THE EFFECTS OF DYNAMIC GEOMETRY USE ON EIGHTH GRADE STUDENTS' ACHIEVEMENT IN GEOMETRY AND ATTITUDE TOWARDS GEOMETRY ON TRIANGLE TOPIC

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ABSTRACT

THE EFFECTS OF DYNAMIC GEOMETRY USE ON EIGHTH GRADE STUDENTS' ACHIEVEMENT IN GEOMETRY AND ATTITUDE TOWARDS GEOMETRY ON TRIANGLE TOPIC

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The purpose of this study was to investigate the effect of dynamic geometry based computer instruction on eighth grade students' achievement in geometry, attitudes toward geometry and technology compared to traditional instruction. Moreover, it was aimed to get the students' ideas about the effects of computer based instruction and to interpret their learning process. The study was quasi-experimental design that includes experimental and control groups. The sample of the study was 36 eighth grade students (18 students in experimental and 18 students in control group) from a public elementary school in Ankara. The study was conducted in the 2012-2013 academic year, lasting 16 lesson hours (four weeks). The data were collected from geometry achievement test, geometry and technology attitude scale. The quantitative analyses were carried out by using independent-samples t-test analyses and correlation analysis. The results revealed that dynamic geometry based computer instruction had a significant effect on students' achievement in geometry compared to traditional instruction. The results also indicated that dynamic geometry based instruction had a significant effect on students' attitudes toward geometry and technology compared to traditional instruction. Correlation analysis showed that higher level of 8th grade students' achievement in geometry associated with higher level of their attitudes towards geometry. Moreover, open ended questions indicated that computers created a dynamic learning environment which supported students' learning process and developed positive ideas about computer instructions.

Keywords: Dynamic geometry software, GeoGebra, Achievement in geometry, Attitude toward geometry and Attitude toward technology.

ÖZ

DİNAMİK GEOMETRİ KULLANIMININ SEKİZİNCİ SINIF ÖĞRENCİLERİNİN ÜÇGENLER KONUSUNDAKİ GEOMETRİ BAŞARISINA VE TUTUMUNA ETKİSİ

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Bu çalışmanın amacı bilgisayar destekli öğrenme ortamının, geleneksel öğretim yöntemiyle karşılaştırıldığında sekizinci sınıf öğrencilerinin geometri başarılarına, geometriye ve teknolojiye karşı tutumlarına etkisini araştırmaktır. Buna ek olarak, öğrencilerin bilgisayarlı öğretimin etkileri ile ilgili fikirlerini almak ve öğrenme süreçlerini yorumlamak amaçlanmıştır. Çalışma kontrol ve deney grubunu içeren yarı deneysel bir çalışmadır. Çalışmanın örneklemini Ankara ilinde bir devlet ilköğretim okulunda sekizinci sınıfta okuyan 36 öğrenci (18'i deney, 18'i kontrol grubu) oluşturmaktadır. Çalışma 2012–2013 öğretim yılında gerçekleştirilmiş, 16 ders saati (dört hafta) sürmüştür. Veri toplamak amacıyla, başarı testi, geometri ve teknoloji tutum ölçeği kullanılmıştır. Elde edilen niceliksel veriler, yapılan bağımsız örneklemler t-testi ve korelasyon analizi ile incelenmiştir. Analiz sonuçlarına göre, gruplar arasında geometri başarısı testinden alınan puanlar arasındaki fark istatistiksel olarak anlamlı bulunmuştur. Ayrıca analiz sonuçlarına göre, gruplar arasında geometriye yönelik tutum ölçeğinden alınan puanlar istatistiksel olarak anlamlı bir fark göstermiştir. Korelasyon analizi, 8. Sınıf öğrencilerinin başarısının tutumlarıyla ilişkili olduğunu göstermiştir. Buna ek olarak, açık uçlu sorular, bilgisayarların öğrencilerin öğrenme sürecini destekleyen dinamik bir öğrenme ortamı yarattığını ve bilgisayar dersine karşı pozitif düşünceler geliştirdiklerini belirtmiştir.

Anahtar Kelimeler: Dinamik geometri yazılımı, GeoGebra, Geometri başarısı, Geometriye yönelik tutum, Teknolojiye yönelik tutum

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To My Parents and my Village School Students

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATONS

DGS	Dynamic Geometry Software
NCTM	National Council of Teacher of Mathematics
NETS	National Educational Technology Standards
MoNE	Ministry of National Education
GAT	Geometry Achievement Test
CAS	Computer Attitude Scale
GAS	Geometry Attitude Scale
Sig	Significance
df	Degree of freedom
N	Sample size

CHAPTER 1

INTRODUCTION

Instructional technologies are the effective use of technological tools in learning and teaching. Everyday, the uses of them in classes are increasing and they are becoming an important part of the school lives. The Principles and Standards for School Mathematics (2000) states that “technology is essential in teaching and learning mathematics and enhances students’ learning of different concepts.” Since, technology supports problem solving, spatial thinking and reasoning skills in mathematics and geometry lessons, the use of these kinds of technologies are essential in mathematics classes.

Geometry that is the field of mathematics about spatial concepts, shapes, figures and it takes an important place in school mathematics. The National Council of Teachers of Mathematics (NCTM) expresses the significance of it in the *Principles and Standards for School Mathematics* (2000) and expresses that geometry provides an ability to interpret our environment and can be used as tools for the study of other topics in mathematics and science. Geometry is the natural area of the mathematics for the development of students' reasoning and justification skills and in new mathematics curricula geometry teaching and improving these skills are one of the major goals (MoNE, 2005).

In new mathematics curriculum, concrete models, drawings, and dynamic software were recommended in geometry teaching to help students for seeing the spatial concept and logical relations. Teaching of it serves various purposes in different fields, such as architecture, building, structuring, designing and other activities (Laborde, Kynigos & Strasser, 2006). New methods, tools and studies about geometry teaching help teachers, teacher educators and curriculum developers.

Computers and calculators are also facilitator in learning of new concept. The use of computers helps students to spend less time on drawing geometric figures making calculations and give more time investigating relationship and learning mathematics (Kersaint, 2003). Spending less time increases students' motivation and attitudes and provides a more positive feedback for slow-learning students. Additionally, students gain individual self-learning experience by using technology (Keşan & Çalışkan, 2013). National Educational Technology Standards (NETS) also expressed the positive influence of technology and the importance of connecting curriculum and technology. Therefore, the use of technology in teaching mathematics is essential in terms of supporting teaching methods, students' learning and curriculum development.

Today, students are more proficient with the use of computers than their families but the use of computers in their mathematics classes is limited in Turkey (TIMMS, 2011). MoNE (Ministry of National Education) mathematics curriculum also supports, use of technology in mathematics teaching. The use of calculators and dynamic geometry programs are recommended in the curriculum and projects that enhance the use of computers in schools funded by government (FATİH Project, 2012). These projects aim to increase the use of technology in the schools and make it accessible to many schools. These technological improvements are important step when that supports the students' academic achievement and motivation.

Many studies showed that technology has positive effect on students' geometry achievement (Myers, 2009; Sauter, 2001; Smith, 2010; Tayan, 2011; Ubuz, Üstün and Erbaş, 2009; Yemen, 2009). Since technological tools give opportunity to use multiple representations; they support students' conceptual understanding. Dynamic geometry software is one of the important technological tools that provide students to construct activities in geometry lessons. Kokol Vojc (2007) states that DGS can be considered as dynamic models of paper and pencil environment with the dragging tool feature. By using these tools, students can visualize and move geometrical objects. Geometersketchpad, Cabri 3D and GeoGebra are well-known dynamic geometry software.

GeoGebra software that is used in this study combines both algebra and geometry tools of other DGS. It is freely available and open source software. In addition, more than 50 language options is available in both menus and commands. GeoGebra gives opportunities to students for mathematical exploration, supporting group work and discussion and generally it can make mathematics a more practical subject (Hohenwarter & Fuchs, 2004). Its mathematically rich environment and interactivity improve mathematical investigations. It also provides teaching of various mathematical concepts such as algebra and geometry. Since it is freely available, students can use it not only at school but also at home to do homework and practice their work.

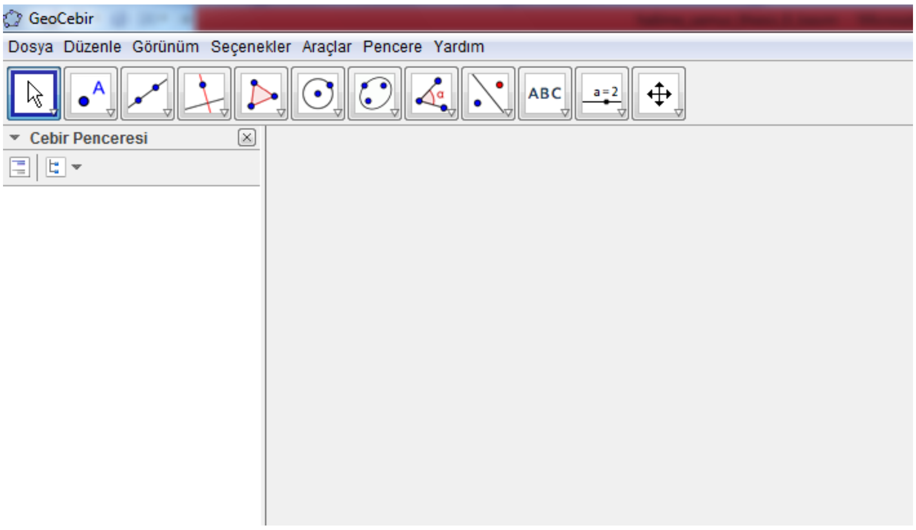

Figure 1.1 GeoGebra Screen

There have been various studies which are focused on use of dynamic geometry software and GeoGebra in Turkey (e.g. Filiz, 2009; İçel, 2011; Tayan, 2011; Ubuz, Üstün and Erbaş, 2009; Yemen, 2009; Zengin, 2011). These studies show that the effect of using DGS on students' achievement in different topics of mathematics and different grade levels. Unlike from other studies, this study is based on change of students' achievement in geometry and attitude toward geometry on triangle topic. Subject is chosen as "Triangle Inequality and Pythagoras Theorem". The participants were 8th grade students of a public school.

1.1. Purpose of the study

The purpose of this study is to investigate the effects of use of dynamic geometry in eighth grade students' achievement in geometry and attitudes toward geometry and relationship between them. This study also attempts to get students' ideas about computer instruction.

1.2. Problem of the Study

Research problems of the study are stated as:

What is the effect of dynamic geometry based instruction compared to the traditional teaching on 8^{th} grade students' achievement in geometry?

What is the effect of dynamic geometry based instruction compared to the traditional teaching on 8^{th} grade students' attitudes toward geometry in the triangle concept?

Is there a relationship between the attitudes and achievement scores of the students?

What are the student's attitudes towards dynamic geometry environment for experimental group students?

To investigate the problems, following null hypotheses are stated:

Null Hypothesis 1: There is no significant mean difference between the groups on the means of the post test scores on "Geometry Achievement Test" after the treatment.

Null Hypothesis 2: There is no significant mean difference between the groups on the means of the post test scores on "Geometry Attitude Scale" after the treatment.

Null Hypothesis 3: There is no relationship between the attitudes and achievement scores of the students.

1.3. Significance of the Study

Geometry, the study of space and spatial relationships, plays a crucial role in mathematics curriculum at all grade levels. NCTM (2000) stressed that spatial understanding is essential for interpreting and understanding our world. Students who have a strong sense of spatial relationships and geometric concept are better prepared to learn advanced mathematical topics.

Despite the importance of geometry, PISA (Programme for International Student Assessment) and TIMSS (Trends in International Mathematics and Science Study) reports show that Turkish students have low achievement in mathematics and geometry tests. According to PISA 2009, Turkey ranks the 41st in science and mathematics among 65 countries. That result shows that Turkish students have difficulties in mathematics when they are compared to the students from other countries. Moreover, TIMSS reports are similar to PISA results. TIMSS 2007 indicates that Turkey's educational achievement at the eighth grade is far below that of other countries in the EU. In the same way, students have low mathematics achievement in national examinations like YGS (University Entrance Examination) and SBS (Elementary Students' Placement Examination). Geometry problems are the most common errors of the students in these examinations. This shows the importance of geometry teaching. However, there are still some problems in teaching of geometry. Therefore, there is a need to improve the teaching methods of geometry and support teachers to use these methods.

In geometry teaching, the problem is giving many rules and formulas about the subject. This causes that students memorize them without understanding. In primary and secondary school geometry lessons, students are instructed with ragged drawings and these drawings even make confusions about the subject (Keşan & Çalışkan, 2013). It has been tried to overcome this difficulty with use of technologies in geometry lessons (MoNE, 2005). It is expected that worksheets created by researcher and GeoGebra software used in this study can be helpful for use of teachers in the classrooms. In this study, the courses were done in the computer laboratory and student-centered environment was provided. In this process, teachers' guidance supported the students' learning. The students created geometric shapes (triangle, line and angle) themselves by using GeoGebra tools and reached the conclusions and formulas. GeoGebra helped to the students' understanding of the topic, attention and motivation to the subject. Even though, it is known that the use of dynamic software supported the students' learning and motivation, there are little sources for teachers to use in their lessons. Researches showed that attitude towards mathematics affects students' learning of mathematics and achievement in mathematics. In the literature, attitudes have been studied in relation to different factors; academic achievement, use of computers and school life. The results of these studies are not consistent. In some studies positive correlation is found between academic achievement and attitude (Boyraz, 2008; Genç, 2010; Gün, 2011; Mehdiyev, 2009; Myers, 2009; Souter, 2001). However, in some other studies, such as (Eryiğit, 2010; Klein, 2005; Yemen, 2009; Zengin, 2011) have found no significant correlation between them. Therefore, relationship between attitude and achievement investigated in this research.

In new mathematics curriculum (MoNE, 2005), it is suggested using dynamic software in geometry lessons but in mathematics textbooks, there is no lesson plans or activities about instructions with these tools. Lesson plans, activities and worksheets developed for this study can be beneficial for teachers and students to use technology supported lessons. Research results also indicated that geometry teaching supporting the lessons with dynamic geometry software improve students' understanding of geometric concept (e.g. Filiz, 2009; İçel, 2011; Keşan and Çalışkan, 2013; Tayan, 2011; Ubuz, Üstün and Erbaş, 2009; Yemen, 2009; Zengin, 2011). In this study, students solves problems, generalizes formulas and theorems by using technology tools. This makes contribution to students' cognitive abilities. The use of dynamic environments also may help students to develop their visualization, construction and reasoning skills (Dixon, 1997). It is also helpful for seeing the relationships between geometric objects and their parts and interacting with figures that are constructed by students. There have been many studies related to students' ideas about geometry lessons with dynamic geometry software and its effects on teaching middle school mathematics (e.g. Filiz, 2009; İçel, 2011; Tayan, 2011; Yemen, 2009; Zengin, 2011). Unlike from other studies, this research was implemented in a village school with limited technological facilities in rural area. The students did not have computer accessibility in their home and they used computer only mathematics lessons. Since not much studies has been applied in such samples I explore GeoGebra's potential and implications for geometry lessons in middle school classroom practice in rural area. This quasi-experimental study investigates the effect of using dynamic geometry software on students' attitudes and understanding of triangles compared to traditional teaching of these concepts in an experimental-control group design. In this study, 8^{th} grade students were taught the subject triangles and technology based instruction was used as a teaching method.

1.4. Assumptions

The study is based on the following assumptions:

The students who participated in the study respond to the items sincerely and accurately. Data collected under similar conditions for both groups. Students from different groups did not have interaction and communication about the items of pre and posttests before administration of these tests.

1.5. Limitations

Data are collected from a public school in Ankara. The sample of the study is not randomly selected, it is convenient sampling. Therefore, findings are limited to the sample of the study.

The teacher is also the researcher of this study. Therefore, teacher biases may have influenced the results of the study.

The duration of the study can be a limitation of the study. Four weeks might not have been long enough to have an effect on students' achievement, attitudes toward geometry and technology.

1.6. Definition of Terms

Computer Based Instruction: Computer is used as an important component of teaching and learning environment.

Dynamic Geometry Software: Dynamic geometry software allows students to create geometric constructions and manipulates them easily. Dragging, the dynamic property of DGS, provides users with moving the elements of a drawing freely and observing other elements (Goldenberg & Cuoco, 1998).

GeoGebra: GeoGebra is dynamic geometry software for teaching and learning mathematics from middle school through college level. It combines the properties of other software and it is also free to use (Hohenwarter & Jones, 2007).

Traditional Instruction: Traditional instruction is based on lecture and question-answer parts. Generalizations, rules and definitions are explained firstly and then examples are provided. The students listen and take notes in their own places (Duatepe, 2004).

Achievement in geometry: The scores on the "Geometry Achievement Test" in this study.

Attitude toward geometry: Attitude represents individual's degree of like or dislike about geometry. In this study, the scores on the "Geometry Attitude Scale".

CHAPTER 2

LITERATURE REVIEW

In this part, the literature about the study was presented in detail. The use of technology in geometry education, literature about dynamic geometry software and GeoGebra, students' performances in geometry and mathematics and attitude toward geometry were explained in this part.

2.1. The Use of Technology in Geometry Education

The power of the new technologies is one of the strongest factors in the contemporary developments and evolution of mathematics and mathematics teaching. In mathematics, new fields have been fostered with the advent of computers. In education, importance of certain ideas have been promoted, some problems and topics have started to be more accessible with the use of computers and new ways were found to represent and function the mathematical information about content, pedagogy and learning that we've never had provided before (Goldenberg, 2000).

Since learning is not a one dimensional thing, there are some different aspects of use of computers in the mathematics lessons. Teachers, educational theories and beliefs, parents, curricula, students' interests and aspirations, resources, cultural expectations are some of them. Describing the roles of technology in mathematics education and examining how they are affecting different content areas (arithmetic, algebra, geometry, calculus, discrete mathematics, probability and statistics) are also important aspect (Goldenberg, 2000). Heid (1997) expressed certain assumptions and values of technology use in mathematics education. When technology environments are used; there are four main principles that have the significance of student centered education, experience of being mathematicians, enhancing learning with reflections and redefinition of information in technology instruction. Technology in mathematics instruction is student-centered and helps students to construct their own knowledge. Moreover, students have the opportunities of engaging in authentic mathematical experiences in terms of different aspects of use of technology in mathematics instructions (Heid, 1997).

Moreover, the National Educational Technology Standards for Teachers (NETS, 2008) expressed the considerations for technology integration in teaching and learning mathematics. Firstly, concept and technology operation are one of these concerns for teachers since teachers should decide how they will apply them to mathematics-specific technologies and what mathematics-specific concepts are important in technologies. Secondly, teaching, learning and the curriculum are another consideration for teachers. Teacher should think whether students learn mathematics concepts before using the technology tools or not. Next, assessment and evaluation are another teacher concern that is about how assessment different in a technology-rich educational experience is. Lastly, social, ethical, legal and human issues are important since there is a diversity of students accessing to technologies.

The new technologies contributed to higher-level mathematical thinking for students. Computer algebra systems, technology-based laboratory devices (calculator-based laboratory devices [CBLs] and microcomputer-based laboratory devices [MBLs]), graphics calculators, microworlds and dynamic geometry tools are examples of these new technologies. Each helps to exceed the limitations of the mind in different ways. Computer algebra systems help users produce symbolic, graphical, and numerical representations and reason within and among them. Calculator-based laboratory devices enhance students' learning with collecting and analyzing real-world data, and graphics calculators give opportunity to them to get computational and graphical results. Microworlds and dynamic geometry tools provide students with expressing, developing, and investigating mathematical ideas (Heid, 1997). For example, while solving geometry problems, using dynamic software highlights certain aspects of the problem and suppresses others when compared the ruler and compass using (Goldenberg, 2000). When problem situations are selected properly, this motivates students to investigating the properties of objects and relationships between them, in order to identify unclarities, ask questions and make conjectures. Students' abilities focused on reasoning and justification of statements and their logical thinking are improved by verification and proof of formulated conjectures. Geometry that is one of the important concepts of mathematics supplies many interesting theorems and suggest students new perspectives that reveal the beauty of geometric relationships and spatial concepts and procedures (Lukac, 2010).

Geometry helps students' justification and reasoning skills in everyday situations (NCTM, 2000). Geometry is used in mathematical problem solving and representations of real world situations. Different technological tools can be used in school classrooms and these can do more than compass and straightedge. Technological improvements enable applications of geometrical activities in mathematics education. NCTM suggests that geometry can be learned using concrete models, drawings, and dynamic software. Therefore, use of technology has a significant role in teaching geometry concepts.

In literature there are many studies about the use of technologies in mathematics education (Laborde, Kynigos & Strasser, 2006; Myers, 2009; Sauter, 2001; Smith, 2010; Tayan, 2011; Ubuz, Üstün & Erbaş, 2009; Yemen, 2009).

Laborde, Kynigos and Strasser (2006) explained effects of different technologies on learning and teaching of geometry in their study. This review of research is based on PME (Psychology of Mathematics Education) international group work. It includes general theoretical approaches, specific technologies and results from different researches. In the last thirty years, researches about new technologies such as DGS (Dynamic Geometry Software) have increased. Euclidean concepts triangles, quadrilaterals, geometric transformations, polyhedra, measurements of areas and ratio and proportions are common research areas on the use of technology for teaching and learning of geometry.

Smith (2010) compared the eighth grade students' development in justification and proof by using technological and non-technological environment. Students studied on definitions, properties, theorems, and classification systems about the triangles. Experimental design was used in this study and experimental group received treatment with Geometer Sketchpad in technology class. Findings of this study showed that students in the technology class presented more arguments than students in the non-technology class. Similarly, Myers (2009) examined the effects of the use of technology on students' mathematics achievement. The study was based on the students' mathematics test result of Florida Comprehensive Assessment Test (FCAT). While Geometers Sketchpad (GSP) was used in the teaching of experimental group, traditional method was used in the control group. The 10th grade students from three public schools in Florida were participated in this study. The findings of the study revealed a significant difference in the FCAT mathematics scores of students who were taught geometry using GSP compared to those who used the traditional method. For both of the studies, it was seen that the tools and the abilities of technology enhanced students' learning.

In a similar study, Ubuz, Üstün and Erbaş (2009) searched effects of technology use on seventh grade students' immediate and retention level of achievement. This study was quasi-experimental design and 63 seventh grade students in a public elementary school participated. Experimental group received instruction with Geometer Sketchpad and control group took traditional instruction. Results of the study revealed that students used dynamic geometry environment in their lessons significantly performed better than those instructed in the traditional environment. Students in EG group had clear definitions and explanations about the geometric properties of the shapes.

Tayan (2011) also studied the effect of computer assisted instruction method on 7th grade students' success in teaching of linear equations and graphics. Data of the study were obtained by using Mathematics Anxiety Scale, Achievement Test for Linear Equations and Graphs, the written interview and focus group call. Experimental method was used and experimental group received computer assisted instruction and the other took traditional one. The research was implemented in the spring semester of 2010-2011 academic years. Results of the study revealed that computer assisted instruction enhanced the students' learning. In a similar study, Yemen (2009) investigated the effect of technology assisted instruction on 8th grade students' achievement and attitudes on analytical geometry instruction. The pretest-posttest control group experimental design was conducted to 50 eighth grade students. "Analytical Geometry Achievement Test" and "Mathematics Attitudes Scale" were used in data collection procedures. For both of the studies, students in experimental groups had higher achievement scores than control groups. This was also indicated that technology assisted instruction method was more effective than traditional method.

Souter (2001) made an action research study to compare the effects of technology enhanced instruction and traditional instruction in terms of students' academic achievement, student motivation, and student attitude towards algebra. The study included four teachers and 92 ninth-grade students in five algebra classes. According to student achievement surveys, after using technology in the technology enhanced classes (TE), 54% of the students had higher grades. Moreover, 62% of TE students claim to be motivated to learn algebra, and 54% of TE students claim that technology makes them more motivated. This result can be interpreted in such a way that technology use in other topics of mathematics increases the student motivation and achievement.

Use of technology supports students' learning, achievement and motivation. Dynamic geometry software that will be explained in the following part was one of the important tools of technology environment.

2.2. Dynamic Geometry Software in Literature

Dynamic geometry software (DGS) are computer programs that allow one to create geometric figures and then manipulate these constructions, primarily in plane geometry. They are effective tool in the mathematics classrooms. This is the reason of suggesting the use of dynamic geometry software in school curriculum (Clark & Jeavonsen, 2002). DGS enhance the students learning. Nickerson (1995) explained five categories how DGS help the understanding of students.

- *Facilitating Simulation:* It helps students to construct the figures and produce the representation of a geometric situation. For example, students can explore a geometric situation such as angle properties and ratios within right-angled triangles.
- *Providing Supportive Environment:* Students are able to make their own construction such as constructing a perpendicular line, a point and a line.
- *Dealing with Misconceptions:* Students question their original knowledge while constructing the geometric shapes and redefine it in the light of their practical experience.
- *Providing Dynamic and Interactive Representations:* This is the property of putting the students in control. Learners internalize activities by extending the pointer on the screen.
- *Promoting Active Processing and Discovery:* Since this software have mathematical construction design tool, the learner can construct simulations and explore the different parameters within the limitations of the software.

The main learning principle in DGS is to provide diagrams that represent a set of geometrical objects and relations instead of a single static diagram (Laborde, Kynigos & Strasser, 2006). They also provide users with the exploring, investigating and posing problems, and constructing flexible representations of situations on symbolic and formal level and serve an ideal learning environment for studying geometry. They add new tools to possible interactions of students with diagrams. These new tools are unavailable in paper and pencil geometry. The range of accessible geometrical constructions and solutions is widened with the use of them (Straesser, 2001).

