden ve hangi durumlarda gerekli olduğu sorulur. Öğrenci yanıtlarından sonra şu örnekler verilir: "Televizyonda izlediğimiz görüntüler gerçek görüntülerinin belli oranda küçülmüş halleridir. Çizgi film (masal) kahramanlarının bir büyüyle küçülür ya da büyür. Bazı durumlarda şekiller ve nesnelerin görüntüleri küçültülür (harita gibi). Bazı durumlarda ise büyültülür (mikroskoptaki mikrobun görüntüsü gibi). Bir şeklin her tarafının aynı oranda küçülüp ya da büyümesi gerekir. Küçültme ya da büyütme oranı mutlaka belirtilmelidir."

2. Dikdörtgensel bölge şeklindeki mahallenin gerçek boyutları 1200m x 1700m'dir. Mahalle planını 48cm x 68cm boyutlarındaki kartona çizeceklerdir. Mahalle planının ölçeğinin 1:2500 olacağı sınıfta tartışılarak bulunur. Her bir gruba işlem yaparken zorlanmasınlar diye hesap makinesi verilir. Burada önemli olan öğrencilerin hangi

işlemleri yapacaklarına kendileri karar verip o işlemi kolayca hesap makinesinden bulmalarını sağlamaktır.

3. Proje Çalışma Yaprağı-6.1'nin ikinci ve üçüncü sayfalarında yer alan iki tabloda mahallelerinde yer alan çokgen şeklindeki binaların gerçekte ve plan üzerindeki açı ve kenar ölçülerine karar verirler. Öğrencilerin eş ve benzer şekilleri uygulayabilmeleri için sadece iki şekli eş seçmeleri, diğer şekilleri eş seçmemeleri beklenir.

4. Öğrenciler, bu tabloları tamamlarken gerekirse krokilerinde düzeltmeler yaparlar. Öğretmen bu tabloları kontrol eder ve gerekli düzeltmeler için doğrudan yanıtları vermek yerine genel uyarılarda bulunur, yönlendirici sorular sorar ve öğrencilerin eksikleri veya yanlışlarıyla ilgili tekrar düşünmelerini sağlar. Örneğin "Şurada düzgün beşgenin iç açıları ve kenarları nasıl olmalı?" ve "Doğru oran kullandınız mı?"

5. Öğrenciler, öğretmenin yorumları doğrultusunda çokgenlerin kenar ve açı özellikleriyle ilgili gereken yerlerde düzeltmeler yaparlar.

DERS PLANI 8

YARARLANILAN DİSİPLİNLER: Fen ve Teknoloji, Matematik, Müzik, Sosyal Bilgiler, Resim, Trafik, Türkçe.
TARİH:
SINIF: 7
SÜRE: 3 ders saati

ÖĞRENME ALANI: Geometri-Ölçme
ALT ÖĞRENME ALANI: Çokgenler- Doğrular ve Açılar-Açıları Ölçme
BÖLÜM: Aynı Düzlemdeki Üç Doğru - Çokgenler

KAZANIMLAR:
1) Krokilerini ve mahallede yer alan çokgen şeklindeki binaların açı ve kenar ölçülerini kullanarak mahalle planını çizerler.

DERS İÇİ İLİŞKİLENDİRME: Uzunluk ölçüleri, ölçek, oran ve orantı
YÖNTEM VE TEKNİKLER: Proje Tabanlı Öğrenme, Araştırma, Keşfetme

KULLANILAN EĞİTİM TEKNOLOJİLERİ: Bilgisayar, Internet
ARAÇ ve GEREÇ: Sınıf içi araç gereçler, A4 kağıdı, cetvel, proje çalışma yaprağı-6.1, hesap makinesi, açıölçer.

DERSİN İŞLENİŞİ

<u>1., 2. ve 3. Ders</u>

Günlük Yaşamla Bağlantı ve Proje Hazırlama

1. Cetvel ve açıölçer kullanarak krokilerini ve Proje Çalışma Yaprağı-6.1'deki tabloda karar verdikleri plan üzerindeki açı ve kenar ölçülerine uygun mahalle planı çizerler. Öğretmen önce yolları sonra çokgenleri çizmelerini önerir ama kesin bir sınırlama getirmez. Gruplar her şeye kendileri karar verirler. Öğrenciler, sınıfta yolların gerçek hayatta ve 1:2500 ölçekli plan üzerindeki genişliklerini enleri tartışırlar. Öğretmen çizilecek yolların 0,5-0,6 cm olmalarını önerir. Öğrenciler kroki ve tablolarında ihtiyaç duyarlarsa düzeltme yapabilirler.

2. Öğretmen, ara sıra öğrencilerin yaptıkları çalışmaları genel değerlendirir. Gereken yerde motive edici sözler söyler ve öğrencilerin projeye daha fazla odaklanmalarına yardımcı olur. Öğretmen bir sorun gördüğü zaman gereken yerde müdahale edip sınıf disiplinini sağlar. Öğretmen öğrencilerin çzimlerini kontrol eder ve bazı yönlendirici sorular sorar: " Eşkenar dörtgen şeklindeki … binasının ölçülerine dikkat edin" gibi.

3. Öğrenciler çizimlerini bitirince isteklerine bağlı olarak planlarını boyarlar.

DERS PLANI 9

YARARLANILAN DİSİPLİNLER: Fen ve Teknoloji, Matematik, Müzik, Sosyal Bilgiler, Resim, Trafik, Türkçe.
TARİH:
SINIF: 7
SÜRE: 1 ders saati

ÖĞRENME ALANI: Geometri-Ölçme
ALT ÖĞRENME ALANI: Çokgenler- Doğrular ve Açılar-Açıları Ölçme
BÖLÜM: Aynı Düzlemdeki Üç Doğru - Çokgenler

KAZANIMLAR:
1) Öğrenciler, öğretmenin yorumlarından sonra projelerini son kez kontrol ederler.

DERS İÇİ İLİŞKİLENDİRME: Uzunluk ölçüleri, ölçek, oran ve orantı
YÖNTEM VE TEKNİKLER: Proje Tabanlı Öğrenme, Araştırma, Keşfetme

KULLANILAN EĞİTİM TEKNOLOJİLERİ: Bilgisayar, Internet
ARAÇ ve GEREÇ: Sınıf içi araç gereçler, A4 kağıdı, cetvel, proje çalışma yaprağı-6.1, hesap makinesi, açıölçer.

DERSİN İŞLENİŞİ

Öğrenciler, öğretmenin çizimleriyle ilgili yorumlarından sonra mahalle planı çizimlerini ölçülere de dikkat ederek son kez kontrol ederler.

DERS PLANI 10

YARARLANILAN DİSİPLİNLER: Fen ve Teknoloji, Matematik, Müzik, Sosyal Bilgiler, Resim, Trafik, Türkçe.
TARİH:
SINIF: 7
SÜRE: 2 ders saati

ÖĞRENME ALANI: Geometri-Ölçme
ALT ÖĞRENME ALANI: Çokgenler- Doğrular ve Açılar-Açıları Ölçme
BÖLÜM: Aynı Düzlemdeki Üç Doğru - Çokgenler

KAZANIMLAR:
1) Planlarında yer alan geometrik kavramların birbirleriyle bağlantılarını tartışırlar.

DERS İÇİ İLİŞKİLENDİRME: Uzunluk ölçüleri, ölçek, oran ve orantı
YÖNTEM VE TEKNİKLER: Proje Tabanlı Öğrenme, Araştırma, Keşfetme

KULLANILAN EĞİTİM TEKNOLOJİLERİ: Bilgisayar, Internet
ARAÇ ve GEREÇ: Sınıf içi araç gereçler, A4 kağıdı, cetvel, proje çalışma yaprağı-10.1, hesap makinesi, açıölçer.

DERSİN İŞLENİŞİ

1. Öğrencilere proje çalışma yaprağı-10.1 verilir. Öğrenciler grup olarak projelerini tamamladıktan sonra bu çalışma yaprağında yer alan geometrik kavramlar arasındaki bağlantıları projelerini düşünerek tartışırlar.

2. Proje çalışma yaprağı-1.1'in son maddesinde yer alan proje sunumlarıyla ilgili yönergeyi de okuyup sunumlarına hazırlanırlar.

PROJE ÇALIŞMA YAPRAĞI-10.1
<u>Planınızda çizdiğinin iki paralel yolu kesen üçüncü bir yolla ilgili aşağıdaki soruları tartışınız:</u> * Paralel dediğiniz yolların tam paralel olduğuna nasıl emin olursunuz? * Yollar arasında oluşan yöndeş açılar eşit ölçüde mi? * Yollar arasında oluşan iç ters açılar eşit ölçüde mi? * Yollar arasında oluşan dış ters açılar eşit ölçüde mi? <u>Çizdiğiniz çokgen şeklindeki binalarla ilgili aşağıdaki soruları tartışınız:</u> * Tüm ikizkenar üçgenler benzer midir? * Eşkenar üçgen ve ikizkenar üçgen arasındaki bağlantı nedir? * Tüm eşkenar üçgenler benzer midir? * Eşkenar dörtgen ve paralelkenar, eşkenar dörtgen ve kare, kare ve dikdörtgen, paralelkenar ve yamuk arasındaki açı ve kenar özellikleri nelerdir? * Eş olan iki çokgen benzer midir? * Benzer olan iki çokgen eş midir? * Sadece kenarları eşit olan çokgenler düzgün çokgen midir? * Sadece açıları eş olan çokgenler düzgün çokgen midir? * Sadece açıları eş olan çokgenler benzer midir? * Düzgün altıgenler benzer midir? * Bir köşede oluşan iç ve dış açılar arsındaki bağıntı nedir? * Tüm dikdörtgenler kare midir? * Tüm kareler dikdörtgen midir? * Tüm eşkenar dörtgenler kare midir? * Tüm kareler eşkenar dörtgen midir? * Tüm eşkenar dörtgenler paralelkenar mıdır? * Tüm paralelkenarlar eşkenar dörtgen midir? * Tüm kareler paralelkenar mıdır? * Tüm paralelkenarlar kare midir? * Tüm dikdörtgenler paralelkenar mıdır? * Tüm paralelkenarlar dikdörtgen midir? * Tüm yamuklar paralelkenar mıdır? * Tüm paralelkenarlar yamuk mudur?

SHARING ARTIFACT (Lesson Plan 11)

Bir grup sunumunu yaparken diğer gruplar grup arkadaşlarıyla ders planı 5-10'daki gibi yan yana oturacaklardır.

DERS PLANI 11

YARARLANILAN DİSİPLİNLER: Matematik, Sosyal Bilgiler, Türkçe.
TARİH:
SINIF: 7
Süre: SÜRE: 2 ders saati
ÖĞRENME ALANI: Geometri-Ölçme
ALT ÖĞRENME ALANI: Çokgenler- Doğrular ve Açılar-Açıları Ölçme
BÖLÜM: Aynı Düzlemdeki Üç Doğru - Çokgenler

KAZANIMLAR:
1) Projelerini grup olarak sunarlar

YÖNTEM VE TEKNİKLER: Proje Tabanlı Öğrenme

KULLANILAN EĞİTİM TEKNOLOJİLERİ: Bilgisayar
ARAÇ ve GEREÇ: Sınıf içi araç gereçler, mahalle planları

DERSİN İŞLENİŞİ

<u>1. ve 2. ders</u>

1. Öğrenciler projelerini grup olarak tamamladıktan sonra öğretmen tüm öğrencilere proje çalışma yaprağı 1.1'nin son maddesini hatırlatır. Tüm grupların yaklaşık 5 dakikalık sunum yapmaları beklenir. Yaptıkları projenin ilgili belediyeden yetkili kişiye tanıtımı ve avantajları anlatılacaklardır.

2. Projenin bitiminde öğrencilerden hazırlayacakları bireysel ve grup raporları, iki boyutlu olan mahalle planı ve mahalle tasarımlarını uygulamaya geçirmek için ilgili belediyeden alınması gereken izin için yazılan bir dilekçe teslim edilir.

APPENDIX N

LESSON PLAN EVALUATION SCALE

	Kesinlikle katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle katılıyorum
1. Proje çalışması, sürükleyici bir soru (driving question) üzerine kurulmuştur.					
2.Proje çalışması, öğrencilerin araştırma yapmalarını sağlamaktadır.					
3. Proje çalışması, öğrencinin grup çalışmaları ile öğrenmelerini sağlamaktadır.					
4. Proje çalışması, öğretmenin ve öğrencilerin teknoloji kullanımını içermektedir.					
5. Proje çalışması, öğrencilerin bir ürün ortaya koymalarını sağlamaktadır.					
6. Proje çalışması, otantik değerlendirme içermektedir.					
7. Proje çalışması, öğrencilerin kavramları ve projeyi anlamaları için ders anlatımı (benchmark lessons) içerir.					
8. Proje çalışması, öğrencilerin gerçek yaşamla bağlantı kurmalarını sağlayacak niteliktedir.					
9. Proje çalışması, öğrenci merkezli eğitimi temel almakta ve öğretmen rehber rolündedir.					
10. Proje çalışması, öğrencilerin yaparak öğrenmesini sağlayacak niteliktedir.					
11. Proje çalışması disiplinler arası bir çalışmadır.					
12. Proje çalışması, öğrencilerin alt düzey becerilerini kullanmak yanı sıra üst düzey becerilerini (analiz, sentez) kullanmaya zorlayacak niteliktedir.					
13.Proje çalışması, öğrencilerin ilgisini çekebilecek niteliktedir					
14. Proje çalışması, yukarıda bahsedilen tüm özellikleri ayrı ayrı yapmak yerine birbiri içinde uygulamayı sağlamaktadır.					

APPENDIX O

TEACHER'S OBSERVATION FORM

1. Üç farklı bilişsel stile sahip öğrenciler projeler içinde hangi detaylara ve soyut özelliklere dikkat ediyorlar?
2. Üç farklı bilişsel stile sahip öğrenciler, bireysel ve grup çalışmalarında hangi özellikleri gösteriyorlar, öğretmenin ve arkadaşlarının söylediklerine nasıl dikkat ediyorlar?
3. Üç farklı bilişsel stile sahip öğrenciler, problem çözerken veya herhangi bir sorunla karşılaşınca nasıl davranıyorlar?
4. Üç farklı bilişsel stile sahip öğrenciler, kullanılan ders materyallerine karşı nasıl tepki gösteriyorlar?
5. Geometri benchmark lessons sırasında ve projeyi hazırlayıp sunarken üç farklı bilişsel stile sahip öğrenciler kavramlar arasındaki bağlantıları kurabilme (conditional knowledge) bilgilerini nasıl gösteriyorlar, neler yapıyorlar?
6. Geometri benchmark lessons sırasında ve projeyi hazırlayıp sunarken üç farklı bilişsel stile sahip öğrenciler kavramları günlük hayattan durumlar içinde kullanabilme (procedural knowledge) bilgilerini nasıl gösteriyorlar, neler yapıyorlar?

APPENDIX P

INTERVIEW QUESTIONS FORM

Time	Interview questions
Before creation of artifact	1. Günlük hayattan resimler gösterilmesi hakkında ne düşünüyorsunuz? Neden?
	2. Geometri diğer derslerde ve günlük hayatta kullanılması ile ilgili ne düşünüyorsunuz? Geometri nerede ve nasıl kullanılıyor?
	3. Günlük hayattan bazı resimler, araç-gereçler göstermenin ve teknoloji kullanmanın geometri öğreniminizde etkisi konusunda ne düşünüyorsunuz? Geometri öğreniminizi hangi durumlar nasıl etkiledi?
During and upon creation of artifact	4. Araştırmanızı nasıl yaptınız, hangi kaynaklar buldunuz ve kullandınız?
	5. Projenizdeki çokgenleri nasıl yerleştirdiniz, belli bir amaca göre mi yoksa rastgele mi?
	6. Bu projeyi sevdiniz mi? Neden? Projede en çok sevdiğiniz veya en çok ilginizi çeken bölüm(ler) nedir? Projede hoşlanmadığınız bölüm(ler) var mı, (varsa nelerdir)? Neden?
	7. Geometri konuları arasında bağlantı kurabiliyor musunuz? Evet ise, geometri konularını nasıl ilişkilendirebildiğinizi projenizden örneklerle açıklayınız.
	8. Geometri konularını günlük hayatınızda kullanabilir misiniz? Evet ise, günlük hayatınızda nasıl kullanabildiğinizle ilgili projenizden örnekler verin. Hangi geometri konularını, nasıl uyguladığınızı düşünüyorsunuz?
	9. Grup çalışması hoşunuza gitti mi? Neden?
	10. Projede grup ya da bireysel olarak karşılaştığınız zorluklar (varsa) nelerdir? Bu zorlukları aşmak için neler yaptınız? Projede en iyi yaptığınızı düşündüğünüz neler vardır? Projenizi hazırlarken kullandığınız yöntemler nelerdir?

APPENDIX R

TURKISH EXCERPTS FROM STUDENTS' INTERVIEW RESPONSES

SORU 1: Günlük hayattan resimler gösterilmesi hakkında ne düşünüyorsunuz? Neden?
SORU 2: Geometri diğer derslerde ve günlük hayatta kullanılması ile ilgili ne düşünüyorsunuz? Geometri nerede ve nasıl kullanılıyor?

Geometrinin hayatımızda her yerde olduğunu fark ettim ve geometri gerçek hayatta kullanılıyor. Mesela, doğada ve binaların yapımında. Ben peysaj mimarı olmayı seçtim ve peysaj mimarları ne yapıyor, öğrenmeye başladım. Daha önceden matematik dersi çok zor geldiği için derse kendimi veremiyordum ama günlük hayattan örnekler verilmesi ve bunlarla ilgili tartışmamız benim dersi iyi dinlememi sağladı. Gerçek hayattan örneklerle öğrenmek çok eğlenceli. Daha iyi öğreniyorum çünkü bu daha zevkli. (INT-FD11)
Uzay mekiğini makete küçülten gösteriyle eğlendim ve çokgenleri top üzerinde konuşmaktan zevk aldım. Dikdörtgenleri benzerdir sanıyordum. Dikdörtgenlerin benzer olmayabileceklerini sizin fotoğrafınızda yüzünüzün değiştiğini hatırlayarak öğrendim. (INT-FD17)
Matematik dersleri günlük hayatla ilgili. Bu zevkli ve anlamlı (böyle olunca derse) daha çok katılıyoruz. Aktivitelere katıldık. Hayatımızda gördüklerimle matematiği düşünüyorum. Hesap makinesi kullanarak (dikdörtgen şeklindeki) iki fotoğrafın benzer olup olmadıklarını buldum. Bunlar geometriyi daha iyi anlamamı sağladı. (INT-FD20)

Geometri her yerde kullanılır. Biz günlük hayattan örnekler verildiği için daha iyi anlıyoruz. (INT-FM14)
Geometrinin binalarda kullanıldığını öğrendim. Niye üçgenleri öğrendiğimizi gördüm. Binaların fotoğraflarını tartışırken üçgenleri ne zaman kullanacağımızı gördüm. (INT-FM20)
Günlük hayattan örnekler görmeyi sevdim. Geometride sosyal bilgilerden yararlandık. Gerçek hayattan örnekler verilmesi güzel. Ben mimar olmayı düşünmüyorum ama mimarlar çok kullanıyormuş. Aslında geometri her şeyle bağlantılı mesela önümüzdeki sırada bile dikdörtgen görebiliriz. Geometrik şekilleri her yerde görüyorum. Bu şekilde öğrenmek çok eğlenceli. (INT-FM25)

Günlük hayatla daha çok bağlantı kurmaya başladım. Önceden düşünmüyordum. Şimdi dışarıda bir şey görünce bu bizim öğrendiğimiz şu konuyla ilgili diyorum. Bunlar öğrenmemi kolaylaştırdı. (INT-FI7)

Günlük hayattan örnekler de hoşumuza gidiyor. Mesela fotoğraflar. Mesela siz çubuklarla üçgen, kare falan oluşturmuştunuz ve üçgenin sağlam olduğunu ama karenin sağlam olmadığını ve hareket ettiğini göstermiştiniz. Bana önceden Eiffel Kulesi pek sağlam gelmezdi nedense ama gösterdiğiniz fotoğraflarda çok üçgenler vardı ve onun şimdi sağlam olduğunu düşünüyorum. Biz 6. sınıfta benzerliği görmüştük ama bu benim için günlük hayattan fotoğraflar, animasyon ve (matruşka) bebeklerle birleştirince daha anlamlı oldu. (INT-FI15)
Geometri günlük hayatla bağlantılıymış çünkü mesleklerde kullanılıyormuş. Biz her şeyin nedenini öğreniyoruz. Bundan dolayı daha iyi öğreniyoruz . (INT-FI22)

SORU 3: Günlük hayattan bazı resimler, araç-gereçler göstermenin ve teknoloji kullanmanın geometri öğreniminizde etkisi konusunda ne düşünüyorsunuz? Geometri öğreniminizi hangi durumlar nasıl etkiledi?

(Geometri) günlük hayatta kullanılıyormuş. Mesela doğada, binaların yapımında. Siz dış açı özellikleriyle ilgili bilgisayarda bir sunu gösterdiniz, o daha çok aklımda kaldı. Tahtada yazılsa o kadar kalıcı olmazdı. Mesela, resimler ve bizler üçgen, kare yaptık ve üçgen sağlam ama kare sağlam değil ve hareket ediyor. (INT-FD11)
Siz bize paralelkenar, kare göstermiştiniz. Onları tahtada gösteremezdiniz. Çok faydalı oldu (INT-FD17)
Öğretme biçiminiz çok güzel. Bilgisayarda gösterdiğiniz zaman bazı şeyleri bizim için görsel oluyor ve daha kolay anlıyoruz. Işıklar kapanınca bilgisayara odaklanmamız gerekiyor. Böylece tüm sınıf dersle ilgili oluyor. Bilgisayarda bazı şekiller göstermiştiniz ve onların şekillerini değiştirmiştiniz. Karenin köşelerinden hareket ettirerek eşkenar dörtgen elde etmişsiniz ama tam tersi olamadı (INT-FD20)
Matematik dersinde bilgisayarda gösterdikleriniz anlamamıza da yardımcı oluyor. Tahtada gösteremeyeceğiniz şeyler vardı orada. Mesela, dörtgenlerde birinden diğerini elde ederken (INT-FD22)

Matematikte bilgisayar kullanıldığı zaman dörtgenlerden birinden diğerini elde ettiğimizi öğrendim. (INT-FM14)
Kalıcı oldu. Bu arada hesap makinesinin üzerinde pek çok şey varmış. Dün onu keşfettim (INT-FM20)
Bilgisayar daha görsel oluyor. (Bu şekilde) daha iyi öğreniyorum. Bilgisayarda bir şeyler görünce daha kolay öğreniyoruz ve daha kalıcı oluyor. Teknoloji daha kolay anlamamızı sağlıyor (INT-FM25)

Bilgisayar kullanıldığı zaman daha iyi öğreniyoruz ve bizim için daha kalıcı oluyor (INT-FI3)
Bilgisayarda sunu çok güzel. Bunu seviyorum. Bunları tahtada gösteremezdiniz. Biz daha iyi anlıyoruz ve benim için daha kalıcı oluyor (INT-FI7)
Matematikte bilgisayar kullanılmasını seviyorum. Örneğin, paralelkenardan kare elde edebileceğimizi gördüm. Daha önceden bunun olabileceğini düşünmezdim. Matematik konuları arasındaki bağlantılar çok ilgimi çekiyor. Bunları bilgisayarda gösterdiğiniz zaman dersi dikkatli dinlemeyenler bile dersi iyi takip etti (INT-FI15)
Bilgisayarda gösterdiğiniz şeyler görsel oldu ve bunu anladım. Örneğin, bilgisayarda gösterdiğinizde paralelkenarla eşkenar dörtgen arasındaki farkı anladım (INT-FI20)

Matematik dersinde bilgisayar kullanılması daha çok zevkli. Bazen tahtada sıkıcı oluyor. Konuyu anlamam için bilgisayar tabii ki faydalı. Daha çabuk görüyorsunuz (INT-FI22)

SORU 4: Araştırmanızı nasıl yaptınız, hangi kaynakları buldunuz ve kullandınız?

Uygun kelimeler seçerek kolaylıkla internetten bilgi buldum. Şehir plancısı, mimar, mühendis, peysaj mimarının görevlerini öğrendim. Biz (yeşil alanlar için) karaçamı seçeceğiz çünkü biz karaçamın diğer ağaçlara göre daha fazla oksijen ürettiğini öğrendik. (INT-FD17)
Sizin verdiğiniz sitelerden araştırma yaptım. Araştırma yaparken zorlanmadım. Gördüm ki mimarlar çizimde dikkat etmezlerse ufak bir hata tüm her şeyi yıkabiliyor. (INT-FD20)

Araştırma yaparken muhtara gittik ama muhtar olmadığı için yerinde başkası vardı. O da örnek mahalle kroki bulamadı . (INT-FM2)
Hangi mahalleyi seçeceğimize Atlastan Türkiye haritasına bakarak karar verdik. Edirne'yle ilgili ve mimar, peysaj mimarı gibi mesleklerle ilgili bilgi topladık. (INT-FM14)
"Örnek kroki" yazarak örnek krokiler ve mahallenin tarihiyle ilgili bilgi buldum. (INT-FM20)
Bizim mahalle başbakanımızın mahallesi. Bunun için internetten mahallenin iklimi, coğrafî konumu, nüfusu, tarihî, kültürel eserleri ve bölümleri ile ilgili bilgiler bulmak çok kolay oldu. Çok bilgi vardı ve uygun olanları seçmek zordu. Babam, ablam ve abim mühendis. Onlardan yardım aldım. Örnek krokiler ve mesleklerle ilgili bilgi buldum. Ayrıca, internetten gazete makaleleri buldum ve onların özetlerini hazırladım. (INT-FM25)

İnternetten araştırma yaptım ama mahalle konusunda çok geniş bilgiler geldi. Ansiklopedilerden baktım ama mahalleyle ilgili pek bir şey bulamadım. Şehir bölge planlamacısının ne yaptığı ve bir yerin krokisi ve coğrafî konumu ve nüfusuyla ilgili bilgi topladım. (INT-FI7)
Ansiklopediden ve bir üniversite öğrencisinin web adresinden araştırdım. Peysaj mimarlığı ve şehir plancılığı mesleklerini öğrendim. (INT-FI13)
Google Earth'ten araştırdım ve mahallenin yeri ve özelliklerini buldum. (INT-FI15)
İnternet ve google'dan yararlandın. Mühendislik, mimarlık ve bir yerin tasarımı ile ilgili bilgimi artırdım. (INT-FI22)

SORU 5: Projenizdeki çokgenleri nasıl yerleştirdiniz, belli bir amaca göre mi yoksa rastgele mi?

Genelde evler kare olduğu için onları kare seçtik. Burada taksi durağını yamuk seçtik çünkü taksiler eğimli park edebiliyor. (INT-FD16)
Limanı geniş olması için dikdörtgen yaptık. Kiliseyi altıgene benzettik. (INT-FD17)
Biz futbol sahasını doğal olarak dikdörtgen şeklinde yaptık. (INT-FD20)

Otel için altıgen seçtik çünkü üçgen olsaydı alan daha az olurdu. (INT-FM10)
Çoğunlukla bir amaçla yaptık. Mesela bu okulu altıgen yapmamızın sebebi eşit olarak yer ayırmak istedik, bütün okulları ilköğretim, lise falan hepsini bir arada topladık. Hatta bahçesini ortak olarak yaptık. (INT-FM15)
İlk önce bir düzene göre yerleştirdik. Sonra kalanları (çokgenleri) yerleştirdik. İki paralel yol yaptık ve arasına (eczane için) paralelkenar koyduk. En son elimizde iki yamuk ve eşkenar dörtgen kalmıştı biz de iki yamuğu da rock bar ve elektrik şebekesini eşkenar dörtgen yaptık. (INT-FM20)
Biz binayı paralelkenar seçtik çünkü bazı insanlar bazı bölümler için dar diğer bölümler için geniş seçebilirler. (INT-FM25)

Mimari açıdan güzel olsun diye sinemayı altıgen şeklinde seçtik. (INT-FI6)
Büyük bir alan kaplamasına dikkat ettiğimiz için havaalanını beşgen yaptık. Çok küçük mesela üçgen yapmak istemedik bu tren garını. Ama terminal daha küçük olduğu için onu üçgen yaptık. Genelde apartmanları çizmesi kolay olsun diye eşkenar dörtgen seçtik. Dinî alanı geniş olması için altıgen seçtik. (INT-FI10)
Binalar iç içe. Üçgenleri, karelerin içine çizdik. (INT-FI13)
Boşluğu dolduracak yerlerde çok köşe düşündük çünkü daha geniş gözüküyordu (düzgün olmayan altıgen olan Pazar yeri için) Şuraların da düzgün olması için dikdörtgen koyduk (taş kahve için) Diyelim ki düz olan bu yola üçgen yapsak düzgün görülmeyecekti. Kiliseleri çok kenarlı seçtik. Müzeleri üçgen düşündük, buradan bir köşeden kapı, şuralardan (diğer iki köşeden) çıkışlar var diye düşündük. Burada devlet binalarında çok aşırı değişik şekiller olmaz. Ben başta biraz değişik olsun dedim de baktım şuralara da bir şeyler daha yerleştirecektik. Onun için klasik olmasına karar verdik ve bu bölgede dörtgenleri topladık. (INT-FI15)
İlk önce, (kartona) sığdırabilir miyiz diye düşündük. Buraya sekizgen koymamızın nedeni yollarla ilgili. Biz binaları simetrik olması için kare yapmayı kararlaştırdık. Alışveriş merkezi için altıgen seçtik. (INT-FI21)
Sığmayınca fikrimizi değiştirdik. (INT-FI22)

SORU 6: Bu projeyi sevdiniz mi? Neden? Projede en çok sevdiğiniz veya en çok ilginizi çeken bölüm(ler) nedir? Projede hoşlanmadığınız bölüm(ler) var mı, (varsa nelerdir)? Neden?

