AN INVESTIGATION ON THE EFFECTS OF PROJECT-BASED LEARNING ON STUDENTS' ACHIEVEMENT IN AND ATTITUDE TOWARDS GEOMETRY

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ABSTRACT

AN INVESTIGATION ON THE EFFECTS OF PROJECT-BASED LEARNING ON STUDENTS' ACHIEVEMENT IN AND ATTITUDE TOWARDS GEOMETRY

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Although geometry is important area in the mathematics curriculum, evidence from numerous research studies makes it clear that many students' geometrical understanding is not at the level they need or are expected to be, especially in Turkey. The project-based learning approach offered to be one of the most effective learning tools to provide for the students an environment in which they can reach their own conclusions instead of just lecturing them, in the new mathematics curriculum in Turkey.

In this study, the effects of project-based learning on the 7^{th} grade students' achievement in geometry and these students' attitude towards geometry were examined. This study was conducted with a group of 24 seventh grade students in the Bilim College during the last five weeks of the 2004-2005 academic year.

One group pre-test and post-test design was used. The instruments used for data collection are as follows: polygon, circle and cylinder achievement tests, geometry attitude scales, student survey forms, teacher's observation scales, and interviews. The data obtained was analyzed by a paired-sample t-test. The results from achievement tests and attitude scale indicated that project-based learning increased students' geometry achievement and attitudes toward geometry, respectively. The student survey form and interview responses of the students, teacher's observation form responses of the teachers and the observation of the researcher also suggest that project-based learning increased their achievement in and their attitudes towards geometry as a result of making their own models, dealing with authentic daily life problems, determining the dimensions and the areas by trial and error. Moreover, this study helped grasp the attention and increase the desire to study particularly of those students with high capacity who performed unsatisfactorily due to their inclination to get distracted during classes. Providing those who were easily distracted and used every chance to disrupt the lectures with the opportunity to engage in something they could see as their own project brought about favorable results.

Keywords: Project-based learning, geometry achievement, and attitude towards geometry.

ÖZ

PROJE TABANLI ÖĞRENMENİN ÖĞRENCİLERİN GEOMETRİ BAŞARILARINA VE GEOMETRİYE YÖNELİK TUTUMLARINA ETKİSİNİN ARAŞTIRILMASI

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Geometri, matematik müfredatında önemli bir yere sahip olmasına rağmen, birçok çalışma özellikle Türkiye'deki öğrencilerin geometriyi anlamaları, olmaları gereken ve beklenen düzeyde bulunmamaktadır. Proje tabanlı öğrenme, yeni matematik müfredatında öğrencilere bilgiyi yapısallaştıracak ortamların sağlanması amacına ulaşmakta kullanılacak etkili yaklaşımlardan biri olarak önerilmektedir.

Bu çalışmada, proje tabanlı öğrenmenin yedinci sınıf öğrencilerinin geometri başarısı ve geometriye yönelik tutumlarına etkisi araştırıldı. Çalışma, 2004–2005 eğitim-öğretim yılının son beş haftasında, Bilim Özel Okullarındaki 24 kişilik yedinci sınıf öğrencilerinden oluşan bir grupla yürütülmüştür.

Bu çalışmada tek gruplu ön test – son test tasarımı uygulandı. Veri toplamak amacıyla, çokgenler, çember ve silindir başarı

testleri, geometri tutum ölçeği, öğrenci görüş formu, öğretmen gözlem ölçeği ve görüşmeler kullanılmıştır. Elde edilen veriler eşleştirilmiş t testi ile incelenmiştir. Başarı testlerinin ve geometri tutum ölçeğinin analiz sonuçları, proje tabanlı öğrenmenin öğrencilerin geometri başarısı ve geometriye yönelik tutumlarını artırdığını göstermiştir. Öğrencilerin öğrenci görüş formu ve görüşmelerde ifade ettiklerine, öğretmenlerin öğretmen gözlem ölçeğine verdikleri cevaplar ile araştırmacının gözlemlerine göre proje tabanlı öğrenmenin öğrencilerin geometri başarılarını ve geometriye yönelik tutumlarını arttırmalarının sebepleri incelenmiştir. Bu sebepler, öğrencilerin kendilerine ait modelleri yapmaları, tek çözümü olmayan günlük yaşam problemleriyle uğraşmaları ve boyut ve alanlara deneme yanılma yöntemiyle karar vermeleri olarak belirlenmiştir. Ayrıca, düşük performans gösteren, derste başka şeylerle ilgilenen ama aslında kapasitesi olan öğrencilerin bu çalışma sayesinde ilgileri çekilmiş ve çalışma istekleri artmıştır. Dikkati çabuk dağılan ve ders düzenini bozmak için her fırsatı değerlendiren çocuklara kendilerine ait bir proje çalışmasının içine katılabilecekleri bir fırsat vermek olumlu sonuçlar doğurmuştur.

Anahtar Kelimeler: Proje tabanlı öğrenme, geometri başarısı, geometriye karşı tutum.

To My Parents
Reyhan and Salih ÖZDEMİR

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PBL	: Project-based learning
PAT	: Polygons achievement test
PRE-PAT	: Students' polygons achievement pre-test.
POST-PAT	: Students' polygons achievement post-test.
CCAT	: Circle and cylinder achievement test.
PRE-CCAT	: Students' circle and cylinder achievement pre-test.
POST-CCAT	: Students' circle and cylinder achievement post-test.
GAS	: Geometry attitude scale.
PRE-GAS	: Students' geometry attitude pre-test.
POST-GAS	: Students' geometry attitude post-test.

CHAPTER 1

INTRODUCTION

Geometry is an important area in the school mathematics curriculum. Throughout history, it has had great importance in people's lives, originating with the need of human beings to specify quantities, to measure figures, land and earth, and make maps. Nowadays, geometry maintains its value with greater importance. In order to represent and solve problems in areas topics of mathematics like trigonometry and in daily life situations, sound geometry knowledge is necessary. Geometry is also used in other disciplines such as science (e.g., optics), geography (e.g., making maps), music (e.g., the pattern of the notes), art (e.g., making models), construction, architecture, gardening, and traffic signs. Students face geometry wherever they go. Artists, builders, designers, masons, machinists, structural engineers, and writers all use geometry on the job.

School geometry is the study of spatial objects, relationships, transformations that have been formalized, and the axiomatic mathematical system that have been constructed to represent them. The National Council of Teachers of Mathematics (NCTM, 2000) has emphasized the importance of geometry in school mathematics by stating, "Geometry and spatial sense are fundamental components of mathematics learning. They offer ways to interpret and reflect on our physical environment." (p.41). Geometry allows students to develop insight to understand other mathematical concepts and connect ideas across different areas of

mathematics (Mammana & Villiani, 1998; Muschla & Muschla 2000; NCTM, 2000). Furthermore, many ideas like symmetry or generalization can help students increase insights into the nature and beauty of mathematics (NCTM, 2000). Even if one does not plan to become a mathematician, he or she needs to develop visualization and reasoning abilities, and appreciation of nature. Every human being needs some geometry intuition to understand and interpret the world and our physical environment. The importance of geometry is best stated by an inscription above the door of Plato's school, "Let no one destitute of geometry enter my doors (Burton, 1999; p.79)."

Although geometry is an important area and much effort is exerted in teaching geometry, evidence from numerous research studies makes it clear that many students' geometrical understanding is not at the level they need or are expected to be (Burger & Shaugnessy, 1986; Clements & Battissa, 1992; Mitchelmore, 1997; NCTM, 1989; Prescott, Mitchelmore, & White, 2002). Especially in Turkey, students' geometry achievement is very low. In the Third International Mathematics and Science Study, the mathematics and science achievement of eight-grade students in 38 countries were measured. Turkish students got the lowest mean scores from the geometry part of the test compared to the other four content areas of fractions and number sense; measurement; data representation, analysis of probability; and algebra. Of the 38 participating countries, Turkey was fifth from the end for the geometry part of the test (Mullis, Martin, Gonzalez, Gregory, Garden, O'Connor, Chrostowski, & Smith, 2000).

The critics of contemporary education have claimed that students do not mastered basic concepts and principles, and cannot apply what they learn to everyday life (Finn, 1991). Although it is difficult to prescribe a "one-size-fits-all" approach, research shows that there are practices that will generally encourage students to be more engaged. In recent years, mathematics education has aimed to move away from rote learning and memorization toward providing more challenging, complex work with an emphasis on deeper thinking; and having an interdisciplinary, rather than a departmentalized focus. One way to approach this goal is to use project-based learning.

Project-based learning engages students in gaining knowledge and skills through an extended inquiry process structured around complex, authentic questions and carefully designed products and tasks (Moursund, 1999; Thomas, Michealson, & Mergendoller, 2002). The benefits of learning by practice have long been touted; the roots of the idea go back to John Dewey (Krajcik, Blumenfeld, Marx, & Soloway, 1994). Most teachers happen to know the value of challenging projects that student can engage in and of interdisciplinary activities that enrich and extend the curriculum. Thomas, Michaelson, and Mergendoller (2002) stated that the need for educational approach to adapt to a changing world is the primary reason that project-based learning has become increasingly popular. It is basically an attempt to create new instructional practices that reflect the environment in which children live and learn.

Project-based learning is still in the developmental stage. There is not sufficient research or empirical data to be able to state with certainty that project-based learning is a proven alternative to

other forms of learning. Based on evidence gathered over the past years, project-based learning appears to be effective model for producing gains in academic achievement (Meyer, 1997) and attitudes(Korkmaz, 2002;Meyer, 1997) although results vary with the quality of the project and the level of student engagement (Thomas, Michaelson, Mergendoller, 2002).

There are research studies that explain the advantages of using project-based learning in educational settings (Balkı-Girgin, 2003; Demirel, 2000; Gültekin, 2005; Korkmaz, 2002; Meyer, 1997; Yurtluk, 2003). However, only a few of them have focused on project-based learning in geometry (Meyer, 1997).

The specific research objectives of this study are twofold, firstly, to investigate on the effects of project-based learning in geometry on students' achievement, and attitude and secondly, to represent an example of implication of project-based learning.

In the last two years, big changes have been made in the mathematics curriculum in Turkey. The aim of the changes was to provide for the students an environment in which they can reach their own conclusions instead of just lecturing them. In achieving this important task, the project-based learning approach proved to be one of the most effective learning model. Since studies about project-based learning are not sufficiently done in Turkey, this study constitutes an example of project-based learning and its application. Teachers may benefit from the study and may plan their lessons considering its results.

1.1 The Main Problems

The main problems of this study can be stated as follows:

What are the effects of project-based learning on the 7^{th} grade students' achievement in and attitudes towards geometry?

What are the students' opinions, feelings, and ideas about the effects of project-based learning on achievement in and attitude towards geometry?

1.2 The Null Hypotheses of the Main Problem

For the problems mentioned above, the following hypotheses are stated.

Null Hypothesis 1:

H_0: There will be no significant difference between pre-test and post-test mean scores of geometry achievement of 7^{th} grade students exposed to project-based learning.

Null Hypothesis 2:

H_0: There will be no significant difference between pre-test and post-test mean scores of 7^{th} grade students' attitude toward geometry exposed to project-based learning.

1.3 Definition of Important Terms

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

Project-based Learning: Project-based learning is an authentic learning model or strategy in which students plan, implement, and evaluate projects that have real-world applications beyond the classroom (Blank, 1997; Dickinson, et al, 1998;

Harwell, 1997). Learning activities that are interdisciplinary, long-term, and student-centered rather than short, isolated lessons are emphasized (Challenge 2000 Multimedia Project, 1999). The most important aspect is that students find projects fun, motivating, and challenging because they play an active role in choosing the project and in the entire planning process (Challenge 2000 Multimedia Project, 1999; Katz, 1994).

Attitude: Ajzen (1988) defined attitude as a disposition to respond favorably or unfavorably to an object, person, institution, or event. Attitudes related to geometry include liking, enjoying, and interest in geometry, or the opposite, and at worst geometry phobia (Ernest, 1989).

Achievement: Achievement is the ability to demonstrate accomplishment of some outcome for which learning experiences were designed. In this study, achievement refers to students' geometry scores on the achievement tests prepared by the researcher.

CHAPTER 2

REVIEW OF RELATED LITERATURE

In this chapter, the definition of project-based learning along with its application, its benefits, and its evaluation as well as the students' attitudes toward geometry, studies about project-based learning, and the summary of literature review can be found.

2.1 What Is Project-Based Learning?

Project-based learning is a comprehensive approach to classroom teaching and learning that is designed to engage students in investigation of complex, authentic problems and carefully designed products and tasks (Blumenfeld, & Soloway, 1991; Moursund, 1999; Thomas, Michealson, & Mergendoller, 2002). In addition, in project-based learning, students plan, implement, and evaluate projects that have real-world applications beyond the classroom (Blank, 1997; Dickinson, et al, 1998; Harwell, 1997). Moreover, learning activities that are interdisciplinary, long term, student centered, and integrated with real world issues and practices are emphasized, rather than short, isolated lessons (Challenge 2000 Multimedia Project, 1999). Projects encompass a spectrum ranging from brief projects of one to two weeks based on a single subject in one classroom to year-long, interdisciplinary projects that involve community participation and adults outside the school (Thomas, Michaelson, Mergendoller, 2002). Most important, students find projects fun, motivating, and

challenging because they play an active role in choosing and applying the project and in the entire planning process (Challenge 2000 Multimedia Project, 1999; Katz, 1994).

Learning not only prepares one for life, but should also be an integral part of life itself. Simulating real problems and real problem solving is an integral function of project-based learning (Dewey, 1897). The Chinese proverb best explains the purpose of the project-based learning: "Tell me and I forget. Show me and I remember. Involve me and I understand."

2.2 How to Use Project-Based Learning in the Class

Project-based learning provides an environment for the application of knowledge and skills but it is not appropriate as a method for teaching certain basic skills (Thomas, Michaelson, & Mergendoller 2002). The use of project-based learning in class is possible after providing the information that is needed for the project. The classroom activities should be student-centered, cooperative, and interactive. Group members are responsible for their own learning. The teacher plays the role of the collaborator, the facilitator and the learner (Moursund, 1999).

The climate of the classroom community where the project-based learning is applied has various aspects. The social aspect reflects the kinds of social interaction that transpires among the community members. The classroom is a place where people can spend a fulfilling life together if their needs and concerns are appropriately expressed. Problems can be discussed. Both teacher and peers can provide support, encouragement, and models. Where expectations for children's learning are high it is important

that the social interaction itself is designed to facilitate learning (Chard, 2001). The classroom can be supplied with a variety of resources. Groups can collect some temporarily resources for use in particular projects and stored in the school for use. Children can acquire information from primary and secondary sources. Primary sources of information may be of at least five main kinds which are people, places, real objects, events, and processes. Secondary sources include books, posters, magazines, videos, libraries, and museums.

2.2.1 Phases in the Application of the Project

Chard (2001) reported that making projects have three phases; a beginning, middle, and an end. During the initial planning stage, the teacher selects the topic of study. The teacher also brainstorms using her own experience, knowledge, and ideas and represents them in a topic web. The teacher discusses the topic with the children to find out what experiences they have had and what they already know about it (Blumenfeld, 2000; Moursund, 1999). The children represent their experiences and show their understanding of the concepts involved by explaining them. The teacher helps the children develop questions their investigation will answer. The teacher encourages the parents to talk with their children about the topic and to share any relevant special expertise.

In the second phase, it is very important to construct the project. Opportunities for the children to do field work and to speak to experts are provided. The teacher and the students provide resources to help the children with their investigations; real

objects, books, and other research materials are gathered. Each child is involved in representing what he or she has learned, and each child can work at his or her own level in terms of basic skills, constructions, drawing, music, and dramatic play. The teacher enables the children to be aware of all the different work being done through class or group discussion and display. The topic web designed earlier provides a shorthand means of documenting the progress of the project.

The last phase includes the product of the project and evaluation of the product, the students, and the teacher. The teacher arranges a culminating event through which the children share with others what they have learned. The children may sometimes need help in telling the story of their project. The teacher helps the children select the material to share and, in doing so, involves them purposefully in reviewing and evaluating the whole project. The teacher also offers the children imaginative ways of personalizing their new knowledge through art, stories, and drama. Finally, the teacher uses children's ideas and interests to make a meaningful transition between the conclusion of the project and the topic of study in the next project.

In this study, project-based learning was implemented after providing the information that is needed for the project. At the beginning phase of the project, the class teacher, who was also the researcher, discussed the topic with the students to find out what experiences they had and what they already knew about. Then, students worked on the project in groups of two. The students in each group designed an apartment complex of their own at their own basic skills level. In the last phase, each group made the model of their project and evaluated the project themselves.

2.3 The Benefits of Project-Based Learning

Project-based learning prepares children for the workplace. Children are exposed to a wide range of skills and competencies such as collaboration, project planning, decision making, and time management. Collaborative learning allows students to bounce ideas off each other, voice their own opinions, and negotiate solutions - all skills that will be necessary in the workplace (Blank, 1997; Dickinson, 1998; Thomas, Michaelson, & Mergendoller, 2002). Project-based learning increases the motivation of the students. Teachers often note improvement in attendance, higher class participation, and greater willingness to do homework (Bottoms &Webb, 1998; Moursund, Bielefeldt & Underwood, 1997). Students retain more knowledge and skills when they are engaged in stimulating projects. Project-based learning enhances the quality of learning and leads to higher-level cognitive development through the students' engagement with complex and novel problems (Blank, 1997; Bottoms & Webb, 1998; Thomas, Michaelson, & Mergendoller, 2002; Reyes, 1998).

Many teachers feel that project-based learning is an important and effective part of their teaching repertoire. A project-based learning lesson provides students with the opportunity to learn in an authentic, challenging, multidisciplinary environment, to learn how to design, carry out, and evaluate a project that requires sustained effort over a significant period of time, to learn to work with minimal external guidance, both individually and in groups, to gain in self-reliance and personal accountability (Moursund, 1999). As a result of these opportunities, many advantages of project-

based learning emerge from a student's point of view. First, project-based learning provides a learner-centered approach and makes use of intrinsic motivation. Second, it encourages collaboration and cooperative learning. Third, it allows students to make incremental and continual improvement in their products, presentations, or performances. Fourth, it actively engages students in 'doing' things rather than in learning 'about' something. Fifth, it requires students to produce a product, presentation, or performance. Sixth, it challenges students with a focus on higher-order skills (Moursund, 1999).

Moursund (1999) reported the advantages of project-based learning from a teacher's point of view. Project-based learning has authentic content and purpose, uses authentic assessment, utilizes the teacher as a guide, has explicit educational goals, stems from constructivism, and aims to make the teacher a learner.

Moreover, teachers report that project-based learning overcomes the separation between knowledge and thinking, helping students to both "know" and "do." It supports students in learning and practicing skills in problem solving, communication, and self-management while encouraging the development of habits of the mind associated with lifelong learning, civic responsibility, and personal or career success. It integrates curriculum areas, thematic instruction, and community issues, assesses performance on content and skills using criteria similar to those in the work world, thus encouraging accountability, goal setting, and improved performance. It creates positive communication and collaborative relationships among diverse groups of students, meets the needs of learners with varying skill levels and learning styles, and

engages and motivates bored or indifferent students (Moursund, 1999).

2.4 Evaluation in Project-Based Learning Approach

Assessment is a complex field. In recent years, ideas such as authentic assessment, performance-based assessment, and portfolio assessment have received a lot of attention (Moursound, 1999). Assessment helps teachers develop more complex relationships with their students and students receive feedback. When students receive feedback, they can plan their next step of project (Mehl, 2003). The teacher doing the assessment in a project-based learning lesson needs to think about the purpose of the assessment. This will shape the evaluative information that will need to be gathered and the way this evaluative information will be used in the assessment. Project-based learning lesson assessment tends to require more careful planning in advance of lesson implementation. Moursund (1999) stated there are three common phases of the evaluation of project-based learning that from teachers' point of view:

Formative Evaluation is designed to provide feedback while the student is still working on the project. This allows both the student and teacher to make mid-project corrections. The teacher may use some of the formative evaluation information in a final assessment, but may choose not to do so.