The first DGS appeared in the eighties (Laborde, Kynigos & Strasser, 2006). There are presently seventy different DGS environments that have been developed across the world. However, original DGS are no more than ten. Some of these DGS which make contribution to investigations in mathematics education listed alphabetically include: *Cabri 3D* (Laborde, Baulac & Bellemain, 1988), *Geometer's Sketchpad* (Jackiw, 1991), *Geometric Supposer* (Schwartz, Yerushalmy & Shternberg, 1985). The *Geometric Supposer* is generally known as the origins of dynamic geometry software. Another commonly used DGS, *Cabri 3D* allows users to build conic sections and investigate the different forms of perspective drawings. *Geometer's Sketchpad* is used as a tool for Euclidean, transformation and co-ordinate geometry. All these constructing programs enhance students' making and testing conjectures.

There are numerous studies about the effects of the use of dynamic geometry software on students' understanding in geometry (Erbas &Yenmez, 2011; Furner & Marinas, 2006; Gecu & Ozdener, 2010; Healy & Hoyles, 2002; Isıksal & Askar, 2005; Kepçeoğlu, 2012; Pierce and Stacey, 2005; Sarı, 2012; Topcu, 2011).

Erbas and Yenmez (2011) investigated the effects of using a dynamic geometry environment together with inquiry-based explorations on the sixth grade students' achievements in polygons and congruency and similarity of polygons. Experimental design was used and groups were formed as 66 students (34 boys and 32 girls) in experimental group and 68 students (35 boys and 33 girls) in control group. Experimental group received the instruction with a DGS, while the students in the control group took textbook-based direct instruction. An achievement test was implemented as pretest, posttest, and delayed posttest in both groups. In addition to this, videotaped classroom observations were used in data collection for qualitative analysis. According to the results, DGS together with open-ended explorations significantly improved students' performances in polygons and congruency and similarity of polygons. Furthermore, students' interest and motivation toward learning geometry in the experimental group was far more than control group. Also, students' comments and interpretations during lessons and tests were more accurate and advanced in the experimental group as they engaged more in the DGS.

Isıksal and Askar (2005) investigated the effect of spreadsheet and dynamic geometry software on the mathematics achievement and mathematics self-efficacy of 7th-grade students. An experimental design was used in the evaluation of the study. Experimental group took Excel and Autograph separately, and a control group took traditional-based instruction without using any technological tools such as a computer or calculator. In the assessment of the students' performance on mathematics "Mathematics achievement" test was used. "Mathematics self-efficacy" scale and "Computer self-efficacy" scale were developed respectively to evaluate the self-efficacy expectation of the students with respect to mathematics and computers.

According to the results of the study, the Autograph group had significantly greater mean scores than the Traditional group. However, no significant mean difference was found between the Autograph and Excel groups and between the Excel and Traditional groups with respect to mathematics self-efficacy. Additionally, significant correlations were found among efficacy scores and achievement. In the comparison of other groups with respect to the mathematics achievement and mathematics self-efficacy, students' scores of the Autograph group had the highest. Moreover, Topcu (2011) investigated the effect of using spreadsheets on self-efficacy beliefs in mathematics. The 10th grade mathematics students in a public secondary school participated in the study. Experimental group received spreadsheet-based instruction in algebra and control group took conventional instruction without spreadsheets. Unlike from the study of Isıksal and Askar, results of this research showed that students who received spread-sheet-based instruction had significantly higher self-efficacy for algebra than those who received conventional instruction.

Healy and Hoyles (2002) investigated the role of software tools in geometry problem solving and how these tools mediated the problem solving process. A nationwide survey was conducted to 2459 students (aged 14-15 years) from 3 different schools in the same area of London; one was mixed-sex, one girl-only and one-boy only. None of the students had used *Cabri* 3D before taking part in this work. Computer activities were organized in four phases. In first phase, students constructed geometrical figures and experimented the relationship with the advent of *Cabri 3D*. In second phase, students organized their explanation. In the third phase, they wrote a proof of one conjecture on the basis of their experimentation. In the last phase, students were given a challenging problem and they were asked to construct a figure with *Cabri 3D* using any of the tools with which they had become familiar. The analysis of successful students' responses revealed that dynamic software tools helped student to move from argumentation to logical deduction in solution process. However, answers of less successful students illustrated how software tools prevent students from expressing their correct mathematical ideas and thus impede their problem solution.

Furner and Marinas (2006) discussed the use of dynamic geometry software to teach geometric concepts for kindergarten to grade 4. Hands on resources that helped learner in technology environment were organized and *Geometer's Sketchpad* was introduced to students. The study showed that dynamic geometry software could be used at the K-4 grade levels as well as middle and high school students since it helped students to understand the topics easily. Use of mathematics software encourages elementary students to have an active role in their own learning. These experiences are foundation for students that can construct ideas into abstract mathematical relationships for future mathematics classes. DGS can be used for the middle school, high school, or college student. Children are more advanced technologically than they were five or ten years ago. Young students' using of the sketching software is an evident for this advancement (Furner & Marinas, 2006). Gecu and Ozdener (2010) examined the effects of using digital photographs on *Geometers' Sketchpad* upon students' achievement, and upon permanence of knowledge. In this study, an experimental research model was used that involved a control group which used *Geometers' Sketchpad*, an experiment group which used *Geometers' Sketchpad* supported by digital photographs that exemplified daily life. Finding of the study demonstrated that there was significant differences in terms of achievement test results in favor of the experiment group. It emphasized that daily life examples and activities, and relationship between them and subjects had a positive impact on students' achievement.

Moreover, Sarı (2012) studied the comparison of effects of learning the seventh grade primary rotation geometry subjects with *Geometer's Sketchpad* and *GeoGebra* on students' success and permanence. While 48 students participated in experimental groups and 24 students participated in control group. First experimental group was taught the subject rotation geometry by using *GeoGebra*, second experimental group took the lessons with *Geometer Skethpad* and control group received the traditional pen and pencil method. According to results, computer aided teaching methods were more effective than traditional methods in terms of learning rotation geometry.

Similarly, Kepçeoglu (2012) examined the effect of using dynamic mathematics software, teaching of continuity concepts on pre-service mathematics teachers' achievement and conceptual learning about these concepts. Experimental design was used and 40 second grade pre-service elementary teachers were chosen as a sample. Control group received traditional instruction; experimental group took some courses in which interactive worksheets were prepared by using GeoGebra software. The findings of the research showed that post test scores of the participants in experimental group were higher than the control group's. Learning limit concept with GeoGebra had a positive effect on achievement of limit and continuity.

Pierce and Stacey (2005) stated that use of dynamic geometry with real world context help students to learn mathematics. Real world images and dynamic simulations provide opportunities for students to collect data and gain mathematical understanding with the use of multiple representations. Students can use the traditional tools of the pen and paper classrooms but the computer established positive associations, color and clarity. Dynamics Geometry software provides advantages for this purposes. GeoGebra is one of these software and it will be discussed in the following part in detail.

2.3. What is GeoGebra?

GeoGebra is open-source dynamic geometry software that was designed to combine arithmetic, algebra, geometry, and calculus in a single, integrated system (Hohenwarter & Preiner, 2007). GeoGebra allows users dynamically to link multiple representations of mathematical objects and it is freely available (Hohenwarter & Jones, 2007). It provides graphical, algebraic, and spreadsheet views for teaching and learning mathematics at all levels and allows users to have the creation of interactive on-line resources which are freely shared by mathematics teachers on a collaborative online platform (http://www.geogebra.org). It is used by thousands of teachers in the 190 countries and 55 languages. It is economically sustainable and intellectually enhancing in supporting the classroom teachers to promote students' learning of mathematics (Hohenwarter, Jarvis, & Lavicza, 2009).

Communication between GeoGebra users is available with its open source properties such as GeoGebraWiki and UserForum where they can discuss their questions and ideas (Hohenwarter & Preiner, 2007). In the use of GeoGebra, teachers need to understand how it works and how it can be effectively combined with classroom activities and curriculum. Teachers can use GeoGebra in the teaching and learning of mathematics in different ways: demonstration, visualization, construction and investigation (Hohenwarter & Fuchs, 2004). Since it is a non-commercial software packages, it has the potential to affect mathematics teaching and learning worldwide without paying money to supply software in the schools (Hohenwarter & Lavicza, 2007). Therefore, these characteristics of GeoGebra are remarkable for researcher in recent years.

Markus Hohenwarter and Yves Kreis are developed the GeoGebra Software. Geometric and algebraic expressions are consisted of a Cartesian coordinate. Not only teachers but also students have the opportunity to use open-source packages both at home and in the classroom and reach the support and user communities. Equal accessibility to technology in teaching and learning of mathematics is a result of such collaborations. (Hohenwarter & Kreis, 2008) It is user friendly in terms of easy interface, multilingual menus, commands and help.

In technology enhanced classrooms students can make explorations to solve problems, communicate mathematical concepts in different ways. Moreover, they use multiple representations that help their visualization and spatial reasoning (Hacıömeroğlu, 2011). There is a great emphasis on the use of multiple representations while presenting the concepts (NCTM, 2000). Since the use of visualization and technology has started to be a significant component of mathematics education, researches on pedagogy that facilitates students' visualization in a technology enhanced classrooms have a priority.

Recently, dynamic geometry software –for example, GeoGebra has provided students with interacting computers, mathematics curriculum and classroom dynamics. Now the difficulty is to design appropriate activities and specify pedagogical strategies for effective teaching and learning of mathematics with GeoGebra (Hacıömeroğlu, 2011).

2.4. Students' Performance on Geometry and Mathematics

National and international examinations are carried out to evaluate the students' performance on mathematics. PISA and TIMSS are studies that measure and compare the students' performance in mathematics and geometry on the international level (PISA, 2009; TIMSS-R, 2011). *Programme for International Student Assessment* (PISA) results showed that Turkish students' rank is 41 from 65 countries. The average mathematics score is 496 and Turkish students are 51 point below the average score. 42 percent of the Turkish students performed below mathematics proficiency level 2. These results are interpreted as most students in Turkey failed to learn basic concepts when they are compared to the other nations (OECD, 2010). *Third International Mathematics and Science Study Repeat* is an international assessment of mathematics and science at the fourth and eighth grades that has been conducted every four years. TIMSS-R (2011) reports revealed similar results. 67 percent of Turkish students reached low benchmarking level in this examination. In the same way, students show low performance in national studies. OBBS (Assessment of Elementary School Students' Achievement) is a study that is conducted every three years in Turkey since 1992. In mathematics, the percentage of average achievement score of questions is approximately 34. National and international assessment studies presented that students' achievement is lower than levels of European Union states (Berberoğlu, 2004). Some of the reasons in low achievement are students' direct inference, single representation, direct reasoning and making literal interpretations about familiar contexts and carrying out routine procedures. In addition to this, minimum standards for basic infrastructure, lack of equipment and educational materials are other causes (Berberoğlu, 2004). TIMSS report showed students who have the opportunity of computer use for mathematics lesson have higher scores than students that do not have this accessibility. The ratio of computer use in lessons is over the 70 percent in countries that are at the top of the list with highest level achievement (e.g. New Zealand) (TIMSS, 2011). High level of achievement can be resulted from the positive effect of computer technology on mathematics achievement among elementary compared to secondary school students (Li &Ma, 2010). However, In Turkey, 33 percent of students use computers at least monthly to explore mathematics principles and concepts look up ideas, information, practice skills and procedures. This is very low ratio when we compare with other European countries. In addition to this, students have some difficulties in learning geometric concepts.

Pierre van Hiele and his wife noticed the difficulties that the students have in learning geometry (Mason, 1998; Usiskin, 1982). In order to eliminate the students' difficulties in learning geometry, they investigated the prerequisite reasoning abilities that help meaningful understanding of the geometric concepts (Malloy, 2002; Mason, 1998). Then, they developed a theory involving students understanding levels of geometry. This theory consists of five levels of understanding of geometry. These levels are visualization, analysis, informal deduction, formal deduction and rigor. In middle school students can be at different levels of understanding. In order to deal with this differentiation, concrete tools, drawing stages and symbolic notations should be used in learning (Malloy, 2002). In brief, in order to develop students understanding of geometry concepts, teachers need to understand the van Hiele levels of their students and they should help them advance through these levels with appropriate learning tools.

In geometry and measurement subcategories of TIMSS and PISA, students in Turkey performed lower achievement than average achievement level (Ubuz, Üstün & Erbaş, 2009). One of the subcategories of measurement is triangle topic and students have misconceptions in this topic. For example, height of a triangle is always inside the triangle, all triangles have similar properties with equilateral triangle (Cutugna & Spagnola, 2002). This shows that students learning are rote and they do not perceive the relationship and implications (Mayberry, 1983). One of the reasons of students' having difficulty in curriculum is both what topics are treated and how they are treated. In the standard elementary and middle school curricula, major focus is recognizing and identifying geometric shapes, writing the proper symbolism for simple geometric concept, developing skills with measurement and construction tools, applying formulas in measurement of geometric shapes (Porter, 1989). From the literature, it can be interpreted that students performance in mathematics and geometry is lacking. In education the question of how we teach is as important as what we teach. Therefore, improvements in teaching of geometry seem inevitable.

Geometry topics where the problems of teaching and learning occurs most in mathematics are planned solid shapes, polygons, triangles, geometrical ratio, geometrical transformation. They are generally identified as difficult concepts for students and teachers (Adolphus, 2011). In the literature there have been many studies related with the students' concept images about these topics (Akuysal, 2007; Aydın, 2007; Cutugno and Spagnolo, 2002; Filiz, 2009; İçel 2011).

For example, Cutugno and Spagnolo (2002) investigated sixth grade students' misconceptions about triangle concept. 77 students participated in this study. Result of this study indicated that students had misconceptions about the definition of triangle, drawing the height, sides and angles of the triangle and explanations of these terms. 45% of the students confused triangle figure with real objects such as flags. This might be because that term was not clear for them. 31% of the students made generalization about property of equilateral triangle to all triangles. 50% of the students had idea that height must be vertical line. The descriptive analysis of this study also showed that important percent of the students did not remember formal rules, definitions and the terms.

Moreover, Aydın (2007) studied on 8th grade students' difficulty about trigonometric concepts. 26 open-ended questions were asked and answers of the students were analyzed qualitatively. Data of the study were collected with semi-structured interview technique during the spring semester in 2005-2006 academic year. In this research 8th grade students were monitored for 16 lesson hours. Then 14 open-ended questions were asked to students. According to the results, students had confusion about sine, cosine, tangent and cotangent. As a conclusion, this qualitative research revealed that students had difficulties on trigonometric concepts such as, drawing angle and triangles, knowing and applying the formulas of Pythagoras and Euclidean Theorems. Parallel with the study result of Aydın (2007), Akuysal (2007) investigated 7th grade students' misconceptions about geometric concepts (angle, polygons, tangent, and triangle). 300 seventh grade students participated in this study and 29 open-ended questions were asked to students. Similarly, result of this study denoted that students had difficulty on side relations and angle-side relations in triangle and trigonometric concept.

2.5. Attitude toward mathematics

Beliefs, conceptions, cognitive variables and emotions are some of the factors that affect students' learning (Ursini & Sanchez, 2008). In particularly, attitudes are known as the key element of learning process. Attitude represents individual's degree of like or dislike about geometry. Aiken (1972) states that "The term attitude as used in the studies refers to the same thing as enjoyment, interest and to some extent level of anxiety". Moreover, attitude towards mathematics is explained as a belief that is the form of a combination of experiences measured in the domains of mathematics (Capraro, 2000). In addition to this, attitude towards mathematics defined as a student's self-reported enjoyment, interest and level of anxiety toward mathematics (Pilli, 2008). It was revealed that attitude towards mathematics affects students' learning of mathematics and achievement in mathematics. In the literature, attitudes have been studied in relation to different factors; academic achievement, use of computers and school life. The results of these studies are not consistent. In some studies positive correlation is found between academic achievement and attitude (Boyraz, 2008; Genç, 2010; Gün, 2011; Mehdiyev, 2009; Myers, 2009; Souter, 2001). However, in some other studies, such as (Eryiğit, 2010; Klein, 2005; Yemen, 2009; Zengin, 2011) have found no significant correlation between them.

Ursini and Sanchez (2004) investigated the changes in girls' and boys' attitudes towards mathematics. It was a longitudinal study and a total of 430 students using technology for mathematics and 109 students not using technology were monitored for 3 years. Students' attitudes were tested at different school levels and it was found that there were some differences between grade levels. While seventh grade students showed negative tendency, eight grade students showed positive tendency to attitude towards mathematics and computer based mathematics. Moreover, the results showed gender differences in students' attitudes and self-confidence did not change significantly over the 3 years. This longitudinal study showed the students' attitudes towards mathematics lessons for different grade levels. Unlike from Ursini and Sanchez, some researchers investigated the effect of DGS on attitude toward mathematics and achievement (Boyraz, 2008; Eryiğit, 2010; Genç, 2010; Gün, 2011; Klein, 2005; Mehdiyev, 2009; Zengin, 2011).

For example, Mehdiyev (2009) investigated on the effects of GeoGebra software on learning geometry. The data were collected by using worksheets, classroom observations, results of pretest and posttest, a questionnaire and interview responses. 20 ninth grade students participated from a secondary school in Azerbaijan. Result indicated that a majority of the students liked the lessons with GeoGebra software program. Moreover, students' motivation, attitude towards mathematics lessons, students' conceptual understanding and problem-solving strategies increased with the use of GeoGebra software program. Results of the study revealed that GeoGebra has a positive effect on attitude towards mathematics lessons and students' motivation.

Gün (2011) examined the seventh grade students' attitudes toward mathematics in terms of cognitive, affective and behavioral components. The subject of the study was 1960 7th grade students from 19 different public elementary schools. According to result, students' attitude towards mathematics significantly explained their confidence in learning mathematics, believes about the usefulness and importance of mathematics. These results indicated that seventh grade students' attitudes towards mathematics can be interpreted in terms of cognitive, affective and behavioral components based on their confidence and believes.

Similarly, Klein (2005) studied the effects of the use of MyMathLab, an online computer assisted instruction (CAI) software program, on college algebra students. One group of the students had access to the online CAI supplemental in traditional classroom instruction. The others received only traditional classroom instruction. The students took a pretest and posttest, filled out a pre-survey and post-survey, and completed a course evaluation and qualitative survey at the end of the semester. The change in test scores was not statistically different between the two sections. As a conclusion, MyMathLab did not influence the students' overall attitude toward mathematics, but it did have a negative effect on the students' beliefs concerning the time.

Moreover, Zengin (2011) investigated the effects of dynamic mathematics software GeoGebra on students' attitudes and achievements in trigonometric functions. The sample of the study was 51 high school students. Among these students while 25 of them were in experimental group, 26 of them were in control group. The experimental group received computer assisted instruction with GeoGebra and the control group took traditional instruction. According to results of this study there is no meaningful difference between the attitudes of the experimental and control group. As a result, the researcher concluded that GeoGebra did not have effect on the students' attitudes towards the mathematics.

Parallel with the study result of Zengin (2011), Boyraz (2008) investigated effects of two different methods of dynamic geometry based on computer instruction on 7th grade students' attitudes towards geometry, technology and spatial abilities and examined the students' ideas related to effects of computer based instruction. Participants of the study were 57 seventh grade students from a private school. The study lasted 14 lesson hours (two weeks). Spatial ability test, mathematics and technology attitude scale, geometry attitude scale and interviews were used to collect data. Consequently, results revealed that dynamic geometry based instruction did not have a significant effect on students' attitude toward geometry.

Genç (2010) investigated the effect of using GeoGebra on 5th grade students' achievement, retention and attitude. Mixed design including experimental design and qualitative methods were used. This model combined the results from qualitative and quantitative researches. 70 students participated in the study Experimental group (n=35) and control group (n=35) were randomly assigned. While the experimental group utilized the computer assisted instruction during the 5 week periods, control group took the lessons with regular classroom activities. Polygons and Quadrilaterals Test and Mathematics attitude scale were used to collect data. Results of the study illustrated that using DGS was more effective on students' success on Polygons and Quadrilaterals compared to the regular classroom activities. Moreover, it was concluded that experimental group showed more positive attitudes and more enthusiasm towards mathematics. Qualitative results showed positive opinions towards the use of GeoGebra such as; easily understandable procedures, applicable practices and free accessibility.

Eryiğit (2010) studied the effects of utilizing the three dimensional dynamic geometry software in geometry teaching on 12th grade students' achievement and attitude toward geometry. The sample of the study was 71 12th grade students in a public school. In experimental group 36 students used *Cabri 3D* in their lessons for five weeks. The prism subject was selected as a learning field. The data was acquired with achievement test and attitude scale. Unlike other studies, results of the study revealed that there was no statistically significant difference between control and experimental groups in attitude scores, but there was a significant difference in terms of achievement.

A causal relationship between attitude and achievement cannot be easily established but in specific groups relationship is seen more clearly (e.g. gender, social economic or ethnics ones). Moreover, attitudes are not stable constructs; they are easily affected by variety of factors. Particularly, attitude towards mathematics can be affected by technology use. However, there is still need to investigate how beliefs and attitude towards mathematics are affected by technology (McLeod, 1992). It is important to investigate how attitude towards mathematics changes with the use of technology in the classroom. Studying these changes in developing countries, where accessibility of technology is still often perceived as a symbol of modernity, needs special interest (Ursini and Sanchez, 2008)

2.6. Summary of the Literature Review

In the literature review chapter, the studies about this study were mentioned briefly. Moreover, the subtitles for the content of the study were determined. To conclude, the use of technology in geometry education, literature about dynamic geometry software and GeoGebra, students' performance, generalization skills on geometry and attitude toward geometry were explained in this part.

The use of technology has a significant role in the contemporary developments and evolution of mathematics and mathematics teaching. The new technologies contributed to higher-level mathematical thinking for students. Computer algebra systems, graphics calculators, microworlds and dynamic geometry tools are some examples of these new technologies. Use of technology supports students' learning, achievement and motivation.

Dynamic geometry software are one of these technologies. They allow users to create geometric figures and manipulate these constructions in plane geometry. They are effective tools in the mathematics classrooms. GeoGebra is one of these DGS that makes contribution to investigations in mathematics education.

GeoGebra is an open-source, freely available software that was designed to combine arithmetic, algebra, geometry, and calculus in a single, integrated system. GeoGebra allows users dynamically to link multiple representations of mathematical objects and help students to increase their performance in mathematics topics.

PISA and TIMSS are studies that measure and compare the students' performance in mathematics and geometry on the international level. According to results, students have low achievement in geometry and use of computers in mathematics education is limited in Turkey. Moreover, students have misconceptions and difficulties in geometry topics. In this study, triangle topic is selected to investigate students' performance in geometry.

Moreover, attitudes are the key elements of learning process. In literature, attitudes have been studied in relation to different factors: academic achievement, use of computers and school life. In this study, attitude towards use of computers is investigated.

CHAPTER 3

METHODOLOGY

This chapter will give basic information about research design, sample, instrumentation, data collection, procedures, data analysis, ethics of the study and threats to internal validity.

3.1. Research Design of the Study

The aim of this study was to investigate the effect of using dynamic geometry on 8th grade students' achievement in geometry and find out about the attitude toward geometry on triangle topic. In this study, quasi-experimental design was used. Experimental research design is the best type to test the hypothesis about cause and effect relationships. It is the only type of research that provides to manipulate a particular variable. The basic experimental design involves two groups of subjects, experimental and control group (Fraenkel & Wallen, 2005). In this study, experimental group was instructed by using dynamic geometry software. On the contrary, control group received instruction with traditional method. The following table shows the overall research design.

Table 3.1.1 The overall research design

Research design	Quasi-experimental Design
Sampling	Convenience sampling
Variables	
• Independent variables	Treatment
• Dependent variables	8th grade students' achievement in geometry and attitudes towards geometry 8th grade students' responses to the open-ended questions

Instruments	Geometry Achievement Test Geometry Attitude Scale Computer Attitude Scale
Data analysis procedure	Independent t-test Correlation Analysis

3.2. Variables

The dependent variable in this study is students' scores in Geometry Achievement Test and Geometry Attitude Scale.

Independent variable in this study is treatment in experimental and control group.

3.3. Participants of the study

Target population of this study was identified as 8th grade public school students in Ankara. The sample was the eighth grade students in a public school in Bala, Ankara where the researcher was a teacher. The researcher's role in this study was to guide students in lessons and provide the active participation of them. The researcher lived and worked as a mathematics teacher in this town for two years. Being a member of the culture of the town, the researcher had a deep understanding of the students' reactions during the treatment. In particular, the researcher could interpret the daily activities of students and their ideas.

Convenient sampling determined the subjects of the study. The school was located in a village that is the 70 km away from the center of the town. A total of 150 students studied in the school. For that reason, class sizes were relatively small as the number of the students in the classes ranged from 15 to 25. However, eighth grade class was crowded when compared to the other grade levels.

There was only one eighth grade class with 36 students in the school. In the implementation of the study, this class was divided into two groups; experimental group with 18 students and control group with 18 students. Groups were equally formed according to students' previous year's mathematics notes. The matching only design was used while forming groups equally. In this design, subjects were matched in the experimental and control groups on certain variables (Fraenkel & Wallen, 2005). Their average of notes in the 6th and 7th grade was used as the matching variable. Students' average notes ranked from highest to lowest and matched according to this order. After the matching, groups were selected randomly as experimental and control groups. Both groups were instructed by the same teacher. Dividing the class as an experimental and control group was not problem for students and teacher. Students in both groups were informed about the study and also permissions were taken from school management. Lesson program arranged according to these new groups. Experimental group instructed in computer laboratory and control group took lesson in their class. For both groups, size of the class became more appropriate than the beginning.