Evet, en çok yaptığımız çizimleri sevdim. (INT-FD1)
Evet, sevdim. En çok şehir tasarlamayı sevdim çünkü hem yaparken komik oluyor, hem şehri kendimiz tasarlıyoruz. Mesela huzur evinin yanında disko var, o komik geliyor. İkincisi, yeni bir şeyi tasarlıyoruz. Her şeyi bize ait. İstediğimizi koyarız, koymayız. Bize sorulacak. O yüzden her şeyin kendi elinde olması bence daha güzel. Projeyi sevdim çünkü grup çalışmasını severim. Sevdiğim arkadaşlarımla çalışmaktan mutlu oldum. (INT-FD2)
Evet, sevdim çünkü çokgenleri, açıları, doğruları tekrar ettim. Açıları (ölçülerini) bulmayı öğrendim. Zorluk çekmeden geometri konularını uyguladığımı düşünüyorum. Açılarına ve kenarlarına göre çizmeyi sevdim. Çokgenleri çizmeyi pratik yaptık. (INT-FD5)
Bütün projeyi sevdim çünkü çok eğlenceli. Geometrinin günlük hayatımızdaki önemini ve değerini bir kez daha anladım. Benim için en ilginç olan yolları birleştirmekti. (INT-FD9)

Evet, bu projeyi sevdim çünkü geometriyi daha iyi anlamamı sağladı. Plan üzerindeki her bir çokgenin ölçülerine karar verirken çokgenlerin temel özelliklerini kullanabildik. Yeterli geometri bilgisine sahipmişim. Bunları kullanarak bir meslek sahibinin yerine koyduk kendimizi. Ben peysaj mimarı oldum. O kişiler ne yapıyor, onu yapıyorum. Bu çok heyecan verici. (INT-FD11)
Çizim yapmayı seviyorum ve bu çok güzel bir proje. (INT-FD12)
Bu projeyi gerçekten çok sevdik çünkü insanın hayal gücünü ortaya koyabileceği, el becerilerini geliştirebileceği, çizim ve boyama yapabileceği zevkli ve eğlenceli bir projeydi. En çok açıları (ölçülerini) hesaplarken eğlendim. Açıölçer kullanarak şekilleri çizmeyi sevdim. En iyi yaptığım, çizerken şekillerin açılarını ölçmek ve uygulamak. (INT-FD13)
Evet, sevdim çünkü bu proje geometri ile ilgili ilginç konuları içeriyordu. (INT-FD16)
Evet, bu proje çok eğlenceli. Binaların şekillerini seçmekte iyiydim. (INT-FD17)
Evet, bu projeyi çok sevdim çünkü hayal gücümüzü matematikle birleştiren oldukça eğlenceli bir projeydi. Zevkliydi. Taslağı çizmeyi sevdim ve adayı çizerken eğlendim. Her şey güzeldi. Sanırım açı ölçülerini iyi yaptık çünkü bir kez ölçtüğümüz açıya tekrar bakarak aynı yeri ikinci kere ölçtük bu da hata yapma riskimizi ortadan kaldırdı . (INT-FD18)
Bu projeyi sevdim. (INT-FD20)
Evet, (projeyi sevdim) çünkü sunum güzeldi. (INT-FD21)
Çizim yapmak en ilginç ve eğlenceli bölümdü benim için. (INT-FD22)
Evet, çünkü çalışmamız eğlenceliydi. En çok çizim yapma bölümünü sevdim. (INT-FD25)
Bu projeyi sevdim çünkü bir yerleri tasarlayıp yaratmak benim hoşuma gidiyor ve ilgimi çekiyor. Kendimi bir mimar olarak düşünmek ve bir yer tasarlayarak hayal etmek ilgimi çekti. Bu projeyi sevdim çünkü geometri konularını anlamamı sağladı. Çizimi severim ben. Bu projeyi hazırlarken çizim yapmanın o kadar da kolay olmadığını fakat çok zevkli olduğunu fark ettim. (INT-FD27)
Sevdim çünkü tasarlamayı ve günlük hayattan örnekler verilmesini severim. En çok ilgimi çeken bölüm taslakların gerçek ölçülere göre çizilmesiydi. Projede hoşlanmadığım bölüm yoktu. Her şey çok eğlenceliydi. (INT-FD29)
Sevdim çünkü zevkliydi. Özellikle çizim aşamasını sevdim. Hoşlanmadığım bir bölüm yok. (INT-FD30)

Proje çizmeyi ve bir şey tasarlamayı çok severim. Bu projede en sevdiğim bölüm taslağı çizmekti. (INT-FM1)
Evet, sevdim. Çokgenlerin yerlerine güzel karar verdim. En çok boyamayı sevdim. (INT-FM2)
Sevdim. Bu projede benim için en ilginç olan mahalledeki çokgenlerin gerçek ve plan üzerindeki uzunlukları bulmaktı. (INT-FM4)
Sevdim. Yaparken eğlendim. Neresi nerede olsun diye karar verirken eğlendim. (INT-FM5)
Bu projeyi sevdim. (INT-FM8)
Evet, sevdim çünkü yaratıcılığımızın ve hayal gücümüzün geliştiğini düşünüyorum. Gelecekte mimar olmak istiyorum çünkü çizimleri sevdim. (INT-FM9)
Evet, sevdim. Çizim yapmayı severim. (INT-FM10)
Projemizi eğlenerek yaptık. (INT-FM11)

Biz bu projeyi çok sevdik. Eğlenceli bir projeydi. Hayal gücümüzü gösteren çizimler yaptık . (INT-FM12)
Bu projeyi sevdim çünkü bu projeyle hayal gücünüzü gösterebiliyorsunuz. Mahalledeki bölümleri doğru yerlere yerleştirdiğimi düşünüyorum. Çizerken, açıları (ölçülerini) ayarlarken ve boyarken zevkli bir projeydi. En çok çokgenlerin kenar ve açı özelliklerini (ölçülerini) hesaplamayı sevdim. (INT-FM13)
Evet, ben çizmeyi severim zaten. Geometri günlük hayatta kullanılıyor ve bunu çok seviyorum. Evet, çünkü geometri hoşuma gider ve bu proje eğlenceliydi. Yani gerçeği söyleyeyim daha önceden yaptığımız performans, proje ödevlerinden bu daha eğlenceliydi. Grup kuruyorsun, çiziyorsun aynı zamanda hesaplamaların ne olacağını biliyorsun, kaç ölçekli küçülteceğine, gerçek hayatta ne olur bu projeyi uygulasak. Sonra o mahalleyi araştırıyorsun. (INT-FM14)
Evet, sevdim, çizim kısmı zevkli ve eğlenceliydi. Krokiyi plandan daha güzel çizdik bence. Böyle bir şey üretmemiz güzeldi bence. Hesap yapmak, hesap makinesi kullanmak, genel olarak eğlenceliydi bence. Genel olarak bize uygun bir projeydi. (INT-FM15)
Evet, sevdim. En çok çizmeyi sevdim. (INT-FM16)
Evet, çok sevdim çünkü ilk defa bir derste cetvel vb. araçlar kullanarak bir plan çizdik. En çok projeyi planlamak ilgimi çekti. Öğrendiğimiz geometrik şekillerin hemen hemen hepsini kullandık. Zor oldu ama başardığımızı düşünüyorum. (INT-FM18)
Evet, sevdim çünkü bu proje geometrik şekillerin binalarda kullanıldığını öğretti. (INT-FM19)
Herkesin ilgisini çektiği gibi benim de ilgimi çizim kısmı çekti. Grup olarak da projeyi sevdik. Bu proje bizleri düşünmeye ve el becerilerimizi kullanmaya itiyor. Hoşlanmadığım bir bölüm yok. (INT-FM20)
Evet çünkü (bu proje) eğlenceli ve güzel. En çok ilgimi çeken bir yer bulmak ve çizmek oldu. (INT-FM21)
Evet, sevdim çünkü bu çalışma (diğerlerinden) farklı. En çok ölçmeyi sevdim. (INT-FM22)
(Gözleri parlayarak) Sevdim ve çok hoşuma gitti çünkü ben zaten bir şeyler tasarlamayı çok severim. Farklı bir etkinlik oldu ve bu tür etkinlikler benim okulu daha çok sevmeme yardımcı oluyor. Bu projeyi çok sevdik çünkü bizleri düşünmeye ve el becerilerimizi kullanmaya itiyor. Hem de öğretiyordu. (INT-FM24)
(Gözleri parlayarak) Ben sevdim çünkü mimarın, bir büyüğün yaptığı işleri yapıyoruz. Böyle daha güzel oluyor. (Mahallenin) bölümlerini nereye ve nasıl yerleştirdiğimiz dikkatimi çekti. Gelecekte mimar olmak istiyorum çünkü çizimleri sevdim. (INT-FM25)
Evet, çünkü insanın kendini mimar olarak düşünmesi ve kısa bir sürede o duyguyu yaşaması çok güzel. En çok ilgimi çeken çizim ve sunum oldu. Gelecekte mimar olmak istiyorum çünkü çizimleri sevdim. (INT-FM26)
Evet, sevdim çünkü bilgilerimi eğlenceli bir biçimde kullanmamı sağlıyor. Bu projedeki konuların neredeyse hepsini daha önceden biliyorduk. Pekiştirme oldu bu bizim için. (INT-FM28)
Projeyi çok sevdim çünkü kendi mahallemizi isteklerimiz doğrultusunda kurmak, tasarlamak çok zevkliydi. Genel olarak gayet kolay ve zevkli bir projeydi. En çok sevdiğim bölüm belirli ölçülerde küçülterek çizmekti. (INT-FM29)

Projeyi sevdim çünkü kendi istediğimizi yapabiliyorduk. (Mahallenin) bölümlerinin yerine karar verdik. En çok bunu sevdim. (INT-FM31)
En çok sevdiğim planı çizmek ve sunum oldu. (INT-FM33)
Evet, çok sevdim. Çizimi çok sevdim. En çok sevdiğim ve ilgimi çeken bölüm çokgenleri çizmekti çünkü dereceleri tutturmak için uğraştık, zorlandık ve eğlendik. (INT-FM34)

Bir şeyler planladığımız için bu projeyi sevdim. Ölçülerine göre yaptık. Bu da eğlenceliydi. Projede en sevdiğim bölüm yolları birbirine bağlamaktı. Yolların tasarımı ve açılı şekiller çizmek epey ilginçti. Paralelliği oluşturmak, kesişim yapmak değişikti. Genel bakıldığında mahalle planladık. O da zevkli bir şeydi.. (INT-FI1)
Evet, sevdim. (INT-FI2)
Evet, çok sevdim çünkü bu proje çok eğlenceli ve düşündürücü bir proje idi. Uzun ve zor bir projeydi. (INT-FI4)
Başta pek sevmedim çünkü grup arkadaşlarımızı biz seçmeliydik. Sonra sevdim. Öğretme biçiminiz çok güzel. Bize bir şeyler üretmemiz için şans veriyorsunuz. Bu çok hoşuma gidiyor. Projede en çok çizimi sevdim. (INT-FI6)
Evet, sevdim. Proje çok eğlenceliydi. En çok çizim ve boyama bölümleri ilgimi çekti.. (INT-FI9)
Bu projeyi çok sevdim. Aslında, benim matematikte en sevdiğim konulardan biri çokgenler. Hani onların açılarını falan bulmayı çok severim. Diğer konulardan daha çok hoşuma gidiyor. Çokgenlerle ilgili bir şey olduğunda epey bir hoşuma gitmişti. Mesela eğer zamanım olsa maketini yapmak isterdim. En çok ilgimi çeken yolları ve çokgen şeklindeki binaları çizmekti. (INT-FI10)
Tüm projeyi çok sevdim. Mahallenin bölümlerini yerleştirirken çok eğlendim. Çokgenler en çok sevdiğim konulardan biridir. Onları kullanarak mahalleyi tasarlamak çok zevkliydi. (INT-FI13)
Evet, çünkü kendi mahallemizi isteklerimiz doğrultusunda kurmak ve tasarlamak çok zevkliydi. (INT-FI14)
Evet sevdim çünkü çok zevkli(INT-FI15)
Evet çünkü zevkli. Projede en çok çizimleri sevdim. Açılarına göre çizmek ve boyamakla güzel zaman geçirdim. (INT-FI17)
Sevdim. Bence, çok eğlenceli bir projeydi ve binaları iyi yerlere yerleştirdik. En çok boyama bölümünü sevdim. (INT-FI18)
Bu projeyi çok sevdim. En çok binaların geometrik şekillerine karar vermeyi ve çizim yapmayı sevdim. (INT-FI19)
Yönergeyi dağıttığınızda bunların matematikle ne ilgisi var diye düşünmüştüm ama bağlantısı varmış. Projeyi sevdim çünkü farklı bir proje. Diğerlerinde sadece sınavlar ve sorular verilir ve biz çözeriz. Bu proje daha pratik ve daha iyi. Çizimleri sevdim. (INT-FI20)
Sevdim çünkü çok eğlenceli. Çizimleri ve boyamayı çok sevdim. (INT-FI22)
Evet, sevdim çünkü çokgenlerin açılarını ve kenarlarını kullandık. Açıları ve kenarları ölçmeyi sevdim. En çok ilgimi çeken mahalleyi çizmek için okul, ev ve alışveriş merkezinin yerlerine karar vermek oldu. (INT-FI27)
En çok binaları çizmeyi sevdim çünkü gelecekte de mimar olmak istiyorum. (INT-FI28)

(Gözleri parlayarak) Proje tabi ki hoşuma gitti çünkü mimarlık yaptım ve bunu sevdim. İleride mimar olmak istiyorum. (INT-FI29)
Sevdim çünkü geometriyle uğraşmak matematiğin en zevkli bölümlerinden biri. Bazı bölümleri istediğimiz gibi bitiremedik. En çok çizim aşamasını sevdim. (INT-FI30)

SORU 7. Geometri konuları arasında bağlantı kurabiliyor musunuz? Evet ise, geometri konularını nasıl ilişkilendirebildiğinizi projenizden örneklerle açıklayınız.

Evet, bu ikisi eştir ve benzerdir ama benzer olan iki şekle her zaman eştir diyemeyiz. Bu eşkenar dörtgene paralelkenar diyebiliriz. Eşkenar dörtgende şu açılar eşitti (karşılıklı açıları göstererek), şunların toplamı 180 derece (yan yana olan U harfi oluşturanları göstererek), paralelkenarda karşılıklı kenarların uzunluklar eşit. O zaman… paralelkenar eşkenar dörtgeni kapsıyor. Mesela şu (muhtarlık) bir beşgen ama düzgün değil. Tüm kenarları eşit uzunlukta ama açıları farklı. Bunu sınıfta tartışırken FI-1 anlatmıştı. (INT-FD1)
Evet, mesela düzgün çokgenlerin açıları eşittir. Bu ikisi eş ve benzer ama benzer şekiller her zaman eş olmayabilir. Eşkenar dörtgendeki bu (karşılıklı) açılar eşittir. Bu açıların (karşı durumlu açılar) toplamı 180 derecedir. Paralelkenarda zıt yönlü açılar eşittir. Paralelkenar eşkenar dörtgeni kapsar. Başka, bu düzgün olmayan beşgendir. Tüm kenarları eşit ama açıları farklıdır. Bu eşkenar üçgen (aynı zamanda) ikizkenardır da. Şu bir kare. Buna eşkenar dörtgen diyebiliriz. Sınıfa getirmiştiniz ya bilgisayarda hani şekillerini değiştirmiştik. İşte kareyi şöyle biraz içeri doğru bastırınca yine bu şekil (eşkenar dörtgen) çıkıyor. Ama bunu (eşkenar dörtgeni) bastırınca kare olmuyor tam olarak. (INT-FD17)
Evet, öğrendim çünkü projede ne yaptığımızı hatırlıyorum. Hesap makinesi işimize yaradı. Mesela bu düzgün altıgenin bir iç açısı 120 derece. Toplam açıyı n-2 çarpı 180le buluruz. Bir açısını bunu n'ye bölerek buluruz. Bu düzgün altıgenler birbirine benzerdir çünkü açıları ve kenarları eşit ve kenarları orantılı. Bu paralelkenarda zıt açılar eşit ama bu yamukta sadece bu iki kenar paralel. Kare şeklindeki evler benzer. Başka, bu düzgün beşgenlerin aynı kenar ve açıları var. İki düzgün altıgen gibi çok benzer çokgen var. Bu dikdörtgenlerin açıları 90 derece. Bu iki dikdörtgen benzer değil çünkü kenarları orantılı değil. Bu kareler eş. Eşse aynı zamanda benzer. Tersi doğru değil. Bu beşgenin kenarları eşit ama düzgün beşgen değil. Düzgün çokgen olması için açıları eşit olmalı. Bu eşkenar üçgenin açıları eşit. Bu ikizkenar üçgenin iki açısı eşit. Üç açı eşitse ikisi de eşittir. Bunun için her eşkenar üçgen ikizkenardır. Tersi doğru değil tabiî ki. Bunları daha önceden bu kadar düşünmezdim. Projemizi yaparken ne yaptığımızın farkındaydık. (INT-FD20)

Evet, mesela şuradaki eş çokgenler benzerdir çünkü bütün açıları ve uzunluk ölçüleri eşit ve aynı zamanda benzerdir. Bu elektrik şebekesi eşkenar dörtgen. Bu bir düzgün çokgen değildir çünkü iç açıları ve kenar uzunlukları eşit olmalı. Eşkenar dörtgende açılarının hepsi eşit değil. Bu eşkenar üçgen ikizkenar üçgendir çünkü ikizkenar üçgenin iki açıları birbirine eşittir. Eşkenar üçgende bütün açılar zaten birbirine eşittir. Bu yamuğa paralelkenardır diyemeyiz çünkü yamuğun iki kenarı paraleldir ama paralelkenarın dört kenarı (ikişerli) paraleldir. (INT-FM1)

Evet, mesela dikdörtgenler her zaman birbirine benzer olmaz çünkü bir sabit oran tutturamayız çünkü her sayı eş değil. Şuradaki eş olan kareler benzerdir. (INT-FM14)
Evet mesela buradaki eş şekiller benzerdir çünkü ölçüleri aynı olduğu için zaten benzer oluyor ama bütün benzerler de eş olmuyor. Buradaki düzgün altıgenler benzerdir. Zaten açıları eşit olur. Bir tek uzunlukları farklı, o da eşit oranda olmak zorunda çünkü zaten bütün kenarları birbirine eşit olacağı için hepsi eşit şekilde dağılacaktır. Ondan dolayı benzerdirler. Burada üç eş şekil kullandık. Lokantalar… Bunlar benzerdir de çünkü her eş şekil aynı zamanda benzerdi ama her benzer şekil eş değildir. Bu eşkenar dörtgene kare diyemeyiz çünkü karenin kenarları ve açıları eşittir. Bu sağlık ocağı kare şeklinde ve buna eşkenar dörtgen diyebiliriz. Eşkenar dörtgenin açıları aynı ya da farklı olabilir. Bu yamuğun tabanları paralel ama diğer iki kenarı değil. Bu (yamuk) paralelkenar değildir çünkü paralelkenarda tüm karşılıklı kenarlar paraleldir. (INT-FM20)
Evet, şurada üç tane eş şekil kullandık. Lokantalar, büfeler…Bunlar birbirine benzerdir de çünkü, her eş şekil aynı zamanda benzerdir ama her benzer şekil eş değildir. Bu eşkenar dörtgene karedir diyemeyiz çünkü karenin tüm kenarları ve açıları birbirine eşit. Bu sağlık ocağı kare şeklinde ve buna eşkenar dörtgen …. Eşkenar dörtgende açıları aynı olabilir ya da olmayabilir. O zaman diyebiliriz. Bu yamukta taban ve alt taban birbirine paralel ama iki kenarı paralel değil. Bu bir paralelkenar değil çünkü paralelkenarın bütün kenarları birbirine paralel ama bunun sadece iki kenarları birbirine paralel diğerleri değil. (INT-FM25)

Evet, mesela bu Ptt'yi paralelkenar yapmıştık. Bu paralelkenar yamuk değildir çünkü bütün kenarları paralel. Yamuk olması için ikisi paralel, öbür ikisi kesişimli olması gerekir. Şu sağlık ocağı eşkenar dörtgendir. Kare de eşkenar dörtgendir zaten çünkü eşkenar dörtgenin tüm kenarları eşit yani özellik olarak artı olarak da hepsi 90 derece. Bu kare paralelkenardır da çünkü iki kenarı paralel, öbür ikisi de paralel. Karşılıklı kenarları eşit. Bu eşkenar üçgene eşkenar diyebiliriz çünkü ikizkenar üçgenin özelliklerini taşıyor en az iki kenarı eşit. Şu muhtarlık (kenarları eşit, açıları farklı olan beşgen) bir düzgün çokgen değildir çünkü iç açıları farklı. Şu eş sekizgenlere benzerdir çünkü her bir açının baktığı kenarı eşit. (INT-FI1)
Evet, mesela şu bir dikdörtgen, bu dikdörtgene düzgün çokgen diyemeyiz çünkü düzgün çokgen olabilmesi için hem açılarının hem kenarlarının eşit olması gerekiyordu. Bu bir yamuk ve buna paralelkenar diyemeyiz. Siz bize bir tablo vermiştiniz. Özel dörtgenler diye. Orada paralelkenarların altında yamuk yoktu (Venn şemasını hatırlıyor.) Yamuk ayrı yeten bir kümeydi. Nedeni, yamukta galiba açıları (karşılıklı her) eşit olmuyordu. Paralelkenarda karşılıklı açıları eşit oluyordu. Yamukta öyle bir kural yoktu. Şu ikisi düzgün sekizgen ve benzerdir çünkü belli bir oranda büyümüştür. Mesela bunun kenarları 3er cm olsun bunun da 4er olsun. Belli bir oranda büyümüş olur. (INT-FI10)
Evet, mesela bu bir dikdörtgen ve düzgün çokgen değildir çünkü düzgün çokgen olması için açılar ve kenarlar eşit olmalı. Bu bir yamuk ve buna paralelkenar diyemeyiz. Özel dörtgenlerin tablosuna (Venn şemasına) baktık. Yamuk, paralelkenarın altında değildir, ayrı kümededir. Bunun nedeni şudur: Tüm (karşılıklı) açılar yamukta aynı değildir ama paralelkenarda aynıdır. Bu ikisi düzgün sekizgen ve bunlar benzerdir çünkü (kenarları) orantılı. (INT-FI15)

Evet, mesela eşkenar dörtgenle paralelkenarın ikisinin karşılıklı kenarları paralel, paralelkenar eşkenar dörtgeni kapsıyor. Bu bir yamuk ve bu bir paralelkenar. Bunlar ayrık kümeler çünkü paralelkenarda her karşılıklı kenar birbirine paralel ama yamukta bir çift paralel. Her dikdörtgen düzgün çokgen değildir. Bunu grubumuzda tartışırken karar verememiştik size sormuştuk. Şu eşkenar üçgen ikizkenardır da. Sonuçta eşkenar üçgenin de iki kenarı birbirine eştir. (INT-FI22)
Evet, birçok şey öğrendik. İç açılar, dış açılar, geometrik şekillerin açıları ve kenarları arasındaki bağlantıları. (INT-FI30)

SORU 8. Bu projeyi hazırlarken neler öğrendiniz? Geometri konularını günlük hayatınızda kullanabilir misiniz? Evet ise, hangi geometri konularını, nasıl uyguladığınızı projenizden örnekler vererek açıklayınız.

Evet, Açıları (ölçülerini) bulmayı öğrendim. Geometri konularını zorlanmadan uyguladığımızı düşünüyorum. (INT-FD5)
Bu projeyi hazırlarken geometrinin günlük hayatımızdaki önemini ve değerini bir kez daha anladım. (INT-FD9)
Geometriyi çok daha zevkli ve eğlenceli işlemiş oldum ve bu konuyu (açılar ve çokgenleri) çok daha iyi öğrendim. (INT-FD11)
Bu projeyi yaparken geometriyi daha iyi anladım. (Binaların) açı ve kenar ölçülerine karar verirken kroki üzerindeki her bir çokgenin temel özelliklerini kullanabildik. Yeterli geometri bilgisine sahipmişim. Çokgenleri, açıölçer kullanmayı, hesaplama yapmayı…vs birçok şey öğrendim. Uygulama yaptık ve farklı mesleklerden kişiler gibi davrandık. Ben peysaj mimarı oldum. Bu insanların yaptıklarını uyguladım ve bu çok heyecan verici. (Geometriyi) kroki, plan vs çizimlerde, ileride mesleklerimizde ve günlük yaşantımızda kullanabiliriz. (INT-FD13)
Çokgenlerin açılarını kenarlarını kullandık. En iyi açıları (ölçülerini) buldum. Geometrik şekillerin kenar uzunlukları ve açıları ile ilgili özellikleri daha iyi kavradım. Ayrıca plan ve ölçek adlı konuyu tekrar hatırladım. Bütün bunlar şekillerin açılarını ve kenar uzunluklarını hesaplamada ve ona göre çizmemizde yardımcı oldu. (INT-FD16)
Bu konuyu, geometriyi eğlenceli ve zevkli yaparak daha iyi öğrendim. Mesela, bu açılar yöndeş. Bu bir düzgün altıgen ve (toplam) ölçüleri 720 derece. Bunu n-2 çarpı 180 olarak buluruz. Sonra bunu n'ye böleriz, bir tanesini bulmak için. Düzgün çokgende tüm açılar ve kenarlar eşit. Bu ikiz kuleler ve futbol sahası (dikdörtgenler) benzer çünkü birinin enleri ve boyları diğerinin üç katı. Bu üçgende bu iç ve bu dış açı. Su şebekesi ve postahane (nin şekilleri) eş. Bu anaokulu, okul ve park alanı paralelkenar (şeklinde) Kuralları unuttuğumda hatırlamak için defterime bakıyorum. Tabloyu tamamlamak için bunları kullandık. Bazı çokgenlerin açılarını ve diğer konuları kolaylıkla uygulayabilirim. (INT-FD17)
Çokgenler, açılar ve ölçüler ile ilgili birçok bilgi edindim. Projeyi tamamlamamızda geometri de bize yardım etti . (INT-FD18)
Bu projeyi hazırlarken yerlerin nasıl tasarlanabileceğini öğrendim. Geometri konularını, şekillerin düzgün olup olmadıklarına göre, paralel vs. özelliklerine göre iyi uygulandığımızı düşünüyorum. (INT-FD20)

Bu projeyi yaparken matematiğin mimaride çok önemli bir yer tuttuğunu düşündüm ve gördüm. Evet, çokgenlerin özellikleri için sizin anlattığınız şeyleri kullandık. (INT-FD22)
Bu projede kullandığımız şeyleri daha önceden biliyordum. Bu projeyi hazırlarken geometri konularını tekrar etmiş oldum. (INT-FD25)
Bu proje geometri konularında gelişme sağladı. (INT-FD27)

Proje yapmayı ve pratik bir şekilde çokgen çizmeyi öğrendim. Ben mimar olduğum zaman tasarım yaparken çokgenleri kullanırım. Özelliklerini kullanmayı öğrendim. Mesela ters açıları. Ölçüleri eşit. Bu açıların (karşı durumlu açılar) toplamı 180 derece. Bu iki açı yöndeş açılar. (Düzgün sekizgenin) toplam açılarını 180 çarpı 8-2 ile buluruz ve bir tanesini bulmak için sekize böleriz. Kuralları ezberlemiyorum. Projemizi hatırlıyorum. Bunlar benim için şimdi anlamlı.. (INT-FM1)
Bu projeyi hazırlarken, belirli bir oranda bir yeri plan üzerinde küçültmeyi, gerçek uzunluğunu bulmayı öğrendim Öğrendiğim geometri konularından çokgenlerin iç açı ve dış açı toplamları sayesinde çalışmamı rahat yaptım. Çokgenlerin hayatımızda ne kadar önemli olduğunu ve nerelerde kullanıldığını öğrendim. (INT-FM2)
Nerede neresi olmalı, nereye koysak daha mantıklı olur, bunu öğrendim. (INT-FM5)
Açıölçerle nasıl geometrik şekiller çizeceğimizi öğrendik. Bence biz bu çalışmayı çok iyi ve düzenli gerçekleştirdik. (INT-FM6)
Matematiği ve geometrik şekilleri nerede kullanabileceğimizi öğrendik. Bunları kolaylıkla, uygun şekilde ve bilerek kullandık. Geometri şekillerini kullanmayı, açıölçer kullanmayı, alan çizmeyi (öğrendik) Konuları bilinçli ve uygun, kolay kullandık. (INT-FM8)
Beşgenin iç açıları,… falan, ve ne kadar oranla nasıl küçülttüğümüzü öğrendim. Ben ileride mimar olmak istiyorum. Onlar bana faydalı olacak bence. (INT-FM9)
Bu projeyi hazırlarken çokgenlerin açılarını hesaplamayı öğrendim. Açılarla, düzgün çokgenlerle ilgili konuları doğru uyguladığımı düşünüyorum. (INT-FM10)
Açıları kullandık. Düzgün çokgenleri ölçtük. Açıölçeri arkadaşlarım ve siz on kez gösterdikten sonra anladım (gülümseyerek) Ben zaten mimar olmak istiyorum. O konuda kendimi geliştirdim. (INT-FM11)
Açıların ölçülerini bulurken hesap makinesini kullandık. Kolay oldu. Açıölçer kullanmayı öğrendim. İyi uyguladım. "Çokgenleri, düzgün çokgen, beşgen, altıgen… çizdik. Bilinmeyen açıları bulmada kullandık. Geometri konularını günlük hayatta uygulamayı öğrendim. (INT-FM12)
Bu projede geometrik konuların gerçek hayatta nasıl kullanıldığını ve uygulandığını öğrendim. Geometrik şekillerin açı, kenar uzunlukları, köşegen konularını, doğruları projemizde eksiksiz olarak tamamladığımızı düşünüyorum. Ben geometrik şekilleri, açıları, benzerlikleri günlük yaşantımda iyi bir şekilde kullandığımı düşünüyorum. Mahalledeki binaların açı ve kenar ölçülerine ve oranlarına karar verdik. (INT-FM13)
Hangi oranda küçülteceğimize ve hesaplamalara karar verdik. Geometriyi ve çokgenleri nerelerde kullanacağımı öğrendim. Bunu iyi uyguladığımı düşünüyorum. Yamuk, dörtgenleri… kullandık. Açılarını ve çevresini kullandık. Alanını pek kullanmadık. Geometri günlük hayatta kullanılıyor ben de çok seviyorum. Mesela plan çizerken kullandık. Temel kuralları öğrendik. Mesela, bunlar yöndeş açılar. Bu açılar Z harfi oluşturur. Bunun (br açısının) ölçüsü 120 derece ve bunu 6-2 çarpı 180 bölü 6 ile buluruz. Bu dikdörtgenlerin açıları 90 derece, dik . (INT-FM14)