Summative Evaluation is carried out after the project is completed. A teacher might decide to base the project assessment

purely on information gathered in the summative evaluation phase. However, a final assessment might also give considerable weight to the process carried out in the project, such as accomplishing a project's milestones on time and the quality of intermediate products.

Portfolio Evaluation: A portfolio is a collection of work samples. Typically, the student and the teacher work together to decide which work samples will go into the student's portfolio. During the school year, a large number of items may be collected for use in the school year portfolio. Then some of them will be added to the student's long-term portfolio.

Authentic assessment is one of the components of project-based learning. Assessment activities not only capture the student‛s understanding of concepts and subject matter, but they also document and promote the development of real world skills which students need outside the classroom and beyond the school environment. Assessments reflect student learning over time, and not just student performance on a piece of work or a final exam. In project-based learning, assessment takes place in a context familiar to the student. Assessment standards are well known by students. Assessment helps build real mastery of a subject by allowing students to revise their work and incorporate new understandings and constructive feedback. Assessment activities also require students to articulate and explain subject matter, their decisions, their initiative, etc. to those doing the assessing (Mehl, 2000).

In this study, formative, summative, and portfolio evaluations were used. Students had the chance to make

corrections in the process. In addition to the summative evaluation, a final assessment was made, and the students turned in their portfolios with the all worksheets, resources and other materials that they used in the project.

2.5 Geometry

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

2.6 Students' Attitudes towards Geometry

The everyday notion of attitude refers to someone's basic liking or disliking of a familiar target. Ruffell, Mason, and Allen (1998) stated that the word attitude originally referred to aspects of posture (as in to strike an attitude) which expressed emotion. It was then applied metaphorically to the mental (an attitude of mind) from which the metaphoric indicators were dropped, leaving simply attitude as a mental orientation.

Ajzen (1988) defined attitude as a disposition to respond favorably or unfavorably to an object, person, institution, or event. The implicit assumption that there is a 'something' which is labeled attitude and that is a multidimensional construct with three interwoven components: cognitive, expressions of beliefs about attitude object; affective, expressions of feelings towards an attitude object, and conative expressions of behavioral intention. (Ajzen, 1988 and Triandis, 1971)

In the beginning of the century when Allport (1935) and others were beginning to research into 'attitudes', researchers viewed attitudes in a single dimension (as either beliefs or feelings) which, naturally enough, coincided with the colloquial meaning of the word. With the evolution of a multidimensional view of the construct of attitude, attitude as a technical term became rather distant from its colloquial sense.

Attitude is a learned pattern of manners that is developed through one's environment (Thompson, 1993). It represents one's feelings toward given circumstances and affects one's reaction to a particular situation. Aiken (1976) defined attitude as a learned predisposition or tendency on the part of an individual to respond

positively or negatively to some object, condition, or concept. According to McLeod (1992), attitude is the positive or negative degree of affect associated to a certain subject.

There is a history of work on attitudes toward mathematics, which Neale defined in 1969 as a multifaceted construct that describes "a liking or disliking of mathematics, a tendency to engage in or avoid mathematical activities"(p.632). Attitudes related to mathematics including liking, enjoying, and interest in mathematics, or the opposite, and at worst phobia (Ernest, 1989). Ma and Kishor (1997) offered the definition of attitudes toward mathematics as an aggregated measure of liking or disliking of mathematics, a tendency to engage in or avoid mathematical activities, a belief that one is good or bad at mathematics, and a belief that mathematics is useful or useless (p.27).

Attitude is often considered in educational research since the development of a positive attitude is desirable because of its association with achievement (Nkwe, 1985). Ma and Kishor (1997) indicated there is a general belief that children learn more effectively when they are interested in what they learn and that they will achieve better in mathematics if they like mathematics. On the other hand, the previous studies have not provided consistent findings concerning the relationship between attitude toward mathematics and mathematics achievement. A number of researchers have demonstrated that there is a significant correlation between attitude and achievement (Aiken, 1976; Davis, 2002; Haladyna, Shaughnessy, & Shaughnessy, 1983; Kulm, 1980; Ma, 1997; Ma & Kishor, 1997; Schoenfeld, 1989; White, 2001) However, it cannot be concluded that positive attitude always causes high achievement in mathematics. For example, Kiely

(1990) showed that on average a small number of pupils who were not good enough mathematics obtained high scores in the attitude test. Another study suggested that extremely positive or negative attitudes tend to predict mathematics achievement better than more neutral attitudes (cited from Bergeson, Fitton, & Bylsma, 2000).

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

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

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

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

2.7 Studies about Project Based Learning

2.7.1 The Effects of Project-Based Learning on Achievement

Meyer *(*1997) studied fourteen fifth and sixth grade students' challenge seeking during project-based mathematics instruction in one classroom. They drew on five areas of research: academic risk taking, achievement goals, self-efficacy, volition, and effect. Data included students' responses to a tolerance for failure survey, an adaptive learning pattern survey, and three individual interviews about their actions during a math project. They reported on the effects of fifth and sixth grade students' motivation and that although the surveys were useful in characterizing general patterns of challenge seeking, more individual and contextualized information was necessary for understanding how to support students engaged in challenging academic work, such as project-based learning. According to the results, project-based learning increased the students' achievement level.

Korkmaz (2002) studied the effects of PBL approach in science on 7^{th} grade students' academic risk taking, problem solving ability, and creative thinking ability. In this research, experimental method was used. It is reported that PBL affected the academic success positively.

Özdener & Özçoban (2004) searched the effectiveness of the project-based learning model on computer courses and multiple intelligence theory. The results displayed that PBL had increased students' achievement.

Gültekin (2005) aimed to investigate the effects of project-based learning in mathematics on fifth grade students' learning outcomes. In the study, both qualitative and quantitative research methods were used. According to the findings, the project-based learning approach affected the academic success of students in primary education.

These studies did not investigate the effects of project-based learning on geometry while studies on mathematics in general focused on 5^{th} and 6^{th} grade students. In this study, the effects of project-based learning on seventh grade students' achievement in geometry in one group were investigated.

2.7.2 The Effects of Project-Based Learning on Attitude

Debra K.Meyer *et.al. (*1997) reported the effects of students' motivation and strategies in project-based learning. In the study, they surveyed students about their preferences for challenge, their individual academic goals, their self-efficacy about math, and their math strategies. Then they interviewed students about their ongoing decisions related to the challenges inherent in their math project. It was observed that project-based learning had on positive effect on students' attitudes and self-efficacy.

Demirel *et.al.* (2000) investigated the effects of project-based learning approach on learning process and learners'

attitudes. In his research, experimental method was used. It was found that there was no significant difference between pre- and post-test results of attitude scale on control and experimental groups.

Toci (2000) aimed to determine effects of project-based learning on intrinsic motivational orientation. It was reported that when the learning environment had an appropriate design, students' attitudes, and motivation increased.

Yurtluk (2003) studied the effect of the project-based learning approaches on the mathematics learning process and student attitudes. In this research both qualitative and quantitative research methods were implemented. In the end, no change was observed in the attitudes of the students. When the views of students with respect to the work were investigated, it was observed that the lessons were more pleasurable and useful. With regard to the views of the teachers, it was emphasized that the study may prove to be useful for the students and teachers and that conducting the studies in conjunction with academicians will prove to be more productive.

Gültekin (2005) aimed to investigate the effects of project-based learning on fifth grade students' learning outcomes. In addition to academic success of the students, he found that project-based learning made students happy during the learning process by providing them with rich learning experiences.

In this study, the effectiveness of project-based learning on 7^{th} grade students' attitudes towards geometry in two dimensions; "interest and enjoyment" and "confidence and anxiety".

2.8 Summary of Literature Review

When the literature on the effects of project-based learning on students' achievement and attitudes is investigated, it is seen that project-based learning affects the academic success of the students positively (Gültekin, 2005; Korkmaz, 2002; Meyer, 1997; Özdener & Özçoban, 2003) and helps improve students' attitudes (Meyer, 1997; Korkmaz, 2002; Toci, 2002). In the application of project-based learning, there are often time related problems (Simkins, 1999; Yurtluk, 2003). Considering the adaptation problems that students face in the beginning stages of the study and the difficulties experienced as a result, the application of project-based learning should start in the early ages of students (Demirhan, 2002). Teachers should be well equipped because they play a critical role in project-based learning (Demirhan, 2002; Erdem & Akkoyunlu, 2002). Assessment in project-based learning should be both formative and summative. (BIE, 2002; Moursund, 1999; PBL, 2002; Yurtluk, 2003)

CHAPTER 3

METHODS

This chapter explains participants, instruments, variables, design and procedure, teaching and learning materials, treatment verification, methods for analyzing data and internal validity of the study.

3.1 Participants

The sample for the study consisted of all seventh grade students at Bilim College. Project–based learning requires a long-term (Thomas, J., Michaelson, A., & Mergendoller, J., 2002) commitment during which monitoring of each class is needed; I opted to conduct the study only at Bilim College, the school where I worked. There were two intact classes and 12 students in each class. The sample size of 24 students constituted at least 16 % of the target population. There were 10 girls and 14 boys in the study. The average age of the students was 13.

3.2 Instruments

In order to gather the data, six instruments were used in the study; two achievement tests, geometry attitude scale, student survey form, teacher's observation form, and lesson plan evaluation scale. Detailed information about these is stated below.

3.2.1 Achievement Tests

The Polygons Achievement Test (PAT) includes items about areas and the perimeters of quadrilaterals. The items of the Circle and Cylinder Achievement Test (CCAT) were about diameter of a circle, area of circular region, area of a sector, the length of arc, central and inscribed angle, the area, and the volume of a cylinder. While preparing the both achievement tests; first, seventh grade mathematics textbooks (Davison, 1991; Taşkın, 1999; Tortumlu, 2001; Yıldırım, 2001) including polygons, circles, and cylinder were researched, then inspired from these textbooks and taking into account the discussion with four elementary mathematics teachers at the private school, and the content of the lesson, real life problems that covered the objectives in appendices C and F were formulated by the researcher. At the beginning of the achievement tests, there was a table which showed the purpose of each question. The original 11 questions in the PAT and 10 questions in the CCAT submitted to five experienced elementary school mathematics teachers, an expert in test construction, and a university professor in mathematics education. Their judgments regarding the extent to which the questions were spread to cover each objective of the topic, language, students' levels, clarity of the questions, difficulty level of questions and the appropriateness of the content. According to these feedbacks, some of the questions were changed. New questions covering the content of the seventh grade geometry course were formulated. After the tests were reformulated, for the grading of the answers, answer keys were constructed by the researcher to characterize students' performance in terms of acquired concepts or skills for each

question rather than simply the scores on the test. The formulated answer keys were submitted to an expert in test construction and five experienced elementary school mathematics teachers. According to their judgments, some minor changes were done.

3.2.1.1 Polygons Achievement Test

Polygons Achievement Test (PAT) was developed by the researcher to investigate the students' achievement on polygons (see Appendix A). This test consisted of 10 open – ended questions, one of which had a sub question. The test included 11 questions altogether. The questions were about comparing polygons (question 6a), and the perimeter (questions 3 and 5) and the area of polygons (questions 1, 2, 4, 6b, 7, 8, and 10). Each question was assessed according to the answer key (see Appendix B) and possible maximum score for the PAT was 100. While preparing the answer key, each question was divided into subtasks according to the objectives covered and each task was scored as 0, 1, 2, or 3. The objectives of each question in PAT are given in Appendix C. The questions in the PAT and their objectives were checked by five Mathematics teachers in terms of appropriateness of the content and students' level.

3.2.1.2 Circle and Cylinder Achievement Test

Circle and Cylinder Achievement Test (CCAT) was developed by the researcher to investigate the students' achievement on circle and cylinder topics (see Appendix D). It involved 10 open – ended questions, 4 of the questions were about circle, and six were

about cylinder. The questions on circle were about diameter of a circle (question 4), area of circular region (questions 1,2 and 10), area of a sector (question 6), the length of arc (question 3), central and inscribed angle (questions 3 and 6). The questions on cylinder were particularly about the area (questions 6) and the volume of a cylinder (questions 5, 7, and 9). Each question was assessed according to the answer key (see Appendix E) and possible maximum score for the CCAT was 100. While preparing the answer key, each question was divided into subtasks according to the objectives covered and each task was scored as 0, 1, 2, or 3. The objectives of each question in CCAT are given in Appendix F. The questions in the CCAT and their objectives were checked by five mathematics teachers in terms of appropriateness of the content and students' level.

3.2.2 Geometry Attitude Scale

A Likert type Geometry Attitude Scale (GAS) developed by Duatepe (2004) was used to determine students' attitudes toward geometry (see Appendix G). This test was a two – dimensional test with 12 items. Seven items (item number 1,2,6,7,9,10 and 11) represented interest and enjoyment dimension and five items (item number 3,4,5,8, and 12) represented confidence and anxiety dimension. Negative statements were scored as 5, 4, 3, 2, and 1 and positive statements were scored 1, 2, 3, 4, and 5 in the order of alternatives. The possible scores of the GAS range from 12 that indicates low attitude to 60 that indicates high attitude.

3.2.3 Student Survey Form

The Student Survey Form (see Appendix H) had five open – ended questions on students' self assessment about their geometry achievement, attitudes toward geometry, and criticism and suggestions about the project-based learning. Student survey form was developed to make students write their own opinions, ideas, and feelings about their geometry achievement, and attitudes toward geometry which were measured by the tests and scales were administered as a post-test. Four items (1 – 2 – 3 – 4) were designed for the students to get an assessment of themselves regarding their geometry achievement, and the other item (5) was about attitudes toward geometry after the project – based learning. In addition, an open-ended question was provided for the students' criticism, opinions, suggestions about the project-based learning, and self-assessment of their own work.

3.2.4 Teacher's Observation Form

Teacher's Observation Forms I(see Appendix I) and II(see Appendix J) each consisting of 9 items were developed by the researcher to obtain information about the researcher's and observer teachers' opinion on the class achievement in and attitudes toward geometry, responsibility, and effective time management in the class as a whole. Teacher's observation form I was used prior to the undertaking of the project-based learning while form II was utilized during the project-based learning. The items were Likert type with three possible alternatives as yes, no, not sure. In addition, a section was provided for the observers'

ideas and comments. Three items (2 – 8 – 9) reflected achievement, three items (1 – 3 – 5) students' responsibility, four items, 2 items (6 – 7) attitude toward geometry and one item (4) effective time management.

3.2.5 Lesson Plan Evaluation Scale

In order to develop the worksheets and the lesson plans, a list of criteria for project-based learning was developed after reviewing the relevant literature (Bottoms, 1998; Demirel, 2000; Harwell, 1997; Korkmaz, 2002; Mehl, 2000; Meyer, 1997; Moursund, 1997; Moursund, 1999; Simkins, 1990; Thomas & Mergendoller, 2002; Toci, 2000; Yurtluk, 2003).

Lesson plan evaluation scale (see Appendix K) was developed by researcher to check whether the lesson plans were formed in accordance with the philosophy of the project-based learning (Blank, 1997; Blumenfeld, Soloway, 1991; Challenge 2000 Multimedia Project, 1999; Dickinson, et al, 1998; Harwell, 1997; Katz, 1994; Moursund, 1999; Thomas, Michealson, & Mergendoller, 2002). It includes 10 items and each item uses a five point Likert type format: (1) Strongly Disagree, (2) Disagree, (3) Uncertain, (4) Agree, and (5) Strongly agree. Item 1 reflected the relation of the project with the real life, item 2 reflected the students' and teacher's role, items 3, 5, and 10 reflected the application of the acquired knowledge, item 4 reflected the interdisciplinary of the project, item 6 reflected the product of the project, item 7 reflected group work, item 8 reflected the doing research, and item 9 reflected the students' interest.

3.3 Design and Procedure

The aim of the study was to investigate the effects of project-based learning on students' achievement in and attitude towards geometry. A single group pre-test and post-test design was used when comparing initial and final scores of the students.

Project-based learning was conducted by using the lesson plans developed by the researcher by considering the criteria of project-based learning and the guidance of a university professor in mathematics education. After the lesson plans were designed, they were given to three elementary mathematics teachers to control the criteria of the project-based learning according to the checklist. After the treatment, teachers who observed the lesson, they filled the checklist whether the project-based learning conducted in the class.

A month prior to conducting the project-based learning, five primary school teachers and four elementary mathematics teachers who were going to observe the classes were trained about the features of the project-based learning, its application, and evaluation. After this presentation, the content of the project was explained. Thus, the observer teachers had the basic information about project-based learning, its advantages, disadvantages, application in the classroom environment, and evaluation.

In this study six instruments (two achievement tests, student survey form, teacher's observation form, lesson plan evaluation scale, and geometry attitude scale were used. Achievement tests and geometry attitude scale were administered as pre and post test, with an interval of approximately four weeks between them where student survey form was applied as a post-test. The pre–

tests were administered after the expository geometry teaching and before the project-based learning to determine the students' achievement.

The time allotted for the achievement tests was one lesson hour for each. Prior to the administering the achievement tests, the researcher announced to the students that their scores from these tests would affect their course grade to make them answer questions with diligence, dedicate the duration to the tests, and show serious effort in responding each question.

Students' names were not disclosed while scoring the tests. 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. Upon the completion of grading by the researcher, the other four mathematics teachers in the school checked the grading.

Both the pre and post administration of the PAT yielded Cronbach alpha reliability coefficients of .91, whereas the administration of the CCAT as pre and post yielded Cronbach alpha reliability coefficients of .94 and .89, respectively, which indicate high reliability.

The time allotted for the administration of the geometry attitude scale was approximately 15 minutes each time. Cronbach alpha reliability coefficients of the pre and post implementation of the GAS were found as .95 and .92, respectively, which indicate high reliability.

Student Survey Form was administered as a post-test allotting time approximately 25 minutes. The draft form of the student survey was checked by an elementary school mathematics teacher and a university professor in mathematics education in

terms of the language, the clarity of the questions and appropriateness of the content.

Teacher's Observation Forms were constructed and checked by an elementary school mathematics teacher and a university professor in mathematics education in terms of the language, the clarity of the items and appropriateness of the content. There were two observation forms, one of them was applied before the project-based learning, during the expository teaching, and the other one was applied during the project by the observer teachers. Thus, the comparison between before and after project-based learning was provided in the class as a whole.

Upon the completion of the project-based learning interviews were administered. The interviews for the study were semi–structured. During the interview, first the researcher explained the aim of the interviews, and then the students were asked questions prepared previously. After the students' explanation, general inquiries were made, such as, "explain," "clarify," or "why" and continued to ask more specific questions, until a response was elicited. This process was repeated for each question in the interview. Interview length varied from 10 to 15 minutes. The interview tone was amiable and non-threatening, and efforts were made to make students comfortable with providing candid response. Each interview was conducted individually in a quiet area of the school like the library or an empty classroom.

3.4 Development of the Lesson Plans and Project Worksheets

While developing the project which was comprised of four lesson plans and worksheets (see Table 3.4), features of the

project-based learning were taken into account such as the relation of the project with the real life, student' and teacher's role, group work, the application of the acquired knowledge, the interdisciplinary of the project, the product of the project, the doing research, and the students' interest. Developing and modeling an apartment complex project confront students with a situation related with real life problems. The project also provided a student-centered education. 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. The product of the project is a model of the apartment complex. Developing and modeling an apartment complex is an interdisciplinary task including geometry, art, and geography.

The goal of the project was to help students understand the principles of the subjects of geometry as the polygons, the circle, and the cylinder, integrate them with art and geography by planning, calculating, and modeling an apartment complex, which is comprised of apartments, pools, shopping centers, sport centers, water tanks and green and wooded areas, and apply them to real life problems. Since project-based learning was interdisciplinary, different disciplines such as mathematics (proportions, measurement), geometry (triangles, polygons, circle, and cylinder), social science (climate, etc), and art (making an apartment complex model from the cardboard) were used in the project. In art lesson, there is an aim that is used in this study. The aim is producing the three dimensional figures, object, and subject

with different materials. Thus, mathematics and art lessons have integrated.