3.4. Context

The school was composed of three buildings with one floor. The class of 8^{th} grade and computer laboratory were in the same building. The computer laboratory of the school was used only for technology course in lesson times. For other lessons, teachers of the school generally preferred the classroom to implement the lessons. Except course time, students benefited from the computer laboratory for searching their homework and sometimes playing game. Therefore, students were very enthusiastic to use the computer laboratory. In the computer laboratory of the school, there were twenty computers but only 12 of them could be used by students. All these twelve computers had the GeoGebra software and students used these computers in pairs.

Students' social economical statuses were low and nearly the same in this school. According to grades of the students and common examination results of the town, students' scores were average level. Each of students has enough ability to use the computers, since the students took the computer technologies lesson for two years in this school. However, the students who participated in the study did not have a computer or internet in their home. In the computer laboratory, the number of boys and girls were approximately equal.

Table 3.4.1 Participant of the study

Groups	Number of Boys	Number of Girls	Total
Control Group	10	8	18
Experimental Group	9	9	18
Total Number	19	17	36

3.5. Measuring Instruments

"Geometry Achievement Test", "Geometry Attitude Scale" and "Computer Attitude Scale" were used to collect data.

3.5.1. Geometry Achievement Test

The purpose of this instrument was to investigate achievement of 8th grade students in geometry. The triangle unit was categorized in three part namely; relationship between sides of triangle, relationship between side and angles of the triangle and Pythagoras Theorem and problems about it. Eighteen open-ended questions with sub-questions were prepared by the researcher of the study. The questions of the instruments were prepared by considering the objectives of the triangle unit in MoNE book.

The following table was prepared for showing the number of the questions based on the objectives of the triangle unit in 8th grade curriculum.

Table 3.5.1 Number of questions in Geometry Achievement Test

Objectives	**Number of questions**
Students will be able to construct altitude, angle bisector and median of a triangle.	4
Students will be able to interpret the relationship between sides of triangle.	4
Students will be able to interpret relationship between side and angles of the triangle.	4

Students will be able to formulate Pythagoras theorem.	3
Students will be able to solve problems about Pythagoras theorem.	3

As it is seen from the table 3.5.1, the number of the questions that was distributed the according to objectives of the triangle units had approximately equal proportion in the test.

Validity means that the degree to which a test measures is what it is expected to measure (Fraenkel & Wallen, 2005). To control the validity and reliability in this study following procedures were applied. Three mathematics teachers and two research assistants in mathematics education checked content validity of the achievement test, structure of the questions and problems and appropriateness for grade level. Then, some of the items were eliminated as they seemed to be unsuitable for eighth grade or they assessed the same objective as another question in the test.

Pilot study of the Geometry Achievement Test was done with 19 eighth grade students in May 2012. After the result of the pilot study, arrangements for questions were done and some of them were not used for test. As a result, 18 items remained in the Geometry Achievement Test. A rubric (Appendix E) was prepared for assessing the students' results in the test. Two raters checked the test scores of students. Cronbach Alpha value for inter-rater reliability was .97.

Reliability means the consistency of the scores obtained from the instrument (Fraenkel & Wallen, 2005). Maximum score for test one can get for Geometry Achievement Test was 100 and minimum score was 0. The test was administered to the students as a pretest and posttest. 40 minutes were given for answering the test.

3.5.2. Geometry Attitude Scale

The Geometry Attitude Scale was used to investigate students' attitudes toward geometry. This test was developed by Duatepe (2004). There were totally 12 items in this scale and five of them (item numbers 3, 4, 5, 8 and 12) were negative, seven of them (item numbers 1, 2, 6, 7, 9, 10 and 11) were positive statements. It was five-point Likert scale with the items “strongly disagree, disagree, uncertain, agree, and strongly agree”. Students rated the statements by marking the scale.

Sample size of the study was too small to conduct a factor analysis (Gorsuch, 1983). The scale was used as one dimensional and the internal reliability estimate of the Geometry Attitude scale was found to be .71 by calculating the Cronbach alpha coefficient.

3.5.3. Computer Attitude Scale

Computer Attitude Scale was used to investigate students’ attitude toward the use of computer in instructions for geometry lessons. The questionnaire was taken from the study conducted by Aydogan (2007). The researcher developed the present instrument from the study of Brown (1996).

Computer Attitude Scale was a five-point Likert-type questionnaire with 21 questions. The items were coded as 5 for strongly agree, 4 for agree, 3 for undecided, 2 for disagree and 1 for strongly disagree for positive statements. Negative statement codes were reversed in the analysis. Cronbach’s alpha coefficient for the internal consistency of instrument was .87.

There were three open-ended questions in computer attitude scale. In order to take the students’ ideas related to the effect of use of dynamic geometry on their learning, they were asked these three questions: “How does computer based learning is useful to you while you are learning geometry?”, “What kind of revisions do you suggest to computer based lessons of geometry?”, “What are the factors that affect your studies in geometry? What kind of revisions do you suggest for geometry lessons based on the factors that affect your studies in geometry?”

3.6. Data Collection and Procedure

The study was decided to be conducted in public school because the researcher taught in that school. Sample of this study was convenient. Two classes in this study were formed according to students GPA and gender since it was an important consideration that two classes had equal mean scores.

The required permission was given from school management. Students were informed about the study. Firstly, Geometry Achievement Test and Geometry Attitude Scale were given as a pretest to the both experimental and control groups. Then, treatment was implemented.

The treatment was lasted for 4 weeks in the first semester of 2012-2013 academic year with 36 students. After the treatment, Geometry Achievement Test and Geometry Attitude Scale were given as a posttest. Moreover, experimental group received the Computer Attitude Scale as only posttest.

3.6.1. Treatment in the Experimental Group

In the treatment group, students were instructed 16 lesson hours with GeoGebra program. All lessons were held in the computer laboratory of the school. In the lab, students investigated and explored geometry topics by using GeoGebra software and they had worksheets prepared by researcher about the topics covered in the lessons. At the beginning, students were given an introduction to GeoGebra for two lesson hours. In the lesson, tools of GeoGebra were explained the students and they applied the directions of teacher to investigate the properties of program such as constructing point, line, triangle and square.

In the following lessons, students developed their skills in the program when compared to the first lessons. They constructed triangles and changed the elements of it which were displayed on-screen dynamically by using dragging tool. Active participation of students was observed in the lessons. They were free to ask questions, make discussion and observation and share their ideas with their friends. In each lesson, they worked in pairs and had activity sheet that contained the instructions about how to construct and drag the objects. After dragging the objects, they observed the results of the movement on the screen and filled the table in the activity sheets to formulate and generalize the results. Moreover, teachers' role in the lessons was to guide students to construct figures and shapes, formulate their answers, and provide the active participation of them.

In the experimental group, each lesson plans (Appendix D) were organized for two lesson hours. In these lessons, students studied the topics of construction of elements of triangle, triangle inequality and side angle relationship, Pythagoras Theorem and problems about Pythagoras Theorem. They practiced the construction of elements of triangles by using GeoGebra and to comprehend constructing triangles. In the first week, four lesson hours included construction of height, bisector and median of a triangle. Lessons were carried out with the lesson plans 1 and 2. Students did the activities that were designed to demonstrate an understanding of constructions. They drew height, bisector and median of a triangle and discovered the relationship between them. The second week also consisted of 4 lessons which included concepts of triangle inequality and lesson plans 3 and 4 carried out. They did the activities which were designed to make them to discover the triangle inequality. They drew triangles with different sides and tested whether it can construct a triangle. Then, they tried to formulate the inequality of triangle. In the third and fourth week of the treatment, students tried to discover the Pythagoras theorem and applied it to problem situations. At the end of the each lesson, students were encouraged to share their observations to the class.

In the treatment of the experimental group, researcher prepared worksheets that included the covered topics in lessons. Objectives of each worksheet were given in the table below. Worksheets helped students to follow the directions.

Table 3.6.1 Objectives of Worksheets

Worksheets	**Objectives**
Worksheet 1 Duration: 20 minutes	• Draw angle bisector, median and height of a triangle. • Investigate the relationship between angle bisector, median and height of a triangle. • Measure angle bisector, median and height of a triangle.

Worksheet 2 Duration: 20 minutes	• Construct angle bisector. • Draw triangle and label the points of it. • Measure the angle of a triangle. • Investigate the angle bisector for different triangles with dragging tool.
Worksheet 3 Duration: 20 minutes	• Construct median of a triangle. • Draw triangle and label the points of it. • Construct a midpoint of a line. • Measure the lines of triangle. • Investigate the median for different triangles with dragging tool.
Worksheet 4 Duration: 20 minutes	• Construct height of a triangle. • Draw perpendicular lines. • Measure the height of a triangle. • Investigate the height for different triangles with dragging tool.
Worksheet 5 Duration: 40 minutes	• Draw different triangles to look whether constructing a triangle or not. • Write the triangle inequality. • Formulate the relationship with verbally and symbolically.
Worksheet 6 Duration: 40 minutes	• Draw lines and construct triangle with them. • Make guess for triangle constructions • Use triangle inequality to find the side of a triangle.
Worksheet 7 Duration: 20 minutes	• Construct triangle with two sides of it given. • Investigate the minimum number of element for triangle construction.

Worksheet 8 Duration: 20 minutes	• Construct triangle with two angles and one side of it given. • Investigate the relationship between the sides and angles. • Investigate the minimum number of element for triangle construction.
Worksheet 9 Duration: 40 minutes	• Construct right- angled triangles. • Write the Pythagoras Theorem.
Worksheet 10 Duration: 40 minutes	• Measure the angle of right-angle triangle. • Measure the sides of right-angle triangle. • Formulate the Pythagoras Theorem. • Solve problems about Pythagoras Theorem

3.6.2. Treatment in the Control Group

In control group, students were taught triangle topic with regular classroom activities. Activities in MoNE book (Aygun et all., 2012) were used. The traditional instruction environment was based on a textbook by using chapters related to triangles from MoNE book. The teacher used lessons plans in the teacher book during the study. In this class, generally, the teacher acted as an information giver and supplied knowledge to the students. Students were explained the concepts and given definition by the teacher and the teacher solved some examples on the whiteboard by writing and drawing. Later, the teacher allowed students to write them on their notebooks. The lessons were continued by solving questions in the course book. The students in this group were responsible for listening teacher, taking notes and solving the questions and discuss the questions with their friends in their own places.

The following table was given to compare the classes in terms of topics covered, their orders and administration of the tests.

Table 3.6.2 Topics covered in Experimental and Control group

Weeks	Experimental Group (GeoGebra was used)	Control Group (Traditional Instruction)
Beginning of the first week	Geometry Achievement Test Geometry Attitude Scale	Geometry Achievement Test Geometry Attitude Scale
1	Construction of elements of triangle (Lesson Plan 1, 2)	Construction of elements of triangle
2	Triangle inequality and side angle relationship (Lesson Plan 3, 4)	Triangle inequality and side angle relationship
3	Construction of triangles (Lesson Plan 5, 6)	Construction of triangles
4	Pythagoras Theorem and Problems (Lesson Plan 7, 8)	Pythagoras Theorem and Problems
At the end of the 4. Week	Geometry Achievement Test Geometry Attitude Scale Computer Attitude Scale	Geometry Achievement Test Geometry Attitude Scale

Table 3.6.2 showed the comparison of experimental and control groups. The control groups were lectured with the regular classroom activities. Questions and problems were solved from the textbook followed. Ruler and protractor were used as a material by teacher and students. Teacher was in a presenter role and students were reading and writing. The experimental groups studied in the computer lab. Students investigated the activities in worksheets and answered the open-ended questions which were also in the worksheet. GeoGebra was used as a tool for discovering the properties of the subjects and making conclusions based on these properties. Researcher was only in a facilitator role. Students were reading, doing, reporting,

discovering, reviewing and discussing.

3.6.3. An Example of One Lesson Hour in Experimental Group

The lesson about Triangle Inequality was selected as an example of the experimental groups' lessons. 18 students in experimental group received instruction in computer laboratory. They came to the laboratory 5 minutes before the lesson and turned on their computer and waited for the teacher. The rules and procedures of this lesson were similar with others. Students investigated this formula by using GeoGebra tools in this lesson. At the beginning of the lesson, teacher asked questions about previous lessons to examine their prerequisite knowledge about the topic. After the question answer part, students divided into groups with two students and each of them took worksheet that includes activity related to triangle inequality formula. After the distribution of worksheets, necessary explanations were given. Then, each pair of students opened the triangle inequality file from their computer.

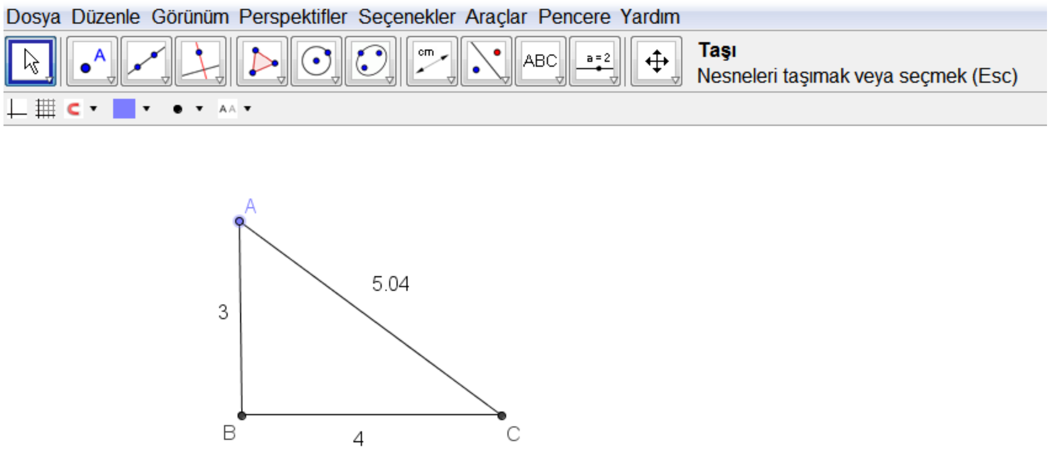

Figure 3.1 Triangle Inequality GeoGebra File

By looking the directions in worksheets, students tried to apply them. Teacher asked students to use selection tool and drag the point A and investigate the changes. Each student discussed the observations with his/her pair, and filled the worksheets. Students were guided by the teacher in this process. For example, there were constant sides with 3 cm and 4 cm. By dragging point A, they investigated the variation in the side c then filled the table to see the relations between sides and cases in which triangle constructed. Students could do this in paper pencil environment but with the help of dragging and other GeoGebra tool, they investigated rapidly and learned with enjoyment. After all groups finished the worksheets, teacher collected them. The projection equipment was used to reflect the questions at the whiteboard. Teacher asked the questions in the worksheet and students shared their answers and ideas about their learning procedures. In this part, students also wrote their solutions at the whiteboard for some of the answers of questions. Students expressed that dragging tool helped them to fill the table easier and faster. Students also said that they had difficulty with reaching and symbolizing the formula while discovering the relationship of sides that is given in the table.

At the end of the lesson, students constructed their own examples in GeoGebra and solved them with their group friends. They had opportunity to solve different examples on their own.

3.6.4. An Example of One Lesson Hour in Control Group

Lessons in control group were applied in students' classroom with traditional teaching. MoNE book was used in all lessons. An example from these lessons was selected to see the procedures in detailed. At the beginning of the course about Triangle Inequality, the repetition of the previous lesson was done. Asking questions about side-angle relationship helped teacher to see the students' prerequisite knowledge. Then teacher wrote the formula (Figure 3.2) at the whiteboard.

In the given ABC triangle, triangle inequality is

$|b-c|<a<b+c$

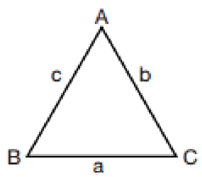

Figure 3.2 Triangle Inequality formula from MoNE book

Next, the teacher gave example (Figure 3.3) at the whiteboard and solved it.

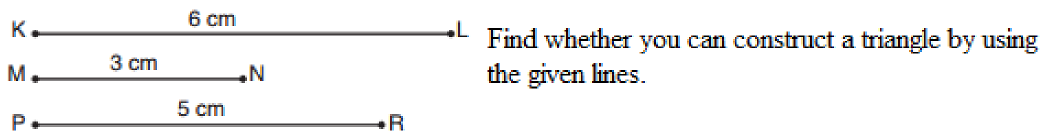

Figure 3.3 Triangle Inequality example from MoNE book

Students posted up the formula and example to their notebook. New examples were also given to support the students' learning. Then, students done the activity namely "Lets' Fold and Measure" in the MoNE book individually (Aygun et all., 2012). Group work was also used in control group and students did the application part in the book. After they completed their work, answers of them were shared and discussed with whole class, teacher corrected the wrong answers. Similar procedures observed in other lessons by following the textbook. Similar to the experimental group, control group students did the activities about the triangle topic from the text book and they made discussion with friends. Major difference between groups was the use of technology tools in the experimental group.

3.7. Data Analysis

SPSS 17.0 was used in data analysis. Both descriptive and inferential statistics were conducted to analyze data. The first and second research questions were investigated by conducting independent t-test. Independent t-test was used when comparing the mean score, on some continuous variable for two different groups of subjects (Pallant, 2007). The third research question was explored with correlation analysis.

The missing data was controlled by using SPSS program. For the test items, the missing data was handled by giving zero point to each blank in the test questions.

The following table was given for looking the time periods for each procedure of this study.

Table 3.7. Time schedule of the study

Date	**Study**
21-25 May 2012	Pilot study
29-31 October 2012	Data collection (Pretests)
November	Treatment
December 2012	Posttests
January 2013	Data analysis and writing thesis

3.8. Ethics of the study

There was no possible harm for the participants of this study. It was ensured that there was no physical, psychological harm for the participants during the study. Moreover, confidentiality of the data obtained from the participants was kept. The names of the participants were not used in any reports. Since students were informed about the study and the procedure clearly, deception was not needed in the study.

3.9. Threats to the interval validity

Internal validity refers to the observed differences on the dependent variable that are directly related to the independent variable. The reason of the difference is not resulted from an unplanned variable (Fraenkel & Wallen, 2005). Since this study included intervention, some of the possible threats to internal validity were data collector bias, testing and attitude of subjects.

Since the researcher of the study was also the teacher of the students, data collector bias could be a threat for internal validity. To minimize this effect, students were informed that treatment was not a part of lessons and the test would not be graded. Moreover, while assessing the test results, researcher covered the name of the students to avoid researcher bias.

Testing was another threat for internal validity of this study, since the students took pretest at the beginning of the treatment. To minimize this threat, time of the treatment was given as four weeks period. That time was given to reduce the possibility of remembering questions.

Moreover, attitude of subject threat could be seen as a result of the treatment in the experimental group. This effect was the result of increased attention about the subject (Fraenkel & Wallen, 2005). To minimize this effect, deception was not used but participants were informed that there would not be grading for applied lessons and measuring instruments.

The results presented in this study were limited with the sample of this study. The participants of the study were eighth grade students in a public school in Ankara. Since convenient sample was used in this study, the participants did not represent a sample of any larger population regarding external validity.

CHAPTER 4

RESULTS

This chapter consisted of quantitative results. In quantitative part, the results of Geometry Achievement Test, Geometry Attitude Scale and Computer Attitude Scale were expressed. Moreover, students' responses from Computer Attitude Scales were presented in details.

4.1. Quantitative Results

4.1.1. Descriptive Statistics of GAT Scores

Geometry Achievement Test was implemented to both experimental and control groups. The descriptive statistics about the pretest and posttest scores were seen in the Table 4.1.

Table 4.1 Descriptive statistics related to pretest and posttest results of experimental and control groups for GAT

	Control Group		Experimental Group	
	Pretest	Posttest	Pretest	Posttest
N	18	18	18	18
Mean	17.61	20.05	21.69	39.44
Median	17.00	19.00	18.25	39.00
SD	7.29	5.44	9.2	13.51
Skewness	1.74	.16	.12	.74
Kurtosis	4.43	-1.05	-1.68	.36
Max	40.00	29.00	34.50	67.50
Min	9.50	11.00	8.00	21.50

Table 4.1 showed that GAT scores were lower at pretest and they changed in the posttest. The mean score of control group increased from 17.61 to 20.05 and experimental group increased from 21.69 to 39.44. This noticeable change in the posttest scores can be considered as a significant difference but statistically it needed further analysis.

In this study independent t-test was used to investigate the mean difference between achievement scores of the groups.

4.1.2. Independent Sample t-test for pretests of GAT Scores

Assumptions of independent t-test; level of measurement, random sampling, independence of observations, normal distribution and homogeneity of variance were checked.

To check normality assumption, Kolmogorov Smirnov test result was looked into for pretest. The non-significant results D=.13 for experimental group and D=.07 for control group indicated the normality. The assumption of equality of variances was violated but other option for this violation using multivariate table was used (Pallant, 2007).

Independence of observations assumption was also checked by observing groups during the administration of all pre and posttests. Observations showed that students did all test themselves. Random sampling was controlled by randomly assigning students to experimental and control groups based on their mathematics grades and gender.

Table 4.2 Independent t-test on experimental and control group students' pretest scores of GAT

Groups	N	$\overline{X}$	T	df	Sig.(2-tailed)
Experimental	18	21.69	1.46	32.18	.15
Control	18	17.61			

Independent samples t-test was conducted to compare the achievement scores for experimental and control groups before the instruction. There was no significant difference in scores for experimental group (*M*=21.69, *SD*=9.28) and control group. (*M*=17.61, *SD*=7.29; *t*(32.18)=1.46, *p*=.15). The pretest results showed that experimental and control groups were equivalent in terms of their geometrical performance at the beginning of the treatment.

4.1.3. Independent Sample t-test for posttests of GAT

Preliminary analyses were performed to ensure that there was no violation of the assumptions. Assumptions of independent t-test; level of measurement, random sampling, independence of observations were checked in a similar way with pretest analysis. To check normality assumption, Kolmogorov Smirnov test result was used. The non-significant results D=.14 for experimental group and D=.15 for control group indicated the normality. The assumption of equality of variances was violated but other option for this violation that using multivariate table was used (Pallant, 2007).

Table 4.3. Independent t-test on experimental and control group students' posttest scores of GAT

Groups	N	$\overline{X}$	T	df	Sig.(2-tailed)
Experimental	18	39.44	5.64	22.37	.000
Control	18	20.05			

$p<.001$

An independent samples t-test was conducted to compare the achievement scores for experimental and control groups after the completion of the treatment. The analysis showed that there was a significant difference in scores for experimental group (*M*=39.44, *SD*=13.51) and control group. (*M*=20.05, *SD*=5.44); *t* (22.37) =5.64, *p*=.00).

4.1.4. Descriptive Statistics of GAS Scores

Geometry Attitude Scale was implemented to both experimental and control groups. The descriptive statistics about Geometry Attitude Scale were seen in the Table 4.4.

Table 4.4. Descriptive statistics related to GAS for experimental and control groups

	Control Group		Experimental Group	
	Pretest	Posttest	Pretest	Posttest
N	18	17	18	16
Mean	31.50	35.7	30.27	47.75
Median	30.50	36	29.50	52
SD	12.98	8.74	13.04	10.98
Skewness	0.054	.16	0.18	-1.59
Kurtosis	-1.25	-.02	-1.31	2.96
Max	52	52	51	58
Min	12	20	12	17

Table 4.4 showed that the mean score of GAS for control group was 35.7 and the mean score of experimental group was 47.75. According to descriptive statistics, attitude towards geometry for experimental group was higher than the control group. Independent t-test was used to investigate the mean difference between GAS scores of the groups.

4.1.5. Independent Sample t-test for GAS before the treatment

Assumptions of independent t-test; level of measurement, random sampling, independence of observations, normal distribution and homogeneity of variance were checked.

To check normality assumption, Kolmogorov Smirnov test result was looked into for attitude scores. The non-significant results D=.20 for experimental and control groups indicated the normality. The assumption of equality of variances was assured with the analysis of Levenes test (p=.99).

Independence of observations assumption was also checked by observing groups during the administration of attitude scales before and after the treatment. Observations showed that students did all test themselves. Random sampling was controlled by randomly assigning students to experimental and control groups.

Table 4.5. Independent t-test on experimental and control group students' GAS scores before the treatment

Groups	N	$\overline{X}$	T	df	Sig.(2-tailed)
Experimental	18	30.27	-.28	34	.78
Control	18	31.50			

Independent samples t-test was conducted to compare the attitude scores for experimental and control groups before the instruction. There was no significant difference in scores for experimental group (*M*=30.27, *SD*=13.04) and control group. (*M*=31.50, *SD*=12.98; *t*(34)=-.28, *p*=.78). The geometry attitude scale scores showed that experimental and control groups were equivalent at the beginning of the treatment.

4.1.6. Independent Sample t-test for GAS after the treatment

Assumptions of independent t-test; level of measurement, random sampling, independence of observations were checked like the pretest and posttest analysis. Normal distribution was investigated with Kolmogorov Smirnov test and homogeneity of variance was checked with Levene's Test (Pallant, 2007). The non-significant results of Kolmogorov Smirnov test D=.15 for experimental group and D=.18 for control group indicated the normality. In this analysis, Levene's Test of equality of variances showed that homogeneity of variance assumption was not violated (p = .55).