Mimarların yaptıkları işin kolay görünse de bir hayli zor olduğunu ama bir o kadar da eğlenceli olduğunu öğrendim. Çizimlerde açıları bilmek yardımcı oldu. Öncelikle çokgenler, açılar falan vardı. Ondan sonra benzerlikler, hepsini kullandık. Benzerliği, mesela bunlar (çizdiği çokgenleri göstererek) bir şekilde düzen oluşturuyor yani. Benzerlikleri ve eşitlikleri var. Hatta aralarındaki boşlukları bile eşit tutmaya çalıştık. (INT-FM15)
Açıların kaç derece olduğunu, iç açılarının kaç derece olduğunu öğrendim. (INT-FM16)
Bu projeyi hazırlarken grup çalışması yapmayı ve uyguladığımız mesleklerin ne kadar zor olduğunu öğrendim. Biz neredeyse öğrendiğimiz bütün geometrik şekilleri kullandık. Zor oldu ama başardığımıza inanıyoruz. (INT-FM18)
Daha önceden öğrendiklerimizi hesaplamalar yaparak kullandık. Açıları için. Özelliklerini kullanarak da uzunluklarına karar verdik. 1/2500 ölçeğimiz de vardı. Onu kullanarak uzunlukları bulduk. Temel kuralları öğrendik. Mesela, bu lokantalar düzgün altıgen (şeklinde) Tüm açıları ve kenarları eşit. Bir iç açıyı bulmak için iç açıların toplamını kenar sayısına böleriz(INT-FM19)
Projeyi hazırlarken bir projenin ne kadar uzun süreçler sonucunda oluştuğunu öğrendim. Açıölçeri kullanmayı öğrendim. Matematikte kullandığımız geometrik şekillerin aslında hayatın her alanında var olduğunu öğrendim. Ayrıca araştırırken İstanbul'un coğrafî özellikleri hakkında bilgim oldu. Meslekler hakkında mesela peysaj mimarlığı, mimarlık. Karar verirken bazı şeylere çoğunlukla grup arkadaşımız FI15 karar verdi. Şunu şuraya yapalım, ölçüleri böyle olsun diye. Aramızda plandaki ve gerçek yaşamdaki ölçülerine karar verdik. (INT-FM20)
Oranlamayı yaptık, ölçtük, açıları yaptık, doğruları öğrendik. (INT-FM21)
Geometri ve açı konusunu pekiştirdik. Geometride çokgenleri nasıl kullanacağımızı öğrendim. (INT-FM22)
Geometrik şekillerin hayatımızda veya ileride nasıl faydalı olduğunu ve bu çalışmada nasıl kullanıldığını öğrendik. (INT-FM23)
Çokgenleri ve açıları kullandım ve pekiştirdim. Aslında projeyi çokgenleri kullanarak yaptık. Sokakları çizerken paralellikleri, kesişimleri ve açıları kullandık. (INT-FM24)
Camilerin, süpermarketlerin ya da başka alanların neden evlere yakın olduğunu anladım. Kısacası şehir planlamayı öğrendim. Üçgen, dörtgen, beşgen, altıgen ve sekizgenleri kullanarak çizmeyi öğrenip uyguladığımı düşünüyorum. Matematiği gerçek hayatta kullandık. (INT-FM25)
Proje eğlenerek bilgimizi kullanmayı sağladı. Çokgenleri, açıölçer kullanmayı, çokgenlerin açılarını öğrendim. Bu proje için gerekli konuları biliyordum. Pekiştirme oldu bizim için. (INT-FM28)
Öğrendiğim geometri konularını projemizi de tasarlarken doğru ve araştırarak kullandığımızı düşünüyorum. (INT-FM34)

Ölçülerine göre yaptık. Bu projede geometrisiz hayatın olamayacağını öğrendim. Günlük hayatta geometri kullanılıyor ve önemli. Örneğin tasarımlarda. Bu projede ölçüleri ve çokgenlerin açılarını kullandık. Ölçeklendirmeyi ve mahalle planının özelliklerini öğrendim. Çokgenlerin özelliklerini ve eşlik benzerlik detaylarını öğrendim. Düzgün çokgenlerin özelliklerini öğrendim. Öğrendiklerimi etkin bir şekilde bina v.b. çizimlerinde kullandığımı düşünüyorum. Bu konuda yeterli bilgi biliyordum. Bunu yaparken de bazı özelliklere dikkat ettik. Gerçek bir mahalle planı yaptık. Gerçek uzunluk, uygun şekilde yerleştirmek, kenar uzunlukları, açı özelliklerine bağlı olarak yaptık. Temel özellikleri öğrendim. Mesela, şu iki açının (iç açıların ölçüleri) toplamı 180 derecedir. Bu (paralel) yollar böyle devam etseydi, bu iki açı yöndeş ve eş olurdu. Bu üçgenin bir dış açısı. Bu (iç) açıyı 180'e tamamlar. Bu kare bir düzgün çokgen. Bunun bir açısını (ölçüsünü) n-2 çarpı 180 bölü n ile buluruz. Bu evler (sekizgen) eş. Eş açı ve eş kenarları var. Bu dikdörtgenler benzer çünkü (kenarlarının) oranları eşit. Mesela, kenarları (uzunlukları) 4 ve 8, diğerininki 3 ve 6. Bu dikdörtgenler benzer değil. Benzer olması için kenarlarının oranları aynı olmalı. Açı ve kenar özellikleriyle ilgili temel kuralları kullandık. Çokgenlerin açı ve kenar özelliklerine karar verdik ve tabloyu tamamladık.. (INT-FI1)

Geometrik şekilleri daha da yakından tanıdığımı düşünüyorum. (INT-FI2)

Çokgenlerin özelliklerini daha iyi kavradım. Geometriyi kullandık. (INT-FI6)

Matematik bilgisini kullandık. (INT-FI7)

Geometriyle ilgili bir sürü şey öğrendik. Mesela eş ölçüler. Bu proje çokgenler konusunu öğrenmemde ve pekiştirmemde etkili oldu. Aslında bir kağıt vermiştiniz. Ben bunu da göstermiştim dış açı olarak (dış açının ters açısını göstererek) Arkadaşlarımla kontrol edince, bu iki açının dış açı olduğunu, bunun dış açı olmadığını öğrendik. Bence güzel bir şekilde uyguladık. (INT-FI9)

Bu projeyi hazırlarken çokgenlerin açı ve kenar özelliklerinden faydalandık. (INT-FI10)

Peysaj mimarı ve şehir planlama uzmanı mesleklerini öğrendim. Öğrendiğimiz tüm geometrik şekilleri kullandık ve onların uzunluklarıyla açılarını belirledik. (INT-FI13)

Hesaplamaları iyi yaptık ve geometrili mesela çokgenleri iyi kullandık. (INT-FI14)

Hesaplamaları iyi yaptığımı düşünüyorum. Açı ve kenarlarına (ölçülerine) karar verirken hesap makinesi kullandım. Çokgenlerin açılarını ve kenarlarını kullandım ve bunları bu projeyi hazırlarken daha iyi öğrendim. Başta ilk projeyi aldığımızda genel olarak birçok kişi "Bu ne?" dedi. Matematikle ilgili bir şey yok diye düşündük ilk başta ama daha sonra benim için faydaları oldu. Bunların hepsini öğrendim bence iyi oldu. (Proje) çokgenleri pekiştirmemi sağladı. Bence bunları daha iyi anladım. Temel kuralları öğrendim. Bu park alanı ve bu hastane dikdörtgen (şeklinde ve açıları 90 derece. Bu camii ve market benzer çünkü bunlar düzgün çokgen (şeklinde) ve camii marketten daha küçük. Bu iki apartman (şekilleri) eş. Bu düzgün sekizgen. (Bir) açısını (ölçüsünü) bulmak için 180 çarpı n-2'yi kenar sayısına böleriz. Çokgenleri çizmek için kuralları hatırlama gereği duyduk. (INT-FI15)

Geometriyi, açıları ve matematiği kullandık. Geometrik şekillerin günlük hayatta kullanıldığı alanları daha iyi öğrendim. Mesela beşgenin iç açılarını yeniden tekrar ettik. Matematik ve geometrim gelişti. (INT-FI17)

Geometrik şekillerin özelliklerini öğrendim. Geometri zor ama projeyi çok iyi yaptığımızı düşünüyorum. (INT-FI19)

Bu proje pratik ve bu daha güzel. Çokgenleri tekrar hatırlamış oldum. Mesela çokgenlerin açılarını kullanıyoruz . (INT-FI20)

Yeni bir şey öğrenmedim. Daha önceden öğrendiklerimi tekrar ettim. (INT-FI22)

Bu projede çokgenlerin açılarını ve kenarlarını kullandık. Paralellik ve diklik konularını pekiştirdik. Bu projeyi hazırlarken, geometrideki temel kuralları, açı ve kenar özelliklerini günlük hayatta kullanmayı öğrendim. Tablo oluşturduk ve

çokgenlerin açı ve kenarlarına karar verirken geometriyi orada kullandık. (INT-FI27)
Temel kurallar uygulayabildik. Açılarını ve kenar özelliklerini. Şimdiye kadar tablo oluşturduk. Geometriyi orada kullandık. Çokgenlerin kenarlarının ve açılarının nasıl olması gerektiğine karar verirken. Düzgün şekiller çizmeyi öğrendim. Bu projede kullandıklarımı önceden biliyordum. Benim için tekrar oldu. (INT-FI28)
Bazı meslekler arasında gidip geliyorum. Ama mimar ne yapıyor? Şu anda yaşadım. Nasıl ölçüyor, nasıl çiziyor, ölçeği nasıl kullanıyor? Mimarlık ağır basmaya başladı. Mimarların bir projeyi hangi problemlerle, hangi zorluklarla hazırladığını öğrendim. Geometri daha çok binaların açı ve kenar ölçülerine karar vermede işime yaradı. (INT-FI29)
Öğrendiklerimi uyguladığımı düşünüyorum. (INT-FI30)

SORU 9: Grup çalışması hoşunuza gitti mi? Neden?

Evet, grup çalışmasında değişik fikirler oluyor. Tek başımıza bazı şeyleri düşünemiyorsun. (INT-FD1)
Evet, fikirlerimizi tartıştık. (INT-FD3)
Evet, çünkü böylece grup çalışmasının zevkine vardık ve takım ruhunu kavradık. (INT-FD5)
Evet, gitti çünkü grup çalışması yapmak çok eğlenceli. (INT-FD6)
Evet çünkü bireysel olarak yapılsaydı uzun ve yorucu olurdu. (INT-FD9)
Evet, hoşuma gitti çünkü grup olarak çalışmayı tek çalışmaya tercih ederim. Arkadaşlarımızla bilgilerimizi paylaşıyoruz. Fikirlerimizi söylüyoruz. Herkes birbirine çok daha sevgi gösterdi. (INT-FD11)
Çok fazla. Çok eğlendik. Beraber bir takım gibiydik. Herkes destek veriyordu. Güzel proje yapınca da çok sevindik . (INT-FD13)
Evet, çünkü herkes birbirine yardım etti. (INT-FD14)
Evet, hoşuma gitti çünkü böylece arkadaşlarımla aramdaki bağ arttı ve birbirimiz ile dayanışma içinde olmaya başladık. (INT-FD16)
Evet, proje zevkliydi ve grup olarak eğlendik. Grup çalışmasında farklı fikirler oluyor. Bazı fikirleri tek başımıza düşünemeyiz. (INT-FD17)
Aslında grup olarak başta biraz fazla kavga etsek de, bir grup olduğumuz kendimize hatırlatarak zorlukları aştık. Grup ile çalışmak zor olsa da birlikte yapılınca ayrı bir güzel oluyor projeler. (INT-FD18)
Evet, çünkü böyle bir projenin kişisel yapılabileceğini düşünmüyorum. (INT-FD20)
Evet, projeyi grup çalışması olduğu için de sevdim. Dayanışma ve işbölümü her şeyi daha da kolaylaştırdı. Grup çalışması tek başımıza çalışmaya göre daha zevkli çünkü her zaman grup çalışması yapmıyoruz. Sadece teknoloji ve tasarım derslerinde yapıyoruz. (INT-FD22)
Evet, çünkü arkadaşlarımla birlikte proje yapmak hoşuma gidiyor. (INT-FD27)
Evet, çünkü tek yapmak benim için zor olabilirdi. (INT-FD29)
Hoşuma gitti çünkü (projeyi) daha çabuk bitirebildik. (INT-FD30)

Evet, hoşuma gitti çünkü bu çalışmayı bireysel olarak yapsaydık daha uzun ve zor olurdu. Ayrıca bu çalışmada birlik olmayı ve yardımlaşmayı da öğrendim. (INT-FM1)

Evet, sevdim çünkü herkes birbirine yardım ederek ve iş bölümü yaparak güzel bir ürün yaptı. Proje bireysel yapılsaydı bu kadar zevkli olmazdı. Bu proje sayesinde grup çalışmasının önemini ve paylaşımın önemini daha iyi anladım. Ayrıca sınıf arkadaşlarımla da kaynaşmış oldum. (INT-FM2)

Evet, çünkü kişisel olsa yetişmeme ihtimali vardı fakat grup çalışması sayesinde yeni fikirler ortaya çıktı ve çalışma bitti. (INT-FM4)

Evet gitti. Eğer tek olsaydım daha yavaş ilerlerdi. (INT-FM5)

Evet, hem fazla kişi olduğumuz için işimiz kolaylaştı hem de beraber çalışmayı öğrendik. Bu projeyi sevdim çünkü hem bireysel çalışmayıp grup çalışması yaptık. . (INT-FM8)

(Gözleri parlayarak) Evet, çünkü grupla beraber çalışmayı ve başkalarının kararlarına da önem vermeyi öğreniyoruz. Daha çok şey paylaşıyoruz. Birimizin bilgisini diğeri kullanıyor. (INT-FM9)

Sevdim çünkü grup olarak kendimizi geliştiriyoruz. Herkes bireysel değil hayatta çünkü. (INT-FM11)

Evet, yardımlaşmamızı geliştiriyor. Zevkli grup çalışması, çok zevkli, bir şeyler birbirimizden öğreniyoruz. Birimiz diğerine fikrini paylaşıyor. (INT-FM12)

Evet, hoşuma gitti çünkü grup arkadaşlarımla tam bir dayanışma ve yardımlaşma içinde sürdürdük projemizi. Evet, grup çalışması çok zevkliydi. Grup arkadaşlarımla çok sıkı bir işbirliği, dayanışma ve paylaşma içinde çalıştık. (INT-FM13)

Gitti çünkü iletişimi artırıyor. Anladığım kadarıyla grupları seçerken birbiriyle çok konuşmayanları seçmişsiniz. İyi olmuş bence. Birbirimizle grupta iyi anlaştık. (Normalde) anlaşmayan kişiler birbiriyle anlaşmış oldu. (INT-FM14)

Evet, çünkü bireysel çalışmadan daha eğlenceli ve ortaya pek çok fikir çıkıyor. (INT-FM15)

Evet çok sevdim. Benim sınıftaki arkadaşlarımdan anlaşamadıklarımız da geldi ama bir grup olarak birleştiğimizde çalışmayı öğrendik, geçinmek zorundaydık bir bakıma. Birlikte bir takım olarak yapmayı öğrendik. Birimiz yaparken diğerimiz oturmadı.. (INT-FM16)

Grup çalışması çok hoşuma gitti çünkü yaparken çok eğlendik. Evet, grup çalışması, bu gibi projeler için çok önemli. Evet, çok sevdim. Bu projeyi hazırlarken grup çalışması yapmayı öğrendim.. (INT-FM18)

Evet, çünkü bu işi tek başımıza yapsaydık, iyi bir iş çıkaramazdık. (INT-FM19)

Hoşuma gitti, her şeyi paylaşarak yapmak kolay bence. (INT-FM20)

Evet çünkü çalışma daha hızlı bitiyor. (INT-FM21)

Evet çünkü tek kişi çok zorlanırdı. (INT-FM22)

Evet, birlikte çalışmak güzel. (INT-FM23)

Evet. Çünkü tek başıma yapsaydım bu projenin zor ve gereksiz olacağını düşünürdüm ama görev paylaşımı yapınca proje daha basit ve eğlenceli oldu. Grup çalışması bireysel çalışmadan daha çok hoşuma gider. Çünkü bireysel olarak zor gelen şeyler grup çalışmasında fikirlerimizi paylaştığımız için daha kolay geliyor. (INT-FM24)

Evet, çünkü kolay oldu ve herkesin kendi fikriyle çok renkli bir tablo oluştu. Arkadaşlarımızla bilgi paylaşıyoruz. O sizden, siz ondan bir şeyler öğreniyorsunuz.

Daha çabuk proje bitiyor. Grup arkadaşları çok önemli. Örneğin FI23 hemen sinirleniyor. (INT-FM25)
Evet, çünkü bütün çalışmaları grupla beraber yapmak eğlenceli oluyor. (INT-FM26)
Böyle bir projenin bireysel olarak yapılması çok daha uzun zaman ve uğraşı gerektirebilirdi. Böyle daha kolay, daha zevkli ve çok daha kısa zamanda oldu. (INT-FM29)
Evet, çünkü herkes birbirine yardım etti. (INT-FM31)
Evet, gitti çünkü fikirlerimiz daha güzel ve yaratıcı oldu. (INT-FM32)
Evet, çok hoşuma gitti çünkü benim yapamadığım yerlerde grup arkadaşlarım bana çok yardım etti. Birbirimizle fikir alışverişinde bulunuyoruz. Örneğin iki kişi ayrı ayrı bir şeye karar veremese de grup olarak hemen karar veriyor. Daha kolay oluyor işler. (INT-FM34)

Evet, bireysel olması yerine bu daha iyi. Evet, çok beğendim. Çünkü grup çalışması çok hoşuma gitti. Bu sayede projeyi zevkle yaptım. Bu sayede grup arkadaşlarımla güzel bir proje hazırladık.. (INT-FI2)
Evet, çünkü grup çalışması demek bir işi paylaştırmak demek ve planlı bir şekilde iken grup çalışması en iyi yöntem olabilir. (INT-FI3)
Grup çalışmasını severim ama grup üyelerini biz seçersek. İstediğim kişilerle olmadık fakat böyle bir projeden tek başımıza hayır gelmezdi. (Yani bireysel çalışmak istemiyor ama grup arkadaşlarını kendisi seçmek istiyor). (INT-FI6)
Hoşuma gitti çünkü tek yapsaydım sıkılırdım ve bir şeyler paylaştık. İlk zamanlarda grup arkadaşlarımızla pek iyi çalışamıyorduk ama sonradan daha bir uyumlu çalıştık. (INT-FI7)
Evet sevdim. Eğlenceli bir projeydi. Takım çalışması yapmamda etkili olduğunu düşünüyorum.. (INT-FI9)
Evet, gitti. Bence arkadaşlarla bir çalışma yapmak eğlenceliydi. (INT-FI10)
Evet, çok kolay oldu. Bireysel çalışma yapınca arada fikir ayrılıkları olmadığı için daha az sorun çıkıyor ama grupta da bir şeyler paylaştığınız için daha zevkli oluyor. (INT-FI12)
Evet, çünkü benim düşünemediğimi arkadaşlarım düşünüyor. Ayrıca birbirimizle hep yardımlaşma içindeydik. (INT-FI13)
Evet, tek başına iş yapmaktan çok daha zevkli. (INT-FI14)
Evet, çünkü ben bazen hep birlikte olmayı severim. Herkesin ortaklaşa çalışması mükemmeli oluşturdu. Tek başımıza ortaya çıkaramayabiliriz ama grup olarak biri diğerinin fikrine başka bir şey ekliyor ve güzel bir şey ortaya çıkıyor. (INT-FI15)
Evet, çünkü herkes paylaşıyor ve takım olarak çalışmayı öğreniyoruz. (INT-FI16)
Evet, çünkü tek başımıza yapmak çok zor olurdu. (INT-FI17)
Evet, çünkü insanlarla çalışmayı seviyorum. (INT-FI19)
Hayır gitmedi. Aynı projeyi tek başımıza yapsak daha iyi olurdu. Grup çalışması da birinin yapamadığını diğeri tamamlayabildiği için iyi ama grubumuzda anlaşmazlıklar oldu bazen.. (INT-FI20)
Evet, hoşuma gitti. Arkadaşlarımla yapmak daha eğlenceli. (INT-FI21)
Kesinlikle hayır. Ben bireysel çalışmayı daha çok severim Bazı grup arkadaşlarımla anlaşamıyordum çünkü. (INT-FI22)
Evet, işimiz çok kolaylaştı. (INT-FI23)
Evet, çünkü hep beraber birbirimizle çalışarak yapmak zevkli. (INT-FI24)
Evet, dayanışma ve işbölümü sayesinde kolay oldu. (INT-FI27)

Başta pek sevmedim. Grup çalışmasını severim çünkü gruptaki arkadaşları ben yönlendiriyorum. Sonradan sevdim. (INT-FI28)
Evet, grup çalışması hoşuma gitti çünkü tek başına çalışmaktan daha zevkli. (INT-FI30)

SORU 10: Projede grup ya da bireysel olarak karşılaştığınız zorluklar (varsa) nelerdir? Bu zorlukları aşmak için neler yaptınız? Projede en iyi yaptığınızı düşündüğünüz neler vardır? Projenizi hazırlarken kullandığınız yöntemler nelerdir?

Yolları çizerken zorlandık ancak yolları çokgenlerden sonra çizmeye karar verince bu zorluk çözüldü. Camiyi (düzgün olmayan altıgen) çizerken çok zorlandık. Başka mesela şu kursu nereye koyacağımız konusunda anlaşamadık Önce sonra oylama gibi yaptık ve boş kalan yere yerleştirdik. (INT-FD1)
Açılarını ayarlamakta zorlandık çünkü daha önce açıölçer kullanmadık. Kareler çok değil de mesela ormanın (düzgün altıgen) ve katedralin (düzgün sekizgen) açısı, onlar zor oldu. Bunu açıölçer yardımıyla çözdük. (INT-FD2)
Ben, açıölçerle açıları belirleyip kenar uzunluklarına göre çokgenleri çizmede biraz zorlandım. Tekrar yaparak denemeyi sürdürdüm. (INT-FD5)
Ben bireysel olarak sadece boyama yapmakta biraz zorlandım. Arkadaşlarımın yardımıyla üstesinden geldim. (INT-FD6)
Altıgen, yedigen gibi çok kenarlı şekilleri düzgünce çizmekte zorlandık Grup arkadaşlarım açıölçeri kullanmayı ve çokgenleri çizmeyi öğretti. (INT-FD16)
Bu kursu (yerini) nereye yerleştireceğimiz konusunda başta anlaşamadık ama sonradan boş yerler için oylama yaptık. (INT-FD17)
Başında projeye ve grup arkadaşlarına alışmakta zorlandım fakat sonradan her şey halloldu. Başka bir zorluk ise çokgenlerin çevresini hesaplamak oldu. Ama grup arkadaşlarımın yardımıyla bitti. (INT-FD18)
Bence bu çalışmada çok büyük zorluklar yoktu. **A**ncak başta açı ölçmede zorluklar oldu. Bunun için öğretmenimizden yardım aldık. (INT-FD20)
Açı ölçmekte zorlandık ve öğretmenimize sorduk ve bize çok güzel bir dille anlattı. (INT-FD24)
Bazı yerlerin cm'leri zordu. Tekrar tekrar ve deneye deneye yaptık. Arkadaşlarım yardım etti. (INT-FD29)

Düzgün olmayan çokgenleri çizerken zorlandık çünkü iç açıları verilmişti, sığmadı. Grup olarak yapamadığımız şekilleri hep birbirimizin üstüne attık. Sonradan bir gönüllü çıkıp o şekilleri çizdi. Bu da böyle çözüldü. Ya da grup arkadaşlarımızdan FI1 ve FI2 orayı ben çizeyim, ben çizeyim diyordu. Sorun yaşadılar. Sonradan sırayla çizerek çözdüler. (INT-FM1)
Açılarıyla çokgen çizmek zordu. (INT-FM2)
Karşılaştığımız zorluklar, çokgenlerin iç açılarını çizmekti fakat soru sorarak ve öğretmenimizden yardım alarak çizmeyi öğrendik. (INT-FM4)
Ölçülü çizmekte biraz zorlandım ama yapa yapa yerine oturdu. (INT-FM8)
Ölçüleri çizmekte zorlandık ama problemi çözdük. (INT-FM11)
Bu projede bireysel olarak karşılaştığım zorluk çizim yapmaktı ama grup arkadaşlarım bana bu konuda yardımcı oldular. Arkadaşlarım da ben de açıların ölçülerini ve kenar uzunluklarını ayarlarken çok zorluk çektik ama dayanışma içinde

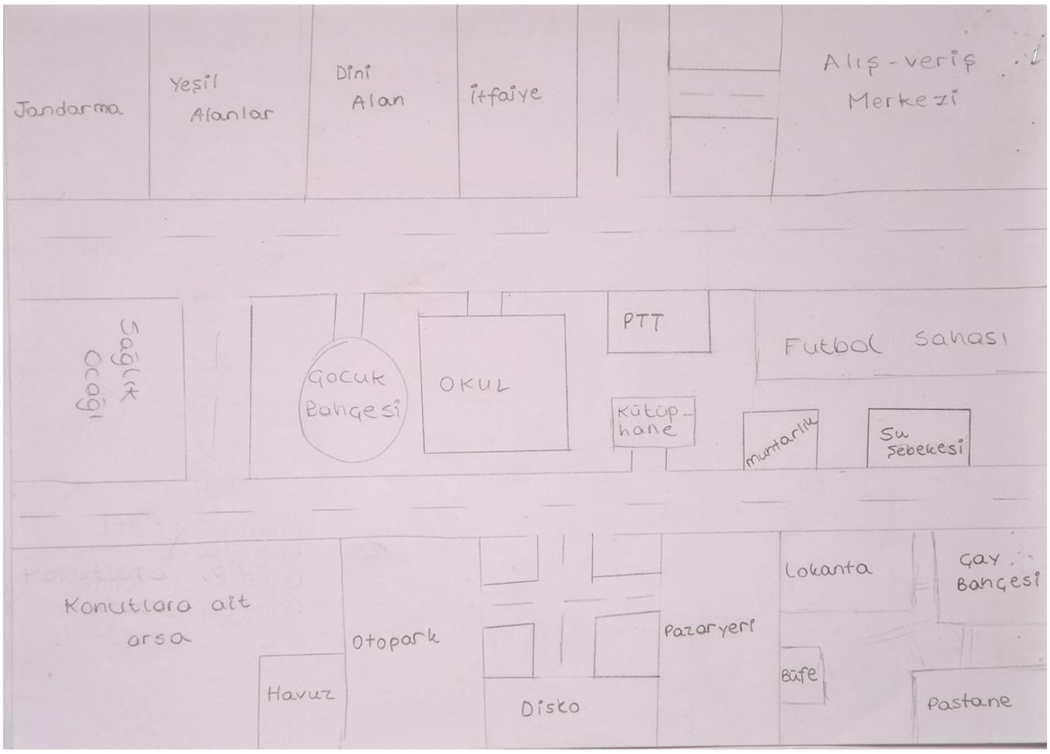
bu sorunu hallettik, ayrıca öğretmenimizden de yardım aldık. En zor yaptığımız iş, geometrik şekillerin açı ve kenarlarını ayarlamaktı. (INT-FM13)
Grup olarak fikir ayrılıklarımız oldu ama sonra çoğunluğun beğendiklerini uyguladık. (INT-FM15)
Grup olarak gerçek ölçüleriyle plan ölçülerini ayarlamakta sıkıntı çektik ama hesap makinesiyle FI15 arkadaşım halletti. (INT-FM20)
Çizmek zordu, biraz kaydırdık fakat çizebildik. (INT-FM21)
Aslında yoktu çünkü benim yapamadığım bir şeyi grup arkadaşlarım bana yardım ederek yapmamı sağladılar. Bende de aynı durum oldu. Ben de onlara yardım ettim. (INT-FM25)
Açıları plana oturtmakta biraz zorlandık. Gerçek boyutları kartona çizmek için belli oranda küçültürken biraz zorlandık. Fakat birbirimize yardım ederek yaptık. (INT-FM26)
Projede açıları ölçerken zorlandım. Bu zorlukları çözmek için tekrar tekrar ölçtük. (INT-FM30)
Grup olarak vardı. Yamuğu dereceli olarak çizerken çok zorlandık. Öğretmenimizden yardım aldık böylece hallettik. (INT-FM34)