The driving question of the project was, "How is an apartment complex built?" This project was inspired by "101 Mathematical Projects" (Bolt&Hobbs, 1989) in which "planning a new kitchen" and "decorating and furnishing a room" were required. Motivated by these projects and discussions with other mathematics teachers at school, a more complicated and interdisciplinary apartment complex project requiring a longer term was developed by the researcher.

After the lesson plans and worksheets were formed, the university professor who specialized in mathematics education along with two elementary school mathematics teachers filled out the evaluation scale. After the project was finished, the observer teachers filled out the scale in order to determine whether project-based learning was conducted according to the instructional approaches or not. The draft forms of the plans and worksheets were checked and a lesson plan evaluation scale was filled out by the university professor who specialized in mathematics education, and with her criticism and suggestions many modifications were made.

The directions in the project worksheets were decreased, and the students were allowed to take more initiative. For example, the determination of the proportions of the areas in the apartment complex was left to the students to be decided.

In the draft form, the mathematical calculations were completed before the model building took place. After the modifications were made, the mathematical calculations were done simultaneously with and not prior to model building. Some

resources were suggested in order to guide students toward doing research.

In addition to the work to be done on the worksheets, the format of the worksheet was further standardized by providing clues about what the next lesson will entail and by assigning homework to prepare the students for the next lesson at the end of each worksheet.

In order to challenge the students, they were given extra problems such as computing the distance between the trees, the area allocated for each tree, the area to be used in the case the shopping center is multi-storied, and the dimensions of the trapezoid given its area.

After forming the lesson plans and worksheets four mathematics teachers in elementary schools checked by using the lesson plan evaluation scale, each lesson plan and worksheet in terms of their content, appropriateness of the project-based learning, the language used, and the grade level of students.

Table 3.1 The aim of the lesson plans

# of Lesson Plan & Work-sheet	Time	Aim
1	4x40' (Mathematics Lessons)	Making the general plan of the apartment complex.
	3x40' (Art Lessons)	Deciding scale of the complex, the dimension of the given area for the model of the complex.
2	4x40' (Mathematics Lessons)	Deciding the number, the shape o the basement, and the area of the apartments. Deciding the volume and the dimension of the water tank.
	3x40' (Art Lessons)	Making the model of the apartments and the water tank.
3	4x40' (Mathematics Lessons)	Choosing the number and the type of trees according to the climate. Calculating the green and the wooded areas.
	3x40' (Art Lessons)	Making the model of trees and green areas.
4	4x40' (Mathematics Lessons)	Deciding the dimension of the swimming pools and shopping center.
	3x40' (Art Lessons)	Making the model of the swimming pools and shopping center.

3.5 Treatment

Project-based learning lasted five weeks (35 lesson hours) during the 2004–2005 academic year. In this study, prior to undertaking the project, expository teaching was made about the knowledge of angles, triangles, polygons, and cylinder which

students would use during the project. The time schedule of subjects was given in Table 3.5. The study was conducted in mathematics and art courses. There were four mathematics classes and three art classes in each week. Each lesson lasted 40 minutes. The project was conducted in students' regular classroom. Students were assigned to two-member, mixed ability groups. While forming the groups the art teacher and the researcher took into consideration those students who work well together. They were instructed to work together as a group, make decisions by consensus, complete the assignments together, ensure that all group members contributed their ideas, suggestions, and seek assistance primarily from each other. In the classroom, single-student desks were organized in order to make students to be able to work in groups of two.

Table 3.2 The geometry subjects instructed before the project-based learning

Subjects	Time Schedule	Duration
Angles	21-25 March 2005	4x40'
Triangles	29 March-1April 2005	4x40'
Polygons	4-8 April 2005	4x40'
The Perimeter and the Area of the Polygons	11-15 April2005	4x40'
Circle, Circular Region	18-22 April 2005	4x40'
The Perimeter of a Circle, the Area of the Circular Region	25-29 April 2005	4x40'
Cylinder	2-6 May 2005	4x40'

In mathematics classes, students selected the main things such as the name and city of the apartment complex, the scale of the project, and calculated the area of the each villa or apartment and other areas in the mathematics classes by the help of the researcher and the other teachers (mathematics and primary school teachers) who observed the lessons. In art classes, the students built small-models of the apartment complex according to the measurements they selected in advance.

Mathematics and primary school teachers observed the lessons. Students asked questions in the beginning particularly and needed to be guided; however, a single teacher was not sufficient to meet the needs of all students, thus mathematics teachers also assisted students.

In the first week, students were informed about the project and were given an area the shape of which was a trapezoid. Then they were asked to design the given area as an apartment complex. The proportion of each area could be changed according to the students' preferences. The needed guidance was provided for those students who had difficulties setting the proportions. After calculating the areas by using the given information, the students focused on each section of the apartment complex.

During the initial lessons, students had problems with group study, homework, research, effective time management, and finding solutions for the real life problems that were different than the problems they had faced. Moreover, the students were instructed to keep a project folder for the worksheets and the resources they searched, but some of them had a hard time bringing their folders to the class regularly.

There were some problems in art classes, too. Some students failed to bring the necessary materials for the model. The students without any material had to borrow the cardboard from their friends. When borrowing was not possible they helped the other group members. While making the models, students had difficulties about guessing the dimensions of the areas of the model. Some students changed the dimensions of the apartment complex after realizing the dimensions they selected were not the dimensions they really wanted.

In the second week, the group of students determined the shape of the apartments or villas and water tank. Apartments could be any quadrilaterals, triangles, or circle. Students had to consider the area of the apartments. They might plan to do only one apartment having large area or many apartments having small area. It depended on the members of the groups. Water tank had to be the shape of cylinder. Subjects were asked to collect data about daily water consumption of their family and research the water bill of their family and according to the information on the bill they calculated the daily assumption. They calculated the average of each family's water consumption and decided the volume of the water tank. In the second week, the problems decreased. Students became more involved in developing an apartment complex and they started to enjoy what they were doing. In art classes, while making the small model of the complex, students worked very fastidiously and they built complex and esthetic apartment models with doors and windows though it was not necessary.

In the third week, the types of trees were selected according to the climate of the region. Trees and green area had to be non allergic. While researching the type of trees subjects used their

geography knowledge. The subjects who needed guidance were provided by the geography teacher at school. The area that covered by a tree and the interval between the trees had to be considered according to properties of the tree. Some of the students bought artificial trees from stores while others made their own trees out of leaves.

In the last week, the swimming pools and shopping centre were designed. The number of the swimming pools was decided by the group members. Shopping centre could be in any shape. The colors of the cardboard used by the students were similar to real life.

In the apartment complex, subjects had to use, circle, cylinder, and all types of quadrilaterals. The researcher took notes in each lesson about problems, interesting ideas. Every group demonstrated their complex, after the work was totally done. The presentations were video recorded the researcher.

Table 3.3 Outline of the procedure of the main study

	Treatment	Time Schedule
Pretests	Geometry Attitude Scale	3 May 2005
	Academic Risk Taking	4 May 2005
	Polygons Achievement Test	5 May 2005
	Circle and Cylinder Achievement Test	6 May 2005
Treatment	Project Based Learning	9 May – 2 June 2005
Posttests	Geometry Attitude Scale	3 June 2005
	Academic Risk Taking	6 June 2005
	Polygons Achievement Test	7 June 2005
	Circle and Cylinder Achievement Test	8 June 2005
	Students Survey Interviews	9 June 2005

Throughout the implementation of the project, the researcher kept a journal to record student questions, reactions, the areas of difficulty and ease for the students, and the process in general. This journal also included wide range of issues that arose from day to day. An informal interview conducted with students was documented in the journal as well. In addition, I as a classroom teacher also added my insights about project-based learning, and its implementation in the classroom.

3.5.1 The Researcher's Diary

Lesson 1 (03.05.05, 40 minutes, mathematics class)

In the first twenty-five minutes of the lesson, problems involving the topic of the cylinder were solved. The students were given the pre-test of the geometry attitude scale for about fifteen minutes. Some of the students having concerns asked question such as "Should we write our genuine opinions?" and "Does this scale affect our grades?" The researcher encouraged them to write what their true thoughts were and told them it definitely would not affect their grades. After filling out the scale, some of the students felt free to say that they wrote they did not like geometry on the scale.

Lesson 2 (04.05.05, 40 minutes, mathematics class)

At the end of the lesson, students were informed about the study after solving the cylinder problems. They were told that they were going to develop an apartment complex in groups of two, which they were free to choose their partner. Moreover, they were advised to observe and investigate the apartment complex around.

Lesson 3 (05.05.05, 40 minutes, mathematics class)

Students were given the pre-test of the polygon achievement test.

Lesson 4 (06.05.05, 40 minutes, mathematics class)

Students were given the pre-test of the circle and cylinder achievement test.

Lesson 5 (09-10.05.05, 4x40 minutes, mathematics classes)

Before the class, students were divided into groups and organized the desks in order to work in groups of two. The lesson began with working on worksheet number 1. Students started to think about the name and city of the apartment complex. In this part of the lesson, it was observed that students had a lot of fun.

A mathematics teacher and two primary school teachers observed the lesson and guided the students. Students had difficulties especially in setting up the scale and calculating the area of the trapezoid. Moreover, students had time management problems.

Students # 20 and # 21 had problems in group work. S20 made decisions without asking her group partner, causing an argument. They were told to make everything together.

Some of the students (S15, S16, and S18) did not pay attention to the study. They perceived the group study as if it were a free period.

Lesson 6 (12.05.05, 3x40 minutes, art classes)

Students cut the cardboard for the base on which the apartment complex would be built. It was observed that they worked very carefully.

The art teacher helped students make the models.

Lesson 7 (16-17.05.05, 4x40 minutes, mathematics classes)

Students worked on worksheet number 2. Although the students were told not to forget to do their homework, some of them did not bring the water bill. They were told to get the information from their friends who had done the homework in class

and then to change the amount of the water consumption as though they had their own bill. Once they went home, they had to calculate the volume of the water tank all over again at home, this time with their real water consumption figures.

S16 became involved in the study. He did his homework carefully. Although he was trying hard, he had difficulty calculating the areas and the proportions, and he needed to be guided a lot because his mathematics achievement was very low.

In this class, students did not have time management problems. Moreover, some students finished their work and started working on the model of the apartment complex.

Lesson 8 (19.05.05, 3x40 minutes, art classes)

Students started making the physical models of their own apartment complexes. While making the models, students had difficulties with guessing the dimensions of the areas of the models. Some students changed the dimensions of the apartment complex after realizing the dimensions they had selected were not the dimensions they really wanted. In addition, students had problems understanding the proportions of the apartment complex. For instance, they wanted to make the increase in the size of the apartments larger than the increase in the size of the shopping centers. The scale of a map was provided as an example of this. They were told that the maps each had a scale and that every measurement decreased or increased by the same scale.

Students stated that this study was very fun, especially making the models of the apartment complexes. Two mathematics teachers and an art teacher observed the lesson and helped the students during class.

Lesson 9 (23-24.05.05, 4x40 minutes, mathematics classes)

Students completed their work. They made the models of the apartment complexes willingly. Some of the students did not have the courage to do the models by themselves. They were afraid of making mistakes. The researcher provided the necessary support for them to do it by themselves.

During the lesson, students worked on worksheet number 3. Students investigated the climate of the city where their apartment complex was located. They searched the type of trees and plants and determined the quantity of them. Students shared their knowledge with each other. Students' photographs were taken by the researcher while they were studying.

Lesson 10 (26.05.05, 3x40 minutes, art classes)

Students made the physical model of trees out of pieces of sponge and tree branches. They enjoyed making the models. While engaging in group work, some students worked harder competing with their group partners. S10 forced S12 to do the calculations quickly and make the models carefully. As a result, S12 worked much more carefully and quickly. S3 and S9 were in the same group, but S9 was not in class on that day. S3 had low mathematics achievement and had difficulty with math. Hence, he did not want to continue with the work. He believed that he could not do anything without his group partner. The researcher helped him make the three dimensional shape of the houses. When he realized that he could do it on his own, his eyes gleamed, and he felt very happy.

Lesson 11 (30-31.05.05, 4x40 minutes, mathematics classes)

Students worked on worksheet number 4. Students decided the shape and the number of swimming pools. Generally, they built a pool for adults and another pool for children.

Students had a lot of fun while building the shopping center. They named the center and argued about what it should involve. Some of them decided to make a small market while others wanted a big shopping center. They picked the names of the stores in it.

Lesson 12 (02.06.05, 3x40 minutes, art classes)

Students made the physical models of the swimming pool/pools and the shopping center. Students insisted on doing the pools from the blue cardboard.

In the final class, they arranged and finished their models of the apartment complexes. Students' photographs were taken while they were working.

3.6 Treatment Verification

Lesson plan evaluation scale was developed by the researcher as a project-based learning implication survey. This scale focuses on the instructional flow in the class. At the end of the treatment period, the observer teachers were given the lesson plan evaluation scale (see Appendix F) to determine the degree to which the researcher implemented the lessons according to this criteria and lesson plans. As seen in the scale, the observer teachers were asked to grade items ranged 1, "strongly disagree" to 5, "strongly agree." All of the observer teachers graded this

scale by giving them grade 5. This demonstrated that the implementation by the researcher went as planned.

3.7 Analysis of Data

The data gathered through the achievement tests and attitude scales were analyzed by using Statistical Package for Social Sciences 11.0.

The descriptive statistics; mean, median, mode and standard deviation were calculated for PAT, CCAT, and GAS to summarize, organize and simplify the data and to control the assumptions of the inferential statistics.

The t-test for correlated means is used to compare the mean scores of the same group before and after a treatment of some sort is given, to see if any observed gain is significant (Fraenkel & Wallen, 1996). A one group pre-test and post-test design was used when comparing pre-test and post-test scores of students' achievement in geometry, and attitude toward geometry.

3.8 Internal Validity

Internal validity is the extend to which detected differences on the dependent variables are associated with the independent variables –treatment- and not some uncontrolled variables (Fraenkel&Wallen,1996). Threats to internal validity are alternative explanations of the results that are not related to the treatment.

In order to control history effect, groups were administered all tests at the same time. The results of the treatment may be associated with specific events occurred between pretest and

posttest. This was not an issue because the length of the study was limited to five weeks.

Another likelihood of threat might be the exposure to pretests could change the performance of subject in related posttests. There were four weeks for the implementation of posttests. This time periods were assumed to be sufficient for desensitization. Moreover, the students were not informed that the test given was a pretest. They just knew that it was an exam which would affect their grades. They were also aware that the posttest administered at the end of the 4 weeks was another exam that would affect their grades. During the posttest, only a few students questioned whether they had taken the test before, yet the others did not become aware.

Maturation threat means the results of the treatment may be associated with the passage of time rather than treatment. This was not an issue because the length of the study was limited to five weeks.

Another important threat comes from the implementation of the treatment, and it might cause some observed differences in outcomes. This threat may come from the differences in instructors (e.g. teacher gender, teaching ability, attitude, or biases toward the treatment, encouragement, verbal reinforcement). However, in our case, the instructor was the researcher for both groups. Therefore, this threat did not apply in our case.

Instrumentation threats can be in the form of instrument decay, data collector bias, or inadequate demonstration of reliability and validity of the assessment. In this study, although open-ended questions were used in the achievement tests, each question was divided into subtasks according to the objectives

covered and each task was scored as 0, 1, 2, or 3. Therefore, instrument decay was not a viable threat. Data collector was the classroom teacher. This was helpful to control data collector characteristics and data collector bias. Besides this, the scoring of the achievement test was completed item-by-item for each student to eliminate the fatigue of the class teacher, such as being tired or being rigorous.

Furthermore, the outcomes of the study might be affected by the attitude of the subjects. Since the researcher was the researcher at the same time, there was no need to announce that an experiment was being conducted. Students had no idea about project-based learning and attitudes. The attitude scale was shown as though they were the work of the counseling unit while the project was announced as a study specific to our school and as a part of the course. Therefore the attitude of subject threat was removed.

3.9 Limitations of the Study

The fact that the questions on the pre-test and post-test of the achievement tests were the same might appear to be a limitation of the study. However, the students were not told that the test they took was a pre-test, and no information was given indicating that the test was going to be re-administered. Moreover, the answers to the questions were not provided in class.

The interviews done by the researcher herself might seem to be another limitation. One might think that the students would be untruthful or hesitant to provide truthful responses. Nevertheless, the participants had stated that they were able to comfortably

express their dislike for geometry on the geometry attitude scale pretest. Hence, one could conclude that they could easily tell what they really felt during the interview. In summary, all these situations that might each appear to be a limitation did not constitute a limitation.

CHAPTER 4

RESULTS

This chapter is divided into four sections. The first section presents the statistical analysis of the data. The second deals with the inferential statistics results produced by testing the null hypothesis. The third presents the qualitative results. The last one summarizes the findings of the study.

4.1 Descriptive Statistics

4.1.1. Descriptive Statistics of the Polygons Achievement Test

Table 4.1 presents the descriptive statistics of the PAT. This table illustrates differences across assessment times. As it is seen in this table, the POST_PAT mean scores was higher than the PRE_PAT mean scores. The PAT men score increased from 39.46 to 63.04.

Table 4.1 Descriptive Statistics of the PRE-PAT and POST-PAT

	PAT_PRE	PAT_POST
Mean	39.46	63.04
Median	30	62
Mode	16	92
Std. Deviation	26.90	25.61

Possible maximum and minimum scores for both exams:100 and 0.

The clustered box plots of the PRE_PAT and POST_PAT are plotted in Figure 4.1. As the figure indicated, there was no outlier. The box contains mid 50% percent and each whisker represents upper and lower 25% of the cases. According to that, the lower 50 % of the PRE_PAT ranged between 10 and 30 whereas the upper 50 % ranged between 30 and 93. On the other hand, the lower 50 % of the POST_PAT ranged between 21 and 62 whereas the upper 50 % of the lied between 62 and 98. Moreover, the mid 50 percent of the PRE_PAT is less than the median of the POST_PAT.

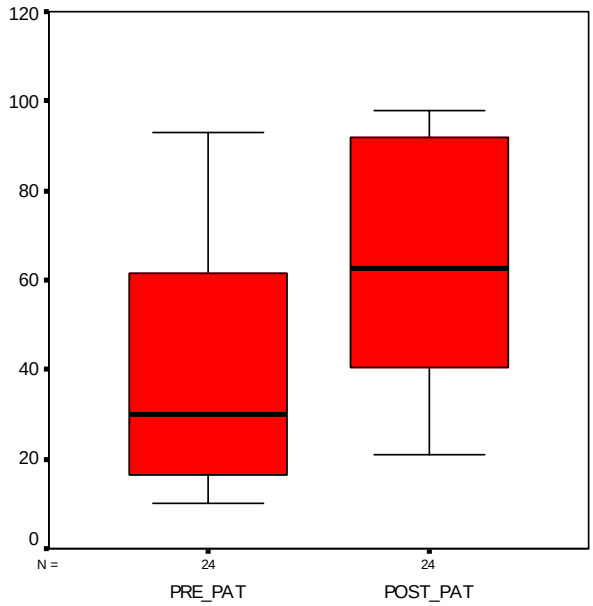


Figure 4.1 Box plot displays of the PREPAT and POSTPAT scores

4.1.2 Descriptive Statistics of the Circle and Cylinder Achievement Test

Table 4.2 presents the descriptive statistics of the CCAT. This table illustrates differences across assessment times. The mean score of the POST_CCAT was higher than the PRE_CCAT mean scores. There is a mean increase of 28.42.