Table 4.6. Independent t-test on experimental and control group students' GAS Scores

Groups	N	$\overline{X}$	T	df	Sig.(2-tailed)
Experimental	16	47.75	3.49	31	.001
Control	17	35.70			

$p<.05$

Table 4.5 demonstrated the t-test results for attitude scores. Independent samples t-test was conducted to compare the attitude scores for experimental and control groups. The results showed that there was a significant difference in attitude towards geometry for experimental group (*M*=47.75, *SD*=10.98) and control group. (*M*=35.70, *SD*=8.74); *t* (31) =3.49, *p*=.00).

4.1.7. Correlation Analysis between GAT and GAS Scores

Prior to running the analysis, the statistical assumptions associated with correlation analysis were checked.

The assumptions to be assured before conducting analysis were level of measurement, related pairs, independence of observations, normality, linearity, and homoscedasticity (Pallant, 2007). The variables for correlational analysis were scores for attitudes towards geometry and achievement in geometry which were continuous variables. Hence, level of measurement assumption was assured. Pallant (2007) stated that providing a score on both variables was another assumption of correlational analysis. Since pairwise deletion method was used while dealing with missing data, participants, who were included in the correlation analysis, had both scores which were attitudes towards geometry and achievement in geometry. Therefore, this assumption was ensured. The issue that each measurement was not influenced by other was already mentioned. That is, the measurements were independent from each other; therefore, there was no violation of this assumption. In correlational analysis, mean scores for each variables should be normally distributed (Pallant, 2007). In order to check normality of attitude towards geometry and achievement scores, histograms, normal Q-Q plots, and skewness and kurtosis values were examined. The shape of these graphs indicated that the distributions were normal. In addition, skewness and kurtosis values of each variable are represented in Table 4.6.

Table 4.7. Skewness and Kurtosis Values of GAT and GAS Scores

	Skewness	Kurtosis	N
GAS	-.29	-.72	33
GAT	.40	.79	33

Table 4.30 indicated that skewness and kurtosis values for both variables were placed in the acceptable range. Therefore, normality of distribution assumption was assured for achievement and attitude scores. Another assumption in correlational studies was linearity which referred that the relationship between variables should be linear (Pallant, 2007). In order to examine the linearity between variables scatterplot for GAT and GAS scores were constructed.

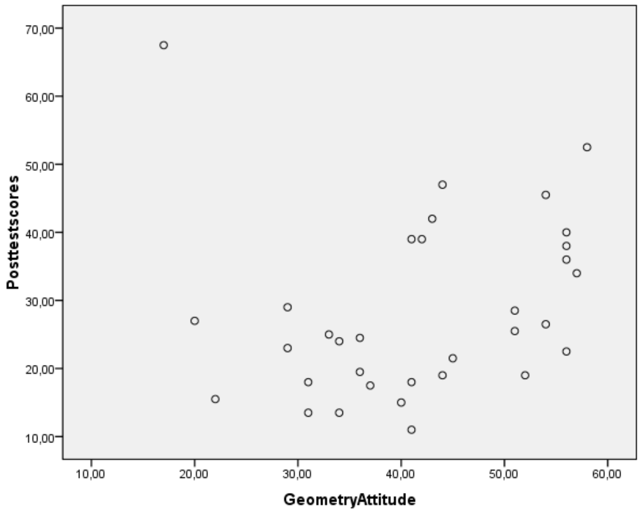

Figure 4 Scatterplot of GAT and GAS Scores

As seen, there was a linear drawn in the scatterplot which indicated the linear relationship between these two variables. Hence, linearity assumption was ensured. The direction of this relationship was positive. Specifically, those who had higher mean scores on achievement had more positive attitude towards geometry. Regarding the slope of the line, it could be inferred that the relationship between achievement and attitude scores were almost moderate.

Homoscedasticity, which referred that variability of achievement scores should be similar to attitude scores, was another assumption of correlation analysis (Pallant, 2007). In order to examine homoscedasticity assumption, scatterplot in Figure 4 was checked. There was a fairly cigar shape in this figure which indicated that homoscedasticity assumption was ensured.

The relationship between attitude toward geometry and achievement in geometry was investigated using Pearson product-moment correlation coefficient. Preliminary analyses were performed to ensure that there was no violation of the assumption of normality, linearity and homoscedasticity. There was a positive correlation between the two variables, $r=.68$, $n=33$, $p<.001$, with a high level of achievement associated with attitude on geometry. This meant that as higher level of 8th grade students' achievement in geometry was associated with higher level of their attitudes towards geometry.

4.1.8. Descriptive Statistics of CAS Scores

Table 4.8. Descriptive statistics related to CAS for experimental group

N	18
Mean	78.44
Median	81.5
SD	8.3
Skewness	-0.94
Kurtosis	-0.10
Max	88
Min	62

Students in experimental group took Computer Attitude Scale after the treatment. Table 4.7 showed the descriptive statistics for CAS scores of them. Maximum score was 88 and minimum score was 62. Mean score for CAS was 78.44. These results showed that students in experimental group have high computer attitude scores.

4.3. Students' Responses from Computer Attitude Scales

In the Computer Attitude Scale, three open-ended questions were asked to the students and they expressed their ideas about the computer lessons. Geometry lessons were interesting and enjoyable for most of them. They were also pleased to use computers and express their ideas in their answers.

In order to get the students' opinions related to the effect of use of dynamic geometry on their learning, they were asked these questions: "How does computer based learning is useful to you while you are learning geometry?", "What kind of revisions do you suggest to computer based lessons of geometry?", "What are the factors that affect your studies in geometry? What kind of revisions do you suggest for geometry lessons based on the factors that affect your studies in geometry?" In the answers, students expressed that computers helped them learn geometry easily and they understood geometry better.

Most of the students in the experimental group except one student was sure that computer based learning were useful for them. The student claimed that computer based learning was not as helpful as it would be because his/her friend who was the pair of that student in the study did not give much chance to use the computer. However, the student also accepted that the figures seen on computer screen were permanent on their mind. Students wrote the benefits of the computer based learning in different ways. These different ways were categorized and the percentages and frequencies were given in table 4.7

Table 4.9 The answers of analyses of Question 1: How does computer based learning is useful to you while you are learning geometry?

	Frequencies and Percentages
Geometry topics were understood better.	11 (61%)
GeoGebra make lessons enjoyable.	9 (50%)
Dragging tool in GeoGebra helped learning.	7 (38%)
Using computer in lessons was difficult.	1 (5%)

It was seen from the Table 4.9 that one student gave negative response and 17 students gave positive responses. However, as it is mentioned above, the student who gave negative response wrote that the learning geometry with computer helped permanent learning.

Table 4.10 The answers of analyses of Question 2: What kind of revisions do you suggest to computer based lessons of geometry?

	Frequencies and Percentages
No suggestions, lessons was good	10 (55%)
Using computers for other mathematics topics such as algebra	6 (33%)

It was seen from the Table 4.10 that 33% of the students suggested that computer could be used for other mathematics topic. Moreover, 55% of the students liked using Geogebra in lessons and they did not have any suggestion for further lessons.

Table 4.11 The answers of analyses of Question 3: What are the factors that affect your studies in geometry? What kind of revisions do you suggest for geometry lessons based on the factors that affect your studies in geometry?

	Frequencies and Percentages
Using GeoGebra for all geometry lessons.	8 (44%)
Each students can have own computer.	5 (27%)
Using games with GeoGebra	4 (22%)

It was seen from the Table 4.11 that 22 % of the students suggested that games can be used with GeoGebra software and this could be combined with activities and geometry topics. Moreover, 44% of the students expressed that GeoGebra can be used for other geometry topics and 27% of them wanted to be have their own computer in the lessons.

Some of the students' answers and explanations of questions: "How does computer based learning is useful to you while you are learning geometry?" "What kind of revisions do you suggest to computer based lessons of geometry?", "What are the factors that affect your studies in geometry? What kind of revisions do you suggest to geometry lessons based on the factors that affect your studies in geometry?" were given below.

Students' answers and their positive ideas about the treatment were given for Question 1. Some of the example for these answers were explained below:

> "In computer, not only I had fun but also learned easier."
>
> "Geometry lessons started to be more enjoyable, we could drag the triangles and change the angles, and it was so funny."
>
> "Learning geometry with computer was not only enjoyable but also more understandable. Therefore, I could understand easier."

Most students found the lessons in computer laboratory funny and enjoyable. They expressed that it was enhanced their learning and helped them understanding better.

Suggestions of the students for mathematics lessons in Question 2 were expressed in following part of the table. Examples were given in the following paragraph:

> "If the mathematic topics was included the lessons, mathematics would also be enjoyable like geometry."
>
> "I want to learn all mathematics topics in the book with computer."
>
> "GeoGebra help us learn more easily. We could design our own game in geometry lesson with this software and construct shapes."

Their suggestions were generally about the use of computer for other mathematics topics. Their regular classroom environment did not include rich learning environment such as teaching materials. In computer laboratory, they were taught with new tools of the GeoGebra software and colorful learning environment on computer screen.

Question 3 was about factors affecting students' learning. Examples was presented below:

> "Drawing in paper pencil environment could require drawings the shapes again and again. However, in computer it is easier and enjoyable."
>
> "For example, in paper-pencil environment, I cannot move or drag the triangle but on computer screen I can do it easily."

"By dragging the shapes, we understood lessons better."

Most students found the dragging tool helpful since it made drawing the shapes easy and fast. Students had difficulty while drawing figures in paper pencil environment but they did it easily in GeoGebra.

4.4. Summary of the Results

To sum up, quantitative results were mentioned in this part. Quantitative result was consisted of independent t-test analysis for achievement and attitude toward geometry and relationship between achievement and attitude. Moreover, their ideas about lessons from computer attitude scales were presented.

An independent samples t-test compared the achievement scores for experimental and control groups after the completion of the treatment and it showed that experimental group (*M*=39.44, *SD*=13.51) had higher achievement than control group (*M*=20.05, *SD*=5.44); *t* (22.37) =5.64, *p*=.00).

Moreover, an independent samples t-test for attitude toward geometry was done to compare the scores for experimental and control groups. Experimental group (*M*=47.75, *SD*=10.98) had higher attitude scores than control group. (*M*=35.70, *SD*=8.74); *t* (31) =3.49, *p*=.00).

Relationship between achievement, attitude toward geometry and attitude toward computer was investigated with correlation analysis. According to results of the analysis, there was a strong positive correlation between students' attitude toward geometry and achievement on geometry with r=.68.

Ideas of students about lessons were given in the last part of the results. Percentages and frequencies of examples from students' sentences were also presented in these results.

CHAPTER 5

DISCUSSION, IMPLICATIONS AND RECOMMENDATIONS

The purpose of this research study was to investigate the effect of dynamic geometry use on the 8th grade students' geometry achievement and geometry attitudes in triangles unit (Triangle Inequality, Pythagoras Theorem).

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

5.1 Discussion of the Findings on Students' Geometry Achievement

Firstly, the results of independent t-test had revealed that there was a statistically significant effect of use of dynamic geometry on students' geometry achievement test scores. In other words, students who were applied technology instruction with GeoGebra had significantly higher scores on Geometry Achievement Test than the students who were not applied. This study results were consistent with many studies in the literature. In those studies it was shown that several dynamic geometry software (Geometry Sketchpad, Cabri 3D, GeoGebra) positively affected students' mathematics achievement (Erbas &Yenmez, 2011; Furner & Marinas, 2006; Gecu & Ozdener, 2010; Healy & Hoyles, 2002; Isıksal & Askar, 2005; Kepçeoğlu, 2012; Pierce and Stacey, 2005; Sarı, 2012; Topcu, 2011).

Moreover, it was confirmed that dynamic geometry based computer instruction had a positive effect on geometry attitude compared to traditional teaching. The result shown here added support to the previous studies that indicated that computer-based instruction affected students' attitudes toward geometry positively (Boyraz, 2008; Genç, 2010; Gün, 2011; Mehdiyev, 2009; Myers, 2009; Souter, 2001). Students' comments were also reflected positive attitudes toward geometry. During the lessons students maintained high level of interest towards geometry topics and they were more willing to participate lessons and give answers to questions. This finding supported the findings of Myers (2009) who found that students in the computer enhanced class demonstrated stronger motivation for doing mathematics than in similar courses where the technology was not incorporated into the learning process. Similarly, Curtis (2006) stated that when students experienced a learning environment different from the traditional teaching, it could have a positive impact on students' attitudes.

The reason for the positive effect on attitude could be explained by the exciting and interesting learning environment that was created by using computers. The enjoyment in the lessons was reflected in the students' comments in computer attitude scale. Most of the students mentioned that studying geometry with computer was very enjoyable and interesting for them. Some of the students also mentioned that they had fun while learning in lessons and they learned easier with GeoGebra tools. From the students' responses, it could be implied that computers provided students with exciting ways of learning geometry which made students find geometry more enjoyable and students' attitudes toward geometry were affected positively. These results supported those of Ursini and Sanchez (2004) who found that students' attitude towards mathematics changed positively from computer based mathematics over the years.

Students' responses in Computer Attitude Scale also expressed participants' interest in mathematics and their attitudes toward the integration of mathematics and technology. Students' comments reflected their attitudes toward technology: "Learning geometry with computer is not only enjoyable but also more understandable"; "I wanted to learn all mathematics topics in the book with computer"; "We see geometry lessons as being fun and something exciting and GeoGebra helps us to learn more easily". Considering these statements, it could be concluded that experience with computers had a positive effect on students' attitudes toward computer use in mathematics education. These findings support the findings of previous studies (Boyraz, 2008; Souter, 2001) which showed positive effect on students' attitude toward technology.

Findings of the study confirmed that use of dynamic software had a significant effect on students' achievement. The result shown here added support to the numerous studies that indicated that technology could be used also to improve students' achievement (Erbas &Yenmez, 2011; Furner & Marinas, 2006; Gecu & Ozdener, 2010; Healy & Hoyles, 2002; Isıksal & Askar, 2005; Kepçeoğlu, 2012; Pierce and Stacey, 2005; Sarı, 2012; Topcu, 2011).

Several reasons might explain the positive effect of computer based instruction on achievement test scores. One of the reasons for the positive effect of computers on achievement could be visual representation that computers provide. Visualization is an important component in learning and teaching geometry and the significance of visualization in the teaching of mathematics was recognized by researchers (Yılmaz, Argün & Keskin, 2009). Using computers provided students a visual way to investigate and understand triangle topic for this research. Students could construct visual representations on the computer screen easily which was often difficult to show with pen and paper. These findings supported that of Nickerson (1995) who expressed that computers help students to visualize concepts and provide dynamic and interactive representations in geometry. Most of the students also indicated that computers provided them supportive environment since it helped them to understand geometry concepts easier.

Another reason for the positive effect of use of dynamic geometry on geometry achievement scores could be beliefs and conceptions which were effective in the students' learning of mathematics concepts (Ursini & Sanchez, 2008). The previous studies showed that the mathematics achievement was affected by students' beliefs about mathematics, especially attitudes toward mathematics (Mehdiyev, 2009; Myers, 2009; Souter, 2001). Students' responses in computer attitude scale emphasized that dynamic geometry software helped them to notice their capacities of being successful in geometry and they gained self-confidence. GeoGebra helped students to gain confidence in their constructions and investigating theorems and formulas. This findings supported the findings of Boyraz (2008) who found that computer based instruction had positive effects on student attitudes toward mathematics and on student self-concept. This finding was also similar to the findings of Mehdiyev (2009) who found that students' motivation, attitude towards mathematics lessons increased with the use of DGS. Considering the mean scores of treatment group, it can be concluded that student centered dynamic geometry computer instruction made much more significant improvement than teacher centered direct instruction. Considering the result of the mean scores, allowing the students to construct triangles, via formulating and testing of their formulas by using the GeoGebra enabled the students to get better scores in geometry achievement test.

Moreover, the results showed that GeoGebra helped students to give true answers for each question, see relations and formulate the generalizations by using the GeoGebra tools. These findings supported the findings of Yılmaz, Argün and Keskin (2009) who found that visualization had an essential role when making general relations and rules therefore it was very important to encourage students to use visualization in their learning process. Similarly, Gecü and Özdener (2010) expressed that using concrete materials such as dynamic geometry software tools, digital images and photographs supported the students' learning of geometry topics.

These results also supported the suggestions of Furner and Escuder (2010) that students were able to make the connections between the images, the mathematics concepts, and the symbolic representation with the use of GeoGebra. Moreover, Furner and Marinas (2006) stated that students today were more willing to learn when activities were presented interactively in a dynamic learning environment . Findings from the students' responses expressed that discovering and exploring with dynamic geometry software affected students' motivation and learning. Some of the students of treatment group stated that their learning were easier and more meaningful than their previous learning since they explored the topics themselves instead of memorizing formulas and theorems. They also expressed that dynamic geometry software allowed them to draw and drag the figures and they actively participated in learning process. These findings supported the findings of Souter (2001) who found that technology use in other topics of mathematics increased the student motivation, achievement and participation.

5.2 Implications

According to research results, the use of dynamic geometry software increased the mathematics achievement and attitude toward mathematics. (Erbas &Yenmez, 2011; Furner & Marinas, 2006; Gecu & Ozdener, 2010; Healy & Hoyles, 2002; Isıksal & Askar, 2005; Kepçeoğlu, 2012; Pierce and Stacey, 2005; Sarı, 2012; Topcu, 2011). Due to this effect, teachers should be aware of the importance of the technology use. Curriculum developers should pay attention to develop computer based instructions for increasing geometry achievement and attitude toward geometry. Teachers could give more importance to include and integrate technological tools to the curriculum.

Teachers need to know how technology could affect their students' understanding of the mathematics and attitudes; they also need to know use of dynamic geometry software. Most of the teachers had a chance to develop their computer skills and integrate the computer to their lessons. However, even though many public schools had computer laboratory, they were generally not used in mathematics or science lessons because of teachers' lack of knowledge about computers and their use for these lessons. Courses about "teaching with computers" should be designed to help and support them for gaining competency of computer use. The government should provide schools with more technology materials. Computer laboratories and internet access should be provided in every school. In addition to this, in every classroom at least one computer with internet access and technical support should be given to teachers.

Pre-service mathematics teachers training programs should develop teachers' use of dynamic geometry programs and their skills about integrating computers to mathematics education. Thus, the prospective teachers can select appropriate activities including technological tools and integrate these to their lessons plans. They could adapt these skills into their job more easily.

Moreover, mathematics textbooks should include mathematics activities that were enhanced with dynamic geometry tools. Even though, use of DGS was recommended in mathematics curriculum, there were lack of activities about the use of these tools in mathematics textbooks. It was suggested that authors of mathematics education books should include computer activities. It was also recommended that the number of educational websites should be increased. Lesson plans and activities about DGS should be included in these websites. The opportunity of using computer software should be given to each student and developed with "Computer Courses".

In this study, participants have low socioeconomical status and they have low mathematics performance. Although, use of GeoGebra increased their performance and motivation when compare to their performance at the beginning, there is still need to discuss the limitation of the study. Many students in rural areas have poor reading performance and lack of problem solving abilities and technology. In addition to this, schools have limited technology and training opportunities. It was suggested that some of the changes may be done in mathematics curriculum for students with low academic achievement. Moreover, it is recommended that further studies may be implemented in these areas.

5.3 Recommendations for Further Studies

The use of dynamic geometry software positively affected the students' achievement in geometry and attitude toward geometry (Erbas &Yenmez, 2011; Furner & Marinas, 2006; Gecu & Ozdener, 2010; Mehdiyev, 2009; Myers, 2009; Souter, 2001). Dynamic geometry software was a technological tool that had been linked to high achievement in mathematics as well as geometry (Klein, 2005). It was recommended that further researches could examine the use of dynamic geometry software on mathematics and science achievement.

Few studies had explored the gender differences on students' achievement and attitude toward geometry (Healy & Hoyles, 2002; Ursini and Sanchez, 2008). It was recommended that more studies should be conducted on effects of gender differences on students' achievement and attitude. Moreover, gender differences of students' use of dynamic geometry software could be investigated.

Dynamic geometry software could be used for every topic in mathematics. Triangles topic were chosen for this study, however it was suggested to use DGS in other topics of geometry. Since convenience sampling was used in this study, the results of the study were limited to the similar samples. Further studies could be done using random sampling methodologies. The treatment of this study could be implemented for longer time period and a larger sample.

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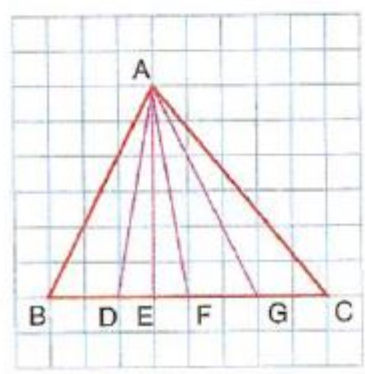
APPENDICES

APPENDIX A

GEOMETRY ACHIEVEMENT TEST

Soru 1: Aşağıda birim karelere ayrılmış zemin üzerinde verilen ABC üçgeninin [BC] kenarına ait kenarortayı aşağıdakilerden hangisidir? Açıklayınız.



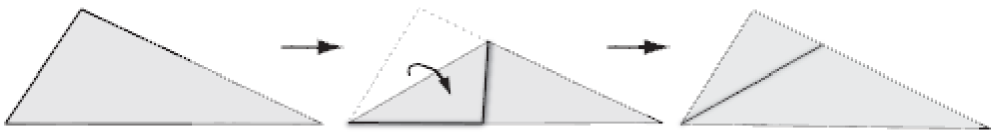
A) [AD]

B) [AE]

C) [AF]

D) [AG]

Soru 2:



Çeşitkenar üçgensel bölge şeklindeki bir kağıdın, yukarıdaki gibi katlanıp açılmasıyla elde edilen katlama çizgisinin, üçgenin hangi elemanı olduğunu işaretleyerek, nedenini açıklayınız.

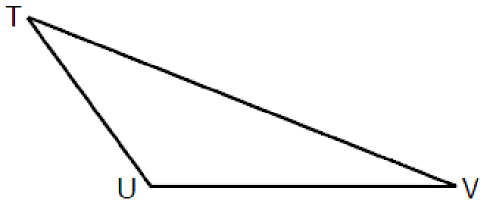
A) Açıortaydır, çünkü...

B) Kenarortaydır, çünkü..

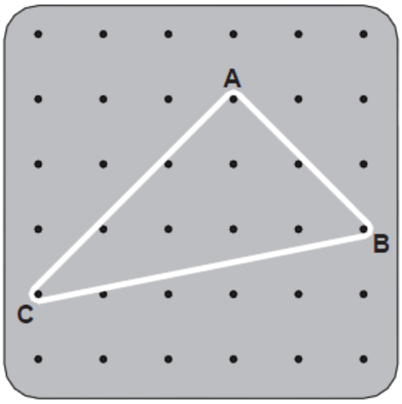
C) Kenar orta dikmesidir, çünkü...

D) Yüksekliğidir, çünkü...

Soru 3: Aşağidaki TUV üçgeninde TUV açısı bir geniş açıdır. Sizce bu üçgenin en uzun kenarı hangisidir? Nedenini açıklayınız.



Soru 4:



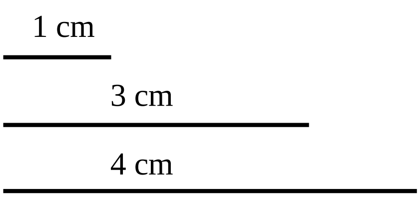
Soru 4: Yandaki geometri tahtasında, bir lastik A,B ve C noktalarındaki çivilere takılarak üçgen oluşturulmuştur. Bu üçgenin iç açılarının ölçülerini büyükten küçüğe doğru sıralayınız. Nedenini açıklayınız.

....

....

....

Soru 5:



a) Yandaki şekilde 1 cm, 3 cm ve 4 cm uzunluğunda çubuklar verilmiştir. Bu çubuklardan bir üçgen oluşturulup oluşturulmayacağını belirtiniz. Nedenini açıklayınız.

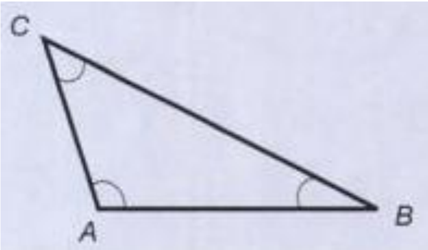
....

b) Aşağıdaki tabloda kenar uzunlukları verilen çubuklardan hangileri ile üçgen oluşturulup hangileri ile oluşturulamayacağını belirtiniz. Tabloyu doldurup açıklayınız.

a kenarı	**b kenarı**	**c kenarı**	**Üçgen oluşur mu?**
2 cm	3 cm	6 cm	
3 cm	4 cm	5 cm	
4 cm	4 cm	7 cm	
3 cm	3 cm	7 cm	

Soru 6: Aşağıda verilen ABC üçgeninde A açısı küçültülüp, AC ve AB uzunluğu aynı tutulursa CB uzunluğu nasıl değiştiğini işaretleyip, nedenini belirtiniz.

A) Değişmez, çünkü.....................................
B) Artar,çünkü..
C) Azalır, çünkü..



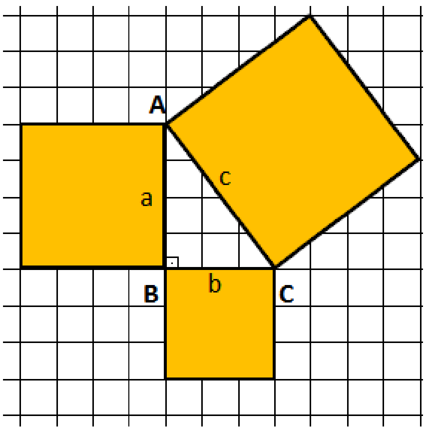
Soru 7: İki kenar uzunluğu 5 cm ve 7 cm olan üçgenin üçüncü kenarının uzunluğunun alabileceği **tam sayı değerleri** nelerdir?