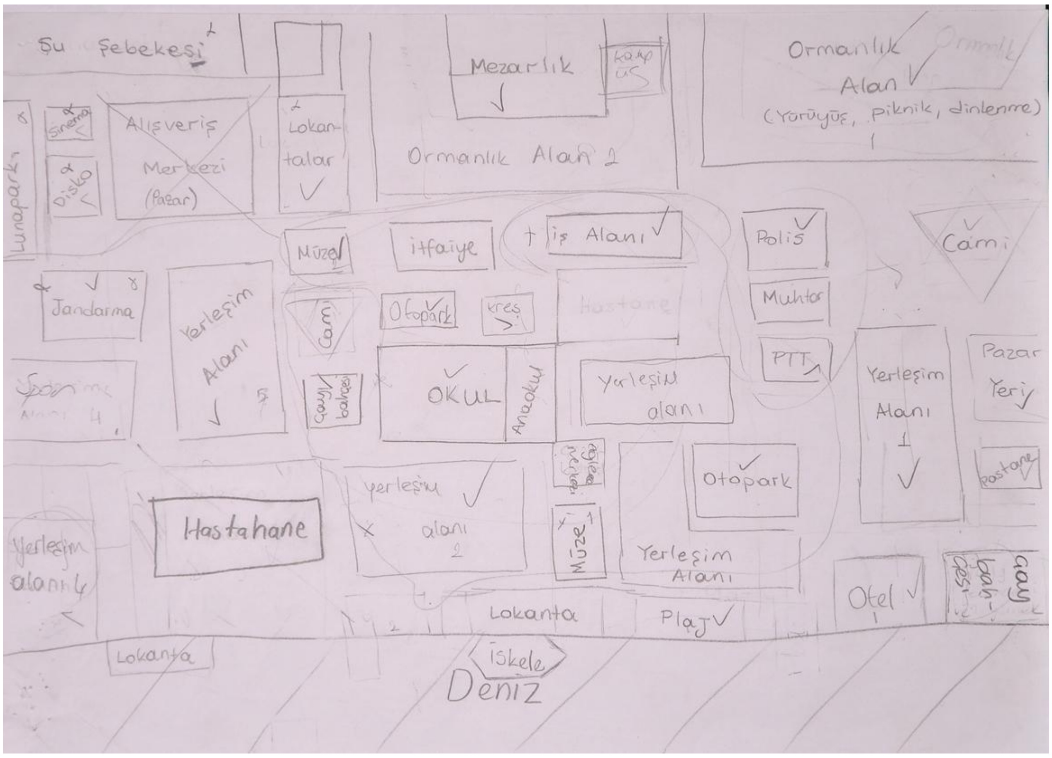
Zorlandığımız kısımlar oldu. Örneğin çizerken açılarda hata yaptığımız zaman şekil oluşturamadık. Açılar ve uzunluklar birbirini tutmamıştı. Sorunu çözdük. Kolay çizimlerden başladık daha zora doğru. Herkes kendine göre kolaydan zora doğru çizdi. Biri diğerine çizimi anlattı. Ayrıca önce açı ayarlayıp sonra çizim yaparak problemi çözdük. (INT-FI1)
Çokgenleri çizerken zorluk yaşadık. Bazılarının (mahalledeki) yerlerini değiştirdik . (INT-FI3)
Çizimde zorlandım. Öğretmenimden yardım aldım. Ona sorular sordum. (INT-FI8)
Bazı şekilleri ölçmede ve çizmede zorlandık ancak sonradan verilen değerleri ve açıları değiştirdik. (INT-FI14)
Bir grup arkadaşımız çizimi diğerine anlattı ve sorunu çözdü. (INT-FI15)
Vardı. Açılarıyla ve kenarlarıyla çizmek zordu. Onun için açıların ve kenarların bazılarını değiştirdik. (INT-FI17)
Çizimlerde zorlandık. Açıölçer kullandık. Hataları birbirimize yardım ederek düzelttik. (INT-FI22)
Diğer arkadaşımla farklı fikirler içindeydik. Geç kalmamamız için ben fikirlerimde ısrarcı olmadım. (INT-FI25)

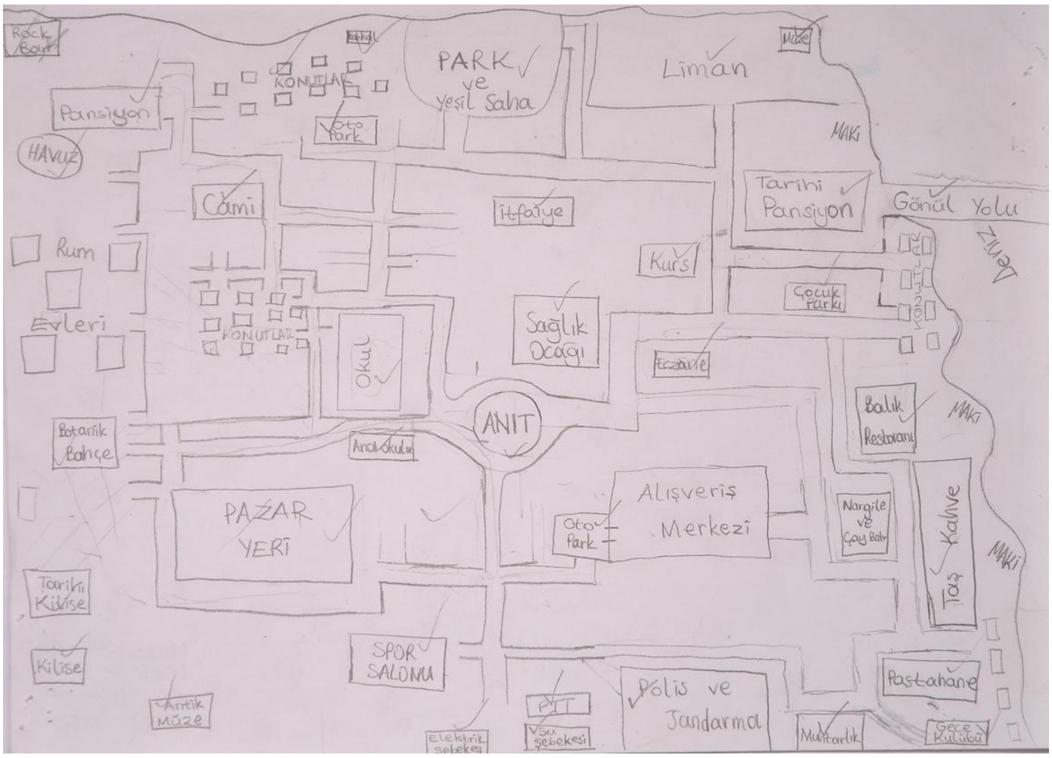
APPENDIX S

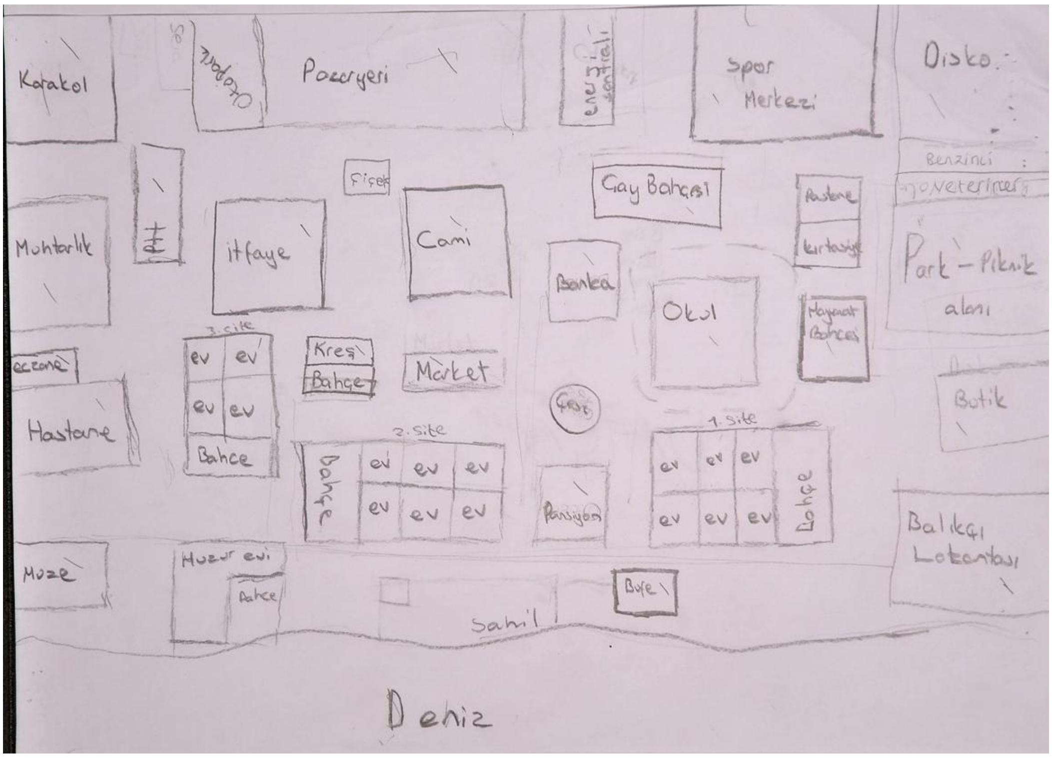
EXAMPLES FROM STUDENT ARTIFACTS

EXAMPLES FROM STUDENTS' BLUEPRINTS

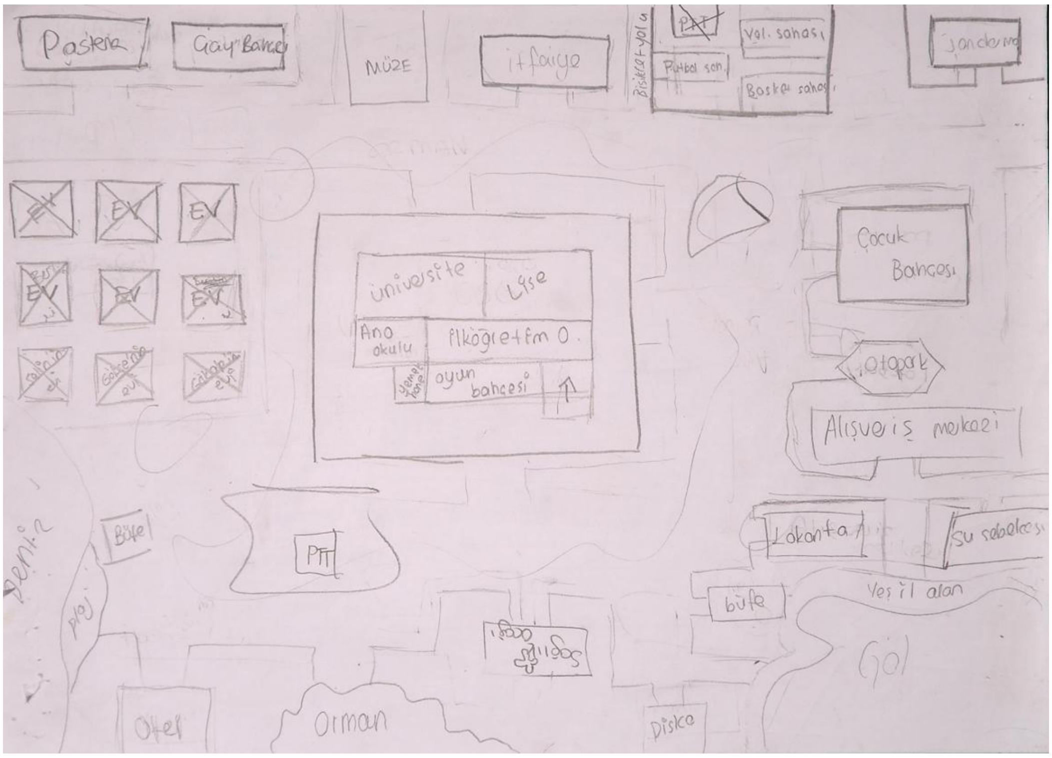


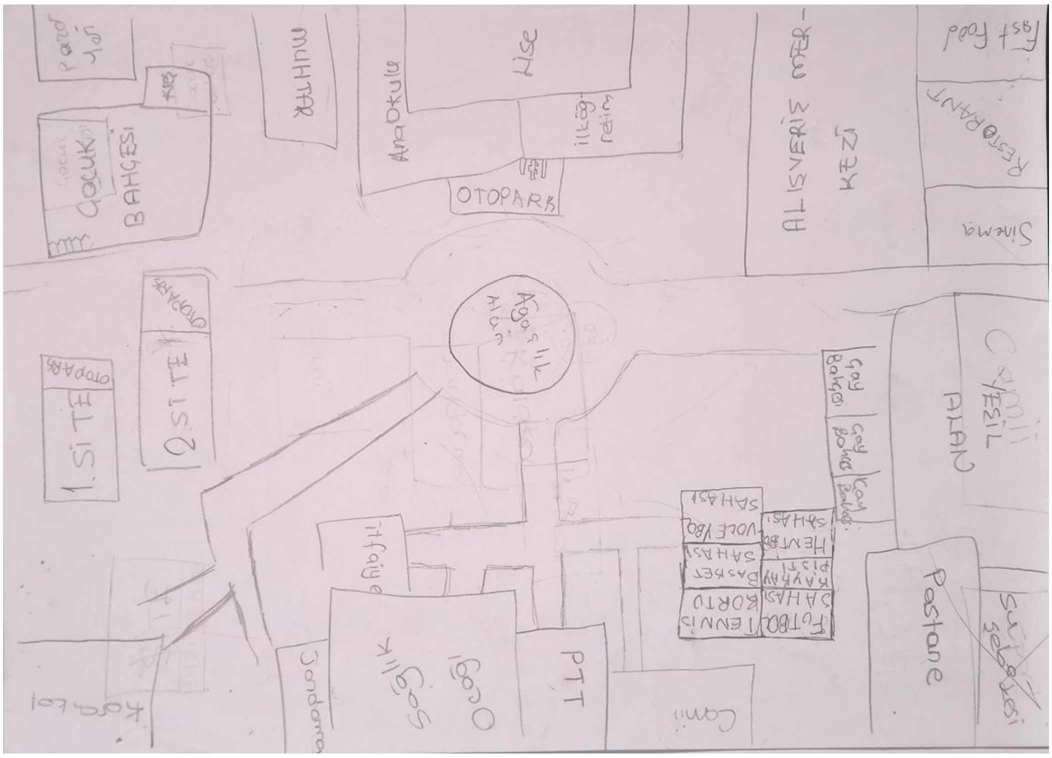

Şu şebekesi
Mezarlık
Ormanlık Alan
(Yürüyüş, piknik, dinlenme)
Sinema
Disko
Alışveriş Merkezi (Pazar)
Lokantalar
Ormanlık Alan 2
Lunapark
Müze
itfaiye
İş Alanı
Polis
Cami
Jandarma
Yerleşim Alanı
Otopark
kreş
Muhtar
PTT
Pazar Yeri
OKUL
Anaokulu
Yerleşim alanı
Yerleşim Alanı
Otopark
Pastane
Hastahane
yerleşim alanı 2
Müze
Yerleşim Alanı
Yerleşim alanı 4
Otel
Lokanta
Plaj
Lokanta
İskele
Deniz

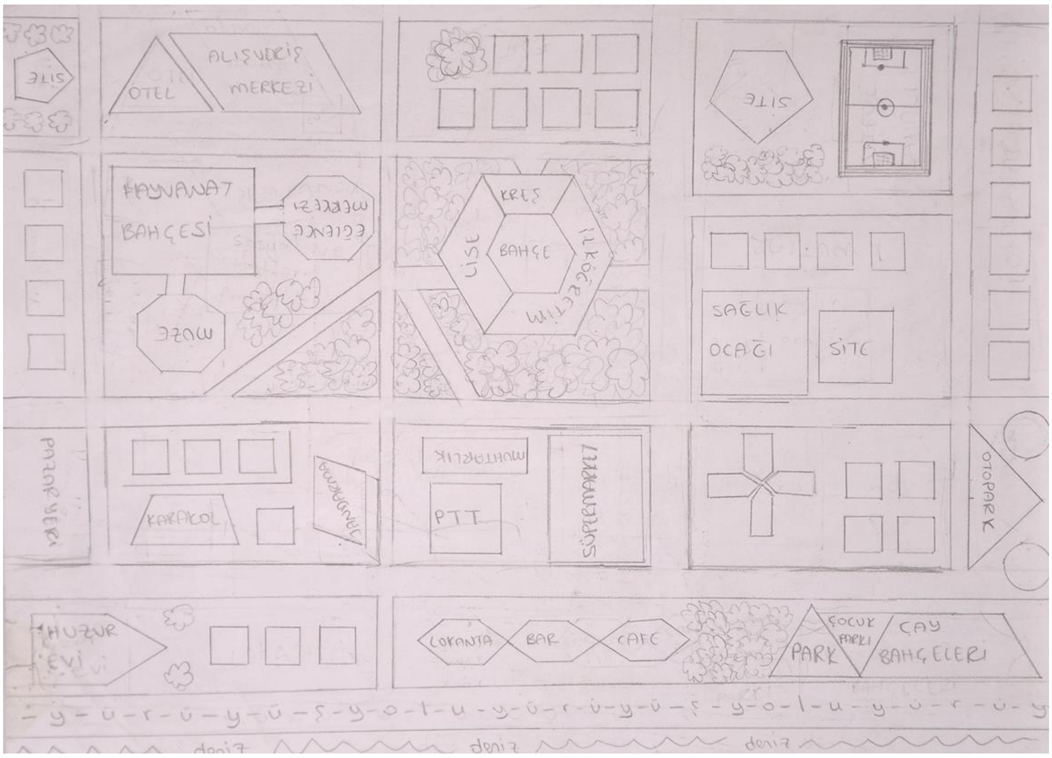

Rock Bar
KONUTLAR
PARK ve yeşil Saha
Liman
Müze
Pansiyon
HAVUZ
Oto Park
MAKİ
Tarihi Pansiyon
Gönül Yolu
Cami
İtfaiye
Rum Evleri
Kurs
Çocuk Parkı
DENİZ
KONUTLAR
Sağlık Ocağı
Eczane
Okul
ANIT
Balık Restoranı
Botanik Bahçe
Anaokulu
MAKİ
PAZAR YERİ
Oto Park
Alışveriş Merkezi
Nargile ve Çay Bahçesi
Taş Kahve
MAKİ
Tarihi Kilise
Kilise
SPOR SALONU
PTT
Polis ve Jandarma
Pastahane
Antik Müze
Elektrik şebekesi
Su şebekesi
Muhtarlık
Gece Kulübü

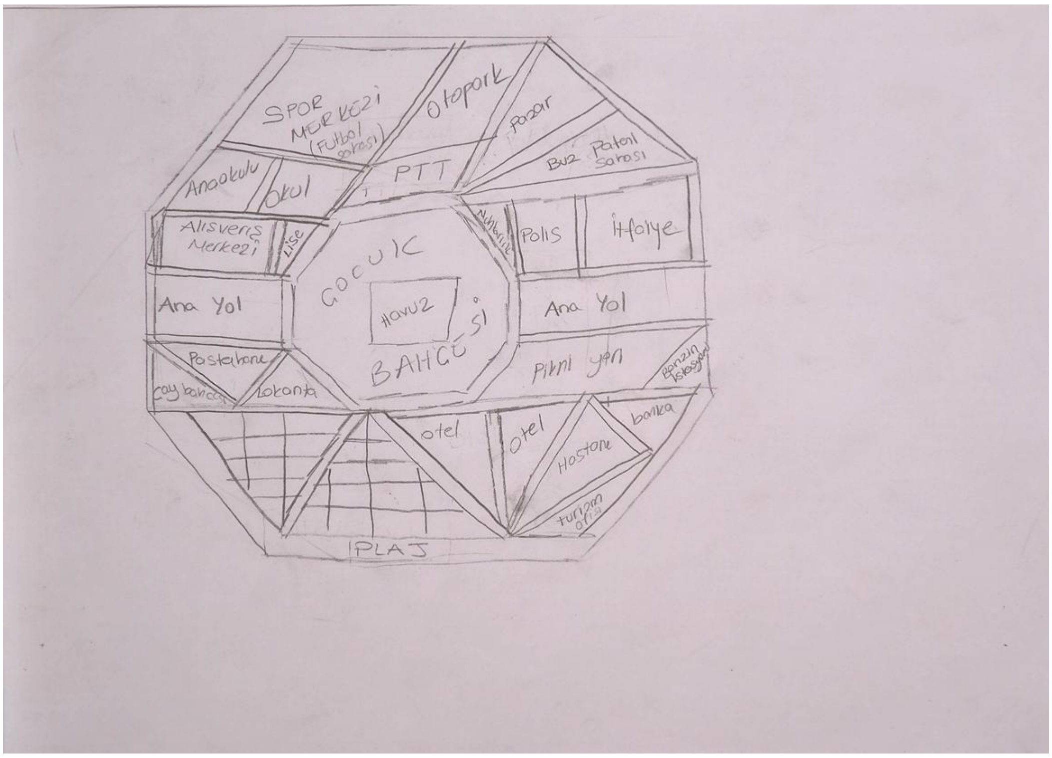

Karakol
Otopark
Pazaryeri
Spor Merkezi
Disko
Benzinci
Muhtarlık
itfaye
Cami
Fişek
Gay Bahçesi
Pastane
Kırtasiye
Park - Piknik alanı
Banka
Okul
Hayvanat Bahçesi
Eczane
Hastane
3. site
ev
Kreş
Bahçe
Market
2. site
1. site
Butik
Pansiyon
Balıkçı Lokantası
Müze
Huzur evi
Büfe
Sahil
Deniz

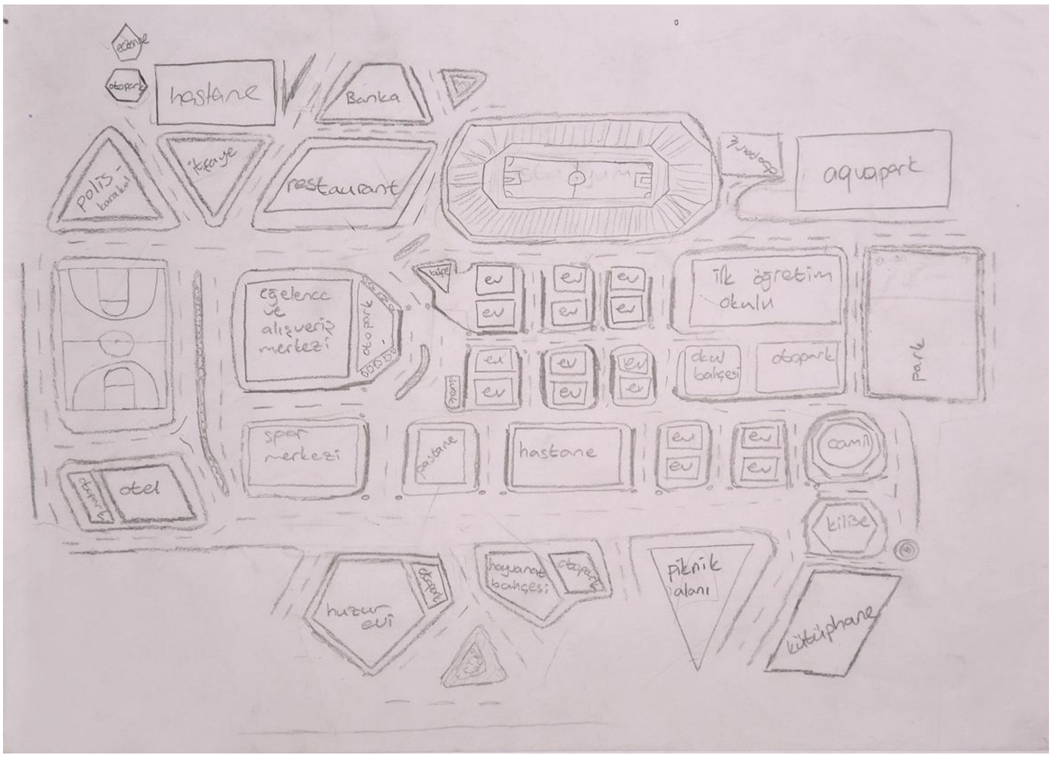

Mezarlık
Su Şebekesi
Ev
SİNEMA
GLEN PARK
Büfe
STRATFORD Tren İstasyonu
KİLİSE
OTOPARK 1
Hastane
Futbol SAHASI
LİSE
ÜNİVERSİTE (Oxford)
Kütüphane
Havuz
PAZAR YERİ
Lokanta
Ana Okulu
OKUL
Eczane
ALIŞVERİŞ MERKEZİ
Gay Bahçesi
Jandarma
Karakol
Yürüyüş Yeri (Atletizm Yeri)
ORMAN
OTOPARK 2
Sanayi Bölgesi
Tarım Bölgesi
Kışla


Pastane
Çay Bahçesi
MÜZE
itfaiye
Bisiklet yolu
Vol. sahası
Futbol sah.
Basket sahası
Jandarma
EV
Çocuk Bahçesi
üniversite
Lise
Ana okulu
İlköğretim O.
oyun bahçesi
otopark
Alışveriş merkezi
Lokanta
Büfe
PTT
Deniz
plaj
büfe
Yeşil alan
Göl
Sağlık ocağı
Otel
Orman
Disko


MUHTAR
Ana Okulu
Lise
İlköğretim
OTOPARK
ALIŞVERİŞ MERKEZİ
Fast Food
RESTORANT
Sinema
ÇOCUK BAHÇESİ
Ağaçlık Alan
1. SİTE
2. SİTE
OTOPARK
Çay Bahçesi
YEŞİL ALAN
FUTBOL SAHASI
TENİS KORTU
BASKET SAHASI
VOLEYBOL SAHASI
Pastane
itfaiye
Sağlık Ocağı
PTT
Jandarma
Karakol
Cami

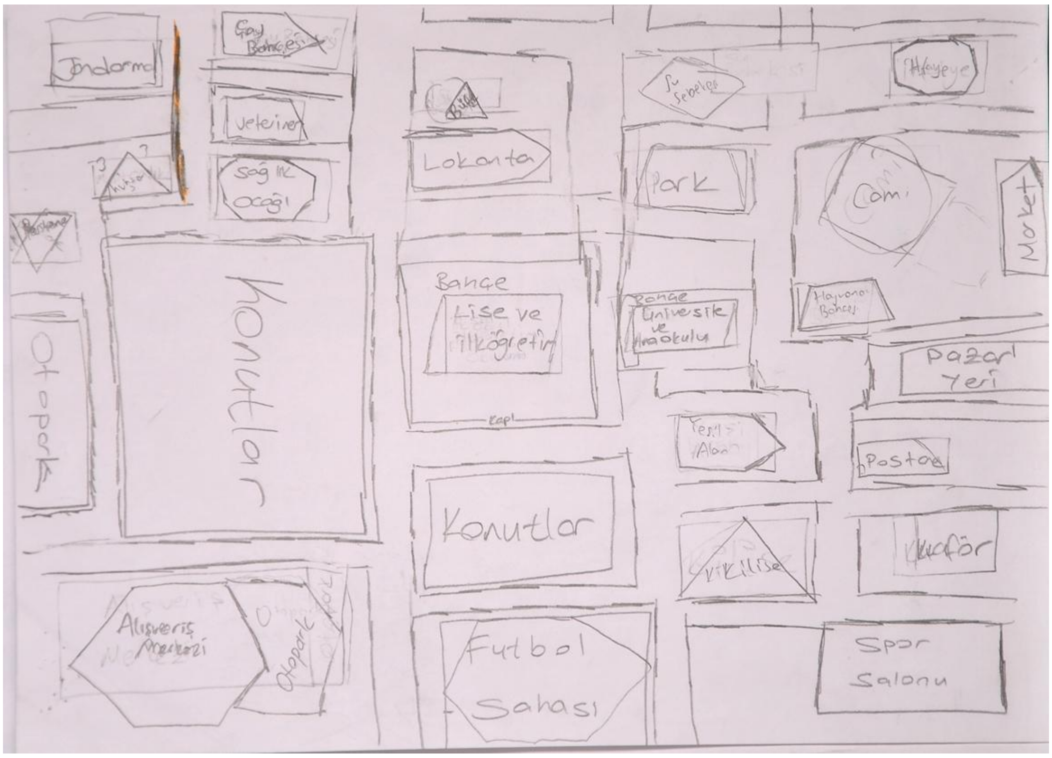

SİTE
OTEL
ALIŞVERİŞ MERKEZİ
SİTE
HAYVANAT BAHÇESİ
EĞLENCE MERKEZİ
MÜZE
KREŞ
LİSE
BAHÇE
İLKÖĞRETİM
SAĞLIK OCAĞI
SİTE
PAZAR YERİ
KARAKOL
MUHTARLIK
PTT
SÜPERMARKET
OTOPARK
HUZUR EVİ
LOKANTA
BAR
CAFE
ÇOCUK PARKI
PARK
ÇAY BAHÇELERİ
- y - ü - r - ü - y - ü - ş - y - o - l - u - y - ü - r - ü - y - ü - ş - y - o - l - u - y - ü - r - ü - y
deniz
deniz
deniz

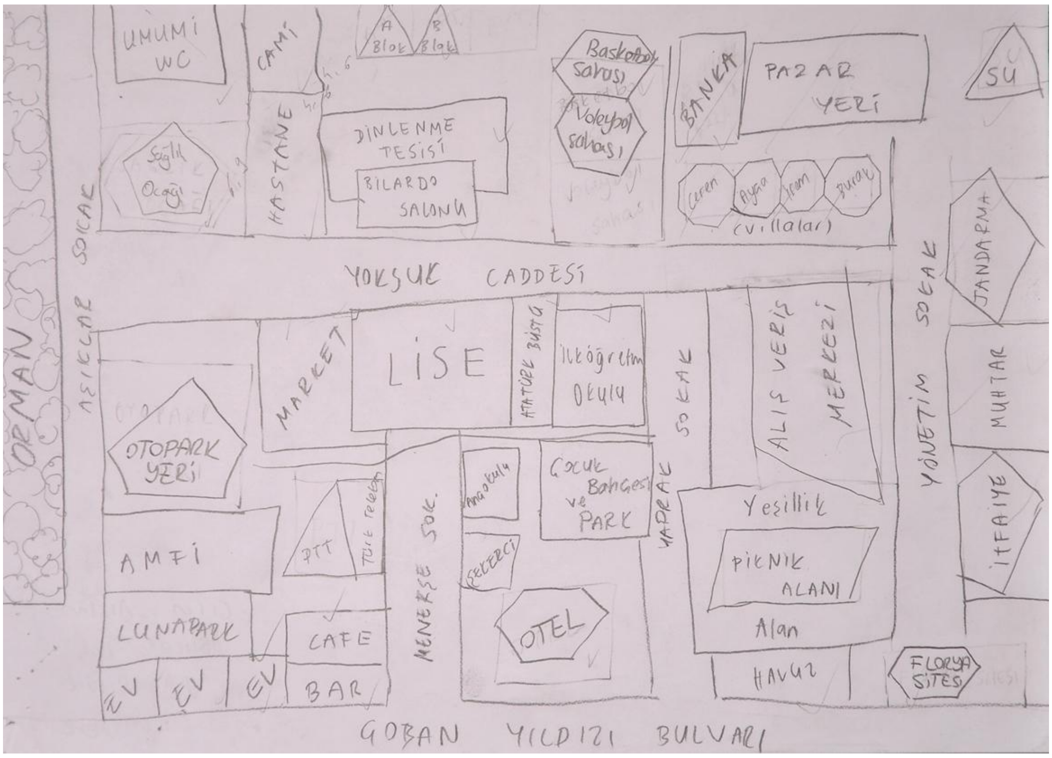

SPOR MERKEZİ (Futbol sahası)
Otopark
Pazar
Buz Pateni sahası
Anaokulu
Okul
PTT
Alisveriş Merkezi
Lise
Muhtarlık
Polis
İtfaiye
ÇOCUK BAHÇESİ
Havuz
Ana Yol
Ana Yol
Postahane
Piknik yeri
Benzin İstasyonu
Çay bahçesi
Lokanta
otel
Otel
Hastane
banka
turizm ofisi
PLAJ