Table 4.2 Descriptive Statistics of the PRE_CCAT and POST_CCAT

	PRE_CCAT	POST_CCAT
Mean	38.50	66.92
Median	23	63.50
Mode	16	100
Std. Deviation	27.68	26.34

Possible maximum and minimum scores for both exams:100 and 0.

To compare the distribution of the CCAT scores visually, the clustered box plots of the pretest and the posttest were constructed (Figure 4.2). Although, in both test the minimum and maximum scores are approximately same, the mid 50 percent of the PRE_CCAT is quite less than the median of the POST_CCAT. The lower 50% of the PRE_CCAT ranged between 10 and 23 whereas the POST_CCAT ranged between 16 and 63.5. Furthermore, the interval of upper 50% of the CCAT scores got smaller.

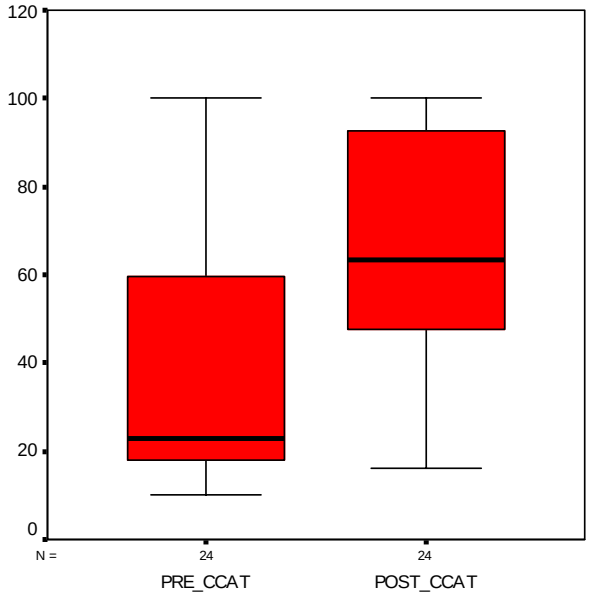


Figure 4.2 Box plot displays of the PRECCAT and POSTCCAT scores

4.1.3 Descriptive Statistics of the Geometry Attitude Scale

The descriptive statistics related with the PRE_GAS and the POST_GAS appears in Table 4.3. The mean of the POST_GAS was higher than the mean of the PRE_GAS. The mean score increased from 41.04 to 47.88.

Table 4.3 Descriptive Statistics of the PREGAS and POSTGAS

	GASPRE	GASPOST
Mean	41.04	47.88
Median	44	48.50
Mode	33	56
Std. Deviation	12.71	8.83

Possible maximum and minimum scores for both exams: 60 and 12.

The clustered box plot of the PRE_GAS and POST_GAS appears in Figure 4.3. As seen from the figure, the mean score slightly increased from pretest to posttest. The minimum score of the scale was increased from 12 to 26. Moreover, the range was decreased from 45 to 34.

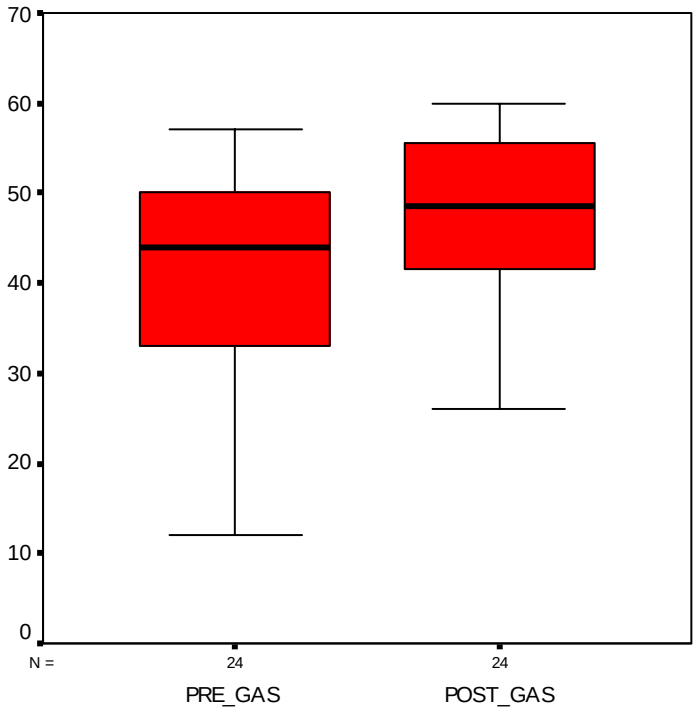


Figure 4.3 Box plot displays of the PREGAS and POSTGAS scores

4.2 Inferential Statistics

4.2.1 Missing Data Analysis

There were no missing data in all pretests and posttests. The fact that the number of students in the study was not high and the fact that the researcher, who was also the class teacher, monitored the class during the application were factor in achieving a result with no missing data.

4.2.2 Inferential Statistics

In this part, the findings of the analyses to answer the research question will be presented. The question was as following:

What are the effects of project based learning on the 7th grade students' achievement in geometry and attitudes toward geometry?

In order to answer this question, data were analyzed by using paired-samples t-test for comparing means at the 0.05 significance level.

4.2.2.1 Null Hypothesis 1

The first null hypothesis was: There will be no significant difference between pre-test and post-test mean scores of polygon achievement of 7th grade students exposed to project-based learning.

A paired-samples t-test analysis was conducted to evaluate this null hypothesis. The first null hypothesis was rejected since the significance value p=0 was below 0.05. There was significant mean difference between the pre and post test of polygon achievement test. Table 4.4 presents the results.

Table 4.4 Paired-Sample t-test for PAT

	Mean Difference	t value	Sig. (two-tailed)
PRE_PAT& POST_PAT	-23.58	-6.70	O

A careful study of the Frequency table of PAT (see appendix N) showed that the number of low achievers with scores under 50 has decreased from 16 on the pre-test to 8 on the post-test.

Moreover, high achievers with score over 85 did not change significantly. Their improvement ranged from 2 to 10.

4.2.2.2 Null Hypothesis 2

The second null hypothesis was: There will be no significant difference between pre-test and post-test mean scores of circle and cylinder achievement of 7^{th} grade students exposed to project-based learning.

A paired-samples t-test analysis was conducted to evaluate this null hypothesis. The second null hypothesis was rejected since the significance value p=0 was smaller than 0.05. There was significant mean difference between the pre and post test of circle and cylinder achievement test. Table 4.5 presents the results.

Table 4.5 Paired-Sample t-test for CCAT

	Mean Difference	t value	Sig. (two-tailed)
PRE_CCAT& POST_CCAT	-28.42	-5.62	O

Frequency table of CCAT (see appendix O) showed that there was an improvement between the pre-test and post-test scores. Among the pre-test scores of the students, there were 16 students who scored below 50. The number of low achievers decreased from 16 to 6 on the post-test. However, high achievers with score over 85 did not change significantly. Their improvement ranged from 3 to 6.

4.2.2.3 Null Hypothesis 3

The third null hypothesis was: There will be no significant difference between pre-test and post-test mean scores of 7th grade students' attitude toward geometry exposed to project-based learning.

A paired-samples t-test analysis was conducted to evaluate this null hypothesis. The significance value was p=0.011. Since this value was smaller than .05, the null hypothesis was rejected. The result indicated that there was significant mean difference between the pre and post of geometry attitude scale. Table 4.6 presents the results.

Table 4.6 Paired-Sample t-test for GAS

	Mean Difference	t value	Sig. (two-tailed)
PRE_GAS& POST_GAS	-5.79	-2.07	0.011

4.3 Qualitative Results

In order to determine the reasons for the improvement in the achievement tests and attitude scale, student survey form, interview responses, the teachers' observation scale and the researcher observation were used. The following excerpts from the interview responses and student survey forms. They are indicated by codes that consist of numbers and letters given in parentheses at the end of each excerpt. For example, in the code (S7), S7

indicates the quote by student number 7 from the student survey form. If the excerpt is taken from the interview responses, then S7 is preceded by INT, such as (INTS7). The comments following the excerpts have been made by taking into account the data obtained from the observations of the researcher and the teacher observation form.

In order to get the students' opinions related to the effects of project-based learning on their achievement, the students were asked the questions of following types, "Does the project affect your geometry achievement? And how?" and "What do you think about your geometry achievement?" All the students stated that project-based learning increased their geometry achievement while the reasons they presented varied. Moreover, in order to get the students' feelings and opinions in relation to the effects of project-based learning on their attitude towards geometry, they were asked the questions of "What do you think about your attitude toward geometry? Do you enjoy the topics of geometry?" and "Do you love geometry?" All the students stated that project-based learning considerably improved their attitudes toward geometry.

The interview responses and the data from the student survey forms suggest that the main reasons for the improvement in the students' achievement levels and their attitudes are making their own products and solving authentic daily life problems by trial and error.

4.3.1 The Effects of Solving Authentic Daily Life Problems on Achievement and Attitude

Some students reported that solving authentic daily life problems affected their learning and achievement positively. Real life problems were more interesting and familiar to them. The project enabled the students to have an opportunity to learn how to use their knowledge. They stated that they felt the importance of geometry and understood more clearly when to use it. Dealing with authentic situations instead of routine math problems captured their attention and helped them concentrate on the topic. They also stated that they had fun with the project. With the help of the study, the students realized the connections between life in other disciplines and mathematics. Solving challenging real life problems helped them gain a new perspective.

Some of the students stated that while determining the dimensions, areas, and the volume of the houses, the water tank, etc., they did a lot of calculating and realized that they had no problems calculating. They frequently calculated areas, volumes and used mathematics as the tool for making the model. Since they became skilled in calculating, their achievement levels were higher. They mentioned about the effects of solving authentic daily life problems on achievement and attitude examples as follows:

> "Before the study, the calculation of the dimensions and the areas were difficult for me. But after the study, I realized that they were not difficult at all, and geometry was everywhere in our lives. For instance, I could not estimate how much 4 centimeters were in reality, but now I am able to. When I

made mistakes, the teacher guided me, and I corrected them sooner or later. I think the study made learning easier (S2)."

S2 was very silent in class. She did not want to get up to the blackboard and was afraid of giving the wrong answer to the questions. Although she had difficulty with the calculation of the proportions and the areas, and she had a difficult time while making the model of the apartment complex, her achievement increased with the help of the project. She explained that this project developed her estimation and helped her learn better.

"I could not understand the circle. After I did the study, I realized it was easy. We should do studies like this in order to understand geometry better because it is then easier to understand. The more I was involved with the study, the more I learned and the better I understood geometry (S3)."

S3 had much difficulty learning geometry. He would just sit without any participation during class. He did not believe he could ever succeed in math, and his belief continued until he worked alone. When his partner was not available, he had to work alone. When he was encouraged and guided by the researcher, he discovered that he could make the model of the project. After he calculated, measured, cut, and pasted the cardboard on his own, he realized that he had actually made the model. His eyes shone with joy and excitement. Although his achievement did not increase sufficiently, he enjoyed and loved geometry with the help of this study. At least, he started to enjoy and love geometry, helping his attitude become more positive. Secondly, he started to

feel some confidence and started to study willingly. Third, he believed that he could regain effectiveness after making mistakes.

> "I don't like things I cannot succeed in. However, doing a study like this is enjoyable. I like calculating the areas of homes and things like that. I still have difficulty in detailed calculations but I can do the parts of geometry that are not complicated. That is why I like it (INTS5)."

S5 was timid in class. Since he had a problem of being hyperactive and was in treatment, he got bored easily and could not concentrate on the lesson. Thus, his achievement level was low. This study attracted his attention, and he started to investigate the features of the apartment complexes in nearby places. He started to work on the calculations of the areas. He had some time management problems while making the project. He usually did not do his homework and had some trouble doing the project on time. He thought that this project was enjoyable and that he acquired additional information about effective time management and about the materials that he used, such as the harmful effects of glue.

> "With the study, I learned areas much better through trial and error. We frequently calculated areas and used mathematics as the tool for making the model. After the study, my geometry achievement level was higher (INTS8)."

S8 was interested in mathematics, participated in class, and wanted to learn the topic completely. As soon as she understood

what to do in the study, she tried calculating the areas by trial and error, i.e. by trying different dimensions until she got it right. She liked to solve the problem using her own ideas. As a result, the study helped her achievement level go up.

> "My geometry achievement went from 0% to 100% with this study. Now I love geometry, I adore it. I loved being involved in this type of study instead of routine problems. Thanks to the study, my geometry achievement improved while my interest in geometry and other topics of mathematics went up. I now think math classes are fun. They are more fun than even physical education classes. Before the study, I was confused about shapes and formulas, but now I know them very well (INTS16)."

S16 had problems with geometry and his achievement. He generally did not participate in class, did not do his homework, and often chatted with his friends. When he learned that the he had to be a part of the study, he became concerned about it and started to research the relevant information. He stated that his achievement in geometry before the project was 0% and after the project 100%. He himself expressed his achievement level in geometry in percentages without any prodding by the researcher. He learned how to calculate the area of the shapes and implemented it. This study got his attention, and he started to love geometry and mathematics. Thus, his achievement was higher.

> "Before this study, there wasn't any topic I did not understand, but there were topics with which I had a hard

time. We calculated the areas, volumes and its dimensions a lot. Now I no longer have a hard time with any topic (S24)."

"I loved geometry after this study. I better understood things because it involved application. I could not hold the formulas in my memory before the study. Because I had to do calculations, I could remember the formulas since we had to use them frequently. Understanding the formulas and applying them to problems increased my achievement level (INTS24)."

Although S24 worked hard, she used to avoid extra work such as projects. In the study, she especially enjoyed making her own apartment complex model. She made the houses from cardboard and then carved the cardboard to make the windows. Moreover, she made the garage for every house. She also made the pool for every house, taking onto account the depth of the pool. In addition, she built the fences around the houses by stapling matchsticks together. She decided on all these details by herself without any guidance. She enjoyed making the model very much. Since she had fun with the study, her achievement went up.

4.3.2 The Effects of Product-making on Achievement and Attitude

All of the students were happy to make their own models of the apartment complex. Making a product of their own skills helped them pay attention, and their desire to work increased. Consequently, their achievement levels went up.

They generally concurred that making their own apartment complex improved their attitudes. Developing the apartment

complex model gave them something of their own, and creating a product with their own efforts in such a manner increased their interest and enjoyment. They started to work more willingly even during breaks. Especially those students who did not like mathematics or geometry started to love geometry and the other topics of mathematics. They mentioned about the effects of product-making on achievement and attitude examples as follows:

> "The study was enjoyable. We built something like a little, cute town. It was nice to have an apartment complex of my own (S4)."
> "It was enjoyable to be involved in a study like this. It was nice to make to make the models ourselves (S7)."
> "I think developing an apartment complex was very enjoyable (INTS7)."
> "I learned by trial and error how to make three dimensional shapes out of cardboards. I had a difficult time at first, but then I got used to doing it (INTS8)."
> "I learned how to make three dimensional shapes. It was fun making models and building our own apartment complex (INTS11)."
> "Achieving something by myself was a good feeling. I think it was enjoyable (S18)."
> "The study was very good, it was fun. Drawing, measuring, cutting, and determining the location of the houses were a lot of fun. The part I liked most was determining the location of the houses, the shopping center, trees, and so on (S19)."

"Studies such as this are like games, a lot of fun. The classes were boring before the study. I like classes now, especially the topic of the polygons (INTS22)."

"Since we built the apartment complex using the geometric shapes, I understood the nature of the geometric shapes better. I will never forget the shapes and how they were drawn (INTS4)."

S4 was very successful, and she enjoyed solving geometry problems. Although she did not like doing the project in the beginning, in time she began liking it. She had difficulty setting the dimensions of the houses, the shopping center, and the scale, but after finally setting them, she started to enjoy the project. She was happy while working on the problem which had more than a single solution and for which the solution depended on her. Moreover, her creativeness developed with the help of this project.

"The part I liked the most was determining the placement of the buildings within the apartment complex. This got my attention, and my desire to work increased. As a result, my achievement was higher (INTS19)."

S19 did not participate in class despite the fact that she paid attention to the topic. Her achievement level was average. She was interested in the study and worked with her partner willingly. Although she had difficulty determining the dimensions of the areas, making of her own apartment complex model made her happy. She started to work more, and her achievement increased.

"My study partner and I discussed the dimensions of the houses in the model very much. First, we made them 15 cm x 15 cm. However, it was too big. Then, we made them 6 cm x 6 cm and 6 cm x 7 cm. My mother and I bought toy soldiers to use as security guards for the apartment complex along with toy animals. We made trees out of pieces of sponge and pine tree branches (S20)."

S20 was interested in mathematics and participated in the lessons. This study attracted her for many reasons. She enjoyed working on daily life problems, studying with her friends, searching for the best solution for the problem. Since her attitude increased, her achievement level went up.

4.3.3 The Effects of Group Work on Achievement and Attitude

Some students mentioned that working as groups affected their learning. Their responses demonstrated that group works facilitated them to learn the responsibility and provided motivation to learn. The social interaction between the students assisted the construction of knowledge. They helped to each other, by this way learned from each other. They claimed that teaching each other provided them learn better. They mentioned about the effects of group work on achievement and attitude examples as follows:

"Working together with my friends made it more enjoyable. During the project, we discussed our own ideas and created some of the things ourselves. The topic became more

enjoyable. My achievement level went up with the study (INTS20)."

S20 had a lot of friends and enjoyed being with her friends. Discussing ideas and solving problems with her friends helped her become more attentive, and her attitude and achievement increased.

"I warmed up to geometry with the study. The study helped us understand the formulas, learn how to make models and build an apartment complex, and enjoy the classes. My geometry achievement level was not very good, but it improved a little with the study (INTS21)."
"I think it is better to work together with a friend and to get help from someone (S21)."

S21 had problems understanding the topic. Even though he studied a lot, he could not accomplish much. He had to be taught on an individual basis. The study enabled him to receive personal guidance from the teacher and his friends. Working with his friend and doing something that he could accomplish increased her attitude and achievement.

4.3.4 The Effects of Future Professions on Achievement and Attitude

Some of the students stated that besides making the model of the complex, primary sources improved their geometry achievement and attitudes toward geometry. Some students'

responses revealed that their preference about future professions affected their attitudes toward geometry positively. They gave examples of the effects of future professions on achievement and attitudes as follows:

> "In the study, I think there were details that helped me improve, even though those details tired us out. Yet, most of them were still fun to do. I even decided to become an architect because of this study. I thank my teacher for this (S8)."
>
> "I think the classes were more fun and enjoyable with the study. Since I personally want to become an architect when I grow up, I am very happy to have been involved in this study (S9)."
>
> "I learned a little about construction engineering. I learned how they do things. I spoke with our neighbor who is a construction engineer. It was fun and enjoyable to do it (S21)."

Another reason why this study could help improve the students' attitudes and achievement was the opportunity it gave them to be more closely acquainted with a vocation. Providing the opportunity for the students to be able to learn more about their possible prospective vocation caused them to explore more and work harder, thus improving their attitudes and achievement.

4.4 Summary of the Results

In the light of the findings, the results could be summarized as follows:

There was a significant mean difference between the pre-test and the post-test scores of the polygon achievement test, the circle and cylinder achievement test, and the geometry attitude scale

Creating a product with the work put into the study increased the students' achievement in and improved their attitudes towards geometry. Working on authentic, daily life problems attracted students' attention and affected their achievement in and attitudes toward geometry positively. Being involved in the study, working as groups, and having fun increased students' achievement in and attitudes toward geometry. Project-based learning affected low achiever students more than the others (see appendix N and O). Project-based learning in geometry helps students develop their estimation.

CHAPTER 5

CONCLUSIONS, DISCUSSIONS AND IMPLICATIONS

The main goal of this study was to investigate the effects of the project-based learning on students' achievement in and attitude towards geometry. In the following sections; first, conclusions are presented; secondly, discussion of the results are given. Finally, implications of the study and recommendations for further studies are announced.

5.1 Conclusions

The quantitative and qualitative analyses confirmed that project-based learning had a significant effect on students' polygons achievement, circle and cylinder achievement, and geometry attitude.