………………………………………………………………………………………
………...

8. soru: Kenar uzunlukları 6 cm ve 9 cm olan üçgenin, üçüncü kenarının uzunluğunun alabileceği tamsayı değerinin **en az ve en çok** kaç cm olabileceğini bulunuz.

En az.........................cm
En çok.......................cm

9. soru:

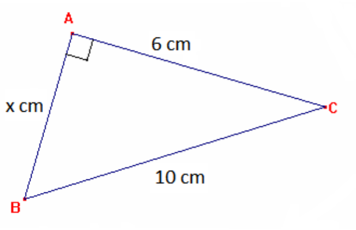


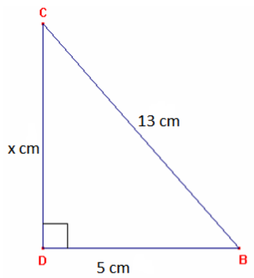
a) Yandaki şekilde verilen ABC dik üçgeninin kenarlarına 3, 4 ve 5 birim kareler çizilmiştir. Karelerin alanları arasında nasıl bir ilişki vardır? Belirtiniz.
....
....

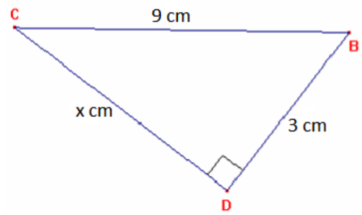
b) ABC dik üçgeninin a, b ve c kenarları arasında nasıl bir ilişki vardır? Açıklayınız.

....
....
....

10. soru: Aşağıda yer alan iki kenar uzunluğu verilmiş dik üçgenlerin üçüncü kenar uzunluğunu bulunuz.





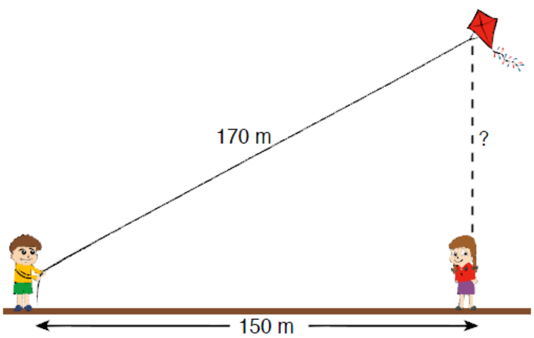


11. soru: Bir dik üçgenin dik kenarlarından birinin uzunluğu 4 cm ve hipotenüsünün uzunluğu 6 cm ise diğer dik kenarının uzunluğu kaç cm'dir?

……………………………………………………………………………………………………

……………………………………………………………………………………………………...

12. soru:



Fatih ve Ayşe birbirlerine 150 m uzaklıkta duruyorlar ve Fatih uçurtma uçuruyor. Uçurtmanın ipi 170 m'dir. Yandaki şekle göre Ayşe ile uçurtma arasındaki uzaklık kaç metredir?

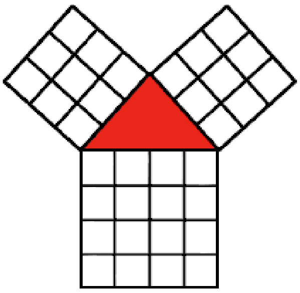
……………………………………………………

……………………………………………………

……………………………………………………

……………………………………………………

……………………………………………………

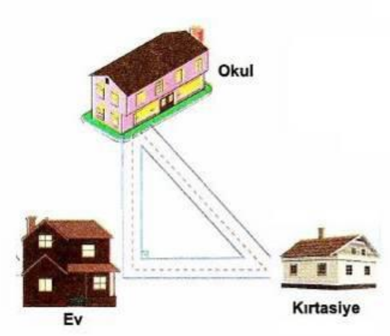


13. soru:

Yandaki şekilde karesel bölgelerin arasında oluşan üçgen dik üçgen midir? Açıklayınız.

....
....
....
....
....

14. soru:

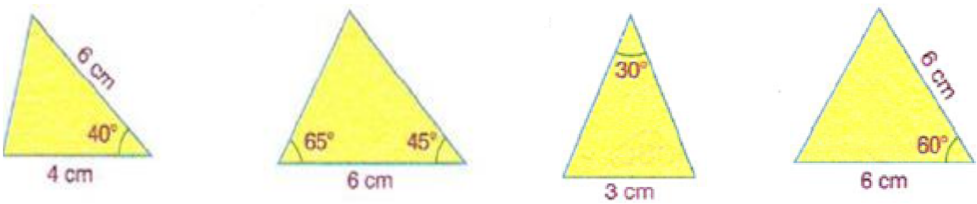


Vedat her gün evden okula giderken 600m yürüyerek gidiyor. Bir sabah okuldan önce kırtasiyeye uğraması gerekiyor. Okul ile kırtasiye arası 1000m dir. Okul, ev ve kırtasiye şekildeki gibi olduğuna göre Vedat kırtasiyeye uğradığı için fazladan kaç metre yürümüştür?

....
....
....

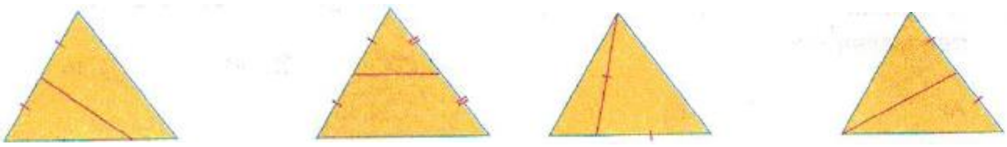
15. Soru: Aşağıda verilen bilgilere göre, üçgenlerden hangisi oluşturulamaz? Açıklayınız.

A) **B)** **C)** **D)**

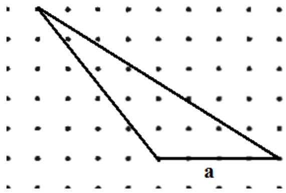


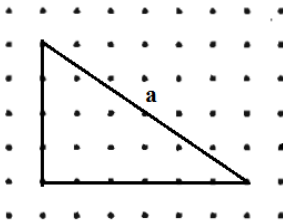
16. Soru: Aşağıdaki üçgenlerden hangisinde herhangi bir kenara ait **kenarortay** çizilmiştir? Açıklayınız.

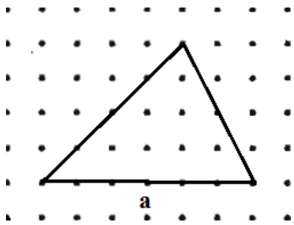
A) **B)** **C)** **D)**



17. Soru: Aşağıda verilen üçgen elemanlarını çizip, açıklayınız.

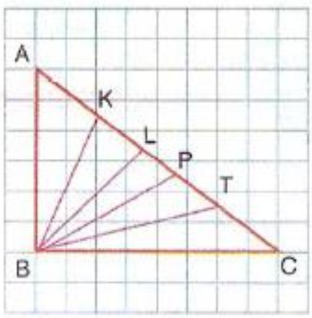






a kenarına ait yükseklik a açısına ait açıortay a kenarına ait kenarortay

18. Soru:



Yanda birim karelere ayrılmış zemin üzerinde verilen ABC üçgeninin B açısına ait **açıortay** uzunluğu hangisidir? Nedenini belirtiniz.

A) [BK]
B) [BL]
C) [BP]
D) [BT]

APPENDIX B

GEOMETRY ATTITUDE SCALE

GEOMETRİYE YÖNELİK TUTUM ÖLÇEĞİ

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

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

APPENDIX C

COMPUTER ATTITUDE SCALE

Ad Soyad: **Yaş:**

Sınıf: **Cinsiyet:**

Genel açıklama: Bu bir bilgi testi değildir ve bu nedenle hiçbir sorunun "doğru" yanıtı yoktur. Aşağıda yer alan sorularla bilgisayar ve bilgisayar ortamında yapmış olduğunuz geometri dersleriniz hakkındaki düşüncelerinizi almak istiyoruz. Her cümle için kendinize en uygun seçeneği işaretleyiniz.

1) Bilgisayar beni korkutuyor.

A) Kesinlikle katılmıyorum B) Katılmıyorum C) Tarafsızım

D) Katılıyorum E) Kesinlikle katılıyorum

2) Bilgisayar kullanma konusunda hiç iyi değilim.

A) Kesinlikle katılmıyorum B) Katılmıyorum C) Tarafsızım

D) Katılıyorum E) Kesinlikle katılıyorum

3) Bilgisayarla çalışmayı seviyorum.

A) Kesinlikle katılmıyorum B) Katılmıyorum C) Tarafsızım

D) Katılıyorum E) Kesinlikle katılıyorum

4) Bilgisayarlarla problemleri çözmek çekici gelmiyor.

A) Kesinlikle katılmıyorum B) Katılmıyorum C) Tarafsızım

D) Katılıyorum E) Kesinlikle katılıyorum

5) Bilgisayarlarla çalışmanın zevkli ve özendirici olduğunu düşünüyorum.

A) Kesinlikle katılmıyorum B) Katılmıyorum C) Tarafsızım

D) Katılıyorum E) Kesinlikle katılıyorum

6) Bilgisayarda geometri öğrenirken kendimi yalnız ve insanlardan uzak hissettim.

A) Hiç B) Çok nadir C) Bazen

D) Çoğu zaman E) Her zaman

7) Bilgisayarda çalışırken kendi kendime öğrenmeye çalışmaktan çok, kendimi yalnızca konuyu bitirmeye çalışırken buldum.

A) Hiç B) Çok nadir C) Bazen

D) Çoğu zaman E) Her zaman

8) Bilgisayarda geometri öğrenirken konu ile ilgili daha çok bilgi edindim.

A) Hiç B) Çok nadir C) Bazen

D) Çoğu zaman E) Her zaman

9) Bilgisayarda geometri öğrenirken konuyu anlamaktan çok bilgisayarı kullanmakla ilgilendim.

A) Hiç B) Çok nadir C) Bazen

D) Çoğu zaman E) Her zaman

10) Bilgisayarlı eğitimle çalışırken geometri konusuna uyum sağlamakta güçlük çektim.

A) Hiç B) Çok nadir C) Bazen

D) Çoğu zaman E) Her zaman

11) Bilgisayarlı eğitim, geometri öğrenirken kendimi rahatsız hissetmeme neden oldu.

A) Kesinlikle katılmıyorum B) Katılmıyorum C) Tarafsızım

D) Katılıyorum E) Kesinlikle katılıyorum

12) Bilgisayarlı eğitim, öğrencinin zamanını boşa harcıyor.

A) Kesinlikle katılmıyorum B) Katılmıyorum C) Tarafsızım

D) Katılıyorum E) Kesinlikle katılıyorum

13) Bilgisayarlı eğitim daha hızlı öğrenmemi sağladı.

A) Kesinlikle katılmıyorum B) Katılmıyorum C) Tarafsızım

D) Katılıyorum E) Kesinlikle katılıyorum

14) Bilgisayarlı eğitimden zevk aldım.

A) Kesinlikle katılmıyorum B) Katılmıyorum C) Tarafsızım

D) Katılıyorum E) Kesinlikle katılıyorum

14) Bilgisayarlı eğitimden zevk aldım.

A) Kesinlikle katılmıyorum B) Katılmıyorum C) Tarafsızım

D) Katılıyorum E) Kesinlikle katılıyorum

15) Bilgisayar destekli eğitimle almış olduğum geometri konularına karşı duygularım çok olumluydu.

A) Kesinlikle katılmıyorum B) Katılmıyorum C) Tarafsızım

D) Katılıyorum E) Kesinlikle katılıyorum

16) Sıkıcı olabilecek konular bile bilgisayarlı eğitimle sunulduğunda ilginç olabilir.

A) Kesinlikle katılmıyorum B) Katılmıyorum C) Tarafsızım

D) Katılıyorum E) Kesinlikle katılıyorum

17) Bilgisayarlı eğitimle öğrendiğim konuyu göz önüne alırsak bilgisayarlı eğitimi geleneksel eğitime tercih ederim.

A) Kesinlikle katılmıyorum B) Katılmıyorum C) Tarafsızım

D) Katılıyorum E) Kesinlikle katılıyorum

18) Bilgisayar üzerinde verilen materyaller derse karşı olan ilgimi arttırdı.

A) Kesinlikle katılmıyorum B) Katılmıyorum C) Tarafsızım

D) Katılıyorum E) Kesinlikle katılıyorum

Aşağıda yer alan soruları bilgisayarlı ortamda yapmış olduğunuz geometri dersleriyle ilgili olarak yanıtlayınız.Lütfen nedenleri de belirtiniz.

1) Geometri öğrenirken bilgisayarlı eğitim sizlere ne şekilde yararlı oldu?

2) Bilgisayar destekli geometri dersine ne gibi değişiklikler önerebilirsiniz?

3) Geometride çalışmalarınızı etkileyen etkenler nelerdir? Bu etkenleri göz önüne alarak geometri dersine ne gibi değişiklikler önerebilirsiniz?

APPENDIX D

LESSON PLANS

DERS PLANI 1

Ders: Geometri

Konu: Üçgenler

Beceriler: Bilgisayar kullanımı, geometrik düşünme, akıl yürütme, ilişkilendirme, problem çözme

Kazanımlar:

- Açıortay, kenarortay, yükseklik ve kenar orta dikmelerini oluşturur, karşılaştırır.
- Açıortay inşaeder.

Süre: 2 saat

Sınıf: 8

Materyal: Bilgisayar, GeoGebra yazılımı, Öğrenci Etkinlik kağıdı 1, Açıortay Çizim Etkinlik Kağıdı

GİRİŞ ETKİNLİKLERİ

Öğrencilerden bir kenarının uzunluğu 4 cm olan eşkenar üçgen oluşturmaları ve eşkenar üçgenin yüksekliğini çizmeleri istenir. Bir üçgen için kaç tane yükseklik çizebilecekleri sorulur. Öğrencilerin ön bilgileri yoklanır.

GELİSTİRME ETKİNLİKLERİ

Öğrenciler gruplara ayırılır ve her birine etkinlik kâgıtları verilir. Ögrenciler ile birlikte etkinlik 1 ve etkinlik 2 deki aktiviteler gerçeklestirilir, sorular ceveplanır.

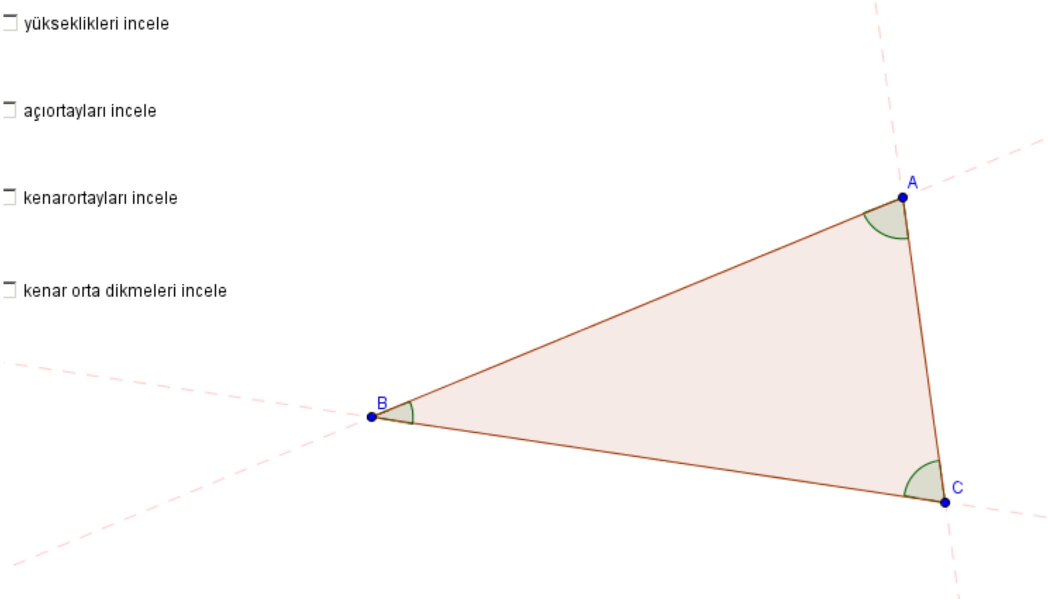
SONUÇ ETKİNLİKLERİ:

Öğrenciler aşağıdaki soruları cevaplarlar.

1. Bir çeşitkenar üçgenin, A, B ve C kenarları için açıortayları, kenarortayları ve yüksekliklerini oluşturup; açıortayların, kenarortayların ve yüksekliklerin kesişim noktalarını bulunuz.
2. Bu kesişim noktalarının aynı olup olmadığını belirtiniz.

ÖGRENCİ ETKİNLİK KAĞIDI 1

1. Bilgisayarınızda interneti açıp, http://samala.pau.edu.tr/main2.php?isim=30 adresine girin. “Üçgendeki özel doğrular”etkinliğini açınız.



2. Yükseklikleri incele seçeneğinden yükseklik A’yı işaretleyiniz. A noktasını kaydırarak yükseklikleri inceleyiniz. Yüksekliğin hangi durumlarda üçgenin dışında olduğunu belirtiniz.

3. Açıortayları incele seçeneğinden açıortay A’yi işaretleyiniz. A noktasını kaydırarak açıortaydaki değişimi inceleyiniz.

4. Kenarortayları incele seçeneğinden kenarortay A’yi işaretleyiniz. A noktasını kaydırarak kenarortaydaki değişimi inceleyiniz.

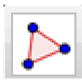
5. Kenar orta dikmeleri incele seçeneğinden A'yi işaretleyiniz. A noktasını kaydırarak kenar orta dikmedeki değişimi inceleyiniz.

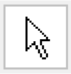
6. Açıortay, kenarortay ve yükseklik hangi durumda birbirine eşittir? A noktasını kaydırarak farklı durumlarda üçgenin elemanlarını uzunluklarını belirleyiniz ve sıralayınız.

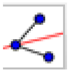
Referans : Sanal Matematik Labaratuarı;
http://samala.pau.edu.tr/index.php

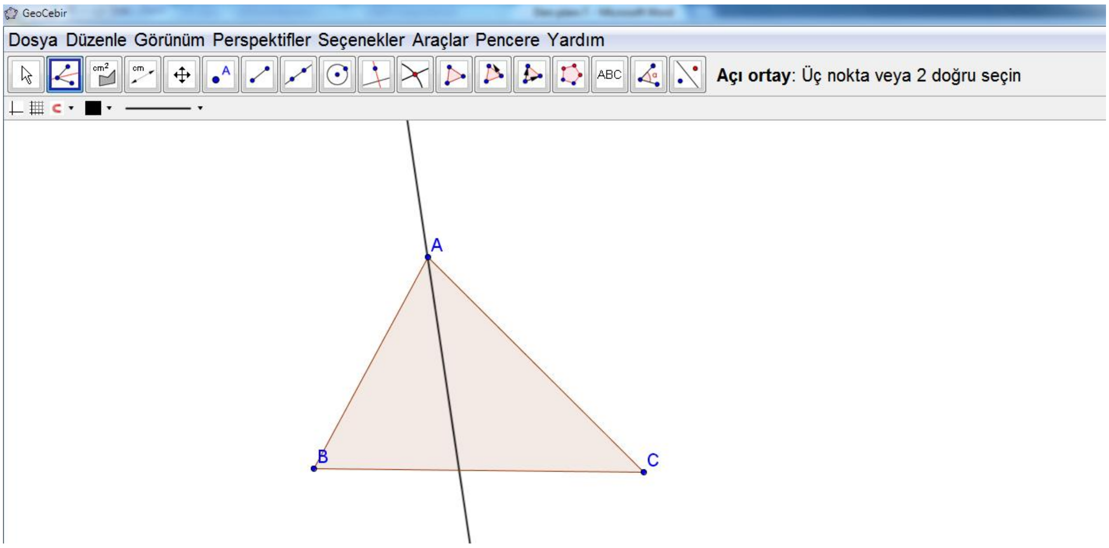
ÖĞRENCİ ETKİNLİK KAĞIDI 2

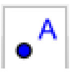
1. Cebir görünümünü ve koordinat eksenlerini gizleyelim. Görünüm menüsüne tıkladıktan sonra Eksenlere ve Cebir Penceresine tıklayınız.

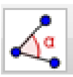
2.  **Çokgene** tıkladıktan sonra A, B ve C üçgeni çizmek için çizim alanında üç farklı yere tıklayınız.

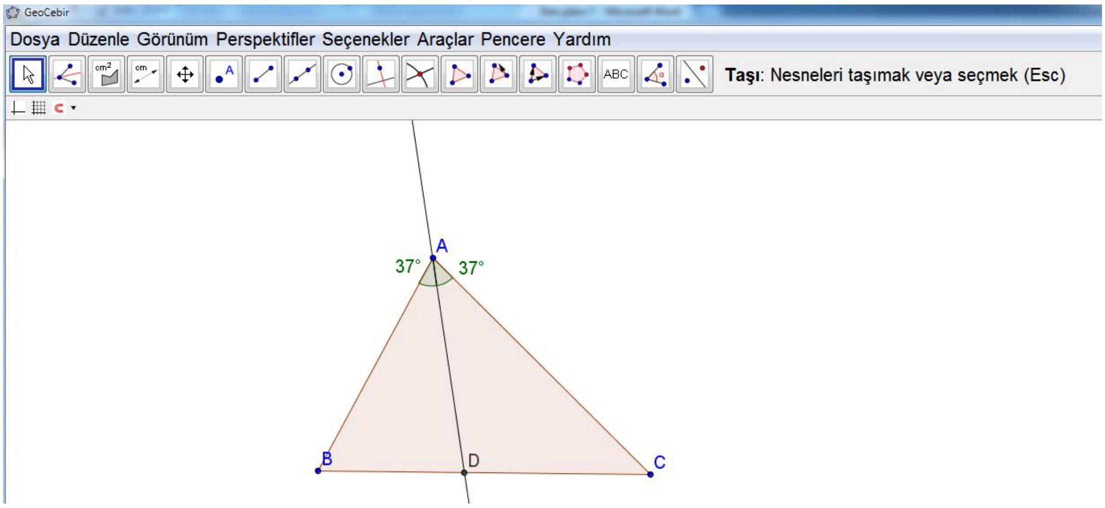
3.  Eğer noktaların etiketleri gösterilmiyorsa, Taşı düğmesine tıkladıktan sonra, her noktanın üzerine sağ tıklayıp çıkan menüden Etiketi gösteri tıklayınız.

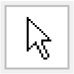
4.  **Açıortay** aracını seçtikten sonra A köşesinin açıortayını oluşturmak için B, A ve C noktalarına tıklayınız.



5.  **Nokta**yı seçerek açıortay ve BC kenarının kesişimini işaretleyiniz. Noktayı sağ tıklayıp etiketi göster seçeneğini tıklayıp D noktasını oluşturun.

6.  Açı aracına tıklayınız ve sırayla C noktası, A noktası ve D noktasını tıklayın. CAD açısını bulduktan sonra aynı şekilde DAB açısını hesaplayın.



7.  A noktasına tıklayıp A noktasını sürükleyin. Açı değerlerindeki değişimi gözlemleyin.

SORULAR

1. Dördüncü adımda oluşturduğunuz doğru A açısını nasıl böler? Bu doğru nasıl isimlendirilir?

2. Yedinci adımda A noktasını sürüklediğinizde açılarda nasıl bir değişim gözlemlediniz? Açıklayınız.

3. A açısı için izlenilen adımları kullanarak B ve C açıları için açıortaylar oluşturunuz.

4. Açıortayların kesişim noktasını belirleyiniz. A, B ve C noktalarını sürüklediğinizde açıortayların kesişim noktası nasıl değişir? Açıklayınız.

DERS PLANI 2

Ders: Matematik

Sınıf: 8

Öğrenme Alanı: Geometri

Alt Öğrenme Alanı: Üçgenler

Beceriler: Bilgisayar kullanımı, geometrik düşünme, akıl yürütme, ilişkilendirme, problem çözme

Kazanımlar:

- Kenarortay inşa eder.
- Yükseklik inşa eder.

Araç-Gereçler: Bilgisayar, GeoGebra yazılımı

GİRİŞ ETKİNLİKLERİ

Öğrencilerden bir önceki derste öğrendikleri açıortay çizimi ile ilgili sorular sorulur. Öğrenci tanımları alınır. Öğrencilerin yükseklik ve kenarortay ile ilgili ön bilgileri yoklanır.

GELİSTİRME ETKİNLİKLERİ

Öğrenciler gruplara ayırılır ve her birine etkinlik kâgıtları verilir. Ögrenciler ile birlikte etkinlik 3 ve etkinlik 4 deki aktiviteler gerçeklestirilir, belirtilen sorular ceveplanır.

- Öğrenciler Etkinlik 3 için aşağıdaki soruları cevaplar.

1. Beşinci adımda oluşturduğunuz doğru parçası BC kenarını nasıl böler? Bu doğru nasıl isimlendirilir?

2. Yedinci adımda A noktasını sürüklediğinizde kenar uzunluklarında nasıl bir değişim gözlemlediniz? Açıklayınız.

3. A köşesinden oluşturlan kenarortay için izlenilen adımları kullanarak B ve C köşeleri için kenarortaylar oluşturunuz.

4. Kenarortayların kesişim noktasını belirleyiniz. A, B ve C noktalarını sürüklediğinizde kenarortayların kesişim noktası nasıl değişir? Açıklayınız.

- Öğrenciler Etkinlik 4 için aşağıdaki soruları cevaplar.

1. Dördüncü adımda oluşturduğunuz doğru parçasının BC kenarı ile oluşturduğu açı kaç derecedir? Bu açı nasıl isimlendirilir?