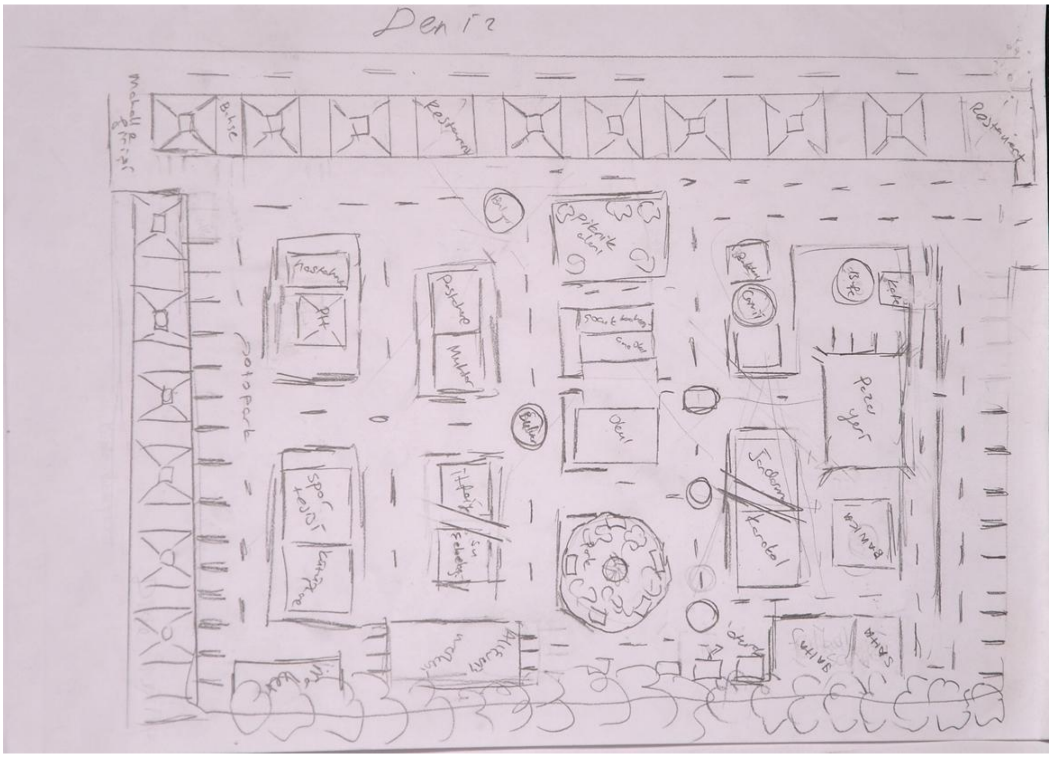

eczane
otopark
hastane
Banka
polis-karakolu
itfaiye
restaurant
aquapark
eğlence ve alışveriş merkezi
otopark
ev
İlk öğretim okulu
okul bahçesi
otopark
park
spor merkezi
pastane
hastane
cami
otel
kilise
piknik alanı
huzur evi
hayvanat bahçesi
kütüphane

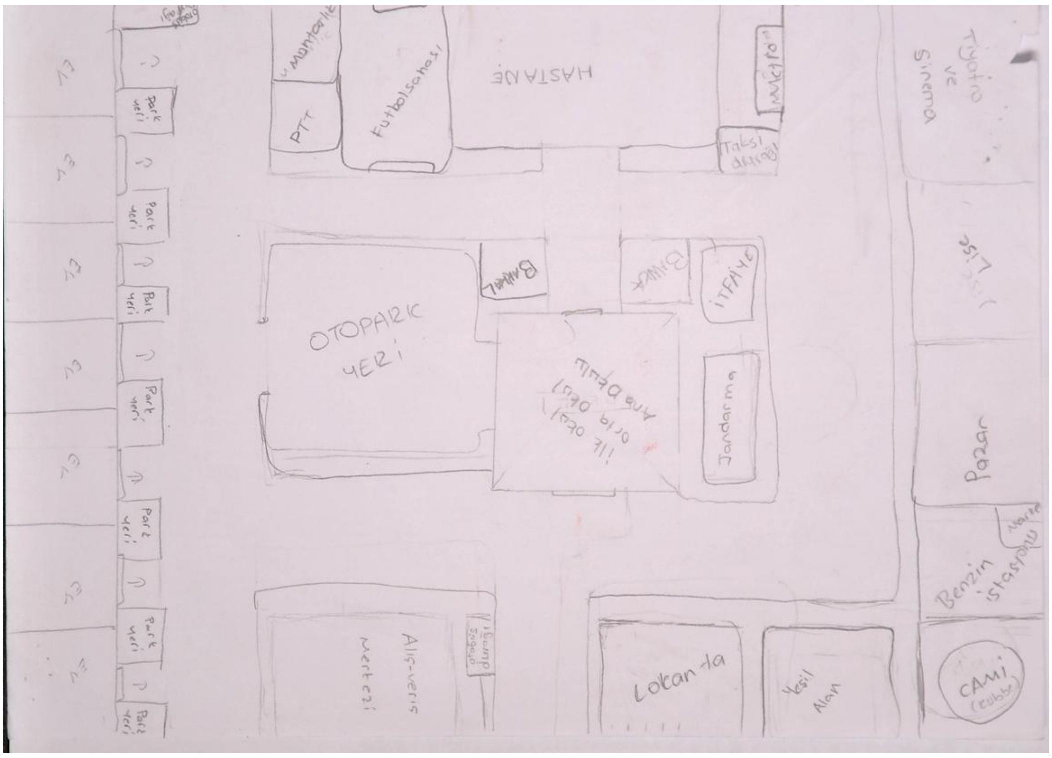

Apt
cami
Apt-
Apt-
apt
apt
Apt-
Apt
Alışveriş merkezi
su şebekesi
polis
itfaiye
muhtar
PTT
spor yeri
otopark
İlkokul
Anaokulu
otopark
lokanta
büfe
çay bahçesi
pastane
park
yeşil alan
hastane
yeşil alan
Apt.
Apt-
sağlık ocağı
sosyal ve kültürel faaliyet binası
apt.
apt.
Pazaryeri


Deniz
Fener kulesi
İSKELE
Çay bahçesi
Postane
PTT
Konutlar ait alanlar
Denize bakan konutlar
Banka
Pazar Yeri
Sağlık ocağı
Cami
Eczane
Hastane
Lokanta
Lokanta 2
Halısaha
AVM
Otopark
Kütüphane
Taksi Durağı
Park
Süpermarket
Okul
Dershane
Havuz
Atletizm Park
Buz Pateni S.
Kuaför
Kırtasiye
Çeşme
Çocuk Bahçesi
Anaokulu
Konutlara ait arsalar
Sokak
Konutlar ait arsalar
Yeşil Alan
Muhtarlık
Yeşilalan
Sosyal ve kültürel faaliyet için bir alan


Jandarma
Çay Bahçesi
Veteiner
Sağlık ocağı
Dershane
Otopark
Konutlar
Lokanta
Bahçe
Lise ve İlköğretim
Kapı
Su sebebesi
Park
Bahçe
Üniversite ve Anaokulu
Atölye
Cami
Market
Hayvanat Bahçesi
Pazar Yeri
Yeşil Alan
Postane
Konutlar
Kilise
Kuaför
Alışveriş Merkezi
Otopark
Futbol Sahası
Spor Salonu


UMUMİ WC
CAMİ
A Blok
B Blok
Basketbol Sahası
Voleybol Sahası
BANKA
PAZAR YERİ
SU
Sağlık Ocağı
HASTANE
DİNLENME TESİSİ
BİLARDO SALONU
(villalar)
JANDARMA
YOKSUK CADDESİ
AŞIKLAR SOKAK
ORMAN
MARKET
LİSE
ATATÜRK BÜSTÜ
İlköğretim Okulu
YAPRAK SOKAK
ALIŞ VERİŞ MERKEZİ
YÖNETİM SOKAK
MUHTAR
OTOPARK YERİ
Anaokulu
Çocuk Bahçesi ve PARK
Yeşillik
İTFAİYE
AMFİ
PTT
Türk Telekom
MENEKŞE SOK.
Şekerci
PİKNİK ALANI
Alan
LUNAPARK
CAFE
OTEL
HAVUZ
FLORYA SİTESİ
EV
EV
EV
BAR
ÇOBAN YILDIZI BULVARI


Deniz
Restaurant
Restaurant
otopark
Pazar yeri
Jandarma karakol
BANKA
Hastane
PTT
Muhtar
Otel
Spor tesisi
İtfaiye
Cami


HASTANE
PTT
Futbolsahası
Otopark yeri
Jandarma
İtfaiye
Pazar
Lise
Benzin istasyonu
CAMİ
Lokanta
Yeşil Alan
Alış-veriş Merkezi
Taksi durağı
Park yeri
Tiyatro ve Sinema

EXAMPLES FROM ANGLES and SIDE MEASUREMENTS of BUILDINGS (POLYGONS) in REAL LIFE and in the PLAN

Taslak Kroki üzerinde gösterdiğiniz her bir bölümün GERÇEK ölçüleri:

	Bölüm adı	Kenarlarının gerçek uzunlukları (m)	İç açılarının ölçüleri	Dış açılarının ölçüleri
1. İkizkenar üçgen olan bir bölüm	Alışveriş merkezi	50°, 50°, 65°	90°, 45, 45°	90, 135, 135
2. İkizkenar üçgen olan diğer bölüm	Benzin istasyonu		150°, 15°, 15°	30°, 165°, 165°
3. Eşkenar üçgen olan bir bölüm	PTT	25, 25, 25	60, 60, 60	120, 120, 120
4. Eşkenar üçgen olan diğer bölüm	muhtarlık	50, 50, 50,	60, 60, 60	120, 120, 120
5. Paralelkenar olan bir bölüm	Jandarma	75, 75, 50, 50	60, 60, 120, 120	120, 120, 60, 60
6. Paralelkenar olan diğer bölüm	Yeşilalan	100, 100, 50, 50	70, 70, 110, 110	110, 110, 70, 70
7. Dikdörtgen olan bir bölüm	Hastane	25, 25, 50, 50	90°, 90°, 90°, 90°	90°, 90°, 90°, 90°
8. Dikdörtgen olan diğer bölüm	Futbolsahası	75, 75, 50, 50	90, 90, 90, 90	90, 90, 90, 90
9. Kare olan bir bölüm	Tiyatro Sinema	50, 50, 50, 50	90, 90, 90, 90	90, 90, 90, 90
10. Kare olan diğer bölüm	Lokanta	100, 100, 100, 100	90, 90, 90, 90	90, 90, 90, 90
11. Eşkenar dörtgen olan bir bölüm	Pazar	75, 75, 75, 75	50, 50, 130, 130	130, 130, 50, 50
12. Eşkenar dörtgen olan diğer bölüm	Lise	100, 100, 100, 100	20, 20, 160, 160	160, 160, 20, 20
13. Yamuk olan bir bölüm	Bakkal		90, 90, 130, 50	90, 90, 50, 130
14. Yamuk olan diğer bölüm	Taksi Durağı		80, 80, 100, 100	100, 100, 80, 80
15. Başka bir dörtgen olan bir bölüm	Evler		60, 60, 120, 120	120, 120, 60, 60
16. Başka bir dörtgen olan diğer bölüm	Cami		90, 90, 90, 90	90, 90, 90, 90
17. Düzgün beşgen olan bir bölüm	okul	50, 50, 50, 50, 50	108, 108, 108, 108, 108	72, 72, 72, 72, 72
18. Düzgün beşgen olan diğer bölüm	site otoparkı	75, 75, 75, 75, 75	108, 108, 108, 108, 108	72, 72, 72, 72, 72
19. Düzgün altıgen olan bir bölüm	Park Yeri	75, 75, 75, 75, 75, 75	120, 120, 120, 120, 120, 120	60, 60, 60, 60, ...
20. Düzgün altıgen olan diğer bölüm	2. Alışveriş Merkezi	100, 100, 100 100, 100, 100	120, 120, 120, 120 120, 120	60, 60, 60, 60, 60, 60
21. Düzgün sekizgen olan bir bölüm	Havuz	50, 50, 50, 50, 50, 50, 50, 50	135, 135, 135, 135, 135, 135, 135, 135	45, 45, 45, 45, 45, 45, 45, 45
22. Düzgün sekizgen olan diğer bölüm	2. Havuz	75, 75, 75, 75 75, 75, 75, 75	135, 135, 135, 135, 135, 135, 135, 135	45, 45, 45, 45, 45, 45, 45, 45
23. Kenarları eşit uzunlukta düzgün olmayan beşgen olan bir bölüm	Paten Pisti	75, 75, 50, 50 25	90°, 90°, 150°, 150°, 65°	90, 90, 30, 30, 120
24. Düzgün olmayan beşgen olan diğer bölüm	Kayak Pisti		110, 110, 100, 120, 100	70, 70, 80, 60, 80
25. Düzgün olmayan altıgen bir bölüm	Hayvan Barınağı		110, 110, 120, 120, 130	70, 70, 60, 60, 50
26. Düzgün olmayan altıgen olan diğer bölüm	Bar		90, 100, 105, 130, 140, 155	90, 80, 75, 50, 40, 25

Not: Yukarıdaki sadece iki çokgeni birbirine eş seçin. Diğer çokgenlerin kenar uzunlukları birbirinden farklı olsun.

Ölçeğe göre çizeceğiniz PLAN ÜZERİNDE gösterdiğiniz her bir bölümün ölçüleri:

Ev → Üçgen 90,45,45 Ev=Kare 4/4/4/4 4/4/5,5 Ev=90°/90°/120°/60°	Bölüm adı	Kenarlarının plan üzerindeki uzunlukları (cm cinsinden)	İç açılarının ölçüleri	Dış açılarının ölçüleri
1. İkizkenar üçgen olan bir bölüm	Süpermarket	2,8 - 2 - ? 2	90⁰- 45⁰ - ? 45°	90,135,135
2. İkizkenar üçgen olan diğer bölüm	Benzin İstasyonu		110, 35°, 35	70, 145,145
3. Eşkenar üçgen olan bir bölüm	PTT	5,5,5	60°,60°,60°	120,120,120
4. Eşkenar üçgen olan diğer bölüm	Muhtarlık	5,5,5	60°, 60°, 60°	120°,120°,120°
5. Paralelkenar olan bir bölüm	Jandarma	3,3/5.5 ve 5.5	60,60,120,120	120°,120°,60°,60°
6. Paralelkenar olan diğer bölüm	Tesisler	5,5,6,6	70,70,110,110	110,110,70,70
7. Dikdörtgen olan bir bölüm	Hastane	7,5/7,5/11/11	90°,90°,90°,90°	90°,90°,90°,90°
8. Dikdörtgen olan diğer bölüm	Futbolsahası	7/7/10,5/10,5	90°,90°,90°,90°	90°,90°,90°,90°
9. Kare olan bir bölüm	~~Tiyatro~~ Sinema	10,5/10,5/10,5/10,5	90,90,90,90	90,90,90,90
10. Kare olan diğer bölüm	Lokanta	3,3,3,3	90,90,90,90	90,90,90,90
11. Eşkenar dörtgen olan bir bölüm	Pazar	3,3,3,3	70,70,110,110	110,110,70,70
12. Eşkenar dörtgen olan diğer bölüm	Lise	4,4,4,4	40,40,140,140	160,160/20,20
13. Yamuk olan bir bölüm	2.Alışveriş Merkezi.		90,90,124,56	90,90,56,124
14.Yamuk olan diğer bölüm	Taksi Durağı		80,80,100,100	100,100,80,80
15. Başka bir dörtgen olan bir bölüm	Evler		90,90,90,90	90,90,90,90
16. Başka bir dörtgen olan diğer bölüm	Cami		90,90,90,90	90,90,90,90
17. Düzgün beşgen olan bir bölüm	Okul	1,1,1,1,1	108,108,108,108,108	72,72,72,72,72
18. Düzgün beşgen olan diğer bölüm	Otopark	3,3,3,3,3	108,108,108,108,108	72,72,72,72,72
19. Düzgün altıgen olan bir bölüm	Lise otoparkı	2,2,2,2,2,2	120,120,120,120,120,120	60,60,60,60,60,60
20.Düzgün altıgen olan diğer bölüm	1. Alışveriş m.	4,4,4,4,4,4	120,120,120,120,120,120	60,60,60,60,60,60
21. Düzgün sekizgen olan bir bölüm	Havuz	1,1,1,1,1,1,1,1	135,135,135,135,135,135,135,135	45
22.Düzgün sekizgen olan diğer bölüm	2. Havuz	2,2,2,2,2,2,2,2	135,135,135,135,135,135,135,135	45°
23. Kenarları eşit uzunlukta düzgün olmayan beşgen olan bir bölüm	Buz Pateni Pisti	2,2,2,2,2	90⁰-90⁰ -150⁰- 150⁰- ? 60°	90,90,30,30,120
24. Düzgün olmayan beşgen olan diğer bölüm	Kaykay Pisti		110⁰ – 110⁰ – 100⁰ – 120⁰ - ? 100	70,70,80,60,80
25. Düzgün olmayan altıgen bir bölüm	Hayvan Barınağı		110⁰-110⁰-120⁰– 120⁰– 130⁰ - ? 130°	70,70,60,60,50,50
26. Düzgün olmayan altıgen olan diğer bölüm	Bar		90⁰ – 100⁰ – 105⁰ – 130⁰ – 140⁰ - ? 155	90,80,75,50,40, 25°

Grup üyeleri:

Taslak Kroki üzerinde gösterdiğiniz her bir bölümün GERÇEK ölçüleri:

	Bölüm adı	Kenarlarının gerçek uzunlukları (m)	İç açılarının ölçüleri	Dış açılarının ölçüleri
1. İkizkenar üçgen olan bir bölüm	Market	70-50-50	90°-45°-45°	90°-135°-135°
2. İkizkenar üçgen olan diğer bölüm	Liman		90-45-45	90-135-135
3. Eşkenar üçgen olan bir bölüm	Muhtar	hepsi 50	60-60-60	60-60-60
4. Eşkenar üçgen olan diğer bölüm	Jandarma	hepsi 50	60-60-60	60-60-60
5. Paralelkenar olan bir bölüm	İtfaiye	100-125-100-125	70-110-70-110	110-70-110-70
6. Paralelkenar olan diğer bölüm	Mücevher Marketi	300-250-300-250	100-80-100-80	80-100-80-100
7. Dikdörtgen olan bir bölüm	Park	300-225-300-225	90-90-90-90	90-90-90-90
8. Dikdörtgen olan diğer bölüm	Futbol Sahası	150-100-150-100	90-90-90-90	90-90-90-90
9. Kare olan bir bölüm	1. sitedeki evler	hepsi 50	90-90-90-90	90-90-90-90
10. Kare olan diğer bölüm	2. sitedeki evler	hepsi 50	90-90-90-90	90-90-90-90
11. Eşkenar dörtgen olan bir bölüm	Tenis sahası	hepsi 125	70-110-70-110	110-70-110-70
12. Eşkenar dörtgen olan diğer bölüm	Basketbol sahası	hepsi 125	60-120-60-120	120-60-120-60
13. Yamuk olan bir bölüm	1. otel		40-140-60-120	140-40-120-60
14. Yamuk olan diğer bölüm	2. otel		40-140-60-120	140-40-120-60
15. Başka bir dörtgen olan bir bölüm	3. site		90-90-90-90	90-90-90-90
16. Başka bir dörtgen olan diğer bölüm	4. site		90-90-90	90-90-90-90
17. Düzgün beşgen olan bir bölüm	Banka	hepsi 100	108-108-108-108-108	72-72-72-72-72
18. Düzgün beşgen olan diğer bölüm	Sağlık ocağı	hepsi 100	108-108-108-108-108	72-72-72-72-72
19. Düzgün altıgen olan bir bölüm	sinema	hepsi 50	hepsi 120	hepsi 60
20. Düzgün altıgen olan diğer bölüm	Tiyatro	hepsi 50	hepsi 120	hepsi 60
21. Düzgün sekizgen olan bir bölüm	Kilise	hepsi 25	hepsi 135	hepsi 45
22. Düzgün sekizgen olan diğer bölüm	4. otel	hepsi 50	hepsi 135	hepsi 45
23. Kenarları eşit uzunlukta düzgün olmayan beşgen olan bir bölüm	lokanta Pastane	hepsi 100	90-90-150-150-60	90-90-30-30-120
24. Düzgün olmayan beşgen olan diğer bölüm	Müze		110-110-100-120-100	70-70-80-60-80
25. Düzgün olmayan altıgen bir bölüm	~~Hayvanat~~ Bahçesi		110-110-120-120-130	70-70-60-60-50-50
26. Düzgün olmayan altıgen olan diğer bölüm	3. otel		90-100-105-130-140-155	90-80-75-50-40-25

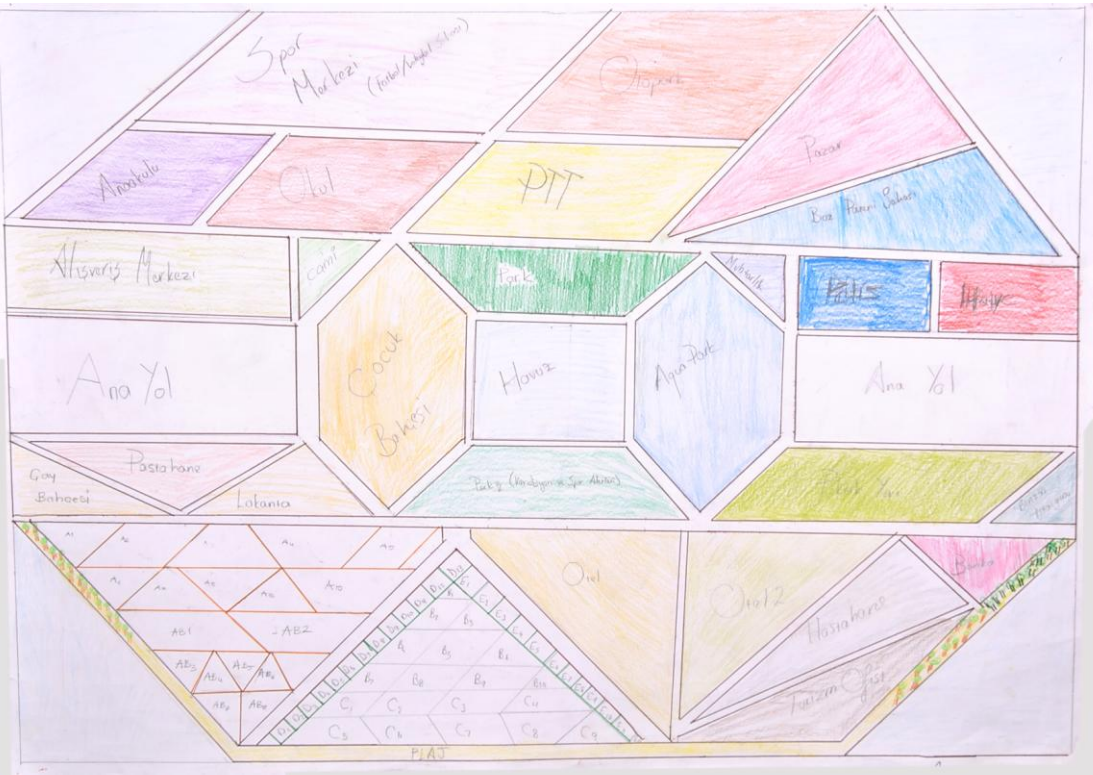
Not: Yukarıdaki sadece iki çokgeni birbirine eş seçin. Diğer çokgenlerin kenar uzunlukları birbirinden farklı olsun.

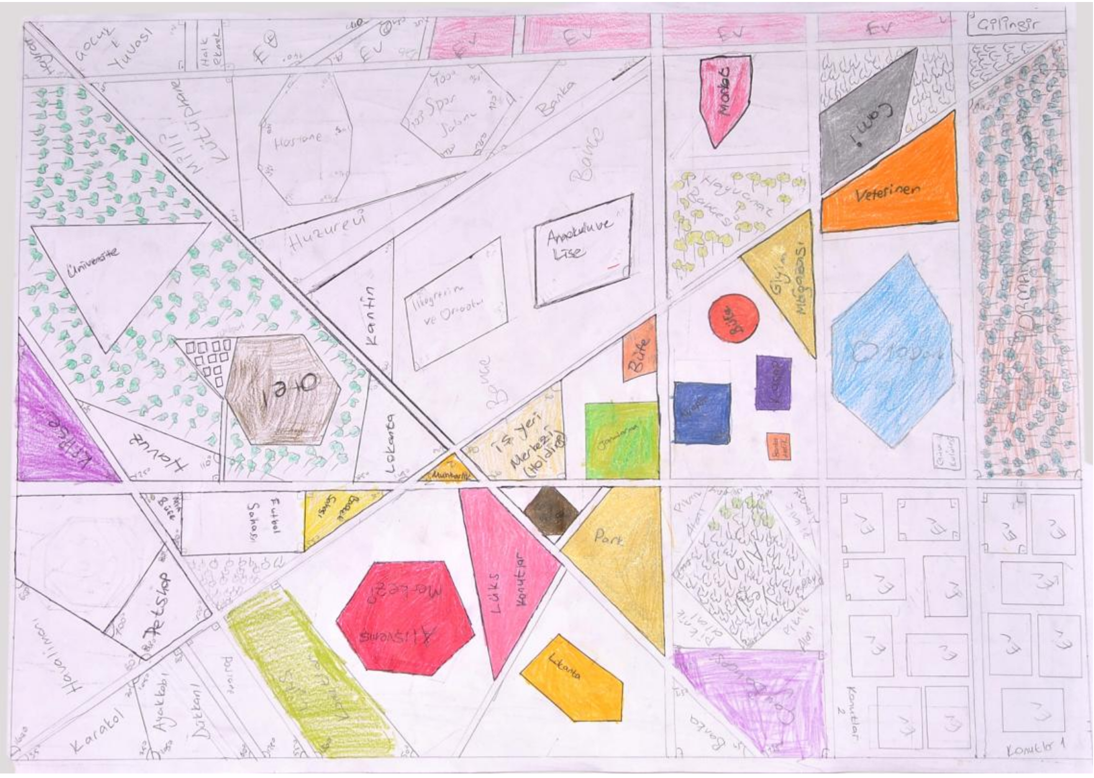
<u>Ölçeğe göre çizeceğiniz PLAN ÜZERİNDE gösterdiğiniz her bir bölümün ölçüleri:</u>

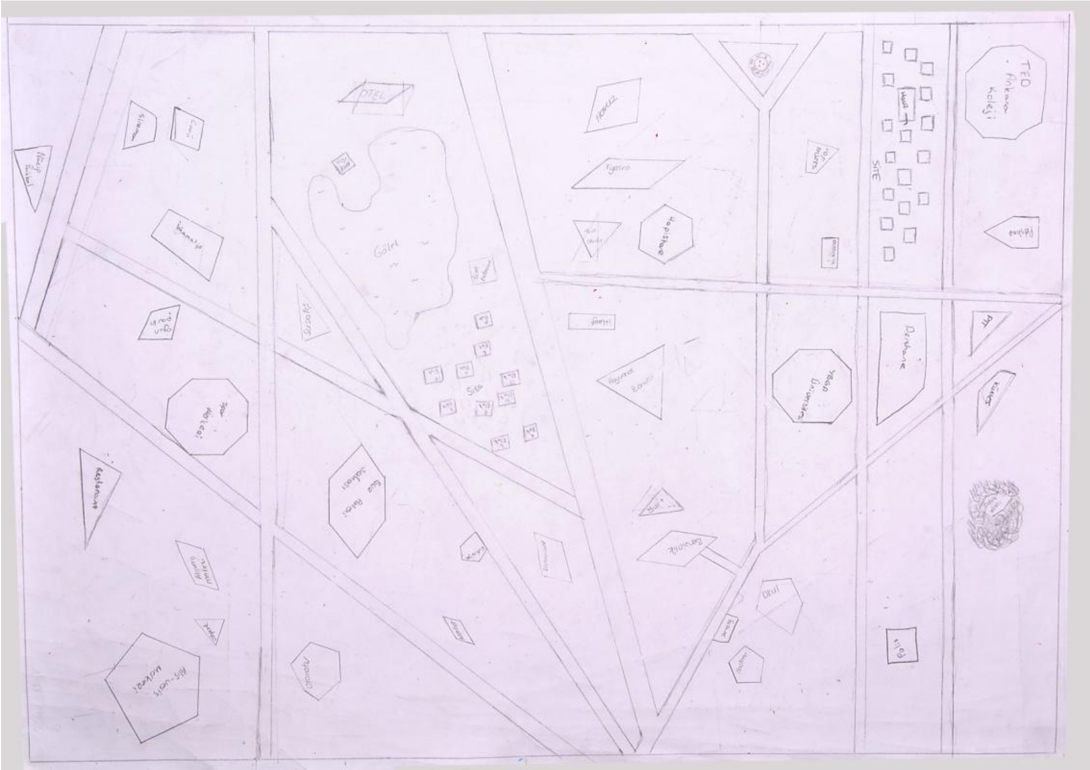
	Bölüm adı	Kenarlarının plan üzerindeki uzunlukları (cm cinsinden)	İç açılarının ölçüleri	Dış açılarının ölçüleri
1. İkizkenar üçgen olan bir bölüm	Market	2,8 - 2 - 2	90^{0}- 45^{0}- 45	90-135-135
2. İkizkenar üçgen olan diğer bölüm	Liman		90-45-45	90-135-135
3. Eşkenar üçgen olan bir bölüm	muhtar	2-2-2	60-60-60	60-60-60
4. Eşkenar üçgen olan diğer bölüm	jandarma	2-2-2	60-60-60	60-60-60
5. Paralelkenar olan bir bölüm	itfaiye	4-5-4-5	70-110-70-110	110-70-110-70
6. Paralelkenar olan diğer bölüm	Alışveriş Merkezi	12-10-12-10	100-80-100-80	80-100-80-100
7. Dikdörtgen olan bir bölüm	Park	12-9-12-9	90-90-90-90	90-90-90-90
8. Dikdörtgen olan diğer bölüm	Futbol Sahası	6-4-6-4	90-90-90-90	90-90-90-90
9. Kare olan bir bölüm	1. sitedeki evler	2-2-2-2	90-90-90-90	90-90-90-90
10. Kare olan diğer bölüm	2. sitedeki evler	2-2-2-2	90-90-90-90	90-90-90-90
11. Eşkenar dörtgen olan bir bölüm	Tenis Sahası	5-5-5-5	70-110-70-110	110-70-110-70
12. Eşkenar dörtgen olan diğer bölüm	Basketbol Sahası	5-5-5-5	60-120-60-120	120-60-120-60
13. Yamuk olan bir bölüm	1. Otel		40-140-60-120	140-40-120-60
14. Yamuk olan diğer bölüm	2. Otel		40-140-60-120	140-40-120-60
15. Başka bir dörtgen olan bir bölüm	3. site		90-90-90-90	90-90-90-90
16. Başka bir dörtgen olan diğer bölüm	4. site		90-90-90-90	90-90-90-90
17. Düzgün beşgen olan bir bölüm	Banka	4-4-4-4-4	108-108-108-108-108	72-72-72-72-72
18. Düzgün beşgen olan diğer bölüm	Sağlık Ocağı	4-4-4-4	108-108-108-108-108	72-72-72-72-72
19. Düzgün altıgen olan bir bölüm	Sinema	2-2-2-2-2-2	hepsi 120	hepsi 60
20.Düzgün altıgen olan diğer bölüm	Tiyatro	2-2-2-2-2-2	hepsi 120	hepsi 60
21. Düzgün sekizgen olan bir bölüm	Kilise	hepsi 1	hepsi 135	hepsi 45
22.Düzgün sekizgen olan diğer bölüm	4. otel	hepsi 2	hepsi 135	hepsi 45
23. Kenarları eşit uzunlukta düzgün olmayan beşgen olan bir bölüm	pastane lokanta	4, 4, 4, 4, 4	90^{0}-90^{0} -150^{0}- 150^{0}- ? 60	90-90-30-30-120
24. Düzgün olmayan beşgen olan diğer bölüm	Müze		110^{0} – 110^{0} – 100^{0} – 120^{0} - ? 100	70-70-80-60-80
25. Düzgün olmayan altıgen bir bölüm	Hayvanat Bahçesi		110^{0}-110^{0}-120^{0}– 120^{0}– 130^{0} - ? 130	70-70-60-60-50-50
26. Düzgün olmayan altıgen olan diğer bölüm	3. otel		90^{0} – 100^{0} – 105^{0} – 130^{0} – 140^{0} - ? 155	90-80-75-50-40-25