Significantly better performance of the students was attributable to the potential of the project-based learning to make understanding better by engaging students authentic and real life problems, providing interdisciplinary environment, providing making the product of the study, and creating group work environment.

5.2 Discussions

The aims of this study were to investigate the effects of the project-based learning on the seventh grade students' polygons and circle and cylinder achievement in and attitudes toward geometry.

When involved in an experimental study, the researcher needs to be well acquainted with the students in his/her study group and to possess the knowledge that will enable him/her to interpret the possible changes in the student's behavior. Therefore, the results of the study could be better evaluated if the researcher was the class teacher or if the researcher monitored the group for 1 to 2 months in order to get acquainted with the group. Selecting a sample group with which the researcher was familiar provided certain advantages. First, the researcher had the detailed information about students' previous behavior and success in various areas. Second, the students cooperated more willingly. In addition, the researcher was able to monitor the whole process much more clearly. Thus, interpreting the whole process with students' personalities helped obtain detailed information.

Findings of the study confirm that project-based learning has a significant effect on students' polygons and circle and cylinder achievement. This finding of the study related with achievement supports the findings of previous studies on fifth graders' achievement on mathematics (Gültekin, 2005), seventh graders' achievement on science (Korkmaz, 2002), fifth and sixth graders' achievement on geometry (Meyer, 1997), students' achievement on computer (Özdener & Özçoban, 2004).

Several reasons may account for the positive effects of project-based learning on geometry achievement. Learning with project-based learning approach was enjoyable, which was also found by Girgin-Balkı (2003) who stated that the projects motivate students and let them have fun while learning something and Gültekin (2005) who stated that the project-based learning

approach makes students happy during the learning process by providing them with rich learning experiences. Furthermore, making a product of their own increase the students' attention level and their desire to work, thus their achievements improve. The project enabled the students to have an opportunity to learn how to use their knowledge and students realized the connections between life in other disciplines and mathematics (Yurtluk, 2003). Solving challenging authentic real life problems helped them gain a new perspective. Since the topic of the project was directly related with people's real lives, students became involved as they feel familiar enough to possess and express opinions. Thus, project allowed students to utilize the knowledge which they had already acquired in school.

The significant difference in achievement in this study was partly attributable to capability of project-based learning to enable students to work together (Gültekin, 2005; Meyer, 1997; Yurtluk, 2003). Working in groups made the students learn the responsibility, provided them motivation to learn, and enabled them to acquire knowledge by receiving different ideas and understanding others point of view. Project-based learning provided the meaningful learning with the help of authentic real life problems, which were more logical, interesting, and familiar to the students, their understanding of the mathematical situation can be enhanced (Civil, 1998; Gialamsa, Karaliopoulou, Klaoudatos, Matrozos, & Papastavridis, 1999; Presmeg, 1998), and they can be motivated to learn (Bussi & Boero, 1998; Koirala, 1999; Wyndhamn & Salijo, 1997). In addition, working in a group enabled to increase students' interaction, communication, motivation, and creative.

The questions that brought about the highest boost in achievement were in those problem situations on which the students most frequently worked; namely, the questions of area, rate and ratio, volume of cylinder calculations. Because of the study, the students found the opportunity to work with concrete examples in geometry and were able to comprehend what they were doing rather than memorizing them in abstract formulas. They comprehended not just geometric subjects, but also mathematical subjects, such as scale, ratio, and proportion.

According to the observations of the researcher and the teacher observation form, the increase in attitude can be explained by the fun students had during the project. In the interviews, many students mentioned how enjoyful time they had during the process of the project, especially making the product. While they had fun during the lessons, their attitude increased. They implied that they willingly participated to the lessons. As literature suggested, the development of positive geometrical attitude is linked to the direct involvement of students (Bergeson, Fitton, & Bylsma, 2000).

In this study, no significant change was observed in the test scores of those students with high achievement. However, the study helped to grasp the attention and increase the desire particularly of those students with high capacity who performed unsatisfactorily in the pre-tests due to their inclination to get distracted during class. Providing those students, who were easily distracted and used every chance to disrupt the lectures, with the opportunity to engage in a project that belonged to them brought about favorable results. In this study which was implemented for the students to like geometry, to increase their

comprehension and achievement, my target group were the middle-level students left after taking out the very successful and insufficient students. The successful students succeed in any case. The students whose efforts are insufficient along with those who comprehend late do not go up to the desired level, but they show improvement within themselves. However, I think that the main point in achieving is, as in this study, increasing the achievement of those students who are capable, but are underachievers sometimes due to prejudgments, other times due to carelessness, indifference, or some other reason.

Previous studies have shown a positive relationship between students' attitudes towards geometry and their performance in geometry (Aiken, 1976; Davis, 2002; Haladyna, Shaughnessy, & Shaughnessy, 1983; Kulm, 1980; Ma, 1997; Ma & Kishor, 1997; Schoenfeld, 1989; White, 2001). Thus, one way that can be attempted to improve a student's performance is to improve their attitude. This study has shown that an interdisciplinary course may be more successful for achieving this goal. By doing interdisciplinary projects, students begin to believe that geometry is useful, important, and even interesting.

5.3 Implications of the Study and Recommendations

Based on the findings of this study and literature review following suggestions can be offered:

More quantitative studies should be conducted on the effects of project-based learning in different mathematics topics. Increased performance of the students in the given instruments suggests that project-based lessons should be developed in other topics of geometry and mathematics.

Since the students in this study experienced project-based learning for the first time, they had difficulties at the beginning. It should be conducted in the group of students who experienced project-based learning before. Taking into consideration that it is more effective on students who are low achievers, the results of the study can be re-evaluated after dividing the students into high-medium-low achievement levels.

Replication of this study on different grades sample and other mathematics topics are recommended to provide more in-depth results. This would help to determine whether project-based learning is effective for a wider range of age groups regardless of the concepts. Complete randomization if provided in a replication of this study would allow researcher to generalize over a wider population. In this study, the videotaping of the process of the project-based learning would have been preferred, but the permission needed was not given. It is also recommended that project-based learning be videotaped in future researches so that

some more information can be gathered from students' behaviors, gestures, and participation etc.

5.3.1 Recommendations for Teachers

Considering the difficulty of guiding and controlling the students in classroom, it would be better to use project-based learning in the class with small number of students or more than one teacher. In addition, the number of students in the groups can be increased while the number of groups can be reduced. With respect to time, it should be taken into consideration that particularly in the early stages, time problems emerge, and thus planning should allow for ample time.

The teacher should give the students assignments that involve doing research. In situations in which it is not suitable to implement project-based learning in class, teachers can assign these projects to students, either individually or in groups, as term projects. They can then establish frequent meetings with students in order to help them and provide them with the necessary guidance.

5.3.2 Recommendations for Students

The results of the study done suggest that homework should be undertaken on time, otherwise cannot be completed in time. While

engaging in group study, each and every group member should be responsible in doing the work, in terms of either homework or materials, assigned to him.

5.3.3 Recommendations for National Education Ministry

Time allotted for the geometry subject in the current curriculum was not sufficient to implement this project. During the preparation of the curriculum, the time allotted for the subject should take into consideration the kinds of studies the teacher would like to undertake, such as project-based learning.

5.3.4 Recommendations for Textbook Writers

In the textbooks used in schools, there could be the maximum possible number of project examples. The calculations needed and the instructions for the project can be placed in student workbooks. Hence, teachers would have the opportunity to develop pre-existing projects and adapt them to their own situations instead of creating a project from scratch.

REFERENCES

Aiken, L. R. (1976). Update of Attitude towards Mathematics. *Journal of Educational Research, 46*(3) 293-311.

Ajzen, I. (1988). *Attitudes, Personality and Behavior*. Open University Press: Milton Keynes.

Allport, G. W. (1935). 'Attitudes.' In Murchison. C (ed.) *Handbook of Social Psychology* (pp. 798–844.). Clark University Press, Worcester,

Balkı-Girgin, A. (2003). *Proje temelli öğrenme yönteminin Özel Konya Esentepe İlköğretim Okulu uygulanmasına yönelik bir değerlendirme*. (Unpublished Master Thesis), Selçuk University, Konya.

Bergeson, T., Fitton, R., & Bylsma, P. (2000). *Teaching and Learning Mathematics Using Research to Shift From the "Yesterday" Mind to the "Tomorrow" Mind.* Washington State, State Superintendent of Public Instruction.

BIE (2002). *Introduction to project based learning.* Buck Institute for Education. Retrieved from the Web June 5, 2004. http://www.bie.org/pbl/pblhanbook

Blank, W. (1997). Authentic instruction. In W.E. Blank & S. Harwell (Eds.), *Promising practices for connecting high school to the real world* (pp. 15–21). Tampa, FL: University of South Florida. (ERIC Document Reproduction Service No. ED407586)

Blumenfeld, P.C., Soloway, E., Marx, R.W., Krajcik, J.S., Guzdial, M. & Palincsar, A.S. (1991). Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational Psychologist, 26*, 369-398.

Blumenfeld,P.,Fishman,B.,Krajcik,J.Marx,R.,&Solloway,E.(2000). Creating usable innovations in systematic reform: Scaling-up technology embedded project based science in urban schools. *Educational Psychologist, 35* (3), 149-164.

Bolt, B. & Hobbs, D. (1989). *101 Mathematical Projects*. Cambridge University Press, New York, USA.

Bottoms, G., & Webb, L.D. (1998). Connecting the curriculum to "real life." Breaking Ranks: Making it happen. Reston, VA: National Association of Secondary School Principles. (ERIC Document Reproduction Service No. ED434413).

Burger, W. F. & Shaughnessy, M. (1986). Characterizing the van Hiele Levels of Development in Geometry. *Journal for Research in Mathematics Education, 17*(1), 31-48.

Burton, D. M. (1999). *The History of Mathematics: An Introduction.*4th ed. Boston. WCB McGraw-Hill. (p.79).

Bussi, M. G. B., & Boero, P. (1998). Teaching and Learning Geometry in contexts. In Carmelo Mammana & Vinicio Villani (Eds.,) *Perspectives on the Teaching of Geometry for the 21st Century. An ICMI Study.* Netherlands. Kluwer Academic Publishers.

Capraro, R. M. (2000). *Exploring the Effects of Attitude toward Mathematics, Gender, and Ethnicity on the Acquisition of Geometry Content Knowledge and Geometric Spatial Visualization.* Unpublished PhD Dissertation. The University of Southern Mississippi, USA.

Chard, S.C. (2001). *The Project Approach: Taking a Closer Look CD.* Retrieved from the Web June 5, 2004. http://www.project-approach.com

Challenge 2000 Multimedia Project. (1999). *Why do project-based learning?* San Mateo, CA: San Mateo County Office of Education. Retrieved from the Web June 25, 2004. http://pblmm.k12.ca.us/PBLGuide/WhyPBL.html

Civil, M. (1998). Linking Students' own Cultural Mathematics and Academic Mathematics. In. A. Olivier and K. Newstead (Eds.), *Proceedings of the 22nd Conference of the International Group for the Psychology of Mathematics Education,* Vol: 1 (pp. 152- 159). South Africa. University of Stellenbosch.

Clements, D. H. & Battista, M. T. (1992). Geometry and Spatial Understanding. *In Dougles A. Grouws (Ed.,), Handbook of Research Mathematics Teaching and Learning.* New York. McMillan Publishing Company.

Clifford,M.M. (1991). Risk-Taking: Theoretical, Empirical, and Educational Considerations. *Educational Psychologist, 26*. pp.263-297.

Davis, B. (2002). *Motivating Students. Tools for teaching.* Retrieved from the Web February 2, 2006. http://teaching.berkeley.edu/bgd/motivate.html

Davison, D., M., Landau, M. S., McCracken, L., Thompson, L. (1991). *Pre-Algebra.* Prentice Hall Mathematics, Needham, MA.

Demirel, Ö., Başbay, A., Uyangör, N., & Bıyıklı, C. (2000). Proje Tabanlı Öğrenme Modelinin Öğrenme Sürecine ve Öğrenci Tutumlarına Etkisi. IX. Eğitim Bilimleri Kongresi Bildirisi, Bolu.

Demirhan, C. (2002). *Program Geliştirmede Proje Tabanlı Öğrenme Yaklaşımı.* (Unpublished Master Thesis), Hacettepe University, Turkey.

Department of Labor, Office of Policy & Research. (ERIC Document Reproduction Service No. ED420756)

Dewey, J. (1897). My Pedagogig Creed. *The School Journal, 54* (3), 77-80. Retrieved from the Web May 12, 2002. http://www.infed.org/archives/e-texts/e-dew-pc.htm

Dickinson, K.P., Soukamneuth, S., Yu, H.C., Kimball, M., D'Amico, R., Perry, R., et al. (1998). *Providing educational services in the Summer Youth Employment and Training Program* [Technical assistance guide]. Washington, DC: U.S.

Duatepe, A., & Ubuz, B. (2004). *The effects of drama based instruction on seventh grade students' geometry achievement, van hiele geometric thinking levels, attitude toward mathematics and geometry*. (Unpublished PhD Dissertation), METU, Turkey.

Erdem, M & Akkoyunlu, B. (2002) .*İlköğretim Sosyal Bilgiler Dersi Kapsamında Beşinci Sınıf Öğrencileriyle Yürütülen Ekiple Proje Tabanlı Öğrenme Üzerine Bir Çalışma*. *İlköğretim Online E-Dergi, 1*, 2002, sf 2-11. Retrieved from the Web May 12, 2002. http://ilköğretim-online.org.tr>2002

Ernest, P. (1989). The Knowledge, Beliefs, and Attitudes of the Mathematics Teacher: A Model. *Journal of Education for Teaching, 15*(1), 13-33.

Finn, C. E. (1991). *We must take charge: Our schools and our future*. New York: Free Press.

Fraenkel, J. R., & Wallen, N. E. (1996). *How to design and evaluate research in education.* (3rd ed.). New York: McGraw-Hill.

Gialamsa, V., Karaliopoulou, M., Klaoudatos, N., Matrozos, D. & Papastavridis, S. (1999). Real Problems in School Mathematics. *In the Proceedings of the 23rd Conference of*

the International Group for the Psychology of Mathematics Education. Haifa. Vol. 3, 25-31.

Gültekin, M. (2005). The Effects of Project-Based Learning on Learning Outcomes in the 5th Grade Social Studies Course in Primary Education. *Educational Sciences: Theory and Practice. 5*(2), 548-556.

Haladyna, T., Shaughnessy.J, & Shaughnessy, M. J. (1983). A Casual Analysis of Attitude toward Mathematics. *Journal for Research in Mathematics Education, 14*(1), 19-29.

Hartfield, M. M., Edwards, N. T., & Bitter, G. G. (1997). *Mathematics Methods for Elementary and Middle School Teachers.* 3rd ed. USA. Allyn Bacon.

Harwell, S. (1997). Project-based learning. In W.E. Blank & S. Harwell (Eds.), *Promising practices for connecting high school to the real world* (pp. 23–28). Tampa, FL: University of South Florida. (ERIC Document Reproduction Service No. ED407586)

Harwell, S., & Blank, W. (1997). Connecting high school with the real world. In W.E. Blank & S. Harwell (Eds.), *Promising practices for connecting high school to the real world* (pp. 1–4). Tampa, FL: University of South Florida. (ERIC Document Reproduction Service No. ED407586)

Karahasan, B. (2002). The Effects of Journal Writing on First Year University Students' Performance on Function and Limit-Continuity. (Unpublished PhD Dissertation). METU, Turkey.

Katz, L.G. (1994). *The project approach* [ERIC digest]. Urbana, IL: ERIC Clearinghouse on Elementary and Early Childhood Education. (ERIC Document Reproduction Service No. ED368509)

Keiser, J. M. (1997). *The Development of Students' Understanding of Angle in a Non-directive Learning Environment.* Unpublished PhD Dissertation, Indiana University, USA.

Kenney, M. J., Bezuszka, S. J., & Martin, J. D. (1992). *Informal Geometry Explorations: An Activity-Based Approach.* USA. Dale Seymour Publications.

Kiely, J. H. (1990). *Success and failure in mathematics among standard sevens in the Bafokeng region.* Unpublished PhD Dissertation, University of Witwatersrand, Johannesburg, South Africa.

Koirala, H. P. (1999). Teaching Mathematics Using Everyday Contexts: What if Academic Mathematics is Lost? *In the Proceedings of the 23rd Conference of the International Group for the Psychology of Mathematics Education.* Haifa. v3, p. 161-168.

Korkmaz, H. (2002). *Fen Eğitiminde Proje Tabanlı Öğrenmenin Yaratıcı Düşünme, Problem Çözme ve Akademik Risk Alma Düzeylerine Etkisi.* (Unpublished PhD Dissertation), Hacettepe University, Turkey.

Kulm, G. (1980). Research on Mathematics Attitude. In R. J. Shum Way (Ed.), *Research in Mathematics Education* (pp. 356-387). Reston, Va. NCTM.

Lewy, A. (1996). Postmodernism in the field of achievement testing. *Studies in Educational Evaluation*, *22* (3), 223-224.

Li, Q. (2005). Infusing Technology into a Mathematics Method Course: Any Impact? *Educational Research*, *47*(2), 217-233.

Ma, X. (1997). Reciprocal Relationships Between Attitude Toward Mathematics and Achievement in Mathematics. *The Journal of Educational Research, 90*(4), 221-229.

Ma, X. & Kishor, N. (1997). Assessing the Relationship Between Attitude Toward Mathematics and Achievement in Mathematics: A Meta-Analysis. *Journal of Research in Mathematics Education, 28*(1), 26-47.

Mammana, C. & Villiani, V. (1998). Geometry and Geometry-Teaching Through Ages. In Carmela Mammana and Vinicio Villiani (Ed.,) *Perspectives on the Teaching of Geometry for the 21st Century,* London. Kluwer Academic Publishers.

McLeod, D. B. (1992). *Research on Affect in Mathematics Education: A Reconceptualization*. In Douglas A. Grouws (Ed.), Handbook of Research on Mathematics Teaching and Learning (575-596). New York. MacMillan.

Mehl, J. (2000). *Project Based Learning with Multimedia*. Retrieved from the Web June 20, 2004. http://pblmm.k12.ca.us/

Meyer D.K. (1997). Challenge in a Mathematics Classroom: Studenys' Motivation and Strategies in Project Based Learning. *The Elemantary School Journal, 97* (5), 501-521.

Milli Eğitim Bakanlığı (MEB), (2005). *İlköğretim Matematik Dersi 6-8.Sınıflar Öğretim Programı.* Devlet Kitaplar Müdürlüğü, Ankara.

Mitchelmore, M. C. (1997). Children's Informal Knowledge of Physical Angle Situations. *Cognition and Instruction, 7* (1) 1-19.

Moursund, D., Bielefeldt, T. & Underwood, S. (1997). *Foundations for The Road Ahead: Project-based learning and information technologies.* Washington, DC: National Foundation for the Improvement of Education. Retrieved from the Web January 24, 2005. http://www.iste.org/

Moursund, D. (1999). Project-Based Learning Using Information Technology. International Society for Technology in Education.

Mullis I. V. S., Martin M. O., Gonzales E. J., Gregory K. D., Garden R. A., O'Connor K.M., Chrostowski S. J., & Smith T. A. (2000). *TIMSS 1999 International Mathematics Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eight Grade.* Chestnut Hill, MA. Boston College.

Muschla, J. A. & Muschla, G. R. (2000). *Geometry Teacher's Activities Kit, Ready-to-use Lessons & Worksheets for Grades 6-12.* USA. John Wiley & Sons, Inc.

NCTM (1989). *Curriculum and Evaluation Standards for School Mathematics.* Reston, Va. NCTM. Retrieved from the Web February 20, 2005.

NCTM (2000). *Principles and Standards for School Mathematics.* Reston, Va. NCTM.

Neale, D. C. The role of attitudes in learning mathematics. *Arithmetic Teacher. 16*, 631-640.

Nevo,D. (1983). The conceptualization of educational evaluation: An analytical evaluation of the literature. *Review of Educational Research*, *53*, 117-128.

Nevo,D. (1994). Combining internal and external evaluation: A case for school-based evaluation. *Studies in Educational Evaluation*, *20* (1), 87-98.

Nevo,D. (1995). *School-based Evaluation*: *A dialogue for school improvement.* Oxford: Elsevier/Pergamon.

Nkwe, D. T. (1985). *Teachers Attitude, with Special References to Mathematics Teaching.* Unpublished Med Dissertation, University of Witwatersrand, Johannesburg, South Africa.

Özdener, N., & Özçoban, T. (2004). A project based learning model's effectiveness on computer courses and multiple intelligence theory. *Education Sciences: Theory & Practice, 4*, 147-170.

Prescott, A., Mitchelmore, M., & White, P. (2002). Students' Difficulties in Abstracting Angle Concepts from Physical Activities with Concrete Material. *In the Proceedings of the Annual Conference of the Mathematics Education Research Group of Australia Incorporated Eric Digest* (ED 472950).

Presmeg, M. (1998). A Semiotic Analyses of the Students' own Cultural Mathematics. In. A. Olivier and K. Newstead (Eds), *Proceedings of the 22nd Conference of the International Group for the Psychology of Mathematics Education,* Vol: 1 (pp. 135-151). Stellenbosch, South Africa. University of Stellenbosch.

Reyes, R. (1998). *Native perspective on the school reform movement: A hot topics paper*. Portland, OR: Northwest Regional Education Laboratory, Comprehensive Center Region X. Retrieved from the Web January 23, 2005. http://www.nwrac.org

Ruffell, M., Mason, J. & Allen, B. (1998). Studying attitude to mathematics. *Educational Studies in Mathematics 35*, 1-18.

Schoenfeld, A. H. (1989). Problem Solving in Context(s). In Randall I. Charles & Edward A. Silver (Eds.), *Teaching and Assessing of Mathematical Problem Solving, Research Agenda for*

Mathematics Education, vol: 3 Reston, VA. Lawrence Erlbaum Assoc. And Ntcm.

Serra, M. (1993). *Discovering Geometry.* Berkeley, CA. Key Curriculum Press.

Simkins,M. (1990). Project Based Learning with Multimedia. *Educational Leadership,28* Mar/Apr:10.

Sinlair, M. (2003). Some Implications of the Results of a Case Study for the Design of Pre-Constructed, Dynamic Geometry Sketches and Accopmanying Materials. *Educational Studies in Mathematics,* 52: 289-317.

Taşkın, S., Z., & Serengil, H. C. (1999). *İlköğretim Matematik 7*. Dörtel Yayıncılık, Ankara.

Thompson, K. M. (1993). *Geometry Students' Attitudes toward Mathematics: An Empirical Investigation of Two Specific Curricular Approaches,* Unpublished Master Thesis, California State University Dominguez Hills, USA.

Thomas, J., Michaelson, A., & Mergendoller, J. (2002). *Project Based Learning Handbook.* Retrieved from the Web, April 24, 2004. http://www.bie.org/

Toci, A. (2000). The Effect of A Technology- Supported, Project-Based Learning Environment On Intrinsic and Motivational Orientation.

Tortumlu, F., Kılıç, A., & Şahin, H. (2001). *İlköğretim Matematik 7*. Milli Eğitim Basımevi, İstanbul.

Triandis, H. C. (1971). *Attitude and Attitude Change,* Wiley and Sons Inc, New York.

White, J. N. (2001). *Socioeconomic, Demographic, Attitudinal, and Involvement Factors Associated with Achievement in*

Elementary School. Unpublished EdD Dissertation, East Tennessee State University, USA.

Wyndhamn, J. & Saljo, R. (1997). Word Problems and Mathematical Reasoning- A Study of Children's Mastery of Reference and Meaning in Textual Realities. *Learning and Instruction, 7*(4), 361–382.

Yıldırım, H., Yıldırım, U., Ekmekçi, S., Ayhan, K., & Kıymetli, İ.(2001). *İlköğretim Matematik 7*. Yıldırım Yayınları, Ankara.

Yurtluk, M, (2003). *Proje Tabanlı Öğrenme Yaklaşımının Matematik Dersi Öğrenme Süreci ve Öğrenci Tutumlarına Etkisi*. (Unpublished Master Thesis), Hacettepe University, Turkey.

APPENDIX A

POLYGONS ACHIEVEMENT TEST

T.C. ANKARA VALİLİĞİ ÇANKAYA ÖZEL BİLİM İLKÖĞRETİM OKULU 2004-2005 Eğitim Öğretim Yılı 2.Dönem 7.Sınıf Matematik Dersi Konu Tarama Sınavı												
AD-SOYAD: SINIF: NO:												
	1	2	3	4	5	6	7	8	9	10		
	10	10	10	10	10	10	10	10	10	10	100	5

SORULAR

1. Kenar uzunlukları tam sayı olacak şekilde, alanı 110 br^2 olan kaç dikdörtgen çizilebilir? Çizilebilecek dikdörtgenlerin kenar uzunluklarını yazınız.

2. Bir fidanın dikilmesi için ayrılan eşkenar dörtgen şeklindeki alanın köşegen uzunlukları 2m ve 3m'dir. Buna göre köşegen uzunlukları 6m ve 8m olan eşkenar dörtgen şeklindeki alanın içine en fazla kaç fidan dikilebilir?

3. Kısa kenarı 20 m olan dikdörtgen şeklindeki bahçenin çevresi 90m'dir. Bu bahçeye bir kenarı 5m olan üç tane kare şeklinde havuz yapılacak ve geriye kalan alan çimlendirilecektir. Çimlendirilecek alan kaç m^2'dir?

4*. Eşkenar dörtgen şeklindeki bir havuzun köşegen uzunlukları 28m ve 21 m'dir. Bu eşkenar dörtgenin bir kenarı 49 m ise o kenara ait yüksekliği kaç m'dir?

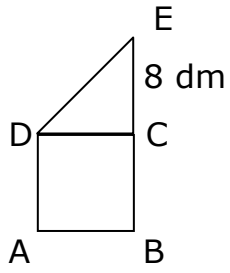
5. Çevresi 40 cm olan bir dikdörtgenin uzun kenarı 15 cm olduğuna göre kısa kenarı, çevresinin yüzde (%) kaçıdır?

6.a) Kare ve eşkenar dörtgenin benzer ve farklı yanları nelerdir? Şekil çizerek gösteriniz.

b) Yamuk şeklindeki bir arazinin alanını hesaplamak için hangi bilgileri bilmemiz gerekir? Şekil çizerek açıklayınız.

7. Deltoid şeklindeki bir uçurtmanın köşegen uzunlukları 50 cm ve 70 cm'dir. Bu uçurtmanın yapımı için kaç m^2 kağıt kullanmak gerekir?

8.

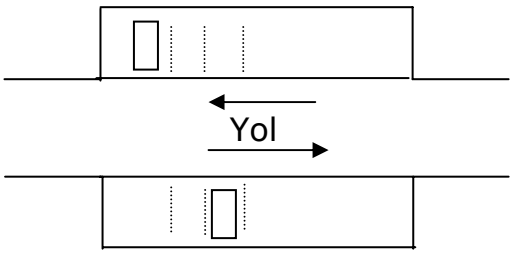


Yandaki şekilde ABCD bir karedir. $A(\overset{\Delta}{DEC})=56\ dm^2$ ise ABED yamuğunun alanı kaç dm^2 olur? (E,C,B noktaları doğrusaldır.)

*Bu soru, formülle hesaplandığında sayısal değeri bulunuyor, ancak bu değerlerle bir eşkenar dörtgen çizilemiyor.

9. Alanı 40 cm^2 olan bir yamuğun yüksekliği 10 cm'dir. Alt taban uzunluğu, üst taban uzunluğunun 2 katından 1 cm fazla olduğuna göre taban uzunluklarını bulunuz.

10.



Yanda verilen yolun her iki tarafında bulunan ve park yeri olarak kullanılan dikdörtgen şeklindeki eş arsaların tamamı 252 m^2'dir. Her araba için 2mx3m'lik bir alan ayrıldığına göre, park yeri dolu iken park yerinde kaç araba vardır?

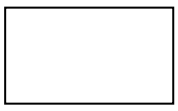
APPENDIX B

ANSWER KEY OF POLYGONS ACHIEVEMENT TEST

T.C. ANKARA VALİLİĞİ ÇANKAYA ÖZEL BİLİM İLKÖĞRETİM OKULU 2004-2005 Eğitim Öğretim Yılı 2.Dönem 7.Sınıf Matematik Dersi Konu Tarama Sınavı												
AD-SOYAD:								SINIF:				NO:
	1	2	3	4	5	6	7	8	9	10		
	10	10	10	10	10	10	10	10	10	10	100	5

SORULAR

1. Kenar uzunlukları tam sayı olacak şekilde, alanı 110 br^2 olan kaç dikdörtgen çizilebilir? Çizilebilecek dikdörtgenlerin kenar uzunluklarını yazınız.



b

a

A=a.b=110 br^2 (1 p)

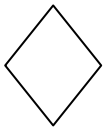
110=2.55 (3 p)

110=5.22 (3p)

110=11.10 (3p)

} 3 tane çizilebilir.

2. Bir fidanın dikilmesi için ayrılan eşkenar dörtgen şeklindeki alanın köşegen uzunlukları 2m ve 3m'dir. Buna göre köşegen uzunlukları 6m ve 8m olan eşkenar dörtgen şeklindeki alanın içine en fazla kaç fidan dikilebilir?

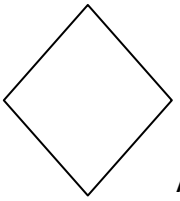


e=2m

f=3m (1 p)

$A=\frac{2.3}{2}=3m^2$ (1 p)

(2 p)



e=6m

f= 8m (1 p)

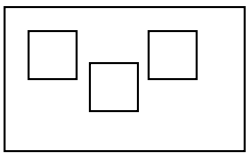
$A=\frac{6.8}{2}=24m^2$ (1 p)

(2 p)

Fidan Sayısı=$\frac{24}{3}$=8 adet (2 p)

3. Kısa kenarı 20 m olan dikdörtgen şeklindeki bahçenin çevresi 90m'dir. Bu bahçeye bir kenarı 5m olan üç tane kare şeklinde havuz yapılacak ve geriye kalan alan çimlendirilecektir. Çimlendirilecek alan kaç m^2'dir?

a=25m

b=20m 

40+2a=90 (2p)

2a=50

a=25 m

A=20x25=500 m^2 (2p)

Kare havuzun alanı:

A=5x5=25 m^2 (2p)

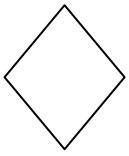
3 kare havuzun alanı:

3x25=75 m^2 (2p)

Çimlendirilecek alan:

500-75=425 m^2 (2p)

4. Eşkenar dörtgen şeklindeki bir havuzun köşegen uzunlukları 28 m ve 21 m'dir. Bu eşkenar dörtgenin bir kenarı 49 m ise o kenara ait yüksekliği kaç m'dir?



e=28m
f=21 m

$A = \frac{28 \times 21}{2} = 294m^2$

(2p) (2p)

A=a.h_a (2p)

294=49.h_a (2p)

h_a=6m (2p)

5. Çevresi 40 cm olan bir dikdörtgenin uzun kenarı 15 cm olduğuna göre kısa kenarı, çevresinin yüzde (%) kaçıdır?

15m

a=5m 

2a+30=40 (2p)

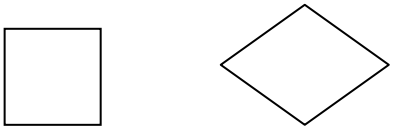
2a=10

a=5cm (2p)

$\frac{\text{Kisakenarı}}{\text{Çevresi}} = \frac{5}{40} = \frac{1}{8} = \%12,5$

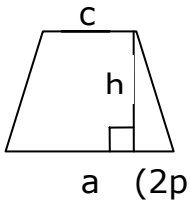
(2p) (2p) (2p)

6. a) Kare ve eşkenar dörtgenin benzer ve farklı yanları nelerdir? Şekil çizerek gösteriniz.



1. Her ikisi de paralelkenardır. (1p)
2. Her ikisinin de bütün kenarları eşit uzunluktadır.(1p)
3. Karenin her açısı 90º, eşkenar dörtgenin değişir.(1p)
4. Köşegenler birbirini dik olarak ortalar.(1p)
5. Köşegenler açıortaydır.(1p)

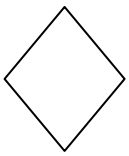
b) Yamuk şeklindeki bir arazinin alanını hesaplamak için hangi bilgileri bilmemiz gerekir? Şekil çizerek açıklayınız.



(2p)

- Alt taban uzunluğu (1p)
- Üst taban uzunluğu (1p)
- Yüksekliği (1p)

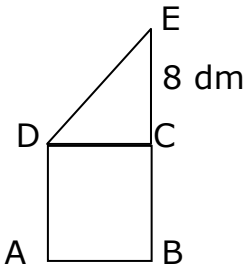
7. Deltoid şeklindeki bir uçurtmanın köşegen uzunlukları 50 cm ve 70 cm'dir. Bu uçurtmanın yapımı için kaç m^2 kağıt kullanmak gerekir?



e=50cm
f=70cm
(2p)

$$A = \underset{(2p)}{\frac{50 \times 70}{2}} = \underset{(2p)}{\frac{3500}{2}} = \underset{(2p)}{1750cm^2} = \underset{(2p)}{0{,}175m^2}$$

8.

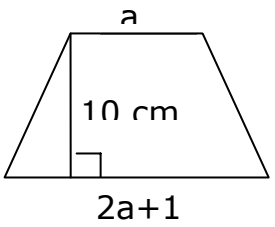


Yandaki şekilde ABCD bir karedir. $A(\overset{\Delta}{DEC})=56$ dm^2 ise ABED yamuğunun alanı kaç dm^2 olur? (E,C,B noktaları doğrusaldır.)

$\frac{a.8}{2}=56$ (2p) $A(ABED)=\frac{(14+14+8).14}{2}=252dm^2$

a=14 dm (2p) (2p) (2p) (2p)

9. Alanı 40 cm^2 olan bir yamuğun yüksekliği 10 cm'dir. Alt taban uzunluğu, üst taban uzunluğunun 2 katından 1 cm fazla olduğuna göre taban uzunluklarını bulunuz.



$A=\frac{(a+c).h}{2}$ (2p)

$40=\frac{(2a+1+a).10}{2}$ (2p)

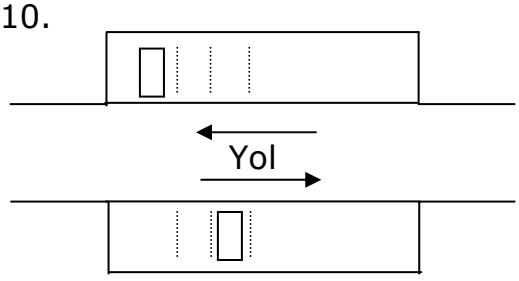
8=3a+1

3a=7 (2p)

a=7/3 cm (2p)

$2a+1=2(\frac{7}{3})+1=\frac{14}{3}+\frac{3}{3}=\frac{17}{3}$cm (2p)

10.



Yanda verilen yolun her iki tarafında bulunan ve park yeri olarak kullanılan dikdörtgen şeklindeki eş arsaların tamamı 252 m^2'dir. Her araba için 2mx3m'lik bir alan ayrıldığına göre, park yeri dolu iken park yerinde kaç araba vardır?

Bir arabanın kapladığı alan :

$A=2x3=6m^2$ (5p)

252:6=42 araba vardır. (5p)

APPENDIX C

OBJECTIVES OF EACH QUESTION IN THE PAT

Questions		Objectives
1		To find the possible integer length of the sides of a rectangle with the given area.
2		To calculate the area of diamond given the length of its diagonals.
3		To find the area of rectangle given the length of the side and perimeter. Find the area of square given the length of the side.
4		To find the area of diamond by using its diagonals and the side and height.
5		To find the side of rectangle given the length of the other side and perimeter. Find the proportion between the side and perimeter of a rectangle.
6	a	To compare the square and diamond.
	b	To write what data is needed to calculate the area of a trapezoid.
7		To find the area of rhombus given the length of its diagonals.
8		To find the side of a right – angled triangle given the area and other side of it. Find the area of trapezoid given the necessary sides of it.
9		To find the bases of a trapezoid given the height, relation between the bases and the area of it.
10		To find the number of given area of rectangles in the rectangle with the given area.

APPENDIX D

CIRCLE AND CYLINDER ACHIEVEMENT TEST

T.C.
ANKARA VALİLİĞİ
ÇANKAYA ÖZEL BİLİM İLKÖĞRETİM OKULU
2004-2005 Eğitim Öğretim Yılı 2.Dönem 7.Sınıf
Matematik Dersi
Konu Tarama Sınavı

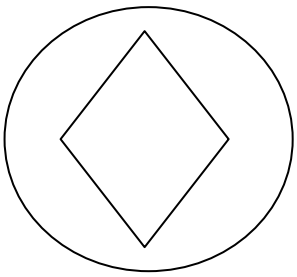
AD-SOYAD: SINIF: NO:

	1	2	3	4	5	6	7	8	9	10		
	10	10	10	10	10	10	10	10	10	10	100	5

SORULAR

1. Çapı 102 cm olan daire şeklindeki halının kapladığı alan kaç cm^2'dir? (π=3,14, şekil çizerek çözünüz.)

2. Yarıçapı 124cm olan masanın üstüne köşegen uzunlukları 90cm ve 75 cm olan eşkenar dörtgen şeklinde bir örtü örtülürse, masada kaç cm^2'lik boş alan (örtüsüz) kalır? (π=3, şekil çizerek çözünüz.)



3. Yarıçapı 56 cm olan daire şeklindeki bir balkonda, 120^0'lik merkez açının sınırladığı kenara (yaya) çiçek ekilecektir. Çiçek ekilen yerin uzunluğu kaç cm'dir? (π=3, şekil çizerek çözünüz.)

4. Denize taş atıldığında oluşan ilk halkanın yarıçapı 5 cm'dir. Onu takip eden her halkanın yarıçapı bir öncekinden 2 cm daha büyüktür. Buna göre 3. halkanın çevresi kaç cm'dir? ($\pi=3$, şekil çizerek çözünüz.)

5. Taban yarıçapı 9m olan dik silindir şeklindeki bir su deposunun hacmi 1215 m^3 ise yüksekliği kaç m'dir? ($\pi=3$, şekil çizerek çözünüz.)

6. Çapı 20 cm olan daire şeklindeki pastanın, 60^0'lik merkez açısının sınırladığı dilimin kapladığı alan kaç cm^2'dir? ($\pi=3$, şekil çizerek çözünüz.)

7. Taban yarıçapı 3cm olan silindir şeklindeki bir bardağın yüksekliği 12 cm'dir. Bardak yarısına kadar limonata ile dolu ise bardakta kaç cm^3 limonata vardır? ($\pi=3$, şekil çizerek çözünüz.)

8. Bir silindir maketinin yapımı için 126 cm^2 karton kullanılmıştır. Silindirin bir taban yarıçapı 3 cm ise yüksekliği kaç cm'dir? ($\pi=3$, şekil çizerek çözünüz.)

9. Silindir şeklindeki bir havuzun yüksekliği, taban çapının yarısına eşittir. Bu havuzun taban yarıçapı 4m olduğuna göre, havuz kaç m^3 su alır? ($\pi=3$, şekil çizerek çözünüz.)

10. Çapı 26m olan daire şeklindeki bir parkın ortasına yarıçapı 5m olan bir havuz yapılacak, geri kalan alana çiçek ekilecektir. Çiçek ekilecek alan kaç m^2'dir? ($\pi=3$, şekil çizerek çözünüz.)

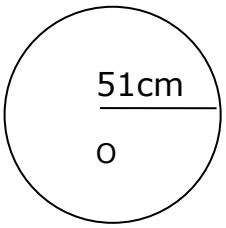
APPENDIX E

ANSWER KEY OF CIRCLE AND CYLINDER ACHIEVEMENT TEST

T.C. ANKARA VALİLİĞİ ÇANKAYA ÖZEL BİLİM İLKÖĞRETİM OKULU 2004-2005 Eğitim Öğretim Yılı 2.Dönem 7.Sınıf Matematik Dersi Konu Tarama Sınavı											
AD-SOYAD:								SINIF:			NO:
1	2	3	4	5	6	7	8	9	10		
10	10	10	10	10	10	10	10	10	10	100	5

SORULAR

1. Çapı 102 cm olan daire şeklindeki halının kapladığı alan kaç cm^2'dir? ($\pi=3$, şekil çizerek çözünüz.)



(2p)

$2r=102cm$

$r=51cm$ (2p)

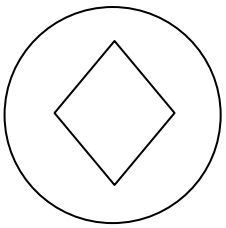
$A=\pi r^2$ (2p)

$A=3x51^2$

$A=3x2601$ (2p)

$A=7803\ cm^2$ (2p)

2. Yarıçapı 124cm olan masanın üstüne köşegen uzunlukları 90cm ve 75 cm olan eşkenar dörtgen şeklinde bir örtü örtülürse, masada kaç cm^2'lik boş alan (örtüsüz) kalır? ($\pi=3$, şekil çizerek çözünüz.)



$A_d=\pi.r^2$ (1p)

$A_d=3.124^2$ (1p)

$A_d=46128\ cm^2$ (2p)

$A_{e.d.}=\frac{e.f}{2}$ (1p)

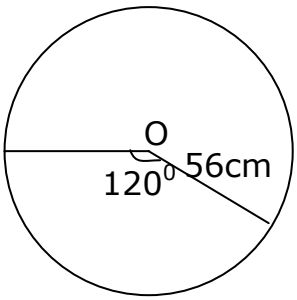
$A_{e.d.}=\frac{90.75}{2}=3375\,cm^2$

(1p) (2p)

$A_{boş}=46128-3375$ (1p)

$=42753\ cm^2$ (1p)

3. Yarıçapı 56 cm olan daire şeklindeki bir balkonda, 120^0'lik merkez açının sınırladığı kenara (yaya) çiçek ekilecektir. Çiçek ekilen yerin uzunluğu kaç cm'dir? (π=3, şekil çizerek çözünüz.)



(2p)

Ç=$2\pi r$ (1p)

Ç=2.3.56 (1p)

Ç=336cm (1p)

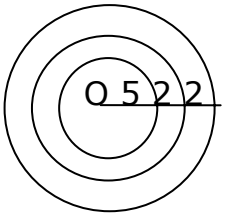
360^0 336 cm

120^0 x (2p)

$x=\frac{120.336}{360}$ x=112 cm

(2p) (1p)

4. Denize taş atıldığında oluşan ilk halkanın yarıçapı 5 cm'dir. Onu takip eden her halkanın yarıçapı bir öncekinden 2 cm daha büyüktür. Buna göre 3. halkanın çevresi kaç cm'dir? (π=3, şekil çizerek çözünüz.)



(2p)

r_3=5+2+2 (1p)

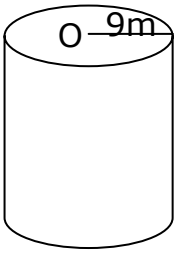
r_3=9 cm (1p)

Ç=$2\pi r$ (2p)

Ç=2.3.9 (2p)

Ç=54cm (2p)

5. Taban yarıçapı 9m olan dik silindir şeklindeki bir su deposunun hacmi 1215 m^3 ise yüksekliği kaç m'dir? (π=3, şekil çizerek çözünüz.)



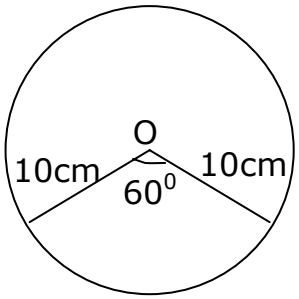
(2p)

V=$\pi r^2 h$ (2p)

1215=3.81.h (2p)

$\frac{1215}{243}$ = h (2p) h=5m (2p)

6. Çapı 20 cm olan daire şeklindeki pastanın, 60^0'lik merkez açısının sınırladığı dilimin kapladığı alan kaç cm^2'dir? (π=3, şekil çizerek çözünüz.)



(2p)

2r=20cm (1p)

r=10cm (1p)

$A=\pi r^2$ (1p)

$A=3.10^2$ (1p)

$A=300cm^2$ (1p)

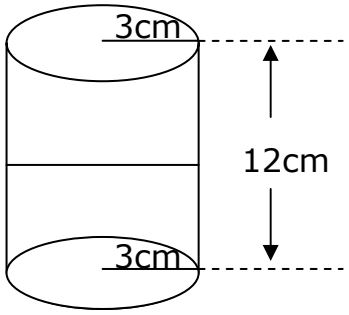
360^0 300 cm^2

60^0 x (1p)

$x=\frac{60.300}{360}=50cm^2$

(1p) (1p)

7. Taban yarıçapı 3cm olan silindir şeklindeki bir bardağın yüksekliği 12 cm'dir. Bardak yarısına kadar limonata ile dolu ise bardakta kaç cm^3 limonata vardır? (π=3, şekil çizerek çözünüz.)



(2p)

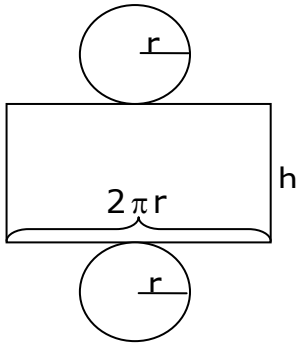
$V=\pi r^2h$ (2p)

V=3.9.12 (2p)

$V=324cm^3$ (2p)

Yarısı: $\frac{V}{2}=\frac{324}{2}=162cm^3$ (2p)

8. Bir silindir maketinin yapımı için 126 cm^2 karton kullanılmıştır. Silindirin bir taban yarıçapı 3cm ise yüksekliği kaç cm'di? (π=3, şekil çizerek çözünüz.)



(2p)

$A=2.\pi.r^2+2.\pi.r.h$ (1p)

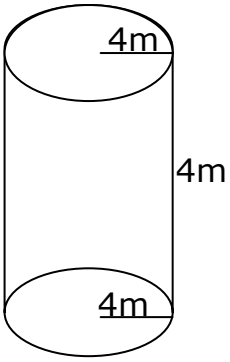
$A=2.3.9+2.3.3.h$ (1p)

$126=54+18.h$ (2p)

$\frac{72}{18}=h$ (2p)

$h=4cm$ (2p)

9. Silindir şeklindeki bir havuzun yüksekliği, taban çapının yarısına eşittir. Bu havuzun taban yarıçapı 4m olduğuna göre, havuz kaç m^3 su alır? (π=3, şekil çizerek çözünüz.)



(2p)

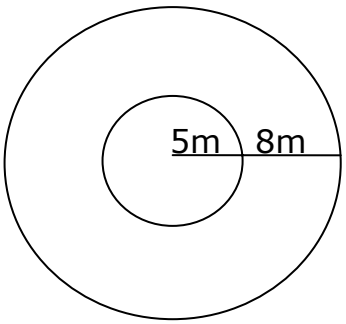
$V=\pi r^2 h$ (2p)

$V=3.4^2.4$ (2p)

$V=3.16.4$ (2p)

$V=192\ cm^3$ (2p)

10. Çapı 26m olan daire şeklindeki bir parkın ortasına yarıçapı 5m olan bir havuz yapılacak, geri kalan alana çiçek ekilecektir. Çiçek ekilecek alan kaç m^2'dir? ($\pi=3$, şekil çizerek çözünüz.)



(2p)

$r_{park}=13m$ $r_{havuz}=5m$

$A_{park}=\pi r^2$ (1p) $A_{havuz}=\pi r^2$ (1p)

$=3.13^2$ (1p) $=3.5^2$ (1p)

$=507m^2$ (1p) $=75m^2$ (1p)

$A_{çiçek}=507-75$ (1p)

$=432m^2$ (1p)

APPENDIX F

OBJECTIVES OF EACH QUESTION IN THE CCAT

Questions	Objectives
1	To calculate the area of a circular region given the diameter.
2	To find the area of a circular region given the radius and find the area of a diamond given the diagonals.
3	To find the length of arc given the radius and central angle.
4	To find the perimeter of a circle given the radius of it.
5	To find the height of a cylinder given the volume and base radius of it.
6	To find the area of a sector given the radius and central angle of it.
7	To find the semi volume of a cylinder given the radius and height of it.
8	To find the height of a cylinder given the area and radius of it.
9	To find the volume of a cylinder given the radius and the relation between radius and height.
10	To find the area of a circular region given the radius of it.

APPENDIX G

GEOMETRY ATTITUDE SCALE

GEOMETRİYE YÖNELİK TUTUM ÖLÇEĞİ

Bu ölçek, sizin geometri ile ilgili düşüncelerinizi öğrenmek için hazırlanmıştır. Cümlelerden hiçbirinin kesin cevabı yoktur. Her cümle ile ilgili görüş, kişiden kişiye değişebilir. Bunun için vereceğiniz cevaplar kendi görüşünüzü yansıtmalıdır. Görüşlerinizi 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: Kararsızım,

Kısmen katılıyorsanız: Uygundur,

Tamamen katılıyorsanız: Tamamen uygundur, seçeneğini işaretleyiniz.

Adı – Soyadı:				Sınıfı:	
	Tamamen Uygundur	Uygundur	Kararsızım	Uygun Değildir	Hiç Uygun Değildir
1. Okulda, daha fazla geometri dersi olmasını istemem.					
2. Matematikte, diğer konulara göre geometriyi, daha çok severek çalışırım.					

	Tamamen Uygundur	Uygundur	Kararsızım	Uygun Değildir	Hiç Uygun Değildir
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 H

STUDENT SURVEY FORM

T.C. ANKARA VALİLİĞİ ÇANKAYA ÖZEL BİLİM İLKÖĞRETİM OKULU 2004-2005 Eğitim- Öğretim Yılı 2. Dönem 7. Sınıf Matematik Dersi
ADI- SOYADI: NO:
TARİH:

ÖĞRENCİ GÖRÜŞLERİ

1. Bu dönem gördüğünüz Geometri dersi hakkında ne düşünüyorsunuz? Sizce kolay mı, zor mu? Neden?

2. Bu dönem gördüğünüz Geometri dersinde anladığınız ve anlamadığınız konular nelerdir? Neden?

3. Geometri dersini daha iyi öğrenmek için neler yapılmasını istersiniz?

4. Geometri başarınız hakkında ne düşünüyorsunuz?

5. Geometri dersine olan tutumunuz hakkında ne düşünüyorusunuz? Sizce konular eğlenceli mi?

APPENDIX I

TEACHER'S OBSERVATION FORM I

DERS DEĞERLENDİRME FORMU

Formu Dolduran Kişinin Adı – Soyadı:
Tarih:
Sınıf:

Bu form gözlenilen derse göre doldurulacaktır.

Kriterler	Evet	Hayır	Kararsızım	Düşünce ve Yorumlar
1. Öğrenciler, Geometri bilgisinin günlük hayatta uygulanabilirliği konusunda bilinçliler mi?				
2. Öğrenciler derse katılmada istekli davranıyorlar mu?				
3. Öğrencilerin çalışmalarında yanlışlık veya eksiklik saptandığında, bunları gidermek için yeterli isteği gösteriyorlar mı?				
4. Öğrenciler etkinlik sonucunda ürettiklerinin niteliğine özen gösteriyorlar mı?				

Kriterler	Evet	Hayır	Kararsızım	Düşünce ve Yorumlar
5. Öğrenciler, verilen soru veya ödevleri zamanında tamamlayabildiler mi?				
6. Öğrenciler, ödev (araştırma) verildiğinde bunu yerine getirmede istekli davranıyorlar mı?				
7. Öğrenciler, dersin dışında farklı çalışmalar yapmayı istiyorlar mı?				
8. Öğrenciler ders sırasında mutlular mı(eğleniyorlar mı)?				
9. Öğrenciler Geometri konularını seviyorlar mı?				
10. Öğrenciler Geometri sorularını çözmeyi başarıyorlar mı?				
11. Öğrenciler, yeni soru tipleri ile karşılaştıklarında fikir yürütebiliyorlar mı?				

APPENDIX J

TEACHER'S OBSERVATION FORM II

DERS DEĞERLENDİRME FORMU

Formu Dolduran Kişinin Adı – Soyadı:

Tarih:

Sınıf:

Bu form gözlenilen derse göre doldurulacaktır.

Kriterler	Evet	Hayır	Kararsızım	Düşünce ve Yorumlar
1. Öğrenciler, proje çalışmasının, Geometri bilgisinin günlük hayatta uygulanmasına yararlı olacağı konusunda bilinçliler mi?				
2. Öğrenciler, teorik bilgilerini uygulamaya dönüştürmede yeterli beceriye sahipler mi?				
3. Öğrenciler etkinlik sonucunda ürettiklerinin niteliğine özen gösteriyorlar mı?				

Kriterler	Evet	Hayır	Kararsızım	Düşünce ve Yorumlar
4. Öğrenciler o güne düşen çalışmaları tamamlayabildiler mi? Zaman problemi yaşayan grup veya öğrenciler oldu mu? Nedenleri?				
5. Grup çalışmalarında öğrenciler üzerlerine düşen görevleri yapıyorlar mı?				
6. Öğrenciler çalışmalar sırasında mutlular mı(eğleniyorlar mı)?				
7. Öğrenciler, yeni soru tipleri ile karşılaştıklarında fikir yürütebiliyorlar mı?				

Eleştiri ve Öneriler:

APPENDIX K

LESSON PLAN EVALUATION SCALE

DERS PLANI DEĞERLENDİRME ÖLÇEĞİ

	1	2	3	4	5
1. Proje çalışması, öğrencilerin gerçek yaşamla bağlantı kurmalarını sağlayacak niteliktedir.					
2. Proje çalışması, öğrenci merkezli eğitimi temel almakta, öğretmen rehber rolündedir.					
3. Proje çalışması, öğrencilerin yaparak öğrenmesini sağlayacak niteliktedir.					
4. Proje çalışması disiplinler arası bir çalışmadır.					
5. Proje çalışması, öğrencilerin üst düzey becerilerini (analiz, sentez) kullanmaya zorlayacak niteliktedir.					
6. Proje çalışması, öğrencilerin bir ürün ortaya koymalarını sağlamaktadır.					
7. Proje çalışması, öğrencinin dışarıdan destek almak yerine bireysel ve grup çalışmaları ile öğrenmelerini sağlamaktadır.					
8. Proje çalışması, öğrencilerin araştırma yapmalarını sağlamaktadır.					
9. Proje çalışması, öğrencilerin ilgisini çekebilecek niteliktedir.					
10. Proje çalışması, öğrencilerin bildiklerini uygulamalarını sağlamakta, bilgi ile uygulama arasındaki ayrılığı yok etmektedir.					

(1)-Kesinlikle katılmıyorum

(2)-Katılmıyorum

(3)-Kararsızım

(4)-Katılıyorum

(5)-Kesinlikle katılıyorum

APPENDIX L

LESSON PLANS

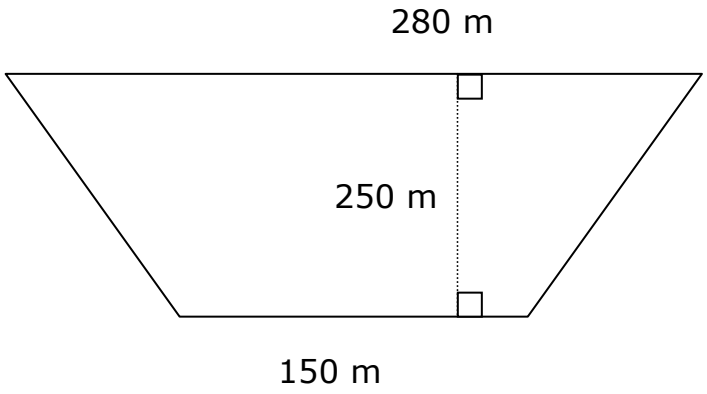
DERS PLANI 1

YARALANILAN DİSİPLİNLER: Matematik, Resim, Sosyal Bilgiler. TARİH: 9-13 Mayıs 2005 SINIF: 7/ A-B ÜNİTE: Çokgenler KONU: Çokgenlerde alanlar. HEDEF: 1) Alanı verilen bir yamuğun boyutlarını bulma. 2) Bir alanın belli bir yüzdesini hesaplayabilme. 3) Yamuk şeklindeki arazinin , ölçeğe uygun olarak kartondan maketinin yapılması. YÖNTEM VE TEKNİKLER: Proje tabanlı öğrenme, araştırma, keşfetme. SÜRE: 7 x 40′

Site Tasarımı Proje Çalışması

- Öğrencilere kendi oturdukları veya çevrelerindeki sitelerin planlarının nasıl olduğu, sitelerin hangi bölümlerden oluştuğu, bu bölümlerin bütün alana nasıl yayıldığı sorulur.
- Öğrenciler ikişer kişilik gruplara ayrıldıktan sonra Çalışma Kağıdı-1 dağıtılır.
- Çalışma kağıdındaki yönergelere göre öğrenciler grup arkadaşı ile birlikte çalışır. Gerekli durumda bireysel veya sınıf genelinde yönlendirme yapılır.

- Sitenin kurulacağı arazinin boyutlarına karar vermekte zorlananlar için aşağıdaki örnek verilir.



- Sitedeki bölümlerin bütün alana nasıl yayıldığı konusunda sıkıntı yaşayan öğrencilere aşağıdaki örnek verilir:

%20'si ev ve su deposu:

%50'si yeşil ve ağaçlık alan:

%30'u yüzme havuzu ve alış-veriş merkezi:

- Yamuğun alanından boyutlarına geçerken öğrenciler sorun yaşabilir. Burada öğrencilere iki boyutunu belirleyip, üçüncüyü alan formülünden hesaplamaları ve bu şekilde istedikleri boyutlara karar vermeleri söylenir. Bu işlemler sırasında öğrencilerin hesap makinesi kullanmalarına izin verilir.
- Maketin ölçeğine karar verirlerken, bazı ölçek oranlarını araştırmaları istenir. Öğrenciler buldukları ölçekleri sınıf ortamında paylaşırlar.

ÖDEV:

1) Su sayacınızı 24 saat ara ile okuyup verilerinizi not ediniz.
2) Evinizin, son aylara ait su faturasını getiriniz.
3) Binanızdaki su deposunun kaç m^3 su aldığını öğreniniz.

DERS PLANI 2

YARARLANILAN DİSİPLİNLER: Matematik, Resim, Sosyal Bilgiler.
TARİH: 16-20 Mayıs 2005
SINIF: 7/ A-B
ÜNİTE: Çokgenler, Silindir
KONU: Çokgenlerin alanı, silindirin hacmi.
HEDEF: 1) Çokgenlerin alanlarını hesaplayabilme.
2) Çokgenlerin alanlarına göre boyutlarına karar verebilme.
3) Çokgenlerin kaplayacağı alana göre sayı ve çeşidine karar verebilme.
4) Su sayacı okuyarak belli bir zamandaki su tüketimini hesaplayabilme.
5) Ortalama hesabı yapabilme.
6) Hacmi verilen bir silindirin boyutlarını bulabilme.
7) Ev ve su deposunun ölçeğe uygun olarak kartondan maketinin yapılması.
YÖNTEM VE TEKNİKLER: Proje tabanlı öğrenme, araştırma, keşfetme.
SÜRE: 7 x 40′

Site Tasarımı Proje Çalışması

- Sitenin bir bölümü olan Apartman veya evler ile su deposunun tasarlanması bu hafta yapılacaktır.
- Öğrencilere Çalışma Kağıdı-2 dağıtılır. Verilen yönergelere göre çalışmalarına devam etmeleri söylenir.
- Apartman veya evlerin kaç m^2'lik bir alana oturtulacağı konusunda sıkıntı yaşayan öğrencilere öncelikle kendi evlerinin kaç

m^2 olduğunu öğrenmeleri istenir. Daha sonra ise aşağıdaki yönlendirme yapılır:

Her bir apartman veya evin kaplayacağı alan 100 m^2'den 1000 m^2'ye kadar değişiklik gösterebilir. Ayrıca bina taban şekilleri kare, dikdörtgen, yamuk, eşkenar dörtgen, deltoid, paralelkenar, daire şekillerinden biri veya birkaçı olabilir.

- Yönlendirmeler sonrasında öğrenciler aşağıdaki tabloyu doldurur.

Apartmanlar Veya Evler	Taban Geometrik Şekli	Kapladığı Alanı	Makette Kapladığı Alan
1.			
2.			
Binaların Tümü	-		

- Öğrencilere evlerindeki su sayacının 24 saat ara ile okumaları ve okudukları sayıları çalışma kağıdına not almaları söylenir. Bu iki sayı arasındaki farktan ailelerinin 1 günlük su tüketimini hesaplamaları istenir.
- Ortalama 1 günlük su tüketimlerinin evlerine gelen su faturalarından yararlanarak da bulmaları istenir.
- İki öğrencinin ikişer su tüketimi bilgilerini aşağıdaki tabloya yerleştirip ortalama alırlar.

A:..... B:.....	1 Günlük Su Tüketimi (m^3)
Sayaç A	
Su Faturası A	
Sayaç B	
Su Faturası B	
Aritmetik Ortalama	

ÖDEV: Siteyi kurmak için belirlediğiniz ilin iklimine uygun ağaç çeşitlerini araştırınız. Bunun için Orman Bakanlığının internet sayfası (www.ogm.gov.tr) ve seralardan yararlanabilirsiniz.

DERS PLANI 3

YARARLANILAN DİSİPLİNLER: Matematik, Resim, Sosyal Bilgiler.
TARİH: 23-27 Mayıs 2005
SINIF: 7/ A-B
ÜNİTE: İklim, Ağaç çeşitleri.
KONU: Bölge iklimleri ve yetişen ağaçlar.
HEDEF: 1) Seçilen ilin ikliminde yetişmeye elverişli olan ağaç çeşitlerini değerlendirme.
2) Ağaç çeşitlerine ve sayısına kaplayacağı alana göre karar verebilme.
YÖNTEM VE TEKNİKLER: Proje tabanlı öğrenme, araştırma.
SÜRE: 7 x 40′

Site Tasarımı Proje Çalışması

- Sitenin bir bölümü olan yeşil ve ağaçlık alanın tasarlanması bu hafta yapılacaktır.
- Öğrencilere Çalışma Kağıdı-3 dağıtılır. Verilen yönergelere göre çalışmalarına devam etmeleri söylenir.
- Öğrencilere seçtikleri ilin iklimine elverişli olan bütün ağaç ve bitkileri belirlemeleri ve buradan grup arkadaşları ile beraber seçim yapmaları istenir. Ağaç veya bitki sayısına karar verirlerken, öğrencilere aşağıdaki tabloyu doldurmaları söylenir.

Ağaç/Bitki Çeşidi	Ağaç/Bitki Sayısı

◆ Her bitki ve ağacın ne kadarlık bir alan kaplayacağı konusunda sıkıntı çeken öğrencilere okulun veya evlerinin bahçesindeki ağaç ve bitkilerin kaç m^2'lik alana ekildiğini ölçmeleri ve kendi projelerinde bu bilgilerden yararlanmaları söylenir.

ÖDEV: 1) Yapmayı tasarladığınızın havuzun alanının ne olabileceğini ve boyutlarını araştırınız.

2) Bir alış – veriş merkezi neler içerir, araştırınız.

DERS PLANI 4

YARARLANILAN DİSİPLİNLER: Matematik, Resim, Sosyal Bilgiler.
TARİH: 30 Mayıs – 2 Haziran 2005
SINIF: 7/ A-B
ÜNİTE: Çokgenler, Çember, Daire.
KONU: Çokgen ve dairenin alanı.
HEDEF: 1) Çokgenlerin alanlarını hesaplayabilme.
2) Dairenin alanını hesaplayabilme.
YÖNTEM VE TEKNİKLER: Proje tabanlı öğrenme, araştırma, keşfetme.
SÜRE: 7 x 40′

Site Tasarımı Proje Çalışması

- Sitenin bir bölümü olan yüzme havuzu ve alış-veriş merkezi bölümünün tasarlanması bu hafta yapılacaktır.
- Öğrencilere Çalışma Kağıdı-4 dağıtılır. Verilen yönergelere göre çalışmalarına devam etmeleri söylenir.
- Yüzme havuzu adet, geometrik şekil ve alanlara öğrencilerin karar vermesi sağlanır.
- Alış-veriş merkezinde hangi bölümler olabileceği, kaç katlı oluşu gibi özelliklerine sitelerinin yapısına uygun olacak biçimde karar vermeleri istenir.

APPENDIX M

PROJECT WORKSHEETS

T.C. ANKARA VALİLİĞİ ÇANKAYA ÖZEL BİLİM İLKÖĞRETİM OKULU 2004-2005 Eğitim- Öğretim Yılı 2. Dönem 7. Sınıf Matematik Dersi SİTE TASARIMI
SİTE ADI:
ÇALIŞMAYA KATILAN GRUP ÜYELERİNİN İSİMLERİ:

PROJE ÇALIŞMALARI-1

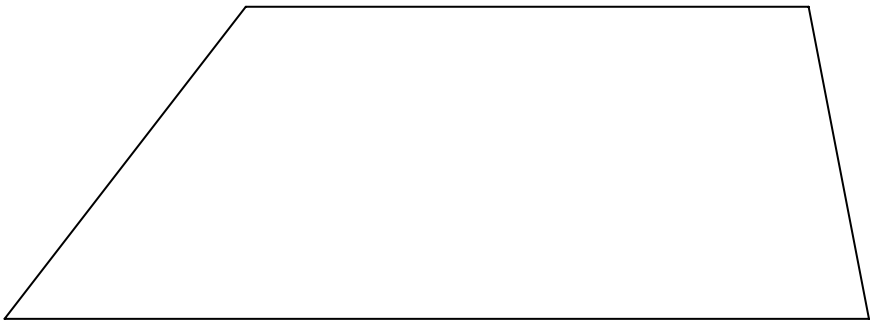
- Sitenizin veya çevredeki sitelerin planlarını araştırınız. Site alanının hangi bölümlerden oluştuğunu ve her bölümün bütün alana nasıl yayıldığını inceleyiniz.
- Tasarlayacağınız sitenin maketini yapmak için;
    1) Çevrenizdeki Mimar ve İnşaat Mühendislerinden bilgi alınız.
    2) Verilen kaynakları araştırınız.
    3) Verilen malzemeleri edininiz.

    Renkli oluklu mukavvalar , maket bıçağı, yapıştırıcı, cetvel.

- Aşağıdaki arazi herhangi bir ilimizde bir site yapımında kullanılmak üzere belirlenmiştir. Dörtgen şeklindeki bu alanda [AB]//[DC] 'dir.

- Siteyi kurmak istediğiniz ili belirleyiniz: .....

D C



A B

- Bu sitenin hangi bölümlerden oluşacağı aşağıda verilmiştir. Her bölümün, bütün arazinin yüzde kaçı olacağına karar veriniz ve her bölüme düşen alanı hesaplayınız.
    - Evler ve su deposu: %
      Alanı:
    - Yeşil ve ağaçlık alan: %
      Alanı:
    - Yüzme havuzu ve alış-veriş merkezi: %
      Alanı:
- İstediğiniz siteyi kurabilmek için verilen arazinin kaç m^2 olması gerekmektedir?
- Bulduğunuz alana göre arazinin boyutlarını hesaplayınız.
- Bu alanın maketini yaparken kullanacağınız ölçeği belirleyip, buna göre alanını hesaplayınız.

ÖDEV: 1) Su sayacınızı 24 saat ara ile okuyup verilerinizi not ediniz.

2) Evinizin, son aylara ait su faturasını getiriniz.

3) Binanızdaki su deposunun kaç m^3 su aldığını öğreniniz.

🏷 Yaptığınız araştırmaların kaynak ve belgelerini dosyanızda bulundurunuz.

T.C. ANKARA VALİLİĞİ ÇANKAYA ÖZEL BİLİM İLKÖĞRETİM OKULU 2004-2005 Eğitim- Öğretim Yılı 2. Dönem 7. Sınıf Matematik Dersi SİTE TASARIMI
SİTE ADI:
ÇALIŞMAYA KATILAN GRUP ÜYELERİNİN İSİMLERİ:

PROJE ÇALIŞMALARI-2

BÖLÜM	ALAN
Evler ve su deposu	

Bu bölüme düşen alan:

- Her bir binanın kaplayacağı alan değişebilir. Binaların kaplayacağı alana, alanın boyutlarına, şekline ve sayısına grup arkadaşlarınızla beraber karar veriniz. Buna göre aşağıdaki tabloyu doldurunuz.

Apartmanlar Veya Evler	Taban Geometrik Şekli	Kapladığı Alanı	Makette Kapladığı Alan
1.			
2.			
Binaların Tümü	-		

Su deposu:

- Evinizde 1 günde kaç m^3 su harcadığınızı su sayacını okuyarak ve su faturalarındaki verileri kullanarak hesaplayınız.

- Bu değerin aritmetik ortalamasını alınız ve aşağıdaki tabloyu doldurunuz.

A:..... B:.....	1 Günlük Su Tüketimi (m^3)
Sayaç A	
Su Faturası A	
Sayaç B	
Su Faturası B	
Aritmetik Ortalama	

- Oluşturduğunuz binalarda kaç ailenin oturduğunu belirleyiniz.
- Yapacağınız deponun su kesintisi durumunda, kaç günlük ihtiyacı karşılayacağına ve su deposunun hacmine karar veriniz.
- Silindir şeklindeki deponun hacmine göre taban alanı ve yüksekliğini hesaplayınız.
- Su deposunun maketteki boyutlarını ve hacmini hesaplayınız.

ÖDEV: Siteyi kurmak için belirlediğiniz ilin iklimine uygun ağaç çeşitlerini araştırınız. Bunun için Orman Bakanlığının internet sayfası (www.ogm.gov.tr) ve seralardan yararlanabilirsiniz.

- Yaptığınız araştırmaları dosyanızda bulundurunuz.

T.C. ANKARA VALİLİĞİ ÇANKAYA ÖZEL BİLİM İLKÖĞRETİM OKULU 2004-2005 Eğitim- Öğretim Yılı 2. Dönem 7. Sınıf Matematik Dersi SİTE TASARIMI
SİTE ADI:
ÇALIŞMAYA KATILAN GRUP ÜYELERİNİN İSİMLERİ:

PROJE ÇALIŞMALARI-3

BÖLÜM	ALAN
Yeşil ve Ağaçlık Alan	

- Seçtiğiniz ilin iklim özelliklerini göz önünde bulundurarak bitki ve ağaç türlerine ve sayısına karar veriniz.

Ağaç/Bitki Çeşidi	Ağaç/Bitki Sayısı

- Seçtiğiniz ağaçları kaçar metre aralıklarla dikeceğinize ve her ağacın kökleri ile beraber yaklaşık ne kadar alan kaplayacağını bulunuz.
- Bir önceki maddede belirlediğiniz alanları, maket için de belirleyiniz.
- Çimlendirmek için kullanacağınız alanı hesaplayınız.
- Çimlendirilecek alanı maket için de belirleyiniz.

ÖDEV: 1) Yapmayı tasarladığınızın havuzun alanının ne olabileceğini araştırınız.

2) Bir alış – veriş merkezi neler içerir, araştırınız.

🏷 Araştırma sonucu elde ettiğiniz belge ve kaynakları dosyanızda bulundurunuz.

T.C. ANKARA VALİLİĞİ ÇANKAYA ÖZEL BİLİM İLKÖĞRETİM OKULU 2004-2005 Eğitim- Öğretim Yılı 2. Dönem 7. Sınıf Matematik Dersi SİTE TASARIMI
SİTE ADI:
ÇALIŞMAYA KATILAN GRUP ÜYELERİNİN İSİMLERİ:

PROJE ÇALIŞMALARI-4

BÖLÜM	ALAN
Yüzme Havuzu ve Alış-veriş Merkezi	

- Büyüklerin yüzme havuzunu, istediğiniz boyut ve şekilde yapabilirsiniz. Belirlediğiniz boyut ve şekle göre havuzun kaplayacağı alanı hesaplayınız.
- Maketteki boyut ve alanlarını hesaplayınız.
- Çocuk havuzunu, istediğiniz boyut ve şekilde yapabilirsiniz. Belirlediğiniz boyut ve şekle göre havuzun kaplayacağı alanı hesaplayınız.
- Maketteki boyut ve alanlarını hesaplayınız.
- Alış-veriş merkezinin şeklini belirleyiniz ve kaplayacağı alanı hesaplayınız.
- Maketteki boyut ve alanlarını hesaplayınız.
- Alış – veriş merkezi için aşağıdakileri belirleyiniz.

Kat sayısı :

İçerdiği bölümler: (Mağaza, sinema, yemek,eğlence merkezi,otopark,vs)

Bölüm	Sayısı	Alanı	Makette Kapladığı Alan

- Belirlediğiniz bölümlerden dilediğiniz birini detaylandırmak üzere seçiniz.

ÖDEV: Seçtiğiniz bölümün ayrıntılı planı için ön bilgi edininiz.

🏷 Araştırma sonucu elde ettiğiniz belge ve kaynakları dosyanızda bulundurunuz.

APPENDIX N

FREQUENCY TABLE OF PAT

	Q1		Q2		Q3		Q4		Q5		Q6		Q7		Q8		Q9		Q10		Total	
1	0	4	5	10	1	2	4	5	0	2	4	2	0	3	2	0	3	0	0	2	19	30
2	0	0	0	10	0	10	0	2	5	8	4	4	8	9	0	6	0	2	0	0	17	51
3	0	2	0	2	0	0	0	2	0	0	1	1	2	0	0	3	3	1	10	10	16	21
4	10	10	8	10	10	10	10	10	10	10	7	10	8	8	10	10	10	10	10	10	93	98
5	0	0	0	10	0	0	0	10	5	10	3	4	6	2	3	0	0	0	10	10	27	46
6	1	10	10	10	9	10	5	2	10	10	4	7	8	9	2	10	8	5	10	10	67	83
7	1	10	10	10	2	10	5	6	5	10	6	10	8	8	9	10	9	10	10	10	65	94
8	7	10	10	10	10	10	10	10	10	10	5	8	8	10	10	6	10	10	10	10	90	94
9	10	8	10	10	10	10	0	10	10	10	7	5	8	10	10	10	10	10	10	10	85	93
10	10	10	10	10	10	10	10	10	10	10	4	6	6	9	6	10	3	7	10	10	79	92
11	7	10	10	10	10	7	1	10	5	10	4	8	8	10	4	10	2	8	6	10	57	93
12	0	1	0	0	0	2	0	0	10	9	3	2	2	5	0	0	10	8	10	10	35	37
13	0	2	4	2	1	5	0	2	4	8	0	2	1	2	0	0	0	3	0	10	10	38
14	0	0	0	8	2	10	0	6	10	10	2	10	6	8	0	3	3	8	10	10	33	73
15	0	10	7	8	10	10	4	10	10	10	5	2	9	9	2	6	1	0	10	10	58	75
16	0	0	4	2	1	4	0	8	4	8	0	4	0	0	0	4	0	3	2	10	11	43
17	0	10	0	10	0	10	0	10	1	10	1	4	0	10	0	10	0	8	10	10	12	92
18	0	4	0	4	0	10	0	0	4	8	5	6	0	2	2	4	1	2	4	10	16	50
19	0	4	7	10	2	5	0	2	5	8	4	4	0	9	4	6	8	8	10	10	40	66
20	3	2	0	8	0	4	2	2	9	10	3	1	1	8	2	6	6	8	0	10	26	59

	Q1		Q2		Q3		Q4		Q5		Q6		Q7		Q8		Q9		Q10		Total	
21	0	0	0	10	0	2	0	6	1	2	1	4	1	2	0	4	1	3	10	0	14	33
22	0	0	2	8	1	2	0	5	5	8	2	2	0	2	3	0	3	2	4	3	20	32
23	0	7	10	10	1	4	0	2	0	5	1	2	0	4	0	4	3	4	10	10	25	52
24	4	4	2	10	2	10	0	2	10	10	5	7	1	8	0	5	6	10	10	10	40	76

APPENDIX O

FREQUENCY TABLE OF CCAT

	Q1		Q2		Q3		Q4		Q5		Q6		Q7		Q8		Q9		Q10		Total	
1	1	8	2	4	2	2	4	7	2	2	2	8	2	10	1	6	2	0	1	4	19	51
2	10	8	3	10	2	3	4	5	0	3	0	10	0	10	0	7	0	10	0	10	19	76
3	2	0	0	0	2	0	4	3	4	8	2	10	1	4	0	2	0	2	1	3	16	32
4	10	9	10	8	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	100	97
5	5	4	5	8	1	2	10	6	0	10	0	10	0	10	0	7	0	10	2	10	23	73
6	6	8	2	7	2	4	10	10	8	6	3	10	10	8	5	8	9	10	3	7	58	88
7	4	10	7	8	2	10	10	10	3	10	2	10	5	10	2	10	4	10	6	7	45	95
8	8	10	9	8	10	10	10	10	10	10	10	10	10	10	5	10	10	10	10	10	92	98
9	10	10	10	10	2	10	10	10	10	10	10	10	10	10	9	10	10	10	10	10	91	100
10	10	10	7	10	10	10	10	10	3	10	10	10	4	10	3	10	4	10	10	10	71	100
11	4	10	0	10	2	10	4	10	1	10	0	10	5	10	0	10	2	10	0	10	18	100
12	8	1	0	2	2	2	4	2	1	2	2	10	0	10	0	8	0	10	0	10	17	57
13	0	2	0	0	0	0	2	2	0	0	0	0	0	2	4	4	4	6	0	0	10	16
14	5	10	3	10	2	10	4	10	2	0	4	10	3	10	1	8	3	10	5	10	32	88
15	8	6	3	6	5	8	6	10	10	2	5	10	10	2	0	3	9	2	5	2	61	51
16	10	5	0	2	0	3	2	0	2	0	0	3	0	0	0	8	2	3	3	5	19	29
17	3	10	0	6	0	10	0	4	3	10	0	10	2	10	0	10	8	10	0	10	16	90
18	4	5	0	5	2	6	2	8	0	4	1	6	4	8	0	7	1	2	2	4	16	55
19	10	8	0	0	6	0	10	10	10	8	8	10	10	8	0	8	5	10	5	2	64	64
20	10	3	4	8	2	2	10	10	2	2	6	8	2	2	0	2	1	2	4	5	41	44

	Q1		Q2		Q3		Q4		Q5		Q6		Q7		Q8		Q9		Q10		Total	
21	4	6	0	3	2	10	3	0	1	4	0	10	2	2	1	0	1	2	4	0	18	37
22	2	8	0	3	2	0	6	10	2	2	1	0	4	10	1	2	2	4	3	2	23	41
23	2	4	0	2	6	10	1	0	3	10	2	3	4	8	2	2	2	10	1	4	23	53
24	2	10	4	10	2	2	4	10	3	2	3	2	5	9	1	10	5	6	3	2	32	63