2. Altıncı adımda A noktasını sürüklediğinizde ADC açısında nasıl bir değişim gözlemlediniz? Açıklayınız.

3. A köşesinden oluşturulan yükseklik için izlenilen adımları kullanarak B ve C köşeleri için yükseklik oluşturunuz.

4. Geniş açılı üçgen oluşturduğumuzda yükseklik çizimini yapınız. Geniş açılı üçgende yükseklik üçgenin hangi bölgesinde oluşur?

SONUÇ ETKİNLİKLERİ:

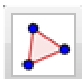
Öğrenciler aşağıdaki soruları cevaplarlar.

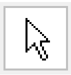
1. Bir eşkenar ve ikizkenar üçgenin, A, B ve C kenarları için açıortayları, kenarortayları ve yüksekliklerini oluşturup; açıortayların, kenarortayların ve yüksekliklerin kesişim noktalarını bulunuz.
2. Bu kesişim noktalarının aynı olup olmadığını belirtiniz.

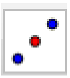
ÖĞRENCİ ETKİNLİK KAĞIDI 3

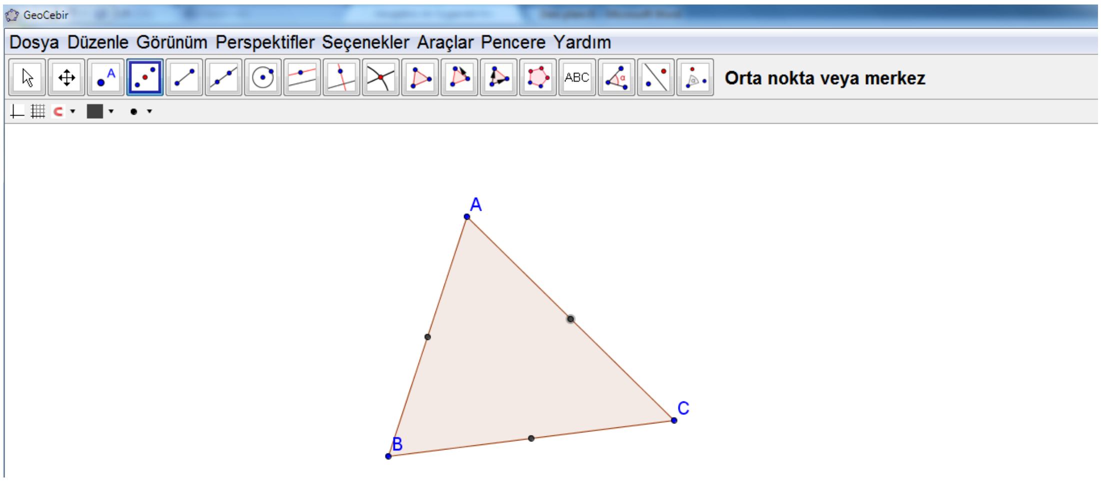
Kenartay Çizimi

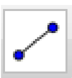
1. Cebir görünümünü ve koordinat eksenlerini gizleyelim. Görünüm menüsüne tıkladıktan sonra Eksenlere ve Cebir Penceresine tıklayınız.

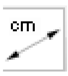
2.  **Çokgene** tıkladıktan sonra A, B ve C üçgeni çizmek için çizim alanında üç farklı yere tıklayınız.

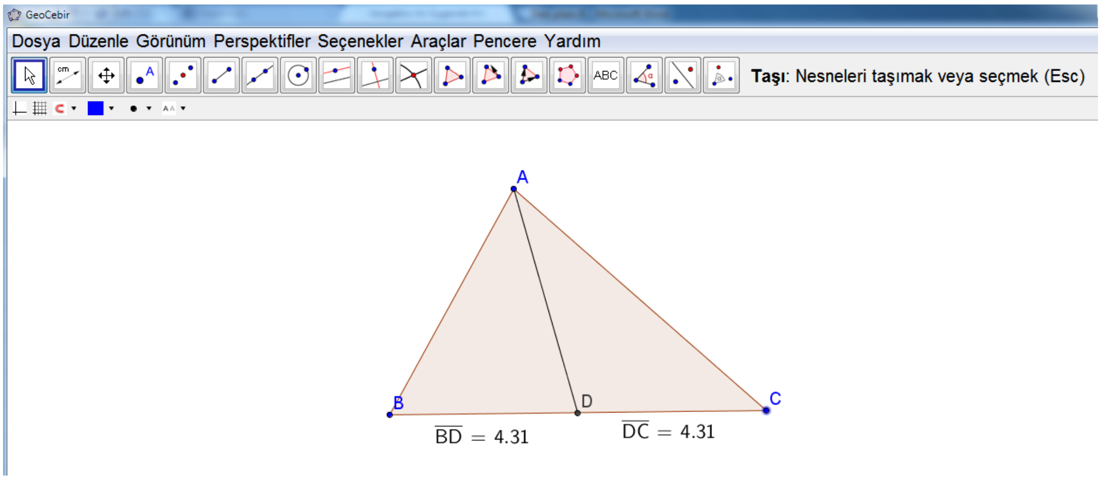
3.  Eğer noktaların etiketleri gösterilmiyorsa, Taşı düğmesine tıkladıktan sonra, her noktanın üzerine sağ tıklayıp çıkan menüden Etiketi gösteri tıklayınız.

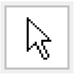
4.  **Orta nokta veya merkez** aracını seçtikten sonra orta noktaları oluşturmak için AB kenarını, BC kenarını ve AC kenarını tıklayınız. Her noktanın üzerine sağ tıklayıp çıkan menüden Etiketi gösteri tıklayınız. Noktalar D, E ve F noktaları olarak işaretlenecektir.



5.  **İki noktadan geçen doğru parçasını** seçerek A ile D noktasını birleştiriniz.

6.  **Uzaklık veya uzunluk** aracını seçip, B ve D noktalarını tıklayınız. Sonra D ve C noktalarını tıklayınız. Uzunluklar otomotik olarak hesaplanacaktır.

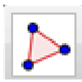


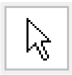
7.  B noktasına tıklayıp, B noktasını sürükleyin. BD ve DC kenarlarındaki değişimi gözlemleyiniz.

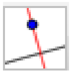
ÖGRENCİ ETKİNLİKKAĞIDI 4

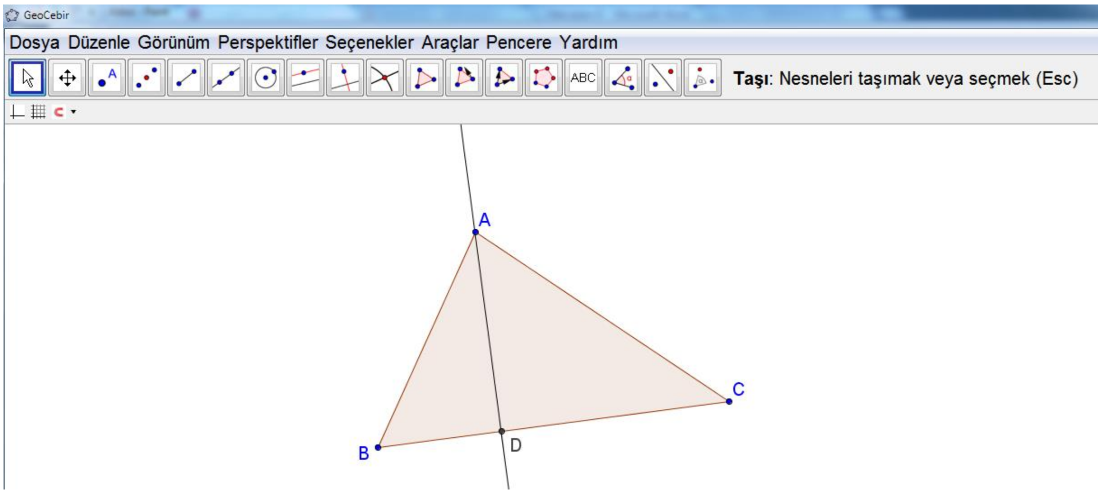
Yükseklik Çizimi

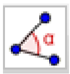
1. Cebir görünümünü ve koordinat eksenlerini gizleyelim. Görünüm menüsüne tıkladıktan sonra Eksenlere ve Cebir Penceresine tıklayınız.

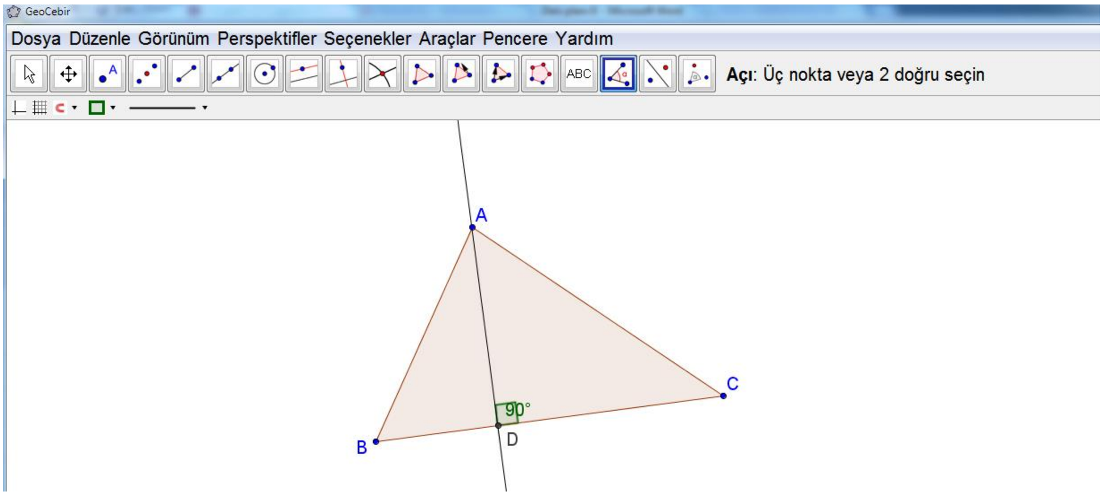
2.  **Çokgene** tıkladıktan sonra A, B ve C üçgeni çizmek için çizim alanında üç farklı yere tıklayınız.

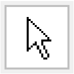
3.  Eğer noktaların etiketleri gösterilmiyorsa, Taşı düğmesine tıkladıktan sonra, her noktanın üzerine sağ tıklayıp çıkan menüden Etiketi gösteri tıklayınız.

4.  **Dik doğru** aracını seçtikten sonra A köşesini ve BC kenarını tıklayınız. Dik doğrunun BC kenarı ile olan kesişim noktasını işaretleyiniz ve noktayı sağ tıklayıp çıkan menüden Etiketi gösteri tıklayınız. Nokta D noktası olarak işaretlenecektir.



5.  **Açı** seçeneğini seçerek A, D ve C noktalarını işaretleyiniz ve açıyı hesaplayınız.



6.  B noktasına tıklayıp, A noktasını sürükleyin. ADC açısındaki değişimi gözlemleyiniz.

DERS PLANI 3

Ders: Geometri

Konu: Üçgenler

Beceriler: Bilgisayar kullanımı, geometrik düşünme, akıl yürütme, ilişkilendirme, problem çözme

Kazanımlar: Üçgen eşitsizliğini kavrar.

Süre: 2

Materyal: Bilgisayar, GeoGebra yazılımı

GİRİŞ ETKİNLİKLERİ

Kenar açı arasındaki bağıntılar konusunda öğrencilerin ön bilgileri yoklanır. Bir üçgenin iki kenarının arasındaki açıyı artırıp azalttığımızda karşı kenarında nasıl bir değişim olduğu konusunda öğrencilerin fikirleri alınır.

GELİSTİRME ETKİNLİKLERİ

Öğrenciler 2'ser kisilik gruplara ayırılır ve her birine etkinlik 5 ve etkinlik 6 kâgıtları verilir. Ögrenciler ile birlikte aktiviteler gerçeklestirilir.

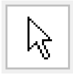
SONUÇ ETKİNLİKLERİ:

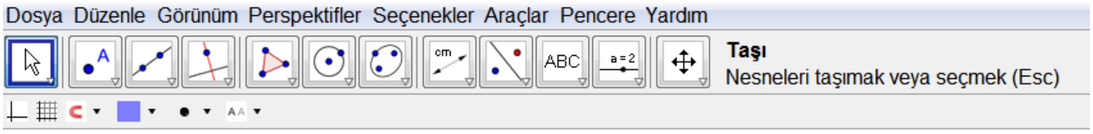
1.Ögrencilere üçgenin kenar uzunlukları arasında bir bağıntı olup olmadığı sorulur, üçgen eşitsizliğini yazmaları istenir.
2. Öğrenciler kendileri farklı üçgenler oluşturup, üçgen eşitsizliğini farklı üçgenler için inceler.
3. Öğrenciler üçgen eşitsizliği formulunü kullanarak, bir kenarı verilmeyen üçgenin kenarının alabileceği değerleri bulur.

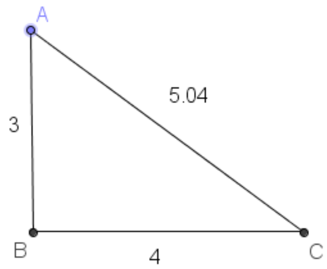
- Kenarları 10 cm ve 15 cm olan üçgenin diğer kenarının alabileceği değerleri bulunuz.

ÖGRENCİ ETKİNLİKKAĞIDI 5

1. Bilgisayarınızdan "Üçgen Eşitsizliği" Geogebra dosyasını açınız.

2. ABC üçgeninin A noktasını seçme  aracını kullanarak seçiniz ve bu noktayı sürüklediğimizde değişimleri gözlemleyiniz.





3. ABC açısını artırırsak AC kenarının uzunluğu nasıl değişir?

4. ABC açısını azaltırsak AC kenarının uzunluğu nasıl değişir?

5. a=3 ve b=4 kenarlarının uzunluğu sabittir. c kenarının hangi değerleri için üçgen oluşabilir? A noktasını sürükleyerek c kenarındaki değişime göre tabloyu doldurunuz.

A	**B**	**C**	**Üçgen oluşur mu?**
3	4	5	
3	4	6	
3	4	7	
3	4	4	
3	4	3	
3	4	2	
3	4	1	

6. Hangi durumlarda üçgen oluşmamıştır? Tabloya göre a+b, a-b ve c kenarları arasında nasıl bir ilişki vardır? Açıklayınız.

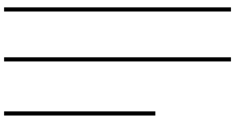
7. a +b, a-b ve c kenarı arasındaki ilişkiyi sembol kullanarak gösteriniz.

Referans:

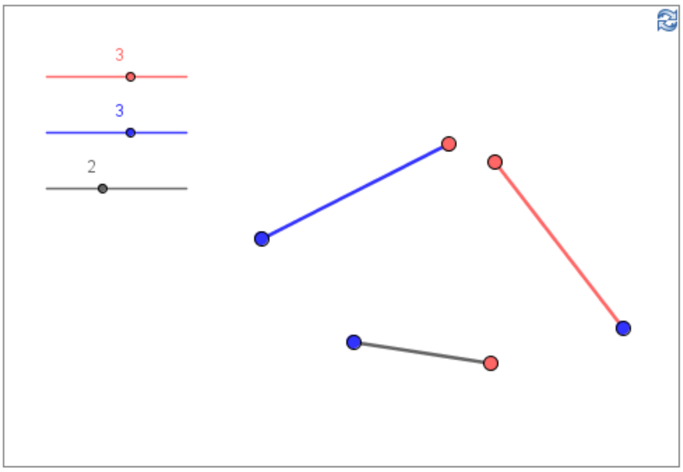
http://geogebra.org/cms/

ÖGRENCİ ETKİNLİKKAĞIDI 6

1. Bilgisayarınızdan “Üçgen Oluşturalım” etkinliğini açınız.
2. Aşağıda kenarları 3 cm, 3 cm ve 2 cm olan çubuklar verilmiştir. Sizce bu çubukları uçlarından birleştirerek üçgen oluştururabilir miyiz? Tahmininizi yazınız.



3. Sürgüleri kullanarak 3 cm, 3 cm ve 2 cm olan bu çubukları oluşturunuz. Noktalardan kenarları birleştirip üçgen oluşup oluşmadığını kontrol ediniz. Bulduğunuz sonuçla tahmininizi karşılaştırınız.



4. Aşağıda verilen değerler için üçgen oluşup oluşmadığını sürgüleri kullanarak kontrol ediniz. Tabloyu doldurunuz.

A	**B**	**C**	**Üçgen oluşur mu?**
1	1	3	
1	2	4	
2	2	5	
3	4	5	
5	1	5	
4	4	4	

5. Hangi durumlarda üçgen oluşmamıştır?

6. Bulduğunuz ilişkiyi kullanarak, iki kenar uzunluğu 3 cm ve 2 cm olan üçgenin diğer kenarı hangi değerleri alabilir? Hesaplayınız.

Referans

Sanal Matematik Labaratuarı http://samala.pau.edu.tr/index.php

DERS PLANI 4

Üçgenin Temel Elemanları Çizimi

Ders: Matematik

Sınıf: 8

Öğrenme Alanı: Geometri

Alt Öğrenme Alanı: Üçgenler

Beceriler: Bilgisayar kullanımı, geometrik düşünme, akıl yürütme, ilişkilendirme, problem çözme

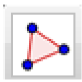
Kazanımlar:

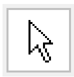
- Yükseklik inşaeder.

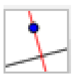
Araç-Gereçler: Bilgisayar, GeoGebra yazılımı

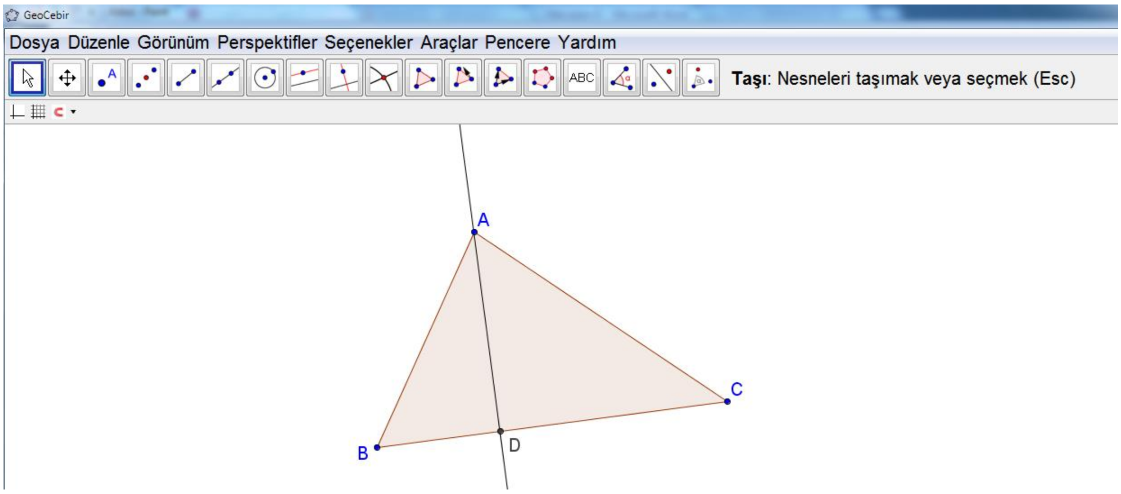
Yükseklik Çizimi

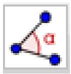
1. Cebir görünümünü ve koordinat eksenlerini gizleyelim. Görünüm menüsüne tıkladıktan sonra Eksenlere ve Cebir Penceresine tıklayınız.

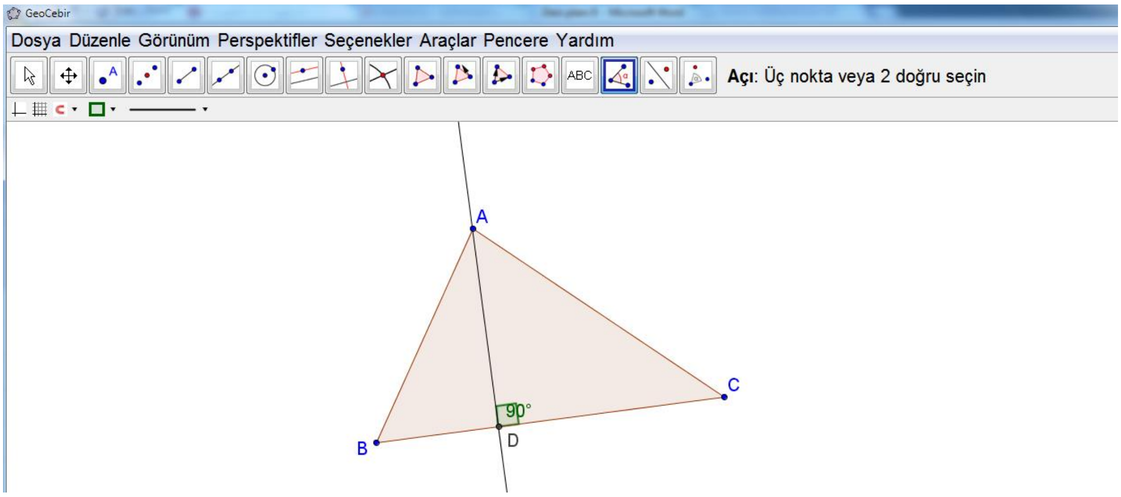
2.  **Çokgene** tıkladıktan sonra A, B ve C üçgeni çizmek için çizim alanında üç farklı yere tıklayınız.

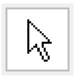
3.  Eğer noktaların etiketleri gösterilmiyorsa, Taşı düğmesine tıkladıktan sonra, her noktanın üzerine sağ tıklayıp çıkan menüden Etiketi gösteri tıklayınız.

4.  **Dik doğru** aracını seçtikten sonra A köşesini ve BC kenarını tıklayınız. Dik doğrunun BC kenarı ile olan kesişim noktasını işaretleyiniz ve noktayı sağ tıklayıp çıkan menüden Etiketi gösteri tıklayınız. Nokta D noktası olarak işaretlenecektir.



5.  **Açı** seçeneğini seçerek A, D ve C noktalarını işaretleyiniz ve açıyı hesaplayınız.



6.  B noktasına tıklayıp, A noktasını sürükleyin. ADC açısındaki değişimi gözlemleyiniz.

Öğrenme ve Öğretme Süreci

1. Dördüncü adımda oluşturduğunuz doğru parçasının BC kenarı ile oluşturduğu açı kaç derecedir? Bu açı nasıl isimlendirilir?

2. Altıncı adımda A noktasını sürüklediğinizde ADC açısında nasıl bir değişim gözlemlediniz? Açıklayınız.

Ölçme ve Değerlendirme

1. A köşesinden oluşturulan yükseklik için izlenilen adımları kullanarak B ve C köşeleri için yükseklik oluşturunuz.
2. Geniş açılı üçgen oluşturduğumuzda yükseklik çizimini yapınız. Geniş açılı üçgende yükseklik üçgenin hangi bölgesinde oluşur?

DERS PLANI 5

Ders: Geometri

Konu: Üçgenler

Beceriler: Bilgisayar kullanımı, geometrik düşünme, akıl yürütme, ilişkilendirme, problem çözme

Kazanımlar: İki kenarı bir açısı verilen üçgen inşa eder.

Süre: 2 saat

Sınıf: 8

Materyal: Bilgisayar, GeoGebra yazılımı

GİRİŞ ETKİNLİKLERİ

Üçgenin hangi elemanlardan oluştuğu sorulur. Öğrencilerin üçgen, üçgenin açıları ve kenarları hakkındaki ön bilgileri yoklanır.

Kenar uzunlukları 5 cm, 4 cm ve 8 cm olan bir üçgen verilir açılarını büyükten küçüğe sıralamaları istenir.

GELİSTİRME ETKİNLİKLERİ

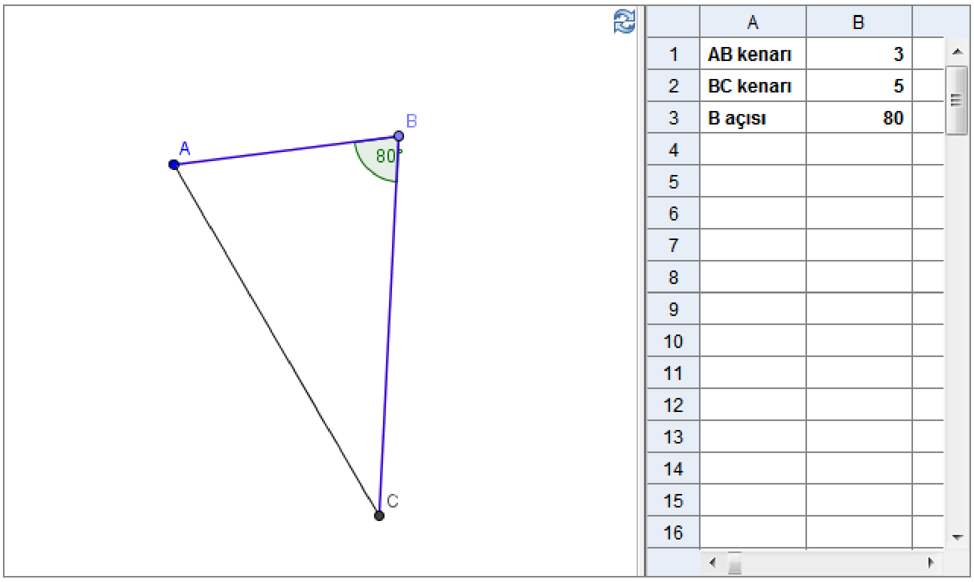
Öğrenciler gruplara ayırılır ve her birine etkinlik kâgıtları verilir. Ögrenciler ile birlikte aktiviteler gerçeklestirilir.