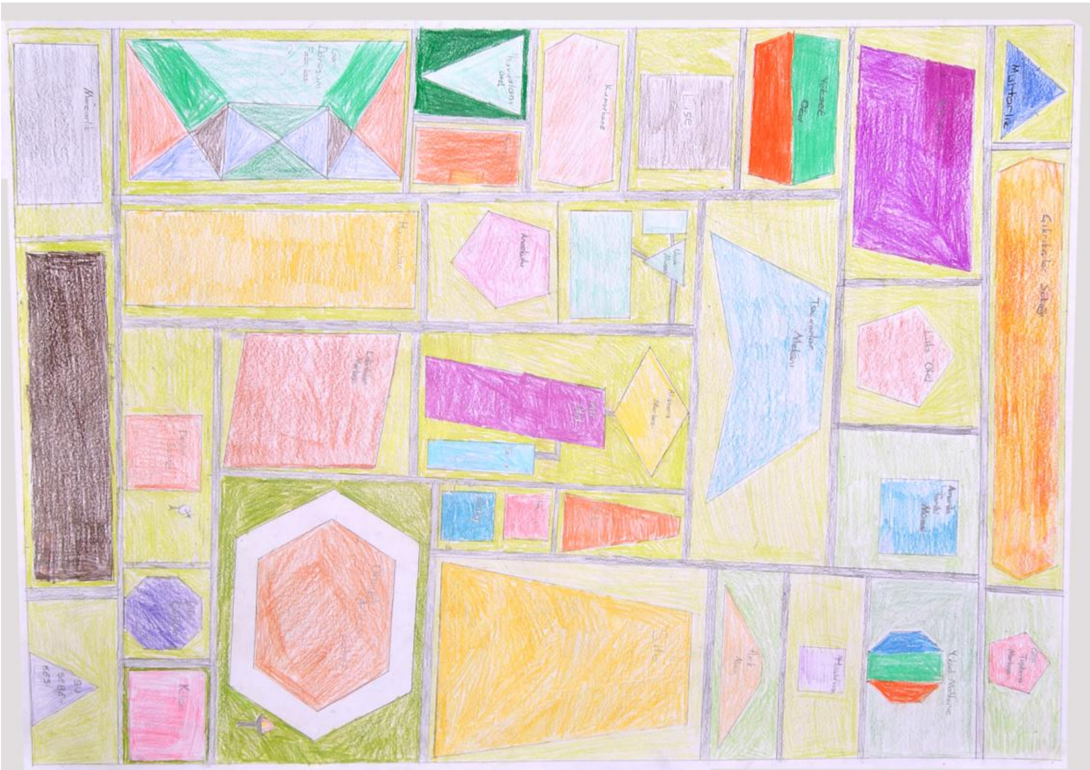
Grup üyeleri:

EXAMPLES from NEIGHBORHOOD PLANS

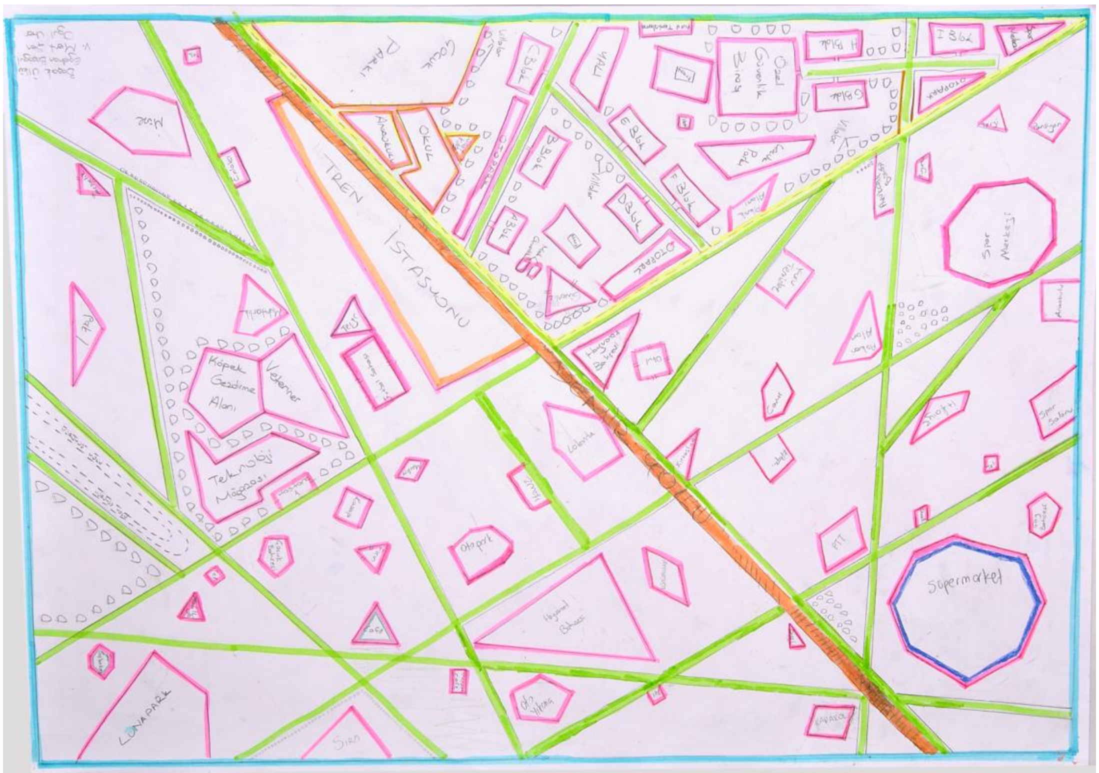


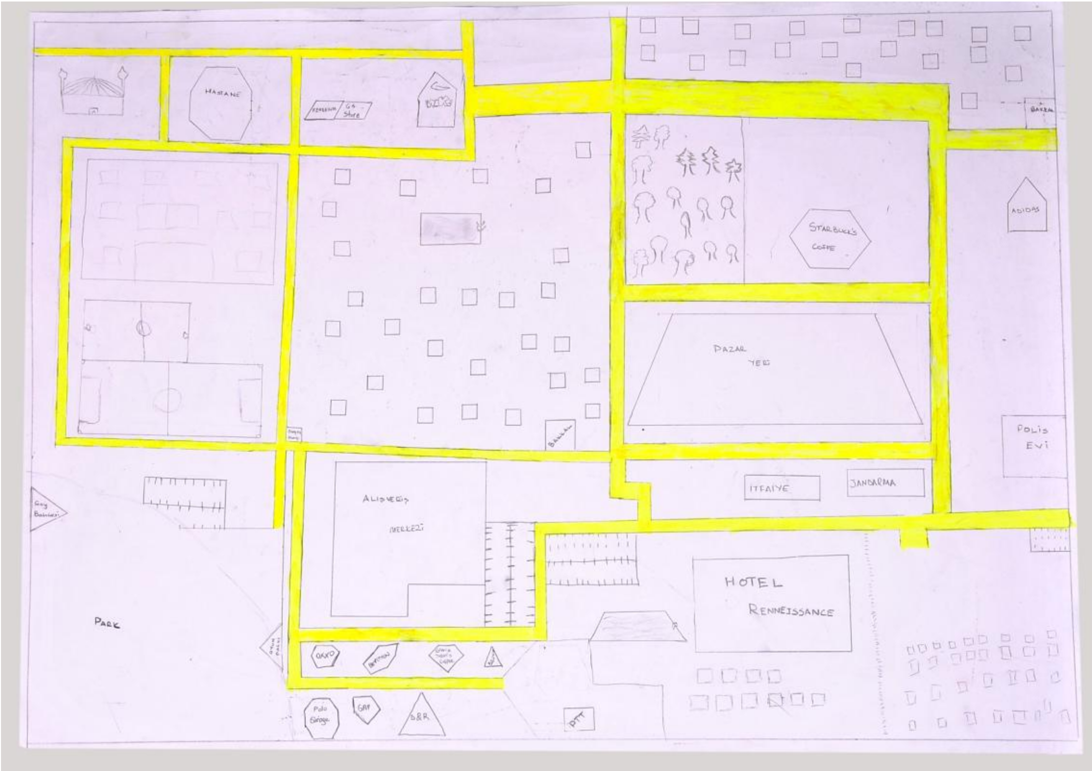




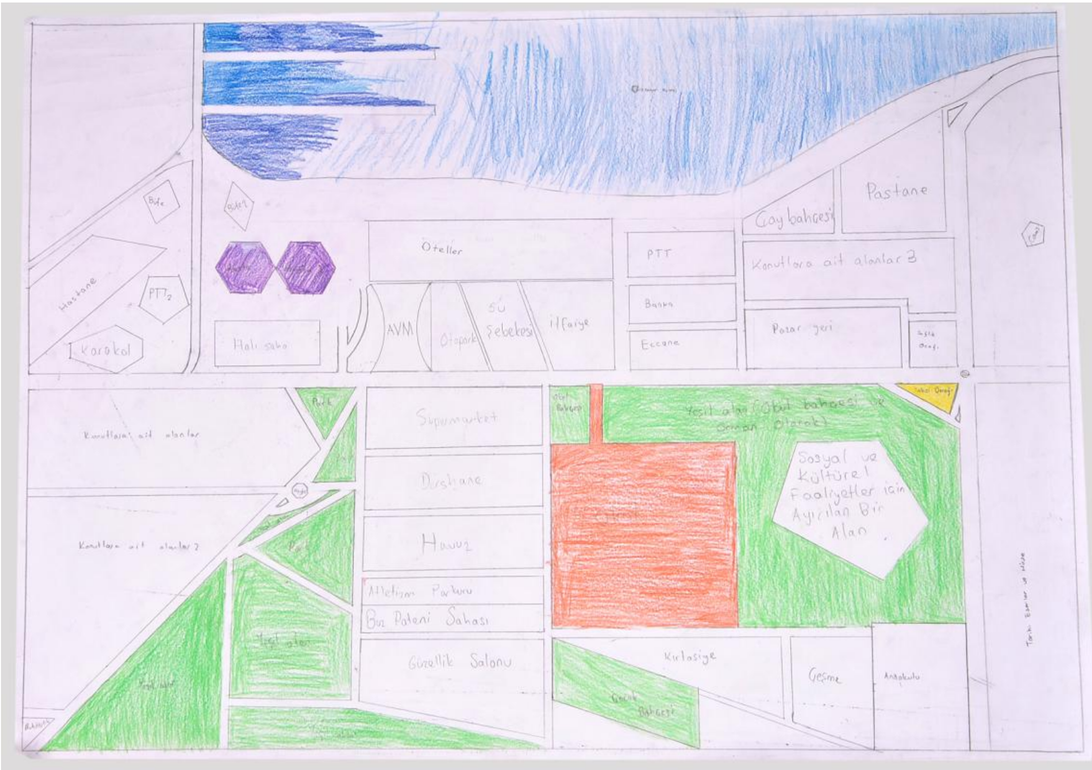



PTT
Central Otel
Central Hastanesi
Cafe
Su Şebekesi
Voleybol Sahası
Futbol Sahası
Central İlköğretim Okulu
Pazar Yeri
Huzurevi
Pastane
Müze
Otopark
Fitness Center
Aqua Park
Elektrik Santrali
İtfaiye
Piknik Yeri
Resmi Gazete
Karakol

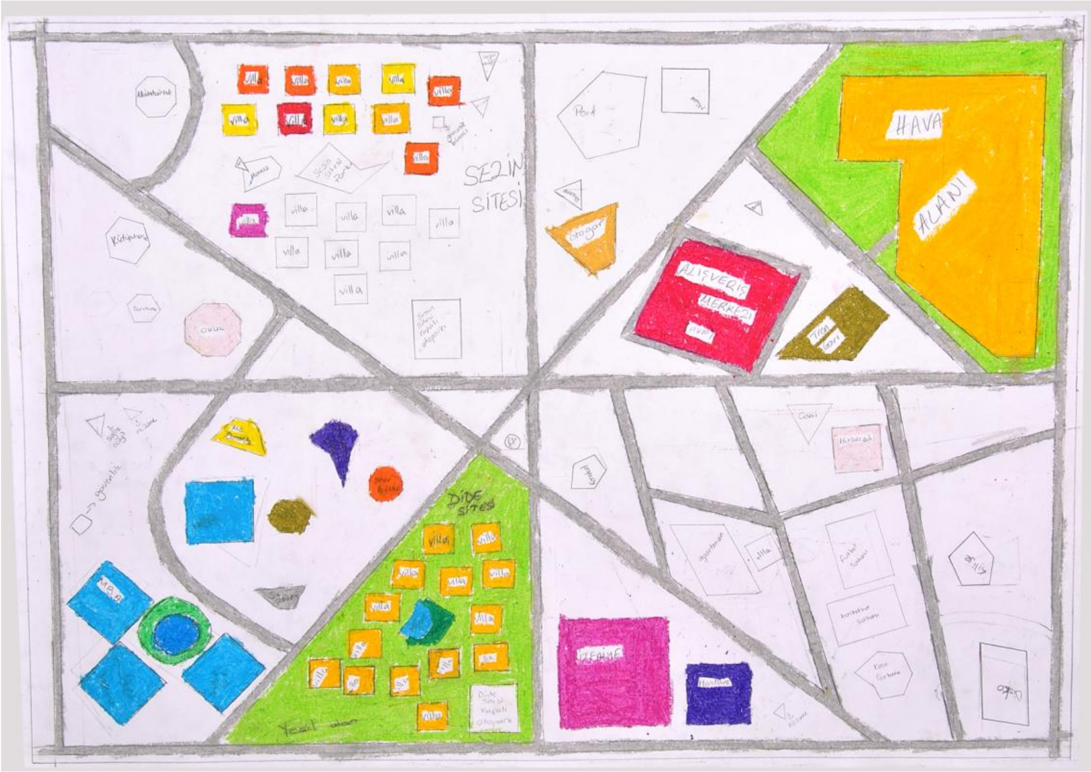

TREN İSTASYONU
OKUL
Köpek Gezdirme Alanı
Veteriner
Teknoloji Mağazası
Spor Merkezi
Süpermarket
Otopark
PTT
LUNAPARK

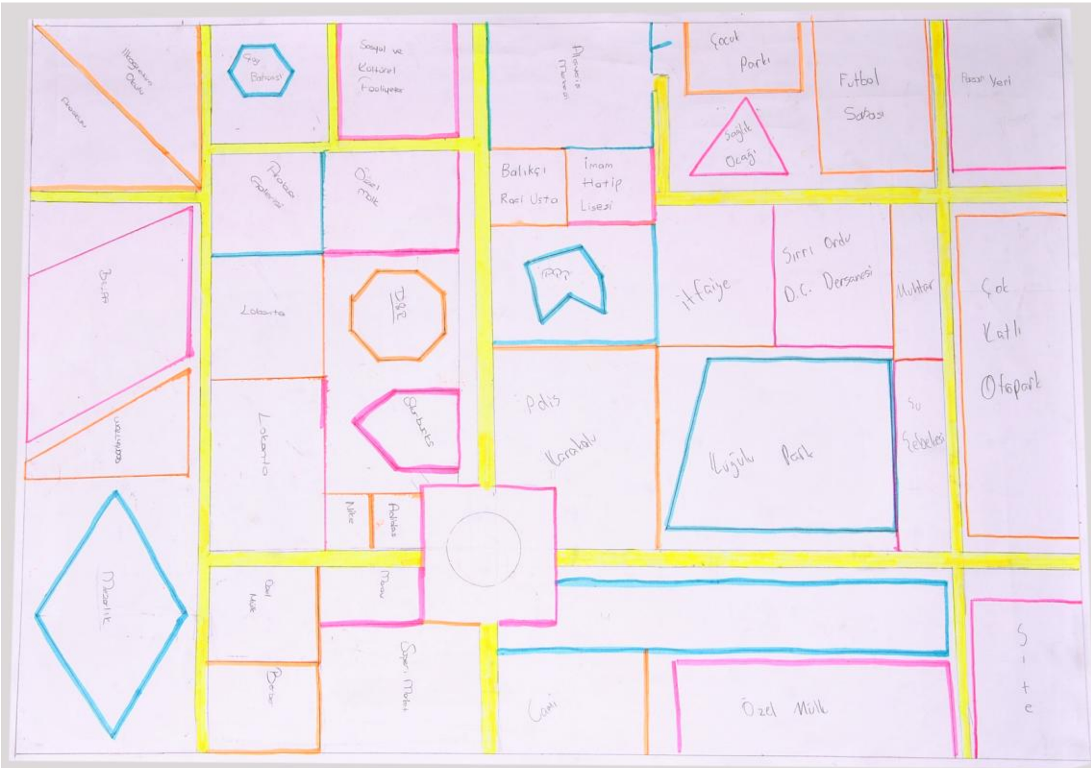


STARBUCK'S
COFFE
ADIDAS
PAZAR
YERİ
POLİS
EVİ
İTFAİYE
JANDARMA
ALIŞVERİŞ
MERKEZİ
HOTEL
RENNEISSANCE
PARK
PTT

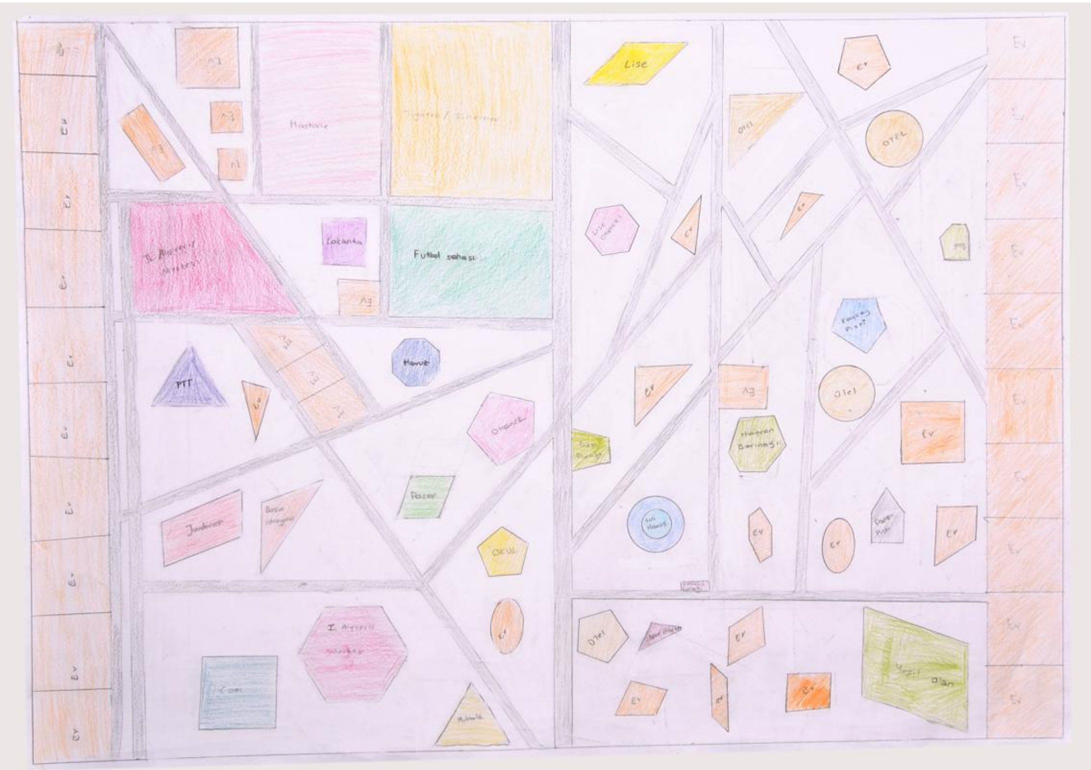


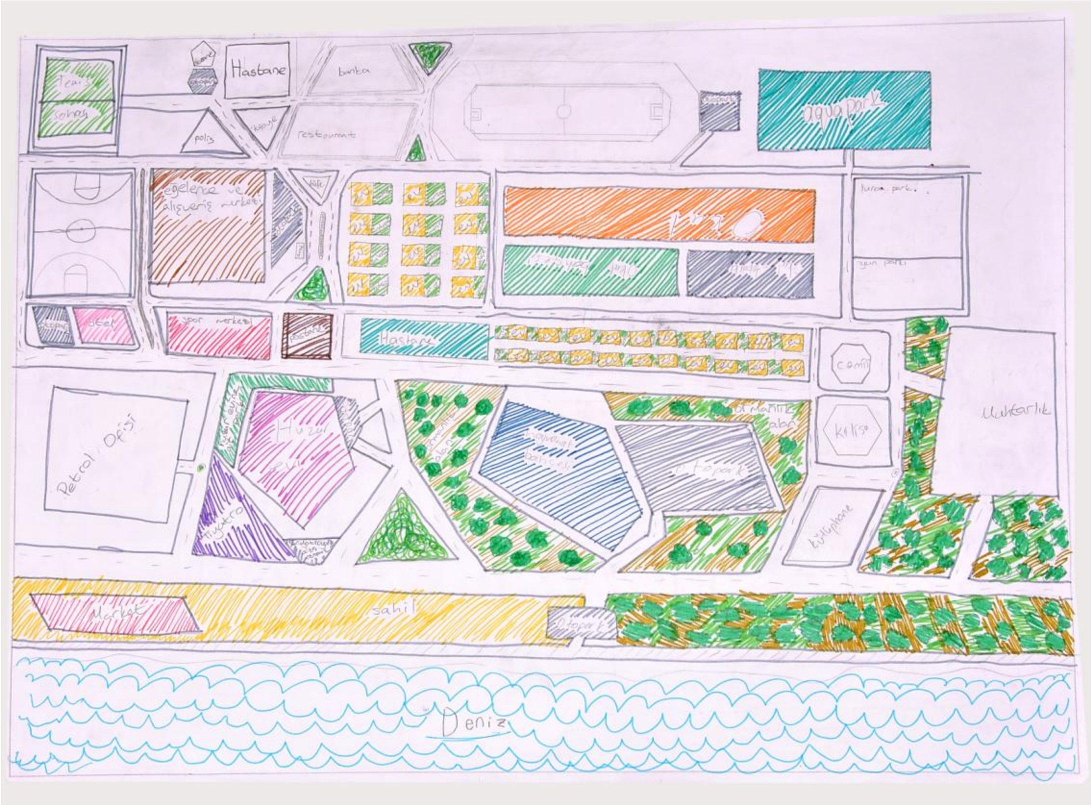
Pastane
Çay bahçesi
Öteller
PTT
Konutlara ait alanlar 3
Hastane
Banka
Pazar yeri
Eczane
AVM
Otopark
Su Şebekesi
İtfaiye
Karakol
Halı saha
Süpermarket
Dershane
Havuz
Atletizm Parkuru
Buz Pateni Sahası
Güzellik Salonu
Konutlara ait alanlar
Konutlara ait alanlar 2
Yeşil alan (Okul bahçesi ve orman olarak)
Sosyal ve Kültürel Faaliyetler için Ayrılan Bir Alan
Kırtasiye
Çeşme
Yeşil alan

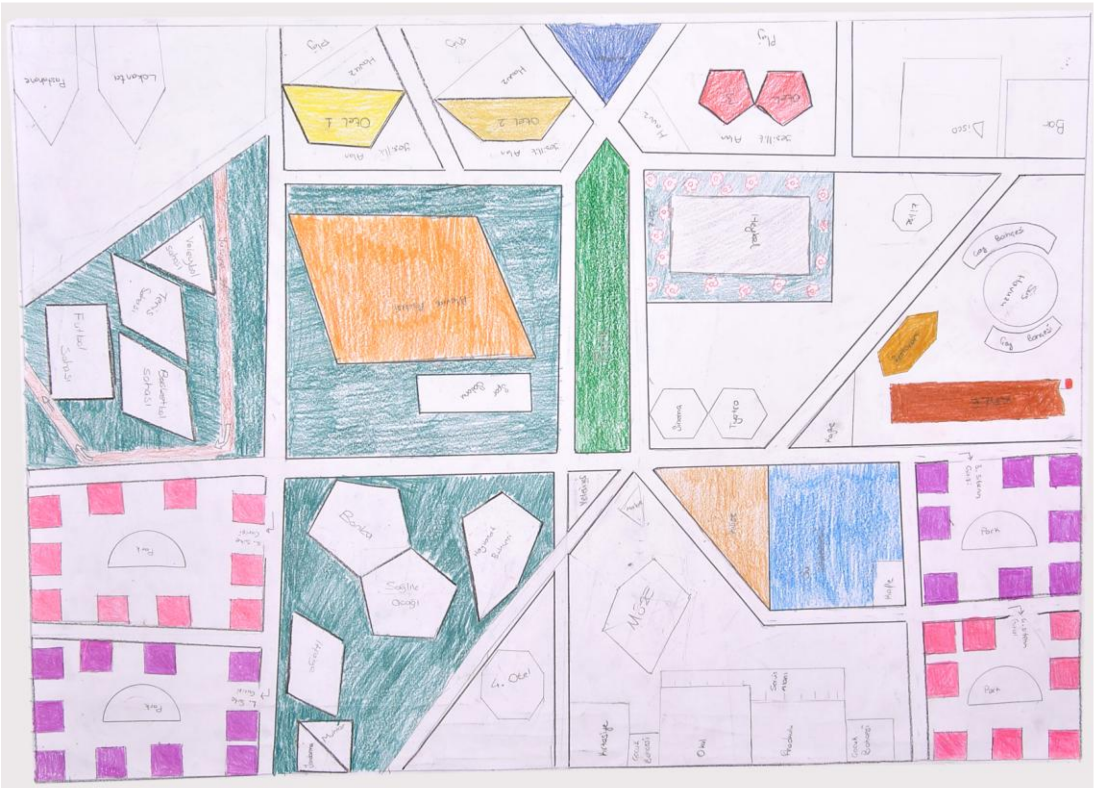

HAVA
ALANI
SEZİN'İN
SİTESİ
ALIŞVERİŞ
MERKEZİ
DİDE SİTESİ

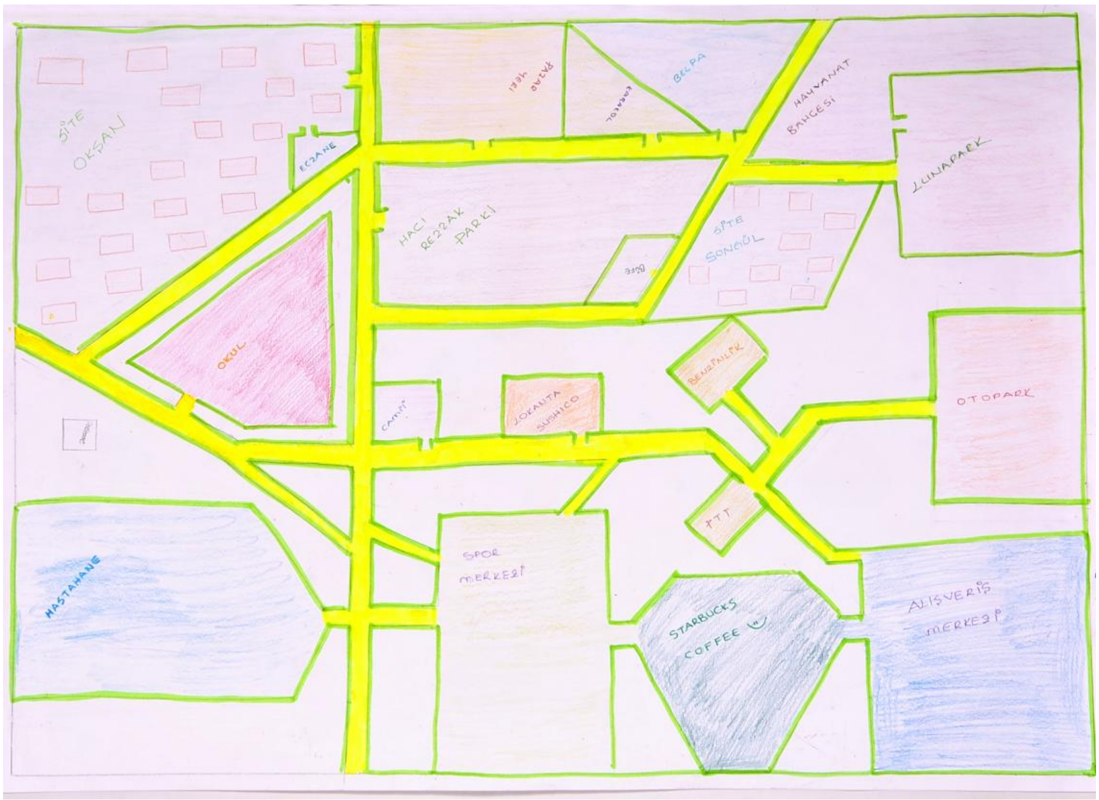

Çocuk Parkı
Futbol Sahası
Pazar Yeri
Sağlık Ocağı
Balıkçı Rasl Usta
İmam Hatip Lisesi
Lokanta
İtfaiye
Sırrı Ordu D.C. Dersanesi
Muhtar
Çok Katlı Otopark
Polis Karakolu
Uçuşlu Park
Su Şebekesi
Mezarlık
Özel Mülk
Cami
Site

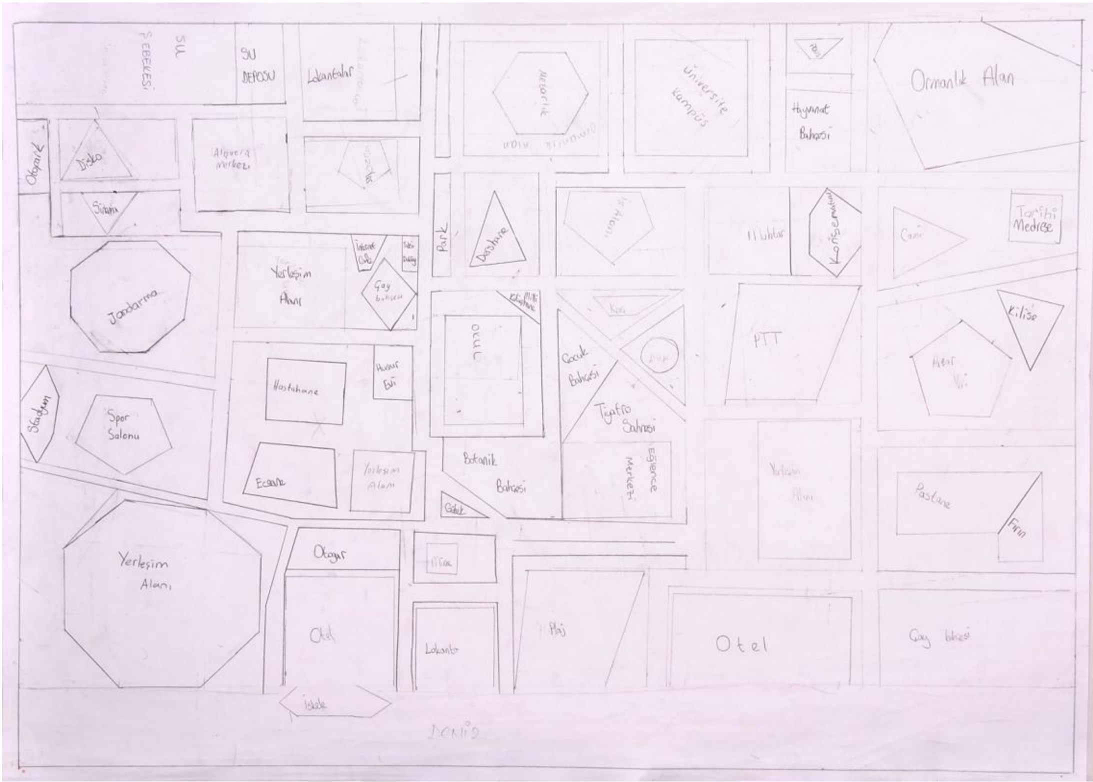

SİTE
OTEL
HAYVANAT BAHÇESİ
EĞLENCE MERKEZİ
MÜZE
KREŞ
BAHÇE
SİTE
SAĞLIK OCAĞI
KONUT
PAZAR YERİ
JANDARMA
KARAKOL
MUHTARLIK
PTT
SÜPERMARKET
BENZİN İSTASYONU
CAMİ
OTOPARK
LOKANTA
BAR
CAFE
ÇOCUK PARKI
PARK

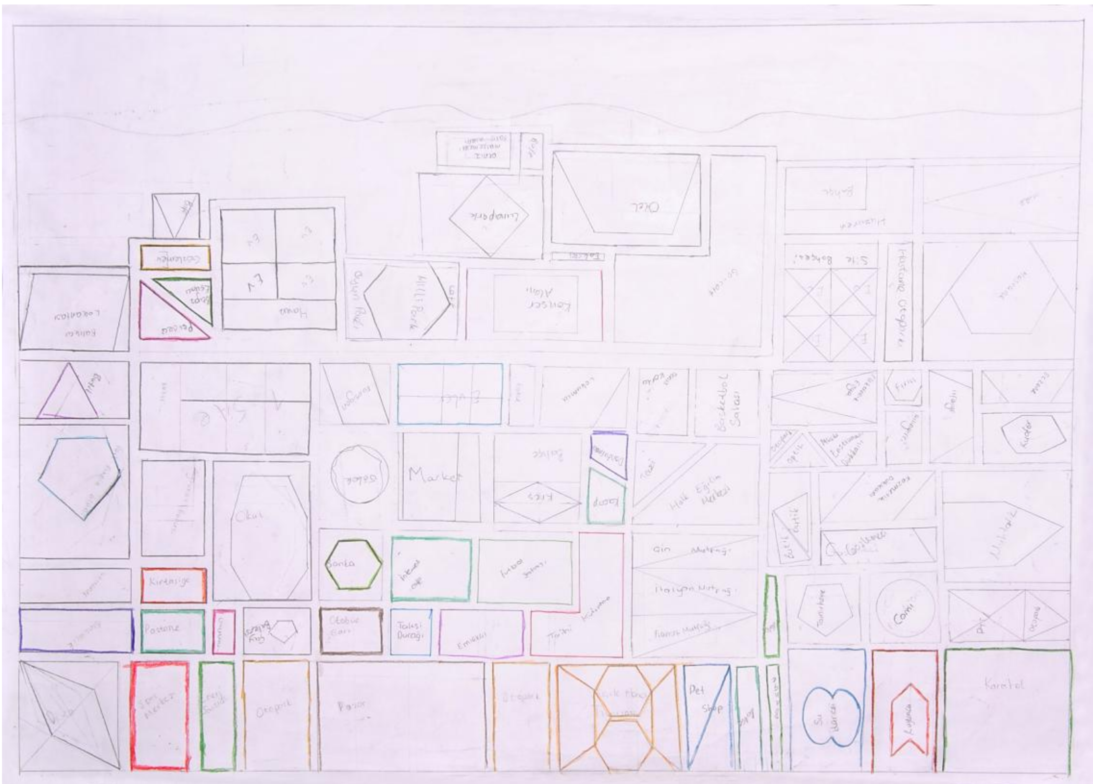

Lise
Futbol sahası
PTT
Okul
Otel

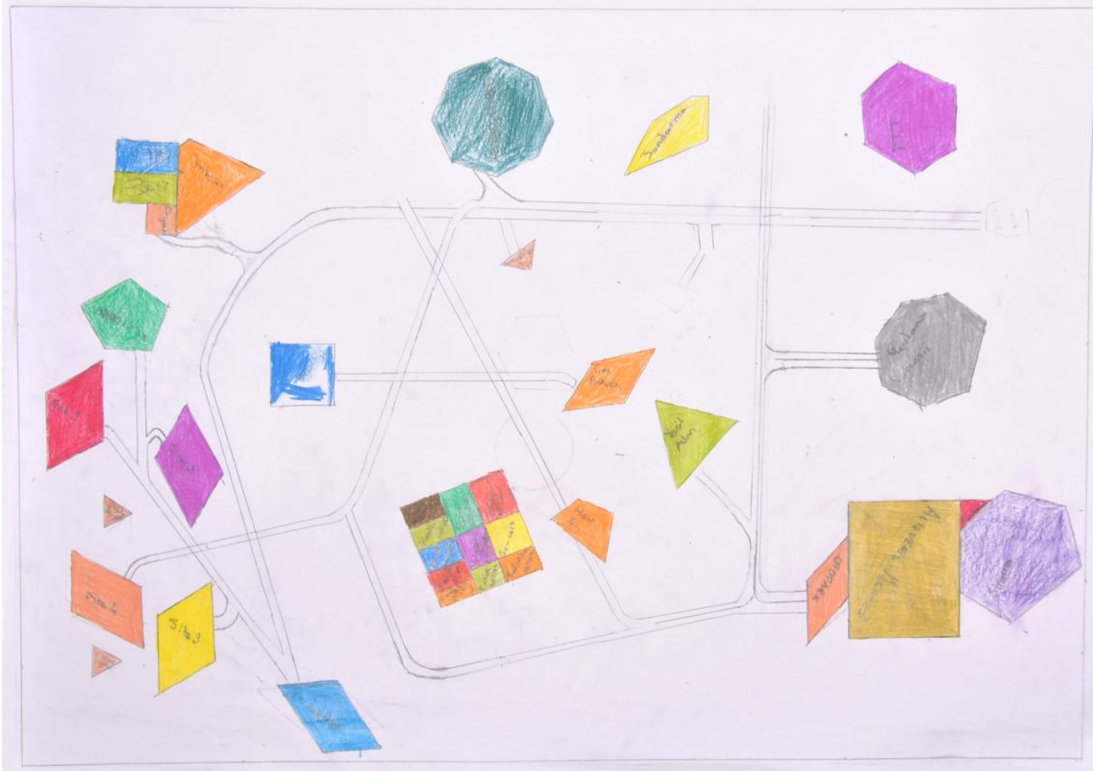

Hastane
banka
polis
restaurant
aquapark
spor merkezi
Hastane
cami
kilise
Muhtarlık
Petrol Ofisi
kütüphane
Market
sahil
Deniz

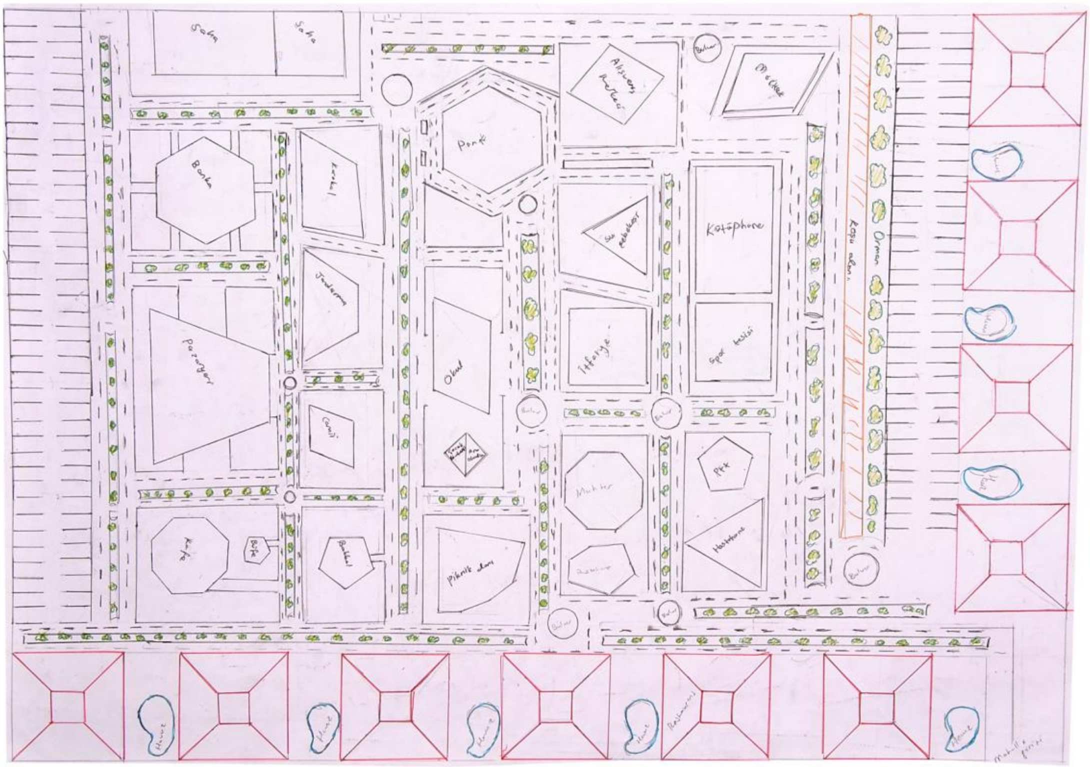


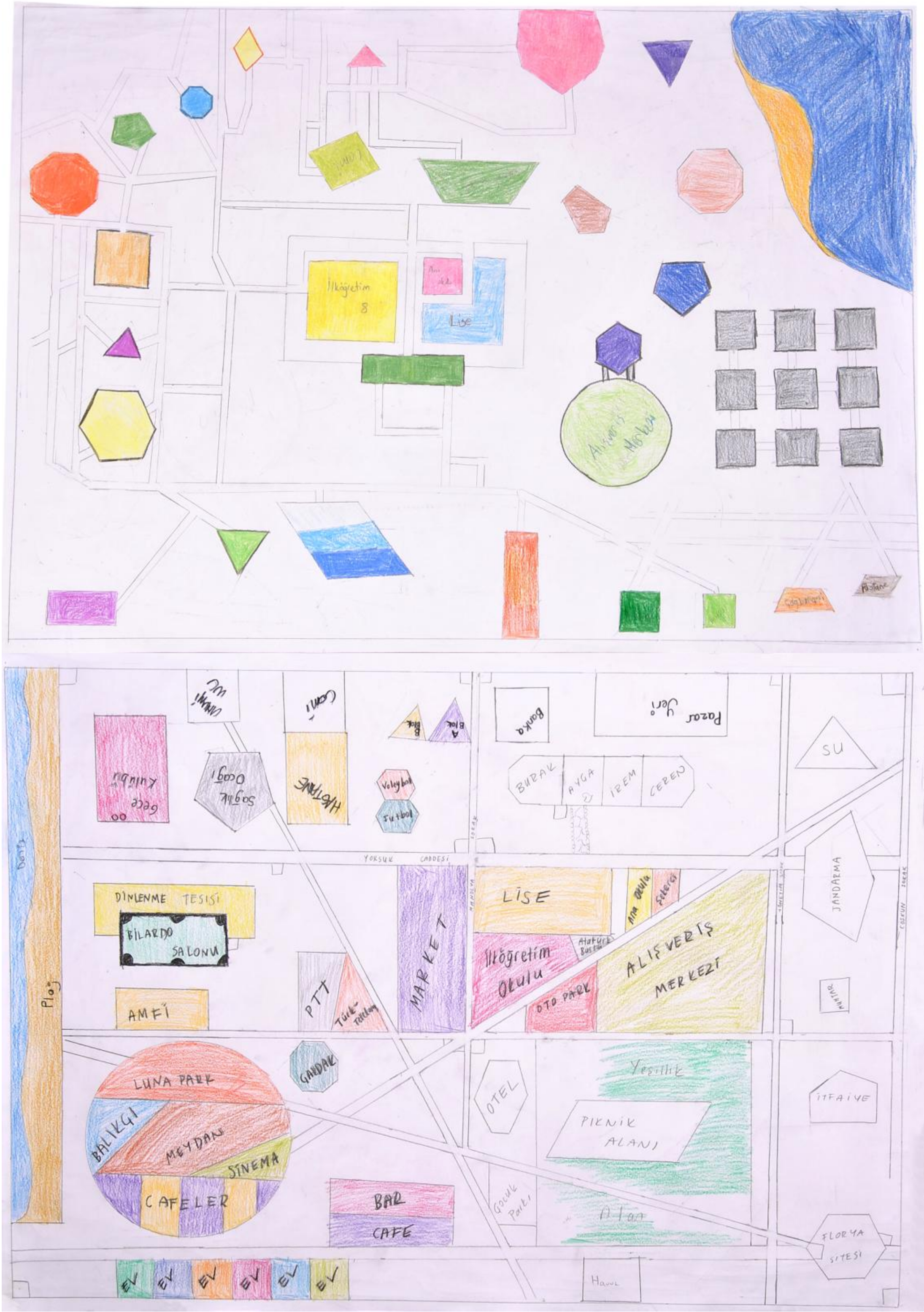

SİTE OKŞAN
ECZANE
BELPA
HAYVANAT BAHÇESİ
LUNAPARK
HACI REZZAK PARKI
SİTE SONGÜL
OKUL
BENZİNLİK
CAMİİ
OTOPARK
PTT
HASTAHANE
SPOR MERKEZİ
STARBUCKS COFFEE
ALIŞVERİŞ MERKEZİ

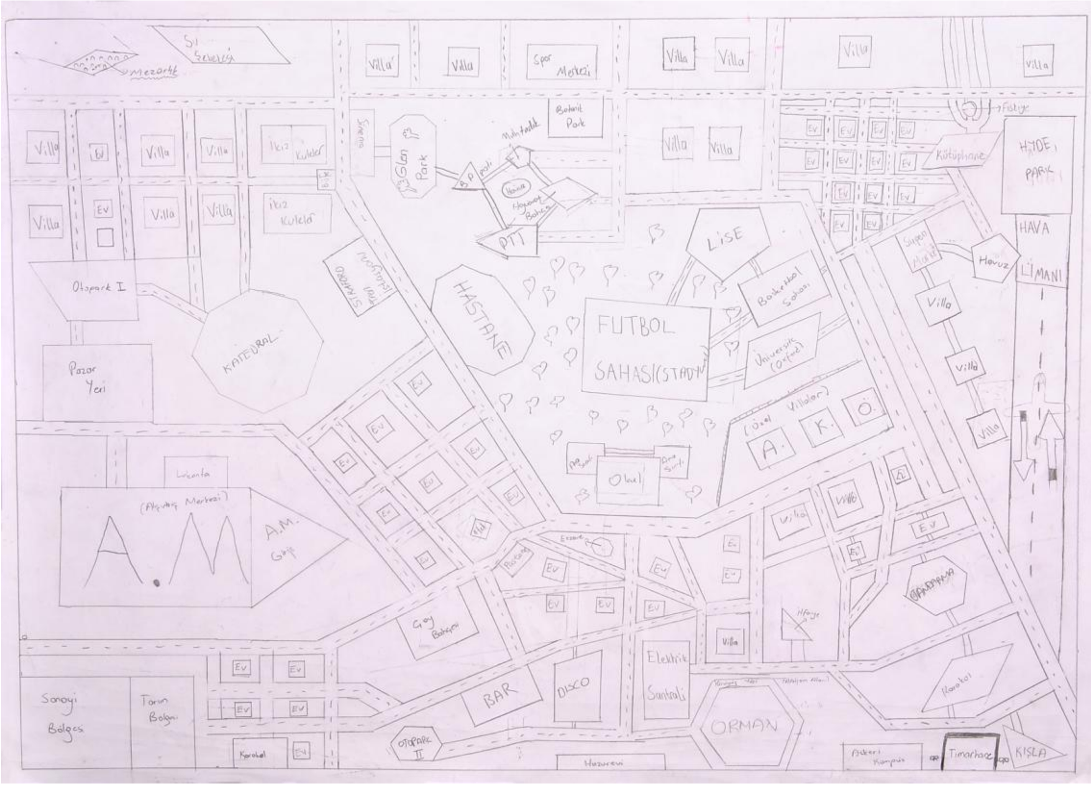

SU DEPOSU
Ormanlık Alan
Üniversite Kampüsü
Hayvanat Bahçesi
Otopark
Disko
Sinema
Alışveriş merkezi
Park
Jandarma
Yerleşim Alanı
Çay bahçesi
Dershane
Okul
Hastahane
Stadyum
Spor Salonu
Eczane
Botanik Bahçesi
Çocuk Bahçesi
Tiyatro Sahnesi
Eğlence Merkezi
PTT
Kilise
Cami
Tarihi Medrese
Pastane
Fırın
Otogar
Otel
Lokanta
Plaj
İskele
DENİZ

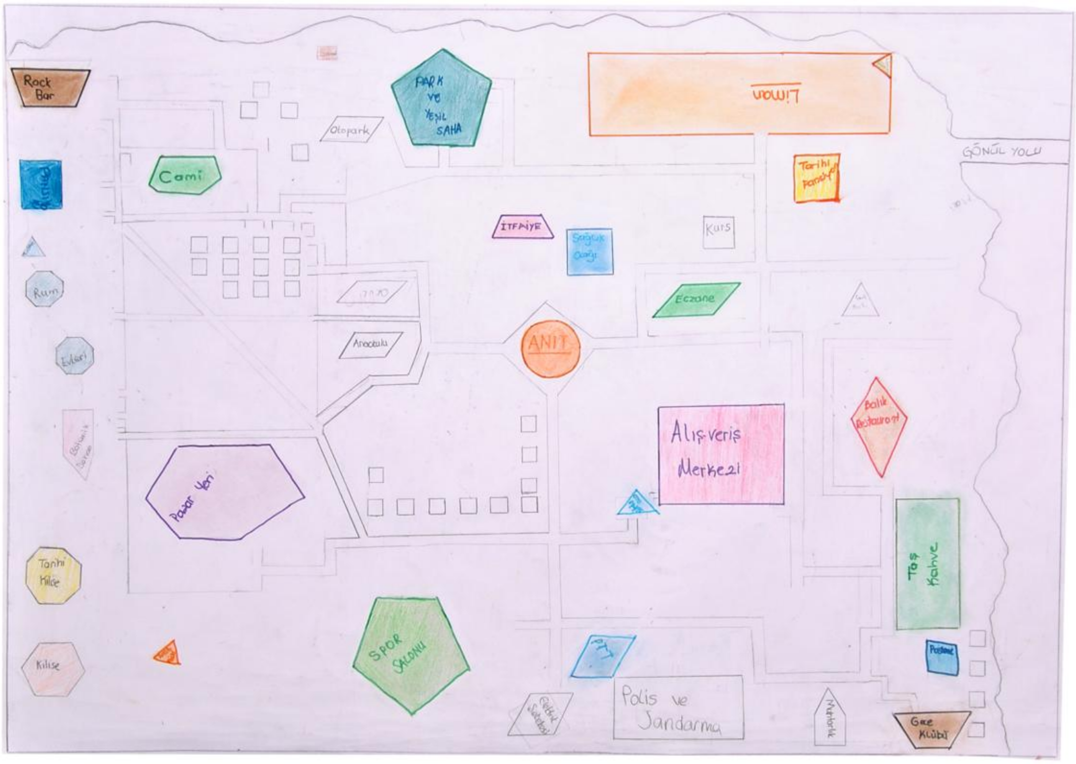

Market
Banka
Pastane
Kırtasiye
Pet shop
Karakol



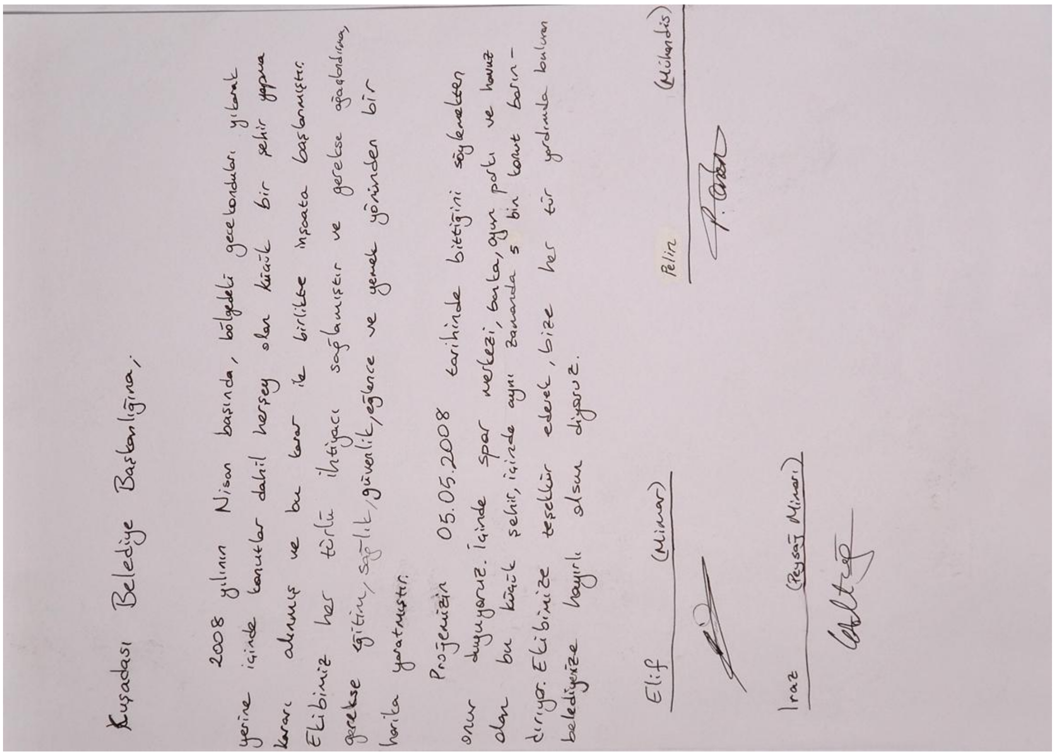



İlköğretim 8
Lise
Alışveriş Merkezi
Pazar yeri
Banka
SU
BURAK
AYGA
İREM
CEREN
Gece Kulübü
Sağlık Ocağı
DİNLENME TESİSİ
BİLARDO SALONU
AMFİ
PTT
MARKET
LİSE
İlköğretim Okulu
OTO PARK
ALIŞVERİŞ MERKEZİ
JANDARMA
Plaj
LUNA PARK
BALIKÇI
MEYDAN
SİNEMA
CAFELER
OTEL
Yeşillik
PİKNİK ALANI
BAR
CAFE
İTFAİYE
FLORYA SİTESİ
EV
EV
EV
EV
EV
EV


Mezarlık
Villa
Spor Merkezi
İkiz Kuleler
Glen Park
PTT
LİSE
HASTANE
FUTBOL SAHASI(STADYUM)
Basketbol Sahası
KATEDRAL
Otopark I
Pazar Yeri
A.M
A.M. Grup
Okul
Kütüphane
HYDE PARK
HAVA LİMANI
Havuz
Ev
Sanayi Bölgesi
Tarım Bölgesi
BAR
DISCO
Elektrik Santrali
ORMAN
Otopark II
Tımarhane
KIŞLA


Rock Bar
PARK ve YEŞİL SAHA
Otopark
Cami
Liman
GÖNÜL YOLU
İTFAİYE
Kurs
Eczane
ANIT
Anaokulu
Alışveriş Merkezi
Balık Restoranı
Pazar Yeri
Taş Kahve
Tarihi Kilise
Kilise
SPOR SALONU
PTT
Polis ve Jandarma
Gece Kulübü

EXAMPLES from PETITIONS (Lastname of the students were erased)



Kuşadası Belediye Başkanlığına;

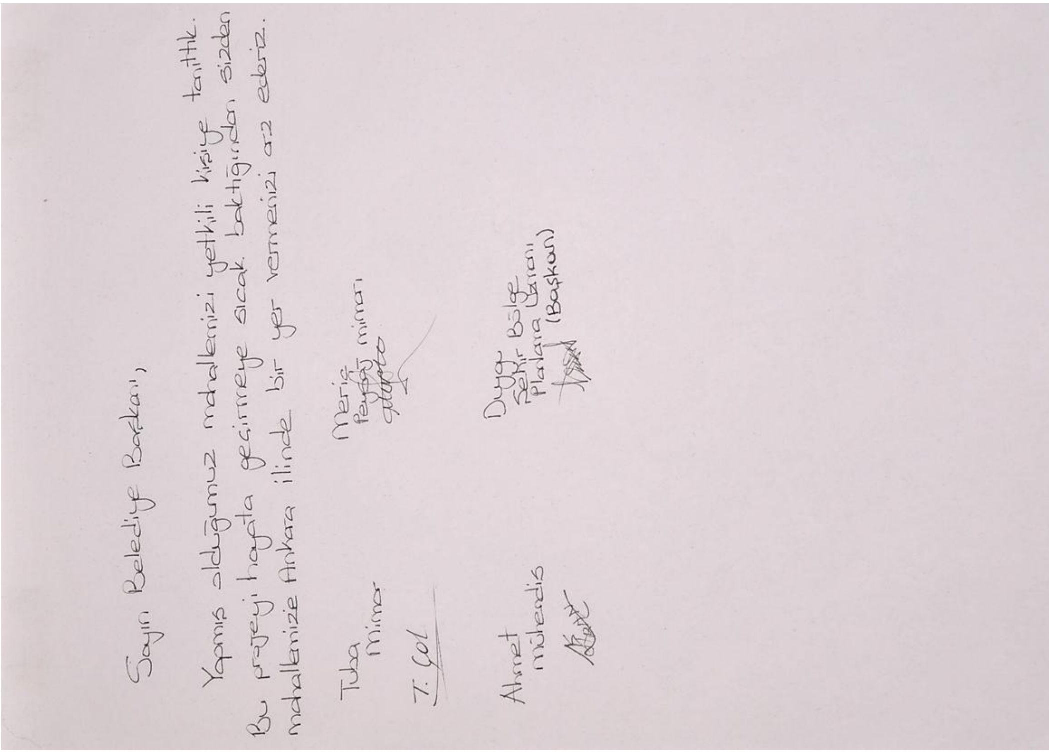
2008 yılının Nisan başında, bölgedeki gecekonduları yıkarak yerine içinde konutlar dahil herşey olan küçük bir şehir yapma kararı alınmış ve bu karar ile birlikte inşaata başlanmıştır. Ekibimiz her türlü ihtiyacı sağlamıştır ve gerekse ağaçlandırma, gerekse eğitim, sağlık, güvenlik, eğlence ve yemek yönünden bir harika yaratmıştır.