SONUÇ ETKİNLİKLERİ:

1. Öğrenciler iki kenarı ve bir açısı verilen dik açılı, geniş açılı ve dar açılı üçgenler oluştururlar.

ÖGRENCİ ETKİNLİKKAĞIDI 7

1. Bilgisayarınızda interneti açıp, http://samala.pau.edu.tr/main2.php?isim=30 adresine girin. "İki kenar bir açı ile üçgen"etkinliğini açınız.



2. Ekrandaki tabloyu kullanarak B açısına 120° değerini giriniz. AC kenarının uzunluğunda nasıl bir değişiklik oldu? Açıklayınız.

3. AB uzunluğuna 2 cm değerini giriniz. AB uzunluğu azaldığında C açısında nasıl bir değişiklik oldu? Açıklayınız.

4. Tabloyu aşağıda verilen değerlere göre doldurunuz. Hangi durumlarda üçgen oluşup oluşmadığını kaydediniz.

AB kenarı	BC kenarı	B açısı	Üçgen oluşur mu?
3 cm	2 cm	90°	
1 cm	5 cm	0°	
0 cm	4 cm	20°	

5. Tabloya göre, sadece iki kenar verilirse üçgen oluşuyor mu?

6. Tabloya göre, bir açı ve bir kenar verilirse üçgen oluşuyor mu?

7. Tabloya göre hangi durumda üçgen oluşmuştur? Üçgen oluşturmak için kaç eleman gerekir?

Referans: Sanal Matematik Labaratuarı http://samala.pau.edu.tr/index.php

DERS PLANI 6

Ders: Geometri

Konu: Üçgenler

Beceriler: Bilgisayar kullanımı, geometrik düşünme, akıl yürütme, ilişkilendirme, problem çözme

Kazanımlar: Bir kenarı iki açısı verilen üçgen inşa eder.

Süre: 2 saat

Sınıf: 8

Materyal: Bilgisayar, GeoGebra yazılımı

GİRİŞ ETKİNLİKLERİ

Üçgenin hangi elemanlardan oluştuğu sorulur. Öğrencilerin üçgen, üçgenin açıları ve kenarları hakkındaki ön bilgileri yoklanır. Öğrenciler aşağıdaki soruları yanıtlarlar.

- Kenarları 1 cm, 2 cm ve 3 cm olan üçgen oluşturabilir miyiz? Nedenini açıklayınız.
- Açıları 20°, 70° ve 90° olan üçgenin en uzun kenarı hangisidir?

GELİSTİRME ETKİNLİKLERİ

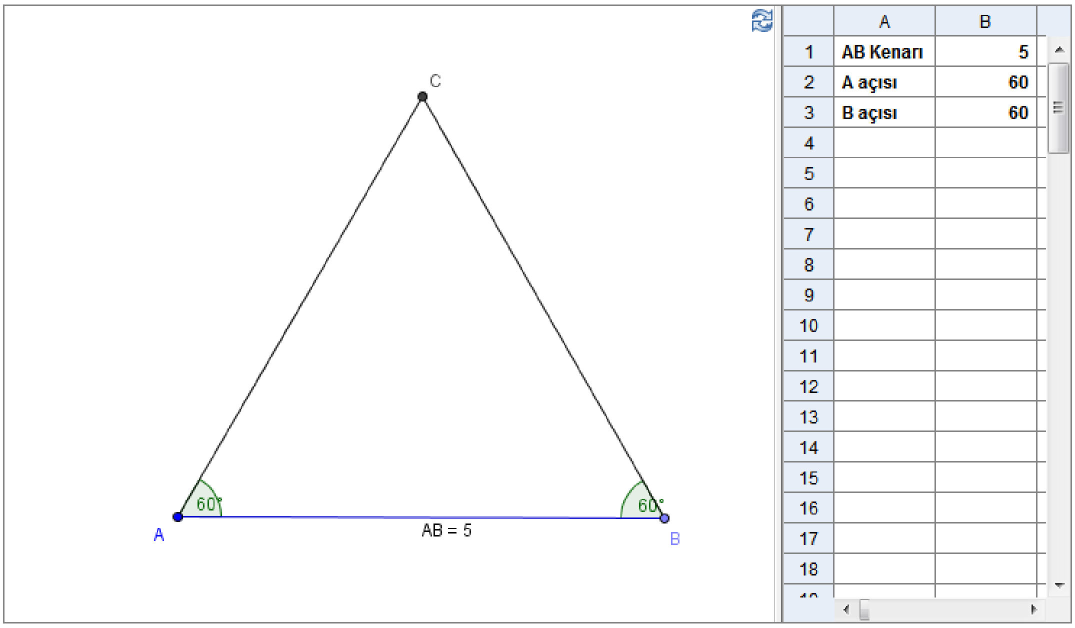
Öğrenciler gruplara ayırılır ve her birine etkinlik kâgıtları verilir. Ögrenciler ile birlikte aktiviteler gerçeklestirilir.

SONUÇ ETKİNLİKLERİ:

1. Öğrencilerden bir kenarı ve iki açısı verilen ikizkenar, eşkenar ve çeşitkenar üçgen oluşturmaları istenir.

ÖGRENCİ ETKİNLİKKAĞIDI 8

1. Bilgisayarınızda interneti açıp, http://samala.pau.edu.tr/main2.php?isim=30 adresine girin. "Bir kenar iki açı ile üçgen"etkinliğini açınız.



2. Ekrandaki tabloyu kullanarak A açısına 40° değerini giriniz. CB kenarının uzunluğunda nasıl bir değişiklik oldu? Açıklayınız.
3. Tabloyu aşağıda verilen değerlere göre doldurunuz. Hangi durumlarda üçgen oluşup oluşmadığını kaydediniz.

AB kenarı	A açısı	B açısı	Üçgen oluşur mu?
3 cm	20°	90°	
1 cm	10°	0°	
0 cm	50°	20°	

4. Tabloya göre, sadece iki açı verilirse üçgen oluşuyor mu?

5. Tabloya göre, bir açı ve bir kenar verilirse üçgen oluşuyor mu?

6. Tabloya göre hangi durumda üçgen oluşmuştur? Üçgen oluşturmak kaç eleman gerekir?

Referans: Sanal Matematik Labaratuarı http://samala.pau.edu.tr/index.php

DERS PLANI 7

Ders: Geometri

Konu: Üçgenler

Beceriler: Bilgisayar kullanımı, geometrik düşünme, akıl yürütme, ilişkilendirme, problem çözme

Kazanımlar: Pisagor Bağıntısını açıklar.

Süre: 2 saat

Materyal: Bilgisayar, GeoGebra yazılımı

GİRİŞ ETKİNLİKLERİ

Öğrencilere dik üçgenin kenarları ve açıları arasındaki ilişkiler sorulur. En uzun kenarın hangisi olduğu ve nedeni tartışılır.

GELİSTİRME ETKİNLİKLERİ

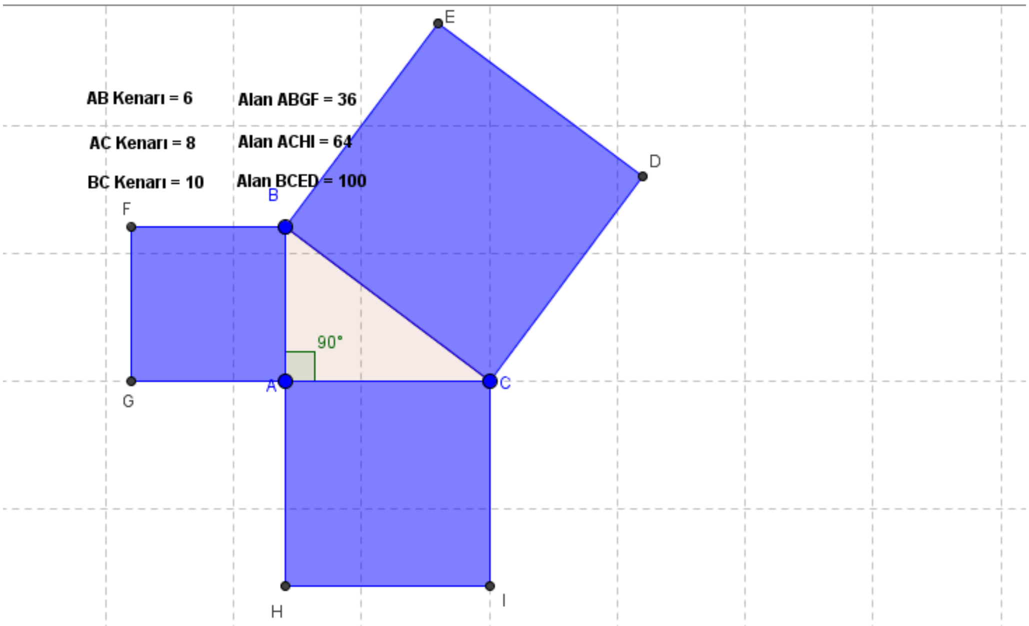
Öğrenciler 2'ser kisilik gruplara ayırılır ve her birine etkinlik kâgıtları verilir. Ögrenciler ile birlikte aktiviteler gerçeklestirilir.

SONUÇ ETKİNLİKLERİ:

1. Öğrenciler Pisagor bağıntısını kullanarak aşağıda verilen üçgenlerin kenarlarını hesaplarlar.
    - Dik kenarlarının uzunluğu 6 cm ve 8 cm olan dik üçgenin diğer kenarının uzunluğunu hesaplayınız.
    - Kenar uzunlukları 9 cm, 12 cm ve 15 cm olan üçgen dik üçgen olabilir mi? Nedenini açıklayınız.

ÖGRENCİ ETKİNLİKKAĞIDI 9

1. Bilgisayarınızda interneti açıp, http://samala.pau.edu.tr/main2.php?isim=30 adresine girin. Pisagor bağıntısı etkinliğini açınız.



2. Sürgüleri kullanarak C noktasının yerini değiştiriniz, açının 90° olmasına dikkat ediniz. C noktasının yerlerine göre aşağıdaki tabloyu doldurunuz.

A(ABGF)	A(ACHI)	A(ABGH+ACHI)	A(BCED)

3. ABCD, ACHI ve BCED karelerinin alanları arasında nasıl bir ilişki vardır? Sembol kullanarak belirtiniz.

4. Karelerin alanları ve üçgenin kenarları ile ilgili aşağıda verilen tabloyu doldurunuz.

AB kenarının karesi	AC kenarının karesi	BC kenarının karesi

5. Dik üçgenin kenarları arasında nasıl bir ilişki vardır?

Referans: Sanal Matematik Labaratuarı http://samala.pau.edu.tr/index.php

DERS PLANI 8

Pisagor Bağıntısı

Ders: Matematik

Sınıf: 8

Öğrenme Alanı: Geometri

Alt Öğrenme Alanı: Üçgenler

Beceriler: Bilgisayar kullanımı, geometrik düşünme, akıl yürütme, ilişkilendirme, problem çözme

Kazanımlar:

- Pisagor bağıntısını açıklar.
- Pisagor bağıntısını problemlere uygular.

Araç-Gereçler: Bilgisayar, GeoGebra yazılımı

GİRİŞ ETKİNLİKLERİ

Öğrencilere dik üçgenin kenarları ve açıları arasındaki ilişkiler sorulur. Bir önceki dersten Pisagor Bağıntısını uygulama sorulur.

GELİSTİRME ETKİNLİKLERİ

Öğrenciler 2'ser kisilik gruplara ayırılır ve her birine etkinlik kâgıtları verilir.

Öğrenciler etkinlik 10 için aşağıda verilen soruları cevaplar.

1. İkinci adımda oluşan karelerin alanları arasında nasıl bir ilişki vardır? Açıklayınız.

2. Üçüncü adımda C ve E noktalarını sürüklediğinizde alanlarda nasıl bir değişim gözlemlediniz? Açıklayınız.

3. Dik üçgenin kenarlarında kare yerine eşkenar üçgen kullansaydık alanlar arasında aynı ilişki gözlenir miydi? Açıklayınız.

4. Alanlar arasındaki bu ilişkiyi sembol kullanarak gösteriniz.

5. Dik üçgenin kenarları ile alanları arasında benzer bir ilişki var mıdır?

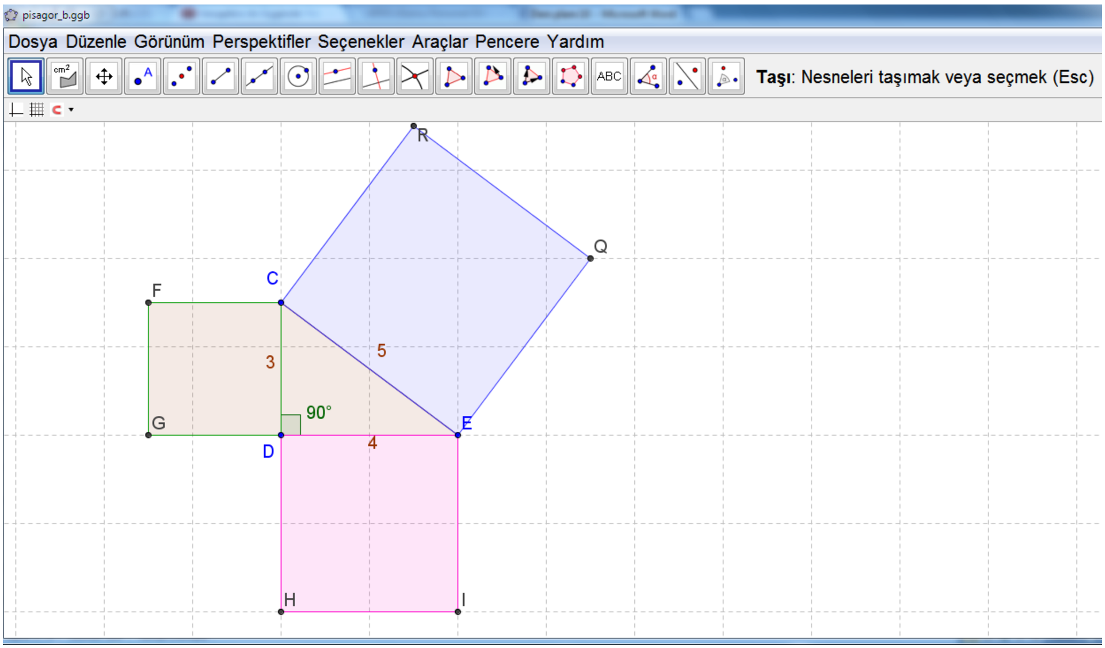
SONUÇ ETKİNLİKLERİ:

Öğrenciler Pisagor bağıntısını kullanarak aşağıda verilen üçgenlerin kenarlarını hesaplarlar.

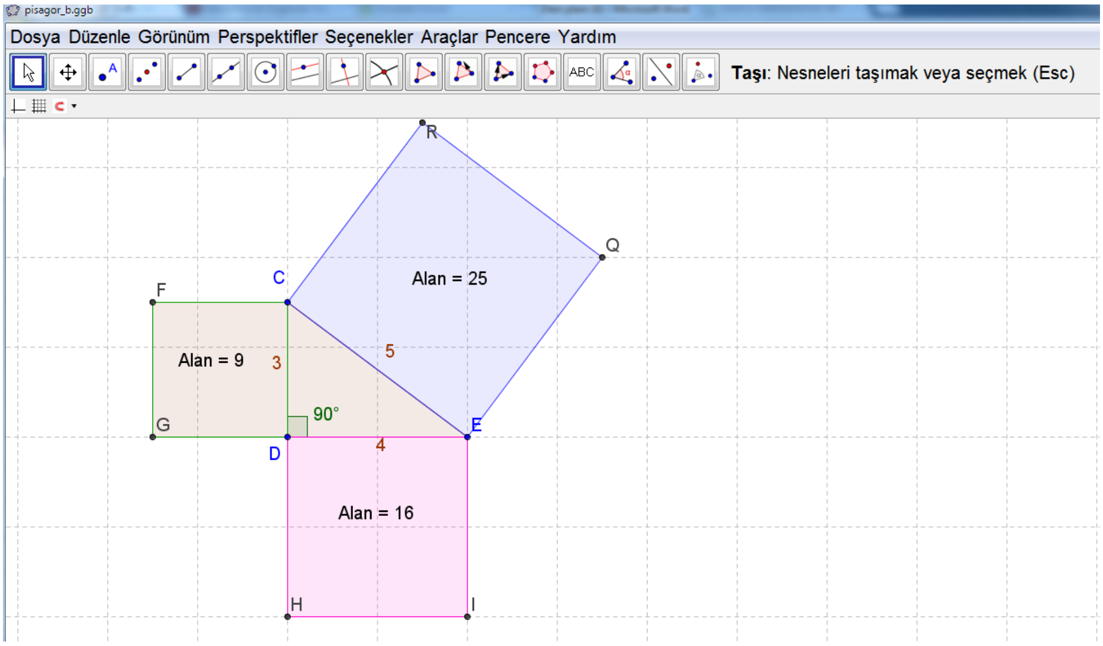
- Dik kenarlarının uzunluğu 6 cm ve 8 cm olan dik üçgenin diğer kenarının uzunluğunu hesaplayınız.
- Kenar uzunlukları 9 cm, 12 cm ve 15 cm olan üçgen dik üçgen olabilir mi? Nedenini açıklayınız.

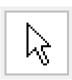
ÖĞRENCİ ETKİNLİKKAĞIDI 10

1. Bilgisayarınızdan “Pisagor Bağıntısı” geogebra dosyasını açınız.



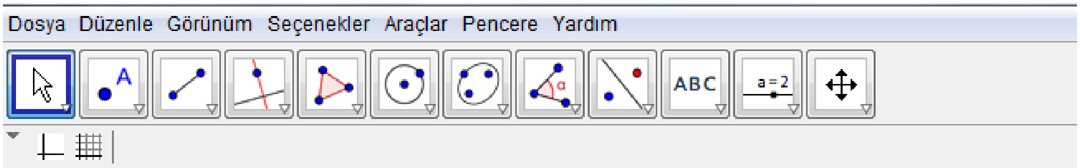
2.  **Alanı** tıkladıktan sonra CDFG karesini, EDIH ve CERQ karelerini tıklayınız. Karelerin üzerinde alanlar hesaplanacaktır.

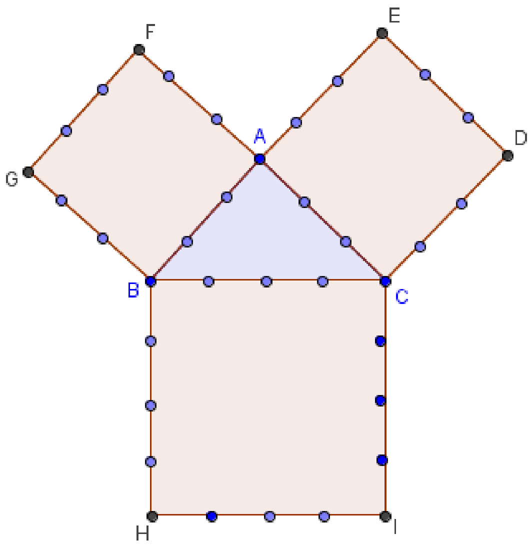


3.  CDE dik üçgeninde, C ve E noktalarını sürükleyip alanlardaki değişimi gözlemleyiniz.

4. Şekilde verilen ABC üçgeni dik üçgen midir?

a) GeoGebra ölçme araçlarını kullanarak dik üçgen olup olmadığını araştırınız.





5. Şekilde verilen her iki nokta arası 1 birimkaredir. Karşılıklı noktaları birleştirerek karesel bölgelerin alanlarının kaç birimkare olduğunu hesaplayınız. Buna göre, ABC üçgeninin dik üçgen olup olmadığını nasıl yorumlarız?

6. Verilen üçgenin kenarlarında, kare yerine yarım çember kullanarak alanları hesaplayınız.

7. Oluşan yarım çemberlerin alanları arasında nasıl bir ilişki var?

APPENDIX E

RUBRIC AND ANSWER KEY

Sorular	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9a**	**9b**	**10**
Doğru Cevap ve DoğruAçıklama	5	5	5	5	5	5	5	5	5	5	5
Doğru Cevap eksik açıklama	3,5	3,5	3,5	3,5	3,5	3,5	3,5	3,5	3,5	3,5	3,5
Doğru Cevap Açıklama yok	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5
Yanlış Cevap ve açıklama yok	0	0	0	0	0	0	0	0	0	0	0
Sorular	**11**	**12a**	**12b**	**13**	**14**	**15**	**16**	**17**	**18**	**Total**	
Doğru Cevap ve DoğruAçıklama	5	5	5	5	5	5	5	5	5	100	
Doğru Cevap eksik açıklama	3,5	3,5	3,5	3,5	3,5	3,5	3,5	3,5	3,5	70	
Doğru Cevap Açıklama yok	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5	50	
Yanlış Cevap ve açıklama yok	0	0	0	0	0	0	0	0	0	0	

1. Doğru cevap: C şıkkı

Açıklama: AF kenarı BC kenarını eşit iki parçaya ayırmıştır.

2. Doğru cevap: A şıkkı

Açıklama: Kâğıt katlamada, köşedeki açı iki eş parçaya ayrılmıştır.

3. Doğru cevap: En uzun kenar TV'dir.

Açıklama: En geniş açının karşısında yer alır.

4. Doğru cevap: A>B>C

Açıklama: Kenar uzunlukları ile açılar arasında doğrusal ilişki vardır. Daha uzun kenarın karşısındaki açı daha büyüktür.

5a. Doğru cevap: Oluşmaz.

Açıklama: İki kenarın toplamı diğer kenardan büyük olmalıdır.

5b. Doğru Cevap: Oluşmaz, oluşur, oluşur, oluşmaz

Açıklama: İki kenarın toplam uzunluğu diğer kenardan büyük olmalıdır.

6. Doğru cevap: C şıkkı

Açıklama: Çünkü açı küçüldüğü için kenar da kısalacaktır.

7. Doğru cevap: 11, 10, 9, 8, 7, 6, 5, 4, 3

Açıklama: a+b>c>a-b olduğundan 12>c>2 c aralıkta verilen tamsayı değerlerini alır.

8. Doğru Cevap: En çok=14 cm En az= 4 cm

Açıklama: a+b>c>a-b olduğundan 15>c>3 c'nin aralıkta alabileceği en küçük ve en büyük tamsayı değerleri 14 cm ve 4 cm'dir.

9a. Doğru Cevap: $3^2+4^2=5^2$

Açıklama: Küçük karelerin alanları toplamı büyük karenin alanına eşittir.

9b. Doğru Cevap: $a^2+b^2=c^2$

Açıklama: Kenarların karesi karelerin alanlarına eşittir ve dik kenarların kareleri toplamı hipotenüsün karesini verir.

10. Doğru Cevap: x uzunlukları sırasıyla 8,12 ve $6\sqrt{2}$'dir.

Açıklama: $a^2+b^2=c^2$ formülünden a, b ve c'yi yerine koyarak x'i hesaplar.

11. Doğru Cevap: $2\sqrt{5}$

Açıklama: $6^2-4^2=\sqrt{20}=2\sqrt{5}$

12. Doğru Cevap: 80 cm

Açıklama: $170^2+150^2=80^2$

13. Doğru Cevap: Dik üçgen değildir

Açıklama: 9+9=18 olmalıdır fakat büyük karenin alanı 16 cm’dir.

14. Doğru Cevap: 1200 m

Açıklama: Ev kırtasiye=800 m olduğundan, 1000+800=1800m ve 1800-600=1200 m

15. Doğru Cevap: C şıkkı

Açıklama: Sadece bir açı bir kenar verilmiş

16. Doğru Cevap: D şıkkı

Açıklama: İki kenar eşit olarak bölünmüş.

17. Doğru Cevap: Çizimler incelenir.

Açıklama: Yükseklik için, a kenarının karşısındaki köşesinden indirilen dik çizgidir. Açıortay için, a kenarının karşısındaki köşede açıyı iki eşit parçaya bölen çizgidir. Kenarortay için, , a kenarının karşısındaki köşesinden indirilen a kenarını iki eşit parçaya bölen çizgidir.

18. Doğru Cevap: B şıkkı

Açıklama: ABC açısını eşit iki parçaya ayırdığı için.

APPENDIX F

TURKISH SUMMARY

ÖZET

APPENDIX F

ÖZET

Son yıllarda, bilgisayar teknolojileri eğitimde etkili bir şekilde kullanılmaya başlamıştır. Matematik öğretiminde teknoloji kullanımı farklı konuların öğretimini ve öğrencilerin öğrenmesini desteklemektedir. Farklı teknoloji araçlarının kullanımı matematiğe yönelik problem çözme becerilerini, görsel ve uzamsal yetenekleri artırmaktadır. Geometri dersleri de öğrencilerin muhakeme ve ispat gibi becerilerini desteklemektedir. Geometri, matematik ve fen konularının öğretiminde araç olarak kullanılabilir ve çevremizi yorumlama şansı sağlar (NCTM, 2000). Son yıllarda, bilgisayarların geometri eğitiminde kullanımına yönelik yapılan pek çok bilimsel çalışma bulunmaktadır (Myers, 2009; Sauter, 2001; Smith, 2010; Tayan, 2011; Ubuz, Üstün and Erbaş, 2009; Yemen, 2009). Bu çalışmalarda teknolojinin öğrencilerin başarıları üzerinde pozitif etkisi gözlenmiştir. Buna ek olarak, dinamik geometri programlarının ve GeoGebra kullanımın öğrenci başarısına etkisine yönelik yapılan pek çok çalışma vardır (e.g. Filiz, 2009; İçel, 2011; Tayan, 2011; Ubuz, Üstün and Erbaş, 2009; Yemen, 2009; Zengin, 2011). Bu çalışmalar, dinamik geometri kullanımının farklı matematik konuları ve farklı sınıf seviyeleri için etkilerini incelemiştir. Diğer çalışmalardan farklı olarak, bu çalışmada üçgenler konusunda, dinamik geometri kullanımının 8. sınıf öğrencilerinin başarı ve tutumuna etkisine bakılmıştır.