Projemizin 05.05.2008 tarihinde bittiğini söylemekten onur duyuyoruz. İçinde spor merkezi, banka, oyun parkı ve havuz olan bu küçük şehir, içinde aynı zamanda 5 bin konut barındırıyor. Ekibimize teşekkür ederek, bize her tür yardımda bulunan belediyenize hayırlı olsun diyoruz.

Elif (Mimar)

Pelin (Mühendis)

Iraz (Peysaj Mimarı)



Sayın Belediye Başkanı,

Yapmış olduğumuz mahallemizi yetkili kişiye tanıttık. Bu projeyi hayata geçirmeye sıcak baktığından sizden mahallemize Ankara ilinde bir yer vermenizi arz ederiz.

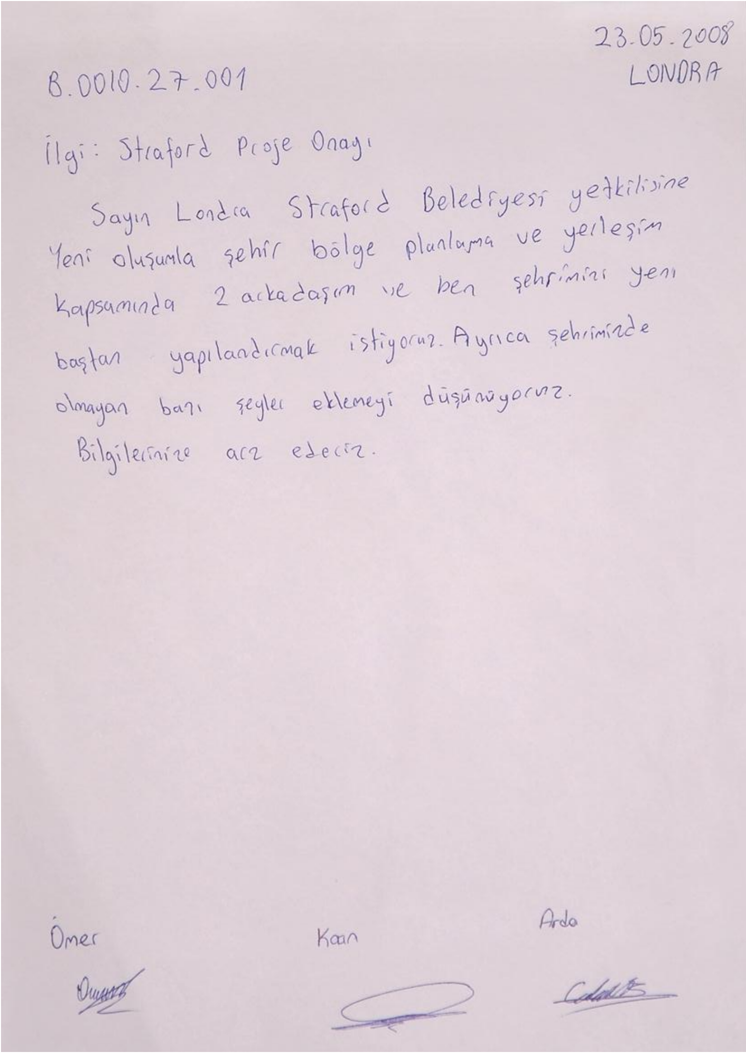
Tuba
Mimar

T. Çol

Meriç
Peysaj mimarı

Ahmet
mühendis

Duygu
Şehir Bölge Planlama Uzmanı
(Başkan)



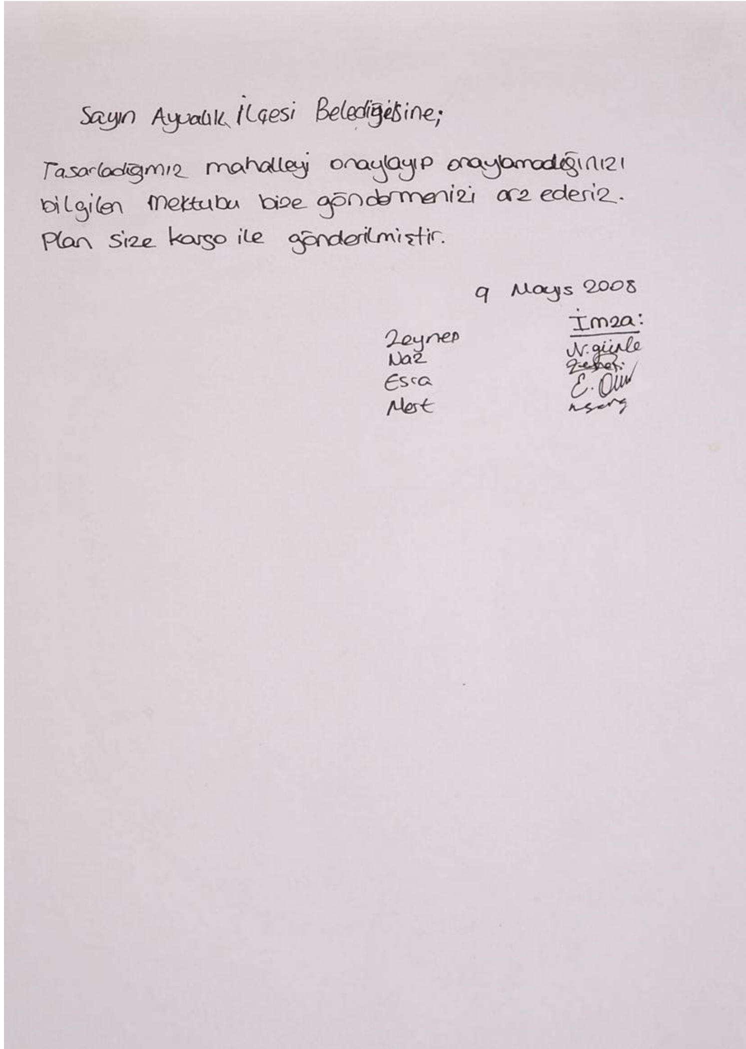
23.05.2008
LONDRA

B.0010.27.001

İlgi: Straford Proje Onayı

Sayın Londra Straford Belediyesi yetkilisine
Yeni oluşumla şehir bölge planlama ve yerleşim kapsamında 2 arkadaşım ve ben şehrimizi yeni baştan yapılandırmak istiyoruz. Ayrıca şehrimizde olmayan bazı şeyler eklemeyi düşünüyoruz.
Bilgilerinize arz ederiz.

Ömer Kaan Arda



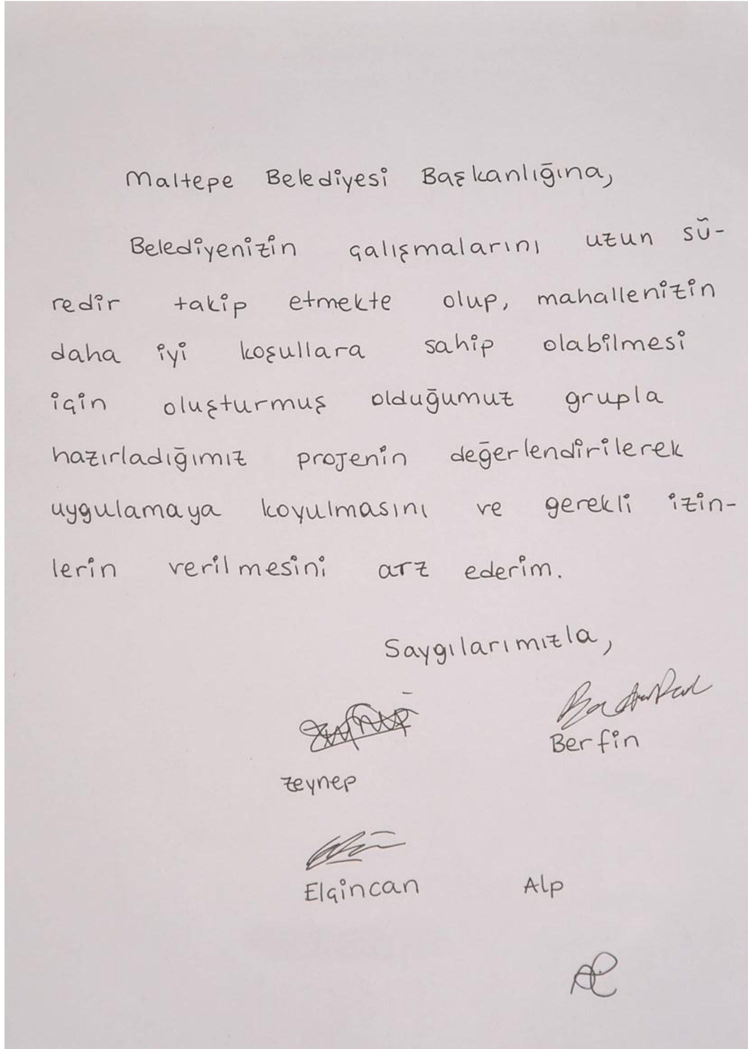
Sayın Ayvalık İlçesi Belediyesine;

Tasarladığımız mahalleyi onaylayıp onaylamadığınızı bilgilen mektubu bize göndermenizi arz ederiz. Plan size kargo ile gönderilmiştir.

9 Mayıs 2008

Zeynep
Naz
Esra
Mert

İmza:



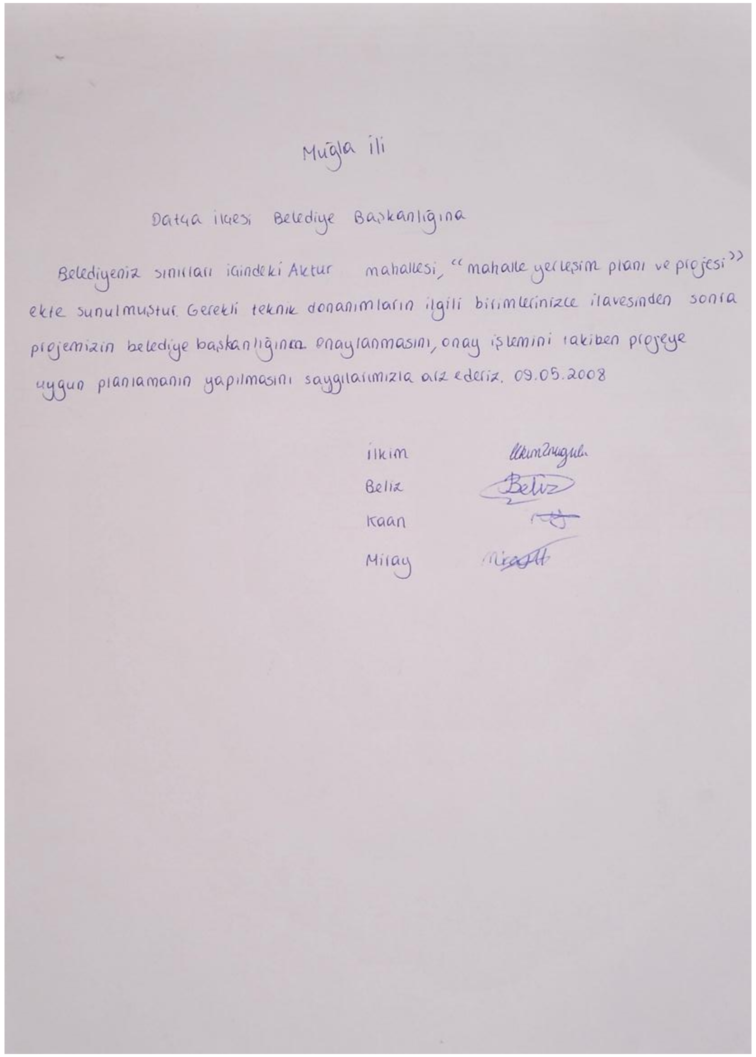
Maltepe Belediyesi Başkanlığına,

Belediyenizin çalışmalarını uzun süredir takip etmekte olup, mahallenizin daha iyi koşullara sahip olabilmesi için oluşturmuş olduğumuz grupla hazırladığımız projenin değerlendirilerek uygulamaya koyulmasını ve gerekli izinlerin verilmesini arz ederim.

Saygılarımızla,

Zeynep Berfin

Elçincan Alp



Muğla ili

Datça ilçesi Belediye Başkanlığına

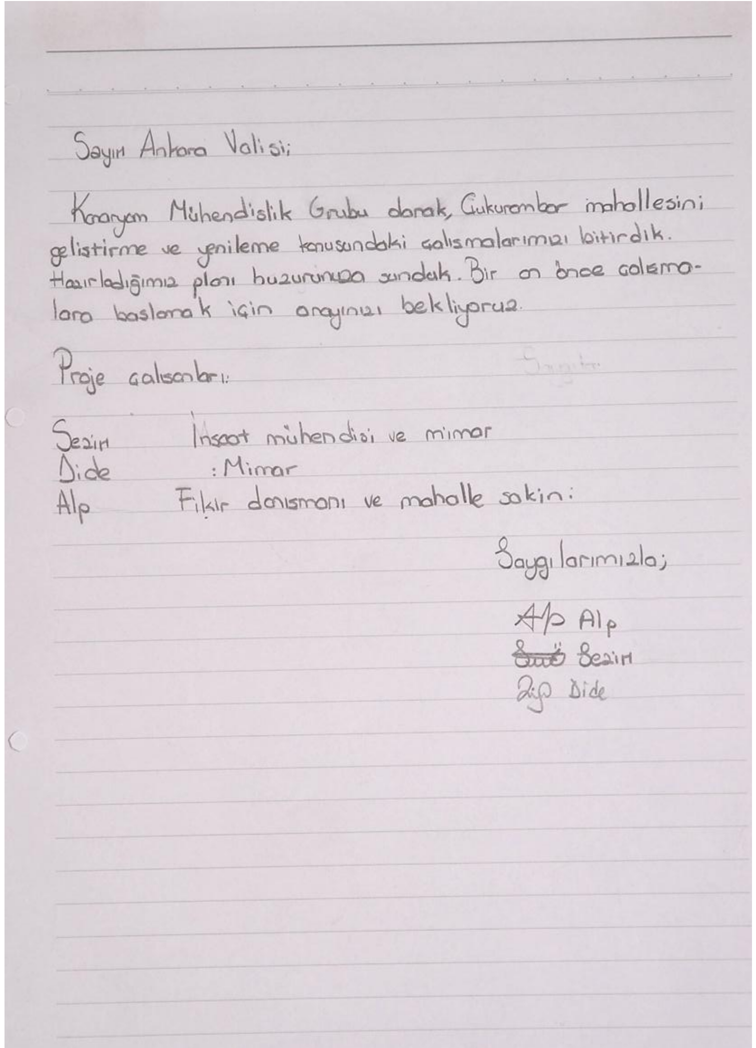
Belediyeniz sınırları içindeki Aktur mahallesi, "mahalle yerleşim planı ve projesi" ekte sunulmuştur. Gerekli teknik donanımların ilgili birimlerinizce ilavesinden sonra projemizin belediye başkanlığınca onaylanmasını, onay işlemini takiben projeye uygun planlamanın yapılmasını saygılarımızla arz ederiz. 09.05.2008

İlkim

Beliz

Kaan

Miray



Sayın Ankara Valisi;

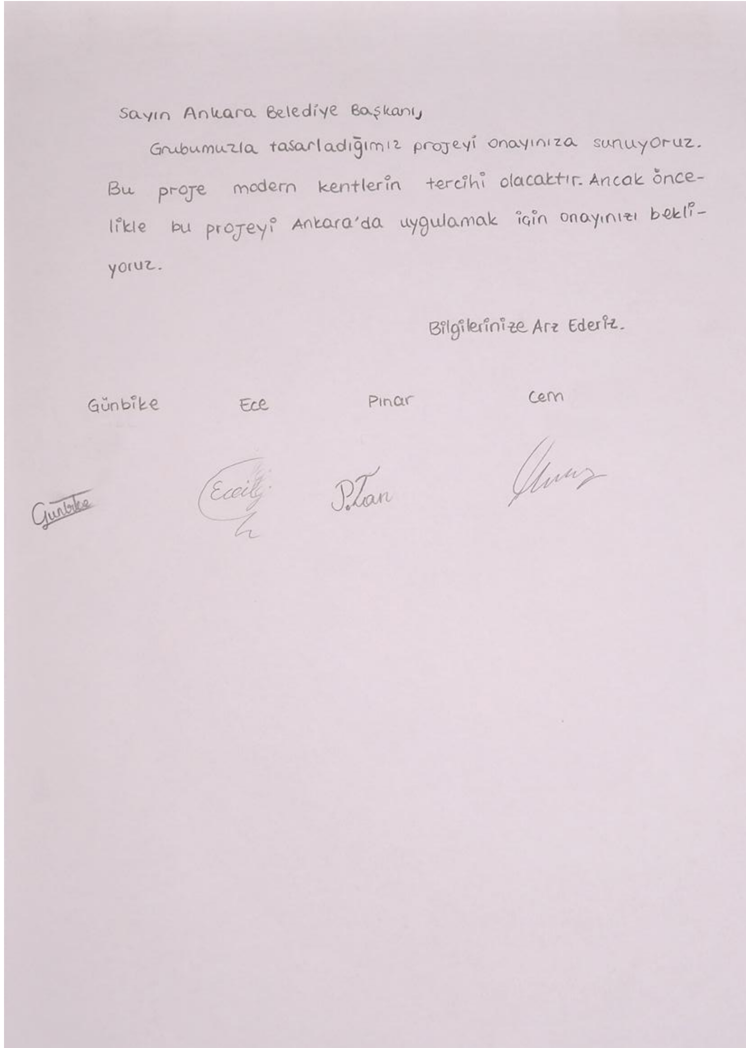
Koranyan Mühendislik Grubu olarak, Çukurambar mahallesini geliştirme ve yenileme konusundaki çalışmalarımızı bitirdik. Hazırladığımız planı huzurunuza sunduk. Bir an önce çalışmalara başlamak için onayınızı bekliyoruz.

Proje çalışanları:

Sezin İnşaat mühendisi ve mimar
Dide : Mimar
Alp Fikir danışmanı ve mahalle sakini

Saygılarımızla;

Alp
Sezin
Dide

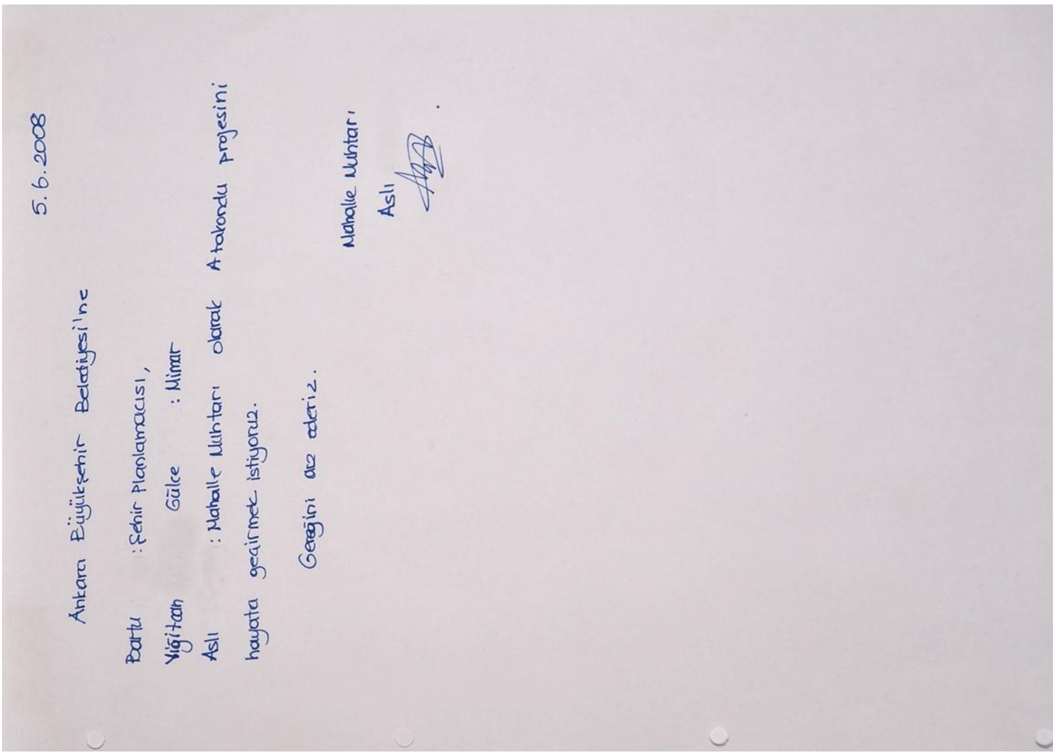


Sayın Ankara Belediye Başkanı,

Grubumuzla tasarladığımız projeyi onayınıza sunuyoruz. Bu proje modern kentlerin tercihi olacaktır. Ancak öncelikle bu projeyi Ankara'da uygulamak için onayınızı bekliyoruz.

Bilgilerinize Arz Ederiz.

Günbike Ece Pınar Cem



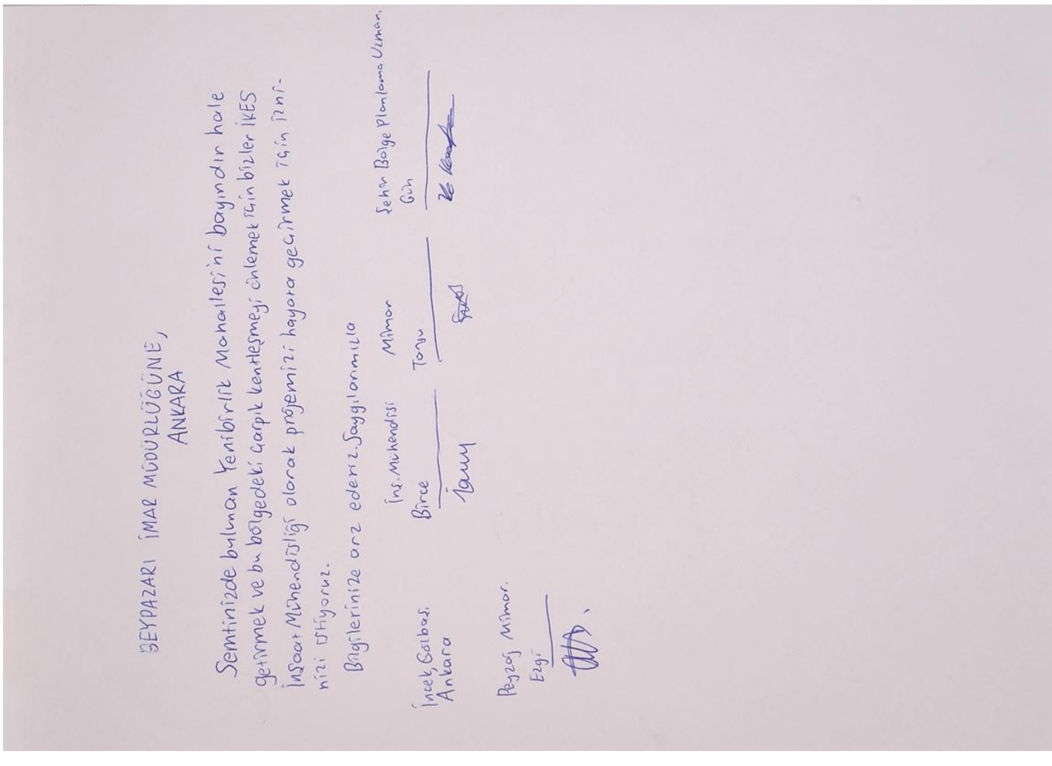
5.6.2008

Ankara Büyükşehir Belediyesi'ne

Bartu : Şehir Planlamacısı,
Yiğitcan Gülce : Mimar
Aslı : Mahalle Muhtarı olarak Atakondu projesini hayata geçirmek istiyoruz.

Gereğini arz ederiz.

Mahalle Muhtarı
Aslı



BEYPAZARI İMAR MÜDÜRLÜĞÜNE,
ANKARA

Semtinizde bulunan Yenibirlik Mahallesi'ni bayındır hale getirmek ve bu bölgedeki çarpık kentleşmeyi önlemek için bizler İKES İnşaat Mühendisliği olarak projemizi hayata geçirmek için izninizi istiyoruz.

Bilgilerinize arz ederiz. Saygılarımızla

İncek, Gölbaşı
Ankara

İnş. Mühendisi
Birce

Mimar
Tonju

Şehir Bölge Planlama Uzman.
Gün

Peyzaj Mimar.
Ezgi

06.05.2008
Salı

KEÇİÖREN BELEDİYESİ MÜDÜRLÜĞÜNE;

ANKARA

Keçiören bölgesini yeniden inşa etmek amacıyla tasarladığımız mahalle projesini yürürlüğe sokmak için sizden gelecek izni beklemekteyiz. Bilgilerinize arz ederim.

Mimar Kaan

K.In

Mühendis Yusuf

Peysaj Mimarı Sevin

Şehir Planlama Uzmanı Arena

Yenimahalle Belediyesi Başkanlığına

Ankara

Belediyeniz sınırları içerisinde Batıkent - Saray bölgesi arasında yer alan 1600 konutluk projemiz tamamlanmış olup, proje kapsamında tamamlanan konutlarımızda yaklaşık 4000 kişi ikamet etmektedir. Şu anda konutlarımız Batıkent Huzur Mahallesi sınırları içerisinde bulunmakta olup, bu sınırların çok geniş olması ve muhtarlık binasının konutlarımıza çok uzak olması nedeniyle yeterli ve etkin düzeyde hizmet alamamaktayız. Projemiz kapsamında oluşturduğumuz 1600 konutta yaşayan 4000 kişinin yerel yönetim hizmetinden daha verimli ve etkin şekilde yararlanabilmesi için proje kapsamındaki konutların yer aldığı alanın Etikent Mahallesi olarak tespit edilmesi hususunda gereğini arz ederim.

Etikent Yönetim Kurulu Başkanı
Etikent Kooperatifi Mensupları Adına

Şeyma

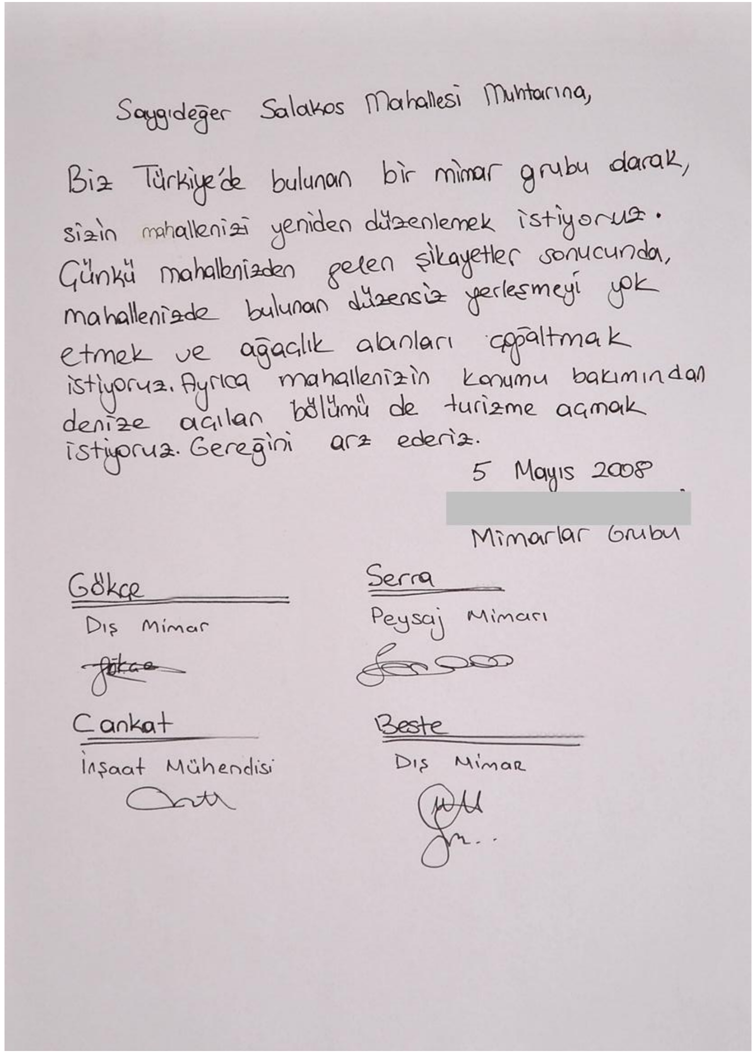
Deniz

Mertalp

M.Ö

Kaan

Adres: Beyaz Gül Sitesi B-1008 Çayyolu/Ankara



Saygıdeğer Salakos Mahallesi Muhtarına,

Biz Türkiye'de bulunan bir mimar grubu olarak, sizin mahallenizi yeniden düzenlemek istiyoruz. Çünkü mahallenizden gelen şikayetler sonucunda, mahallenizde bulunan düzensiz yerleşmeyi yok etmek ve ağaçlık alanları çoğaltmak istiyoruz. Ayrıca mahallenizin konumu bakımından denize açılan bölümü de turizme açmak istiyoruz. Gereğini arz ederiz.

5 Mayıs 2008

Mimarlar Grubu

Gökçe
Dış Mimar

Serra
Peysaj Mimarı

Cankat
İnşaat Mühendisi

Beste
Dış Mimar

VITA

PERSONAL INFORMATION

Surname, Name: Aydınyer, Yurdagül
Nationality: Turkish (TC)
Date and Place of Birth: 27 July 1975, Muğla
Marital Status: Married
e-mail: yurdagultoka@hotmail.com

EDUCATION

Degree	**Institution**	**Year of Graduation**
MS	METU Secondary School Science and Mathematics Education	2001
BS	METU Mathematic Education	1997
High School	Namık Kemal High School, İzmir	1992

WORK EXPERIENCE

Year	**Place**	**Enrollment**
1997- Present	TED Ankara College	Mathematics Teacher
2002-2003	USA, Utah, Park City Treasure Mountain Middle School	Mathematics Teacher

PUBLICATIONS

Toka Y. & Aşkar P. (2002). The effect of cognitive conflict and conceptual change text on students' achievement related to first degree equations with one unknown, *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 22*, 211-217.