Çalışmanın araştırma soruları aşağıda belirtilmiştir:

Dinamik geometri yazılımı kullanılan derslerin geleneksel öğretimle kıyaslandığında 8. Sınıf öğrencilerinin başarılarına etkisi nedir?

Dinamik geometri yazılımı kullanılan derslerin geleneksel öğretimle kıyaslandığında 8. Sınıf öğrencilerinin tutumuna etkisi nedir?

Öğrencilerin başarı ve tutumları arasında ilişki var mıdır?

Deney grubundaki öğrencilerin dinamik geometri programlarına yönelik görüşleri nelerdir? Bu çalışma kapsamında belirtilen araştırma sorularına yanıt aranmıştır.

PISA ve TIMSS raporlarına göre, Türk öğrenciler geometride ve matematikte düşük başarıya sahiptirler. PISA 2009 raporuna göre, Türkiye 65 ülke içinde 41. sırada yer almaktadır. Bu sonuçlara göre, Türk öğrenciler diğer ülkelerdeki öğrencilerle kıyaslandığında daha fazla zorluk yaşamaktadır. Buna ek olarak, TIMSS raporları da PISA raporlarına benzemektedir. TIMSS 2007 raporlarına göre, Türkiye'nin eğitimdeki başarısı sekizinci sınıf öğrencileri için diğer Avrupa ülkelerinin altındadır. Aynı şekilde, öğrenciler ulusal sınavlarda da düşük başarı göstermektedir. Bunlar, geometri ve matematik öğretiminin önemini göstermektedir. Fakat geometri konularının öğretiminde problemler olduğundan geometri öğretim metotlarının geliştirilmesi gerekmektedir.

Geometri öğretiminde önemli problemlerden biri kuralların ve formüllerin verilip öğrencilerin bunları anlamadan ezberlemesidir. Bu tür zorlukların çözülmesi için geometri derslerinde dinamik geometri programlarının kullanılması önerilmektedir. Bu çalışmada, araştırmacı tarafından hazırlanan etkinlik kağıtlarıyla öğrencilerin öğrenmeleri desteklenmiştir. Bilgisayar laboratuvarında yapılan derslerde, öğrenci merkezli bir öğrenme ortamı sağlanmıştır. Süreçte öğretmen öğrencilere rehberlik etmiştir. Öğrenciler, üçgen doğru açı gibi geometrik şekilleri GeoGebra'nın özelliklerini kullanarak kendileri oluşturmuşlardır. GeoGebra öğrencilerin konularını anlamasına, dikkatine ve motivasyonuna yardımcı olmuştur. Araştırma sonuçlarına göre, matematiğe karşı tutum matematik başarısını etkilemektedir. Literatürde, öğrencilerin matematiğe karşı tutumları; bilgisayar kullanımı, akademik başarı gibi çeşitli faktörler açısından incelenmiştir. Bazı çalışmalarda tutum ve başarı arasında pozitif etki bulunurken (Boyraz, 2008; Genç, 2010; Gün, 2011; Mehdiyev, 2009; Myers, 2009; Souter, 2001) bazı çalışmalarda anlamlı bir ilişki bulunmamıştır (Eryiğit, 2010; Klein, 2005; Yemen, 2009; Zengin, 2011). Araştırmalardaki birbirinden farklı sonuçlardan dolayı bu araştırmada, tutum ve başarı arasındaki ilişki incelenmiştir.

Yeni matematik müfredatında (MEB, 2005) dinamik geometri programlarının kullanımı desteklenmekte fakat bu araçlarla ilgili ders planı ve etkinlik bulunmamaktadır. Bu çalışma için geliştirilen ders planları, etkinlik kağıtları ve öğrenci aktivitelerinin öğretmenler ve öğrenciler için faydalı olacağı düşünülmüştür. Bu çalışmada, öğrenciler teknoloji özelliklerini kullanarak problem çözmüş, teoremleri ve formülleri oluşturmuşlardır. Bu da öğrencilerin bilişsel becerilerine katkı sağlamıştır. Dinamik geometri kullanımı buna ek olarak öğrencilerin muhakeme ve şekilleri oluşturma becerilerini olumlu etkilemiştir. Orta öğretimde dinamik geometri programlarının kullanımının etkisine ve bununla ilgili öğrenci görüşlerine yönelik çalışmalar bulunmaktadır (Filiz, 2009; İçel, 2011; Tayan, 2011; Yemen, 2009; Zengin, 2011). Diğer çalışmalardan farklı olarak, bu çalışma kırsal alandaki teknoloji imkanlarının kısıtlı olduğu bir köy okulunda yapılmıştır. Çalışmaya katılan öğrenciler evlerinde bilgisayar ve internet olanağı olmayan öğrencilerdir. Çalışmanın örneklemi uygun örnekleme yöntemiyle seçilmiştir ve çalışma yarı deneysel bir çalışmadır.

Çalışmanın varsayımları; öğrencilerin soruları açık ve doğru bir şekilde cevapladığıdır. Veriler deney ve kontrol grubunda benzer koşullarda toplanmıştır. Farklı gruptaki öğrenciler ön test ve son testlerin uygulamasından önce birbirleriyle etkileşim içinde olmamıştır. Çalışmanın örneklemi rastgele seçilmemiş uygun örnekleme göre seçilmiştir. Bundan dolayı bulgular benzer örneklemlere genellenebilir.

Bilgisayar destekli öğretim, bilgisayarın öğrenme ve öğretme ortamının önemli bir parçası olarak kullanıldığı öğretim olarak tanımlanmıştır. Dinamik geometri programı, öğrencilerin geometrik şekiller oluşturmalarını ve onları kolayca hareket ettirmelerini bu sayede şeklin elemanlarından birini hareket ettirirken, diğer elemanlardaki değişimi gözlemlediği yazılım programları olarak belirtilmiştir (Goldenberg & Cuoco, 1998). GeoGebra ise ortaöğretimden üniversiteye kadar kullanılan dinamik geometri programıdır. Diğer dinamik geometri programlarının özelliklerini içerir ve kullanımı ücretsizdir (Hohenwarter & Jones, 2007). Geleneksel öğretimin tanımı ise, ders ve soru cevap kısmını içeren, kuralların ve tanımların başlangıçta yapıldığı ve daha sonra örneklerin çözüldüğü öğretim olarak tanımlanmıştır (Duatepe, 2004).

Bu çalışmada bilgisayar destekli öğrenme ortamının, geleneksel öğretim yöntemiyle karşılaştırıldığında sekizinci sınıf öğrencilerinin geometri başarılarına, geometriye ve teknolojiye karşı tutumlarına etkisi incelenmiştir. Buna ek olarak, öğrencilerin bilgisayarlı öğretimin etkileri ile ilgili fikirlerini almak ve öğrenme süreçlerini yorumlamak amaçlanmıştır. Bu çalışma, kontrol ve deney grubunu içeren yarı deneysel bir çalışmadır. Çalışmanın örneklemini Ankara ilinde bir devlet ilköğretim okulunda sekizinci sınıfta okuyan 36 öğrenci oluşturmaktadır. Çalışmaya katılan 18'i deney, 18'i kontrol grubu öğrencileri, bir önceki yıllardaki ortalamaları dikkate alınarak eşleştirme yöntemiyle oluşturulmuştur. Çalışmanın gerçekleştirildiği okul, ilçe merkezine oldukça uzak, imkânları kısıtlı ve sosyoekonomik seviyesi düşük olan bir okuldur. Çalışmanın yapıldığı okulda bilgisayar laboratuvarı bulunmaktadır ve uygulamalar esnasında 12 bilgisayar kullanılmış olup öğrenciler bilgisayarları ikişerli gruplar olarak kullanmıştır. Deneysel çalışmalar sebep sonuç ilişkisi belirleme açısından en etkili yöntemlerdir. Çalışmanın bağımsız değişkenini GeoGebra dinamik geometri programıyla desteklenen dört haftalık uygulama; bağımlı değişkeni ise öğrencilerin geometriye yönelik başarı ve tutum puanları ve açık uçlu sorulara verdikleri cevaplar oluşturmaktadır.

Bu çalışmada öğrencilerin geometri başarılarını ve geometriye yönelik tutumlarını ölçmek için Geometri Başarı Testi, Geometri Tutum Ölçeği, Bilgisayara Yönelik Tutum Ölçeği kullanılmıştır.

Geometriye yönelik başarı testinde, açık uçlu 18 soru sorulmuştur. Testin kazanımları, Milli Eğitim Bakanlığının sekizinci sınıf ders kitabına göre belirlenmiştir. Bu kazanımlar; üçgenin yükseklik, açıortay ve kenarortayını oluşturmak, üçgenin kenarları arasındaki ilişkileri yorumlamak, üçgenin açı ve kenarları arasındaki ilişkileri yorumlamak, Pisagor bağıntısını oluşturabilmek ve Pisagor bağıntısıyla ilgili problemler çözebilmektir. Başarı testinin pilot çalışması, 19 öğrenci ile yapılmış ve puanlayıcılar arası güvenirlik .97 bulunmuştur.

Bir diğer ölçme aracı olan Geometriye Yönelik Tutum ölçeğinde Likert Tipi 12 madde bulunmaktadır. Bu test Duatepe (2004) tarafından geliştirilmiştir. Maddeler kesinlikle katılmıyorum, katılmıyorum, kararsızım, katılıyorum ve kesinlikle katılıyorum şeklinde sıralanmıştır. Ölçeğin iç geçerlilik katsayısı .71 olarak bulunmuştur.

Bilgisayara Yönelik Tutum ölçeği ise 21 maddelik Likert Tipi bir ölçektir ve

Cronbach Alpha iç geçerlilik katsayısı .87 olarak bulunmuştur. Bu ölçekte aynı zamanda üç tane açık uçlu soru bulunmaktadır. Bu sorularla öğrencilerin bilgisayar destekli eğitime yönelik görüşleri alınmıştır. Deney ve kontrol grupları öğrencilerin bir önceki yıllardaki matematik ortalamalarına göre rastgele atanarak oluşturulmuştur.

Deney grubunda, uygulamadan önce Geometri Başarı testi ve Geometriye yönelik tutum ölçeği ön test olarak verilmiştir. Uygulamaya başlamadan önce öğrenciler iki saat GeoGebra'ya yönelik ders almışlar ve programın özellikleri hakkında bilgilendirilmişlerdir. Uygulamalar dört hafta sürmüştür. Öğrenciler dersleri bilgisayar laboratuvarında almıştır. Öğrencilere araştırmacı tarafından hazırlanan öğrenci etkinlik kâğıtları verilmiştir ve GeoGebra kullanılarak geometri konularını öğrenmişlerdir. Öğrenciler derslerde bu programın sürükleme, şekilleri oluşturma gibi pek çok özelliğini kullanarak üçgenin elemanlarını oluşturma, üçgen eşitsizliği, açı kenar ilişkisi, Pisagor bağıntısı ve Pisagor bağıntısıyla ilgili problemler konularını işlemişlerdir. İlk hafta, ders planı 1 ve 2 kullanılmış ve yükseklik, açıortay ve kenarortay konuları anlatılmıştır. İkinci hafta üçgen eşitsizliği, üçüncü ve dördüncü haftalarda Pisagor bağıntısı ve problemler işlenmiştir. Derslerde öğrenciler programda keşfettiklerini sınıfla paylaşmış ve tartışmış ve etkinlik kağıtlarındaki soruları çözmüşlerdir.

Kontrol grubunda, öğrenciler üçgenler konusunu Milli Eğitim Bakanlığının (Aygün, 2012) kitabından geleneksel yöntemle işlemişlerdir. Öğretmen ders kitabında bulunan ders planlarını kullanmış, konuları anlatmış, tanımları vermiş ve sorular çözmüştür. Buna ek olarak öğrenciler ders kitabında yer alan etkinlikleri yapmışlardır. Bu etkinlikler GeoGebra ile etkinlik kâğıtlarında verilen aktivitelere benzemektedir. Uygulamalar hem deney hem kontrol grubu dört hafta sürmüştür. Deney grubundaki öğrenciler üçgenler konusunu işlerken GeoGebra özelliklerini kullanmıştır ve hem çizimleri yaparken zaman kazanmış hem de sürükleme özelliği ile daha çok keşfetme şansı bulmuşlardır. İki grup arasındaki temel fark, deney grubunda kullanılan teknoloji kullanımıdır.

Veri analizinde SPSS 17.0 programı kullanılmıştır. Birinci ve ikinci araştırma sorusu bağımsız örneklem t-testi ile araştırılmış. Üçüncü araştırma sorusu korelasyon analizi ile incelenmiştir. Uygulamaları gerçekleştirmek için gerekli etik izinler alınmıştır. Çalışmanın iç geçerliliğine zarar veren durumlar minimize edilmeye çalışılmıştır. Çalışmada nicel sonuçlar, öğrencilerin Geometri Başarı Testi puanlarının ön testte daha düşük olduğunu ve son testte farklılaştığını göstermiştir. Kontrol grubunun ortalaması 17.61'den 20.05'e yükselmiştir. Deney grubunun ortalaması ise 21.69'dan 39.44'e yükselmiştir. Bu değişimin istatistiksel olarak anlamlı olup olmadığına bakmak için t-test yapılmıştır. Geometri Başarı testini karşılaştırmak için yapılan bağımsız örneklem t-test sonuçlarına gore deney grubu ve (*M*=21.69, *SD*=9.28) kontrol grubu için (*M*=17.61, *SD*=7.29; *t*(32.18)=1.46, *p*=.15) anlamlı bir fark bulunmamıştır. Ön test sonuçlarına göre, deney ve kontrol grubu geometri başarısı yönünden başlangıçta aynıdır.

Geometri Başarısının yanında Geometriye yönelik tutum puanlarının betimsel analizlerine bakılmıştır. Geometriye yönelik tutum puanları 35.7'den 47.75'e yükselmiştir. Betimsel analiz sonuçlarına göre, geometriye yönelik tutum yönünden deney grubu kontrol grubundan daha yüksek puanlara sahiptir. Aradaki farkın istatistiksel anlamlılığına bakmak için bağımsız örneklem t-testi yapılmıştır. Geometriye yönelik tutum puanlarında, deney (*M*=30.27, *SD*=13.04) ve kontrol grubu (*M*=31.50, *SD*=12.98; *t*(34)=-.28, *p*=.78) için başlangıçta istatistiksel olarak anlamlı bir fark bulunmamıştır. Geometriye yönelik tutum puanları göstermiştir ki gruplar başlangıçta tutum yönünden eşittir. Uygulamadan sonra yapılan bağımsız örneklem t-test sonuçlarına göre, deney grubu (*M*=47.75, *SD*=10.98) ve kontrol grubu (*M*=35.70, *SD*=8.74); *t* (31) =3.49, *p*=.00) için istatistiksel olarak anlamlı fark bulunmuştur. Bu sonuçlara göre yapılan uygulamalar öğrencilerin geometriye yönelik başarısını ve tutumunu olumlu yönde etkilemiştir.

Bunlara ek olarak, geometriye yönelik tutum ve başarı arasındaki ilişkiye bakmak için korelasyon analizi yapılmıştır. Korelasyon analizine başlamadan önce gerekli varsayımlar kontrol edilmiştir. Tutum ve geometri başarısı arasındaki ilişki Pearson korelasyon katsayısı ile incelenmiştir. İki değişken arasında pozitif korelasyon bulunmuştur, r=.68, n=33, p<.001. Bunun anlamı, sekizinci sınıf öğrencilerinin geometriye yönelik başarıları, geometriye yönelik tutumlarıyla ilişkilidir. Buna ek olarak öğrencilerin bilgisayara yönelik tutum puanlarının betimsel istatistiklerine bakılmıştır. Buna göre, öğrencilerin maksimum puanı 88 ve minimum puanı 62'dir. Bilgisayara yönelik tutum puanlarının ortalaması 78.44'dür.

Bilgisayara yönelik tutum ölçeğinde üç tane açık uçlu soru bulunmaktadır. Bunlar, "Geometri öğrenirken bilgisayarlı eğitim sizlere ne şekilde yararlı oldu?

Bilgisayar destekli geometri dersine ne gibi değişiklikler önerebilirsiniz? Geometride çalışmalarınızı etkileyen etkenler nelerdir? Bu etkenleri göz önüne alarak geometri derslerine ne gibi değişiklikler önerebilirsiniz?" sorularıdır. Deney grubundaki öğrencilerin çoğu bilgisayara dayalı öğrenmeyi faydalı bulmuştur.

Açık uçlu sorulardan birincisi için öğrencilerin %61'i geometri konularının daha iyi anlaşılacağını belirtmiştir. Öğrencilerin %50'si GeoGebra'nın dersleri daha eğlenceli hale getirdiğini söylemiştir. Sürükleme özelliğinin öğrenmelerine yardım ettiğini öğrencilerin %38'i belirtmiştir.

Açık uçlu sorulardan ikincisi için, öğrencilerin %55'i derslerin güzel geçtiğini ve önerilerinin bulunmadığını belirtmiştir. Bilgisayar kullanımının cebir gibi diğer konularda da olmasını isteyen öğrenciler %33'dür.

Açık uçlu sorulardan üçüncüsü için öğrencilerin %44'ü GeoGebrayı tüm geometri derslerinde kullanmak istemiştir. Öğrencilerin %27'si her öğrencinin kendi bilgisayarına sahip olması gerektiğini söylemiştir. Öğrencilerin %22'si ise GeoGebra'yı oyun oynarken kullanabileceğini belirtmiştir. Bazı öğrenci cevapları ise şöyledir: " Bilgisayarda hem eğleniyorum hem de daha kolay öğreniyorum." "Geometri dersleri GeoGebra ile daha eğlenceli geçiyor." "Bilgisayarda geometri hem zevkli hem de kolay anlaşılıyor."

Öğrenci cevaplarında öğrencilerin çoğu bilgisayar destekli dersleri eğlenceli bulmuştur. Öğrenmelerini desteklediğini ve anlamalarına daha iyi yardımcı olduğu belirtmiştir. Bunun yanında öğrenciler bilgisayarın diğer matematik konularında da kullanılmasını önermişlerdir. Bazı öğrenci cevapları şöyledir: "Bilgisayar kullanımı diğer konularda da desteklenirse, diğer dersler de matematik gibi eğlenceli olabilir." "Bütün matematik konularının bilgisayarla işlenmesini isterim." "GeoGebra daha kolay öğrenmemize yardımcı oldu." Son soru için bazı öğrenci cevapları ise şöyledir: "Kağıt kalemle geometrik şekilleri çizmek daha fazla zaman alırken, bilgisayarla çizim yapmak daha kolay ve eğlencelidir." "Bilgisayar ortamında sürükleme özelliğini kullanarak şekilleri hareket ettirebildim." Çoğu öğrenci sürükleme özelliğini faydalı bulmuştur. Şekilleri kolayca ve hızlı çizebilmişlerdir. Öğrenciler kâğıt kalem ortamında zorlanarak yapabilecekleri şeyleri GeoGebra'da kolayca yapmıştır.

Açık uçlu sorular, bilgisayarların öğrencilerin öğrenme sürecini destekleyen dinamik bir öğrenme ortamı yarattığını ve bilgisayar dersine karşı pozitif düşünceler geliştirdiklerini belirtmiştir.

Bu çalışmanın nicel sonuçlarına göre, bağımsız örneklem t-testi dinamik geometri kullanımının geometri başarı puanlarında istatistiksel olarak anlamlı bir fark yaratmıştır. Diğer bir deyişle, GeoGebra programı ile ders gören öğrenciler, teknoloji kullanımı olmayanlara göre daha yüksek Geometri Başarı Testi puanlarına sahiptir. Bu çalışmanın sonuçları literatürdeki diğer çalışmalarla benzerlik göstermektedir. Bu çalışmalarda elde edilen sonuçlara görefarklı dinamik geometri programlarının kullanımı öğrenci başarısını pozitif yönde etkilemektedir (Erbas &Yenmez, 2011; Furner & Marinas, 2006; Gecu & Ozdener, 2010; Healy & Hoyles, 2002; Isıksal & Askar, 2005; Kepçeoğlu, 2012; Pierce and Stacey, 2005; Sarı, 2012; Topcu, 2011).

Buna ek olarak, bilgisayar destekli öğretim kullanımı geleneksel öğretime göre kıyaslandığında geometriye yönelik tutumu pozitif yönde etkilemiştir. Bu sonuçlar, önceki yıllarda yapılan dinamik geometri kullanımının olduğu çalışmalarla benzerlik göstermektedir (Boyraz, 2008; Genç, 2010; Gün, 2011; Mehdiyev, 2009; Myers, 2009; Souter, 2001). Öğrencilerin yorumları da geometriye yönelik pozitif tutum gösterdiklerini desteklemiştir. Dersler esnasında, öğrenciler, geometri konularına yüksek seviyede ilgi göstermiştir ve derse katılım konusunda daha isteklidirler. Bu sonuçlar, bilgisayar destekli sınıflarda öğrencilerin yüksek düzeyde motivasyon gösterdiğini, bilgisayar destekli öğretimin öğrencilerin tutumunda pozitif etki yarattığını göstermiştir. Öğrencilerin pozitif tutumunun nedeni dinamik geometri programlarının yarattığı keşfetmeye yönelik ve ilginç olan öğrenme ortamı olarak açıklanabilir. Öğrenciler GeoGebra özelliklerini kullanarak daha çok eğlenerek ve daha kolay öğrendiler. Öğrencilerin başarı puanlarının nedeni ise bilgisayar destekli öğretimin ve bilgisayar ortamının sağladığı görsel etkidir. Bu sayede öğrenciler, üçgenler konusunu görsel imgelerle daha iyi anlamış ve keşfederek öğrenmişlerdir.

Bilgisayarlı öğretimin pozitif etkisinin diğer bir nedeni ise öğrencilerin matematik konularını öğrenmedeki algıları ve inanışlarıdır. Literatüre göre, öğrencilerin matematik hakkındaki görüşleri matematik başarılarını ve tutumlarını etkilemektedir (Mehdiyev, 2009; Myers, 2009; Souter, 2001). GeoGebra öğrencilere formülleri, teoremleri ve şekilleri oluşturmada kolaylık sağlamıştır. Buna ek olarak, GeoGebra kullanımı şekiller ve matematik konuları arasında bağlantı kurmayı ve sembolleştirmeyi daha iyi sağlamaktadır. Deney grubundaki öğrenciler konuları öğrenirken formülleri ve teoremleri ezberlemek yerine keşfederek öğrenmişlerdir.

Bu çalışmanın sonuçlarına göre, öğretmenler ve öğretmen adayları teknoloji kullanımının farkında olmalıdır. Buna ek olarak müfredatı geliştirenler buna yönelik ders planları düzenlemelidir. Öğretmenler teknoloji özelliklerinin müfredata entegre edilmesine daha fazla önem vermelidir ve teknoloji kullanımı konusunda eğitim verilmelidir. Öğretmenler teknoloji ile ilgili yeteneklerini ve bilgisayar becerilerini geliştirmelidir. Okullar daha fazla teknoloji materyalleriyle donatılmalıdır. Bilgisayar laboratuvarları ve internet bütün okullarda sağlanmalıdır. Matematik ders kitapları dinamik geometri araçlarının kullanıldığı etkinlikler içermelidir. Eğitimle ilgili web-sitelerinin sayıları artırılmalıdır. Her öğrenci için bilgisayar derslerinde bilgisayar programlarını kullanmayı öğrenme şansı verilmelidir.

Bu çalışmada dinamik geometri yazılımı kullanımının öğrencilerin başarılarını ve tutumunu pozitif yönde etkilediği görülmüştür. Matematik ve fen eğitiminde buna yönelik çalışanların sayısı artırılabilir. Cinsiyet farkının öğrencilerin başarılarını, tutumunu ve bilgisayara yönelik tutumu nasıl etkilediği araştırılabilir. Bu çalışmada konu olarak üçgenler konusu seçilmiştir, diğer matematik konuları için dinamik geometri kullanımının etkisi araştırılabilir. Çalışma grubu uygun örnekleme yerine random olarak atanabilir.

APPENDIX G

TEZ FOTOKOPİSİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü	
Sosyal Bilimler Enstitüsü	X
Uygulamalı Matematik Enstitüsü	
Enformatik Enstitüsü	
Deniz Bilimleri Enstitüsü	

YAZARIN

Soyadı : SAMUR
Adı : HALİME
Bölümü : İlköğretim Fen ve Matematik Eğitimi

TEZİN ADI (İngilizce) : The Effects of Dynamic Geometry Use on Eight Grade Students' Achievement in Geometry and Attitude toward Geometry on Triangle Topic

TEZİN TÜRÜ : Yüksek Lisans [x] Doktora [ ]

1. Tezimin tamamından kaynak gösterilmek şartıyla fotokopi alınabilir. [ ]
2. Tezimin içindekiler sayfası, özet, indeks sayfalarından ve/veya bir bölümünden kaynak gösterilmek şartıyla fotokopi alınabilir. [ ]
3. Tezimden bir bir (1) yıl süreyle fotokopi alınamaz. [x]

TEZİN KÜTÜPHANEYE TESLİM TARİHİ: