EFFECTS OF GRAPHING CALCULATORS ON EIGHTH GRADE STUDENTS' ACHIEVEMENT IN GRAPHS OF LINEAR EQUATIONS AND CONCEPT OF SLOPE

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ABSTRACT

EFFECTS OF GRAPHING CALCULATORS ON EIGHTH GRADE STUDENTS' ACHIEVEMENT IN GRAPHS OF LINEAR EQUATIONS AND CONCEPT OF SLOPE

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The purpose of this study was to investigate the effects of graphing calculators on eight grade students' achievement in graphing linear equations and concept of slope. Pretest-posttest experimental-control group design was utilized in the study. While the students in experimental group (EG) received instruction about graphs of linear equations and concept of slope with graphing calculators, the students in control group (CG) was taught the same topics without using graphing calculators. There were 27 students (13 girls and 14 boys) in each group. Students in both EG and CG was administered an achievement test (i.e., MAT) consisting of questions related to graphing linear equations and slope concept before and after the instruction. Additionally, the teacher and six students from the EG were interviewed.

The data obtained from students' post test scores of MAT were analyzed by Analysis of Variance (ANOVA). A statistically significant difference was found between the achievements of students in experimental and control groups. However, gender had no statistically significant effect on students' post test scores of MAT. Additionally, students' pre-test scores of MAT and their mathematics grades of the second semester of the seventh grade (MGS) were analysed by independent samples t-test. The results showed no statistically significant difference. On the other hand, the analysis of interview data revealed that graphing calculators affected students' attitudes towards mathematics in a positive way. Students had no considerable difficulty while using graphing calculators and they found studying with graphing calculators enjoyable. In summary, the results of the study showed that when graphing calculators used at elementary school level, they had positive effects on students' achievement and in some respects to their attitude. Consequently, integration of graphing calculators to elementary mathematics curriculum may be beneficial for students and teachers.

Keywords: Graphing calculators, technology integrations, mathematics achievement, elementary mathematics education, graphing, linear equations, slope

ÖZ

GRAFİKSEL HESAP MAKİNELERİNİN DOĞRUSAL DENKLEMLERİN GRAFİKLERİ VE EĞİM KONUSUNDA 8. SINIF ÖĞRENCİLERİNİN MATEMATİK BAŞARISINA ETKİSİ

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Bu çalışmanın amacı grafiksel hesap makinelerinin sekizinci sınıf öğrencilerinin doğrusal denklemlerin grafiğini çizme ve eğim konusundaki başarısı üzerine etkilerini araştırmaktır. Çalışmada öntest-sontest deney-kontrol grubu metodu uygulandı. Deney grubundaki öğrenciler doğrusal denklemlerin grafikleri ve eğim konusunda grafiksel hesap makineleri ile öğretim alırken, kontrol grubundaki öğrencilere aynı konu grafiksel hesap makineleri olmadan öğretilmiştir. Herbir grupta 27 öğrenci (13 kız ve 14 erkek) vardır. Hem deney hem de kontrol grubundaki öğrencilere doğrusal denklemlerin grafiğini çizme ve eğim konusuyla ilgili bir başarı testi (MAT) uygulandı. Ek olarak, öğretmen ve deney grubundan altı öğrenci ile röportaj yapıldı.

Öğrencilerin Matematik Başarı Testi'nin son test sonuçlarından elde edilen veriler varyans analizi (ANCOVA) yöntemi ile analiz edilmiştir. Deney ve kontrol grubundaki öğrencilerin başarısı arasında istatistiksel olarak anlamlı bir fark bulunmuştur. Fakat, cinsiyetin Matematik Başarı Testi'nin son test sonuçları üzerinde anlamlı bir etkisi olmamıştır. Ek olarak, Matematik Başarı Testi'nin ön test sonuçarı ve yedinci sınıf ikinci dönem matematik puanları (MGS) t testi ile analiz edilmiştir. Sonuçlar istatistiksel olarak anlamlı bir fark göstermemiştir. Diğer taraftan, röportajlardan elde edilen verilerin analizi grafiksel hesap makinelerinin öğrencilerin matematiğe olan tutumunu olumlu yönde etkilediğini göstermiştir. Öğrenciler grafiksel hesap makinelerini kullanırken önemli bir zorluk yaşamamışlardır ve grafiksel hesap makineleri ile çalışmayı eğlenceli bulmuşlardır. Özetle, çalışmanın sonuçları grafiksel hesap makinelerinin ilköğretim okulu seviyesinde kullanıldığı zaman öğrencilerin başarısı ve bazı yönlerden de tutumları üzerinde olumlu etkileri olduğunu göstermiştir. Bu nedenle, grafiksel hesap makinelerinin ilköğretim matematik müfredatına entegrasyonu faydalı olabilir.

Anahtar Kelimeler: Grafiksel hesap makineleri, teknoloji entegrasyonu, matematik başarısı, ilköğretim matematik eğitimi, grafik çizme, doğrusal denklemler, eğim

To My Parents

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LIST OF ABBREVIATIONS

ABBREVIATIONS

EG:	Experimental group
CG:	Control group
PREMAT:	Pretest of Mathematics Achievement Test
POSTMAT:	Posttest of Mathematics Achievement Test
MGS:	Mathematics Grades of the Second Semester of Seventh Grade
ANOVA:	Analysis of Variance

CHAPTER 1

INTRODUCTION

Rapid developments in technology have been affecting every aspect of societal life, what and how we do things effectively in particular. Education is no exception to this change. As an important school discipline, mathematics education should benefit from technology in order to improve teaching and learning. Students need visualizations of concepts and connections to have a better understanding. Technological devices such as graphical calculators can provide students with visualization, confirmation and exploration of problems and concepts they are learning.

Some of the features of graphing calculators made them important and beneficial for mathematics education. Graphics display screen and statistical screen are examples of those features. Graphics display screen of the graphing calculator can be used to display graphs of functions or statistical screen can be used to display graphs of functions and statistical data. Additionally, the mathematical capabilities built into the graphing calculators are important. Those capabilities include the standard functions found on scientific calculators, together with function graphing, matrix manipulation, operations with sequences and series, complex number, arithmetic and numerical differentiation and integration. In addition, all the graphing calculators are programmable, and have considerable memory for longer-term storage of programs, data, matrices and images (Kissane, 1995).

Although the graphing calculators evolved so much, the history of graphing calculators is not too long. Handheld electronic calculators were first introduced to the world by Canon, Inc., in 1972; Hewlett-Packard introduced HP-35, the first "scientific calculator". In 1986, Casio of Japan introduced the first so-called graphing calculator with powerful built-in, computer-like graphing software. In 1996 Texas

Instruments introduced the TI-92. Recently, both Texas Instruments and Casio introduced flash ROM calculators which enabled calculators to be easily renewed with new computer software via the internet (Waits & Demana, 2000).

Several authors (e.g., Pomerantz, 1997; Waits & Demana, 1998) emphasize the importance of graphing calculators in mathematics education and lists benefits of graphing calculators in their reports. Pomerantz (1997) supports the calculator use in mathematics classrooms from kindergarten through university level and lists some of the benefits of graphing calculators. First of all, since calculators reduce the time spent on learning and performing paper-and-pencil arithmetic and algebraic algorithms, calculator use allows students and teachers to spend more time developing mathematical understanding, reasoning, number sense and applications. Next, Pomerantz state that graphing calculators provide students multiple solution techniques by complementing mental and paper-and-pencil skills. In addition, students get familiarized with technology and increase their comfort level with technology by the help of graphing calculators. Moreover, this familiarizing technology will increase openness and willingness of students to use new forms of technology. Finally, Pomerantz argues that group work and communication among classmates were promoted by the use of calculators. Waits and Demana (1998) state that the use of graphing calculators can provide more classroom time for the development of better understanding of mathematical concepts by eliminating the time spent on “mindless paper and pencil manipulations” (p. 4). The research studies of Shore (1999), Clark (2006) and Wong (1998) also supports the idea that graphing calculators leads to saving time in mathematics lessons, since they decrease the time spent on long computations.

One of the benefits of graphing calculators is that they result in increasing performance of students in mathematics lessons (Bucher, 2002; Chreim, 2006; Hollar & Norwood, 1999; Mancilla, 2004). Next, in mathematics classrooms where graphing calculators are used, students were more successful at expressing their ideas and communication (Allen, 2006). Finally, graphing calculators leads to students' developing more positive attitudes about mathematics and students usually enjoys working with the graphing calculators (Bucher, 2002; Hollar & Norwood, 1999; Wong, 1998)

Use of graphing calculators by students is diversive in mathematics lessons. To illustrate, graphing calculators were used by students as a checking tool to see whether the graph they drew was correct (Doerr & Zangor, 2000; Ocak, 2006), as a visualizing tool to visualize problems that would be difficult to graph by hand (Doerr & Zangor, 2000; Ocak, 2006; Clark, 2006) and as a comparing tool to draw conclusions for different function graphs (Ocak, 2006). Additionally, Doerr and Zangor (2000) found different functions of graphing calculators emerged in lessons as computational tool, transformational tool, data collection and analysis tool in their research.

There is not enough research on elementary school level, but use of graphing calculators may be beneficial at elementary grades at subjects like equations of linear graphs and the concept of slope. Additionally, the use of graphing calculators is very limited in Turkey and it is a new technology for teachers, students and curriculum developers. Consequently, that research may be helpful for the use of graphing calculators at elementary school level and for the implementation of graphing calculators into the mathematics curriculum in Turkey.

1.1 The Main Problem and Sub-problems

The purpose of this study was to investigate the effects of graphing calculators on 8^{th} grade students' mathematics performance on graphs of linear equations and the concept of slope. The following research questions have guided the study:

1. What are the effects of using graphing calculators on 8^{th} grade students' mathematics performance?
2. Does gender have significant effect on 8th grade students' mathematics performance when graphing calculators used during the instruction?
3. How does working with graphing calculators change (if it does) students' opinions towards learning mathematics?
4. What kind of difficulties do students confront while working with graphing calculators?

1.2 Null Hypotheses

Null Hypothesis 1: There will be no significant effects of graphing calculators on the 8^{th} grade students' Post Test Scores of Mathematics Achievement Test (POSTMAT).

Null Hypothesis 2: There will be no significant main effect of gender on the 8^{th} grade students' Post Test Scores of Mathematics Achievement Test (POSTMAT).

Null Hypothesis 3: There will be no significant main effect of gender and group interaction on the 8^{th} grade students' Post Test Scores of Mathematics Achievement Test (POSTMAT).

Null Hypothesis 4: There will be no significant mean difference between the Pre Test Scores of Mathematics Achievement Test (POSTMAT) of experimental group and control group.

Null Hypothesis 5: There will be no significant mean difference between the Mathematics Grades of the Second Semester of Seventh Grades (MGS) of experimental group and control group.

1.3 Significance of the Study

Graphing calculators have been used in educational areas for about 21years. In spite of such a short time, the features of graphical calculators have been developed drastically. Their mathematical capabilities, portability and affordability made graphical calculators popular for teachers, students and researchers. In USA and European countries educators and technology developers have been studying on how to adopt graphical calculators into mathematics education better for about 21 years. However, the use of graphing calculators in schools very limited in Turkey and there is a few researches on this topic (Ardahan & Ersoy, 2000; Ersoy, n.d.; Ersoy, 2004; Ersoy & Sirinoglu, 2001). Two of these studies related to the views of teachers and teacher candidates (Ardahan & Ersoy, 2000; Ersoy, n.d.). The study of

Ersoy (2004) was in Physics but included graphing calculators. He investigated the effects of calculator based laboratories on graphical interpretation of kinematic concepts in Physics at METU teacher candidates. His study did not emerge statistically significant results about the use of calculator based laboratories. Different from above research, the study of Ersoy and Sirinoglu (2001) designed to investigate students' responses on using graphing calculators in the concept of function in mathematics. At the end of the study, researchers concluded that a lot of efforts and time were needed to implement the graphing calculators in teaching mathematics. In other words, result of that study showed that more research on graphing calculators should be done in mathematics.

The new Turkish curriculum supports the use of technology including calculators in mathematics lessons ("İlköğretim Matematik Dersi Öğretim Programı", 2006). Ability of using information technology is one of the behavioural objectives which the new Turkish Curriculum aims to acquire to students. This ability includes making right decisions about where to use information technology, making plans while using information technology and owing enough ability about the usage of information technology. Additionally, using a calculator is one of the psychomotor abilities included in new Turkish Mathematics curriculum. The use of calculators is emphasized under the heading of Mathematics Teaching and Learning in the new Turkish Mathematics Curriculum and it is said that with the help of calculators students may study on real life mathematics problems, and use the time they gained from long calculations on creative thinking. It is added that the students must learn where and when to use calculators.

However, graphing calculators are not included in the new curriculum. If benefits of graphing calculators, effective use of graphing calculators and how to implement graphical calculators into the mathematics curriculum examined scientifically, then graphing calculators may be included in the Turkish mathematics curriculum. Hence, this study aims to determine the effects of graphing calculators on students' mathematics achievement and on students' attitude towards mathematics and technology.

Previous studies provide us with a rich knowledge of effects of graphing calculator on student achievement. However, most research concentrated on the role of graphing calculators at high school and college level. This study examines the effects of graphing calculators on students' mathematics achievement at elementary school level. Additionally, this study includes interviews with the teacher, who instructed both experimental and control groups, and six students from the experimental group which result in gaining insight about the teachers' and students' beliefs and ideas about graphing calculators. Therefore, this study is unique examining the effects of graphing calculators on 8^{th} grade students' mathematics achievement both quantitative and qualitative methods at elementary school level.

CHAPTER 2

LITERATURE REVIEW

This chapter is devoted to the presentation of previous studies related to the study. The chapter includes research studies using graphing calculators on functions, qualitative research about graphing calculators, research studies using graphing calculators on algebra, research studies focusing on teachers' attitudes and summary of related literature

2.1 Using Graphing Calculators in Mathematics Classrooms

Doerr and Zangor (2000) examined the role, knowledge and beliefs of a pre-calculus teacher and how students used graphing calculators in support of their learning of mathematics in their qualitative, classroom-based study. They also examined the relationship and interactions between the teacher's role, knowledge and beliefs and the students' use of graphing calculators in learning mathematics. The two classes in the study were taught by the same teacher in an enhanced technology environment. The classroom was equipped with a computer, printer and a "graph link cable" that could be used to transfer pictures of the calculator graph to the computer for printing. Students readily transferred data and programs between calculators using the calculator to calculator link cable. Extensive field notes, transcriptions of audio-taped group work, transcriptions of video-taped whole class discussion, and interviews and planning sessions with the teacher formed the data collections instruments for this study. Doerr and Zangor found that five patterns and modes of graphing calculator use emerged in the practice: computational tool, transformational tool, data collection and analysis tool, visualizing tool and checking tool. With respect to the results, the role, knowledge and beliefs of the teacher influenced the emergence of such rich usage of graphing calculator. In addition they found that the calculator as a private device inhibited mathematical communication in a small group setting, while the shared screen of the graphing calculator appeared to be a powerful tool for supporting the comparison and unification of mathematical ideas.

Similar to Doerr and Zangor, Ocak (2006) studied graphing calculators in a qualitative study. Different from Doerr and Zangor, Ocak wanted to investigate the effect of graphing calculators on college students' graphing abilities for calculus topics in a case study. Attitude survey, prior knowledge survey, and clinical interviews with students were used for collecting and analyzing data. After administering prior knowledge and attitude survey to all students in seven classes from a community college, a private college and a state university, 20 students were selected to be interviewed based on the answers they gave on the survey. The analysis of the interviews showed that experience with the graphing calculator was an important factor in solving tasks with the graphing calculator. In addition, it was found that the graphing calculator and mathematical understanding must work together for the solution of the task. In other words, without understanding the task's underlying principles, using the graphing calculator is not enough for students to reach an acceptable outcome. The following results of the Ocak's study support the previous studies (Slavit, 1994; Clark, 2006; Lesmeister, 1996; Doer & Zangor, 2000). Students used the graphing calculators as a checking tool to see if the graph they drew was correct, as a visualization tool to understand the graph of functions and as a comparing tool to draw conclusions for different function graphs.

Shore (1999), Chreim (2006) and Ritz (1999) examined the role of graphing calculators in Algebra classroom. Shore (1999) aimed to investigate the effect of the graphing calculator on college students' procedural skills and conceptual understanding in Elementary and Intermediate Algebra courses in his 15 week experimental study. Although all students were required to have access to a scientific calculator, only the students in experimental group were allowed to use the graphing calculator in class and on all tests. Data analysis indicated that there were statistically significant gains in procedural skills and conceptual understanding for both the Elementary and Intermediate Algebra graphing calculator sections. According to the graphing calculator questionnaire, students that used the graphing calculator thought that graphing calculator made the mathematics easier, prevented memorization and lead to save time.

In his experimental study, Chreim (2006) wanted to delineate whether the utilization of graphing calculators within the learning environment would impact student success rates of first year technical school students taking Algebra I. One group used graphing calculators to complete the course work, while the other group did not. The research study focused upon the algebraic/geometric subject matter including lines, slopes and angles. Surveys and skills assessment tests were the data collection instruments in the study. Data provided evidence to support that the introduction of such technology would increase student performance. Besides, study indicates that graphing calculators not only improve the participant's performance over all but also the participant's perception of the benefit of this technology.

Ritz is one of the researchers who examined the effect of graphing calculators on high school students' algebra and geometry in an experimental study (1999). The two experimental groups in the study used graphing calculators during class time. Ritz's study spanned two years and the students were given a standardized achievement test at the beginning and end of both years. After the data analysis, no statistically significant differences were found between the groups. Ritz thought that the results might be due to the fact that graphing calculators were great aid for visual learners but for non visual or kinaesthetic learners, it might have no effect or it might have hampered the learning process. However, Ritz's this idea is against the results of Lane's study (2006), since he found that graphing calculator was a essential tool for both visual and non-visual learners.

2.1.1 Effects of Graphing Calculators on Students' Understanding of Functions

The aim of O'Callaghan's experimental study (1998) was examining the effects of the Computer Intensive Algebra (CIA) and Traditional Algebra (TA) curricula on students' understanding of the function concept. The extensive use of technology was one of the characteristics of the function-oriented curriculum CIA.

Quantitative data were obtained by attitude scales, questionnaires and function tests. Additionally, qualitative data were obtained via two sets of interviews conducted with six students from the CIA class and six students from the traditional classes. The most important aspect of O'Callaghan's study was the function tests which were categorized according to the four components of conceptual knowledge of functions: modelling, interpreting, translating, and reifying. Modelling is the ability to represent a problem situation. The reverse procedure is the interpretation of functions. Translating is the ability to move from one representation of a function to another, or to translate. Finally, reifying is the creation of a mental object from what was initially perceived as a process or procedure.

Some researchers replicated O'Callaghan's computer intensive algebra study in different conditions. Hollar and Norwood (1999) are examples of those researchers who extended O'Callaghan's computer intensive algebra study. They aimed to learn whether his results on the four components of his function test would hold within a different curriculum incorporating graphing calculators. Additionally, they examined student performance on a test of traditional algebra skills to determine the influence of the graphing curriculum. 90 college students (46 in treatment group, 44 in control group) enrolled in intermediate algebra course joined the study. Both of the groups used different textbooks. O'Callaghan's function test, the departmental final examination and the Revised Mathematics Attitude Scale were the data collection instruments. The students in treatment group had access to the calculators both in class and for homework exercises and tests but not for the O'Callaghan Function Test or the traditional final examination. At the end of the study, the experimental classes had a significantly better overall understanding of function than the control classes. Although the experimental class had a slightly higher mean score on departmental final, examination, no significant difference was found between the two groups.

Mancilla (2004) was also replicated O'Callaghan's Computer Intensive Algebra and examined whether similar results hold under different demographics with students of a different age group. The participants were high school students enrolled in the second year of high school algebra. She also used O'Callaghan's function test as a data collection instruments. Her study was both quantitative and qualitative in nature since she conducted interview with the four students. Unlike Hollar and Norwood's study, same textbook was used in both of the groups. The data analysis revealed that students in the treatment group did significantly better than students in the control group in modelling and translating functions. However, no significant differences were found in the interpretation or reification of functions.

Slavit (1994), Allen (2006) and Clark (2006) used graphing calculators in both treatment groups and control groups in their experimental research. Slavit (1994) in his year-long study investigated the effects of graphing calculators on students' development of a function concept image. TI-81 graphing calculators were used in experimental and control groups. Data were collected through a series of written tests, individual interviews and questionnaires. Data analysis revealed some effects of graphing calculators on student learning. Those effects can be listed as the graphing calculator facilitates multi-representational problem solving strategies and the graphic images of the graphing calculator strengths the students' structural views of function. After the analysis of the case study with three students, it was found that the students' concept image of the graph of a function involved continuous functions with infinite domains. Slavit (1994) thought that that misconception was due to the use of the graphing calculators.

Allen (2006) tried to find out how varying instructional guidance affected student performance. The two experimental groups and one control group were consisted of undergraduate pre-calculus students in New York State. All of the group activities required the use of a graphing calculator. The amount of written guidance they received was the only difference between different groups. The results showed that the graphing calculator provides support for both cognitive and social activity. Additionally, it served as a tool to individually help students extend their mathematical thinking as well as a tool for facilitating the communication of their thoughts.

Clark (2006) also got benefit from graphing calculators while determining if middle school students will develop a better understanding of functions with a a conceptual approach with real world problems. In the study, the graphing calculator allowed students to easily visualize contextual problems that would be difficult to graph by hand. Another advantage of the graphing calculator was that it decreased the time spent on computational skills so that the students were able to visualize many different forms of a function to attain a better understanding of the function concepts.

Bucher (2002) was one of the researchers who studied functions in an experimental study. Her aim was to determine whether the students develop a better understanding of quadratic functions and their applications. The sample of the subjects was obtained by non-random methods from an urban public high school. Students in the experimental group used graphing calculators while the students in the control group used scientific calculators. Students in the study were measured using a pre-test, a post-test and a retention test. The results of the study showed that students in the experimental group did significantly better on both the post-test and retention test.

Similar to the Bucher, Pilipezuk (2006) studied functions in her quasi-experimental research study. However, unlike Butcher, Pilipezuk used CBL activities in the treatment group. The CBL is a handheld technological device that interfaces with a graphing calculator and uses probes, sensors, or detectors to gather data that can be useful in solving problems that can be useful in solving problems that would require large amounts of time if attempted by hand. The purpose of the study was comparing the academic performance of students in a college preparatory pre-calculus course who engage in five CBL activities with the performance of those who do not engage in these activities. Although a mixed methodology was employed, the research design was primarily quantitative. The qualitative data, which included the responses of students to items on the post-test, were used to clarify the results obtained by quantitative methods and to describe the students' conceptions about modelling, graphing and solving problems. Analyses performed on the data revealed no statistically significant difference on the three components. Students in the experimental class utilized graphical methods more often than those in the control class to solve problems. Qualitative analysis of the posttst responses indicated students in the experimental group outperformed students in the control group on tasks where they were asked to sketch the graph of a function. The descriptive statistics indicated that students in the control class failed to sketch a graph or provide a solution to approximately twice as many items on the posttest as compared to the experimental class.

The aim of the experiment conducted by Lesmeister (1996) was to determine if graphing calculators helped students visualize functions. 139 students at a large public high school in suburban Houston participated in the study. The treatment group received instruction using the TI-82 graphing calculator along with supplemental materials. The control group was taught without using calculators in the traditional lecture, demonstration mode. Three evaluations were conducted during the study. The data analysis of the results did not show a significant difference in achievement scores between the two groups. However, the study did produce some interesting findings. For example, it was noted that students enjoyed "playing" with the calculators and they appreciated the visualization capabilities inherent in their use. On the other hand, students using calculators were more attentive and interested in classroom demonstration.

Lane (2006) also examined the role of graphing calculators in understanding functions in a qualitative case study. Additionally, Lane aimed to learn how visual imagery contributes to visual and non-visual College Algebra students' understanding of functions. Two participants were purposefully selected from the population using Presmeg's Mathematical Processing Instrument. This testing device measured a student's preference for visual thinking in mathematics. Interviews and document reviews were the data sets used in the study. This case study showed that the role of the graphing calculator for the visual and non-visual mathematical learners aided their demonstration of understanding many of the functions used including linear, quadratic, cubic, absolute value, and exponential functions. In fact, the graphing calculator appeared to be an essential tool by the way both of the students used it. In addition, this study showed that visual imagery contributed to the students' demonstrations of understanding some of the functions. When visual imagery and graphing calculators were used, the graphing calculators confirmed or disconfirmed the visual images of the functions held by the students. The results of this study encouraged the integration of using technology in the College Algebra classroom. Educators and textbook authors should be aware that some students have little or no experience using the graphing calculator, so it would be helpful to provide a step by step guide regarding how to use the calculator to explore among numeric, symbolic and graphic forms of functions.

2.2 Teachers' Beliefs and Attitudes on Graphing Calculators

Focus of Arvanis (2003) and Currie's (2003) research was the teachers in graphing calculator based environments. Arvanis aimed to examine the extent of use and obstacles faced by teachers in the integration of the graphing calculator into Algebra I classes in Illinois in his survey study. 879 teachers completed and returned surveys which were created by the researcher. The questionnaire was divided into four parts as teacher characteristics, extent of graphing calculator use, factors influencing graphing calculator use and factors hindering graphing calculator use. The results of the survey revealed that the extent of graphing calculator use was significantly related to certain teacher characteristics: school size, gender, experience, education level, membership in professional organizations, and training. The factors for limiting use of graphing calculators were listed by Algebra I teachers as emphasis on basis, cost/availability, not enough time, lack of training, and lack of materials. The final and maybe the most important finding of that study is that teachers' personal beliefs about teaching and learning provided the greatest influence on whether they used graphing calculators in their Algebra I classes.

Currie (2006) carried out more detailed research on attitudes of teachers. Her aim was to determine if there is a relationship between teachers' attitudes about when graphing calculator technology should be used and the teacher's actual use of graphing calculator. In addition, Currie aimed to determine if the use of graphing calculator technology in Algebra I and Algebra IB affects student achievement. Students in control group were taught Algebra I or Algebra IB without the use of the handheld graphing calculator. Students in treatment group were taught the same lessons with the use of the handheld graphing calculator. The study spanned a six month period from July 2005 to January 2006. Five of the teachers were assigned to the treatment group and the other five teachers assigned to the control group. All the teachers had taught at least 3 Algebra I or Algebra IB classes. Teachers were administered the "Attitude Instrument for Mathematics and Applied Technology-Version II". For students, the pre-algebra 8 final scores, the first semester Algebra I or Algebra IB scores, and other demographic information were collected. Results of the study indicated that the use of graphing calculators positively affected student achievement but the teacher's attitude about when graphing calculators should be used did not determine whether they used the technology.

Heller et al. (2005) also examined how teacher professional development in graphing calculator use related to student achievement in Algebra I. Two teacher surveys and an end-of-course algebra test for students were administered. Results indicated that student scores significantly higher for teachers who reported participating in trainings on how to use a graphing calculator or other computerized technology. However, students did significantly worse on the test when their teachers reported being self-taught using the graphing calculator manual.

2.3 Summary of the Literature Review

Graphing calculators has become the focus of most of the research until today. Since graphing calculators were thought as an effective tool for teaching the concept of functions and functions is one of the important subjects of mathematics lessons, effect of graphing calculators on functions is the main problem of many of those researches. Some of the results of the experimental research showed that treatment groups had a significantly better understanding of functions (Hollar and Norwood, 1999; Mancilla, 2004; Clark, 2006; Butcher, 2002). However, the experiments conducted by Pilipezuk (2006) and Lesmeister (2006) did produce no statistically significant difference between the treatment and control groups.

What teachers think and believe about graphing calculators is an important factor on the use of graphing calculators in mathematics lessons. To illustrate, certain teacher characteristics such as gender, experience and education level, beliefs and attitudes of teachers were related to the extent of graphing calculators use in their classes (Arvanis, 2003; Doerr and Zangor, 2000). Additionally, teacher's treatment about the use of graphing calculators affects their students' mathematics performance. Heller at al. showed in their study that student scores significantly higher for teachers participating in training about graphing calculators or other computerized technology. In addition, Heller at al.'s study revealed that students did significantly worse on the test when their teachers being self taught using the graphing calculator's manual.

Consequently, the literature on graphing calculators is rich in high school and college level. However, there is not enough research about the implementation of graphing calculators to elementary school mathematics. Using graphing calculators in some subjects like graphs of linear equations and concept of slope may be beneficial in elementary grades. Before using graphing calculators in elementary school mathematics, the effects of graphing calculators on students' mathematics achievement and attitude, and how to implement graphing calculators into the elementary curriculum should be examined scientifically. Therefore, this study aims to examine the role of graphing calculators on students' mathematics achievement at eight grades in the subject of graphs of linear equations and concept of slope.

CHAPTER 3

METHODS

In the previous chapters the purpose of the study, significance of the study and hypothesis of the study were stated and review of related literature was presented. In this chapter population, sample, variables, data collection instruments, data analysis methods, assumptions and limitations of the study are explained.

3.1 Participants

To determine the effects of the graphing calculators on eight grade students' performances in graphing linear equations and the slope, a pre test, post test experimental-control group design was employed. This study was a quasi-experimental study, in which two different learning environments were compared. The participants of the present study consisted of 54 eighth grade students from an elementary school in Orhaneli district of Bursa province. Orhaneli is a rural district of Bursa and there are just four elementary schools. Convenient sampling was utilized as the school was accessible to the researcher. There were two eighth grade classrooms in the school and one of the classes was assigned randomly as experimental group (EG) and the other as the control group (CG). There were 27 students in each group. The age of the students were ranged from 12 to 13. The administration of the school equalized the number of boys and girls in each class level. The gender of the students is given in table 3.1.

Table 3.1 Gender of the participants in EG and CG

Gender	Control Group	Experimental Group	Total
Girls	13	13	26
Boys	14	14	28
Total	27	27	54

EG: Experimental Group
CG: Control Group

3.2 Data Collection Instruments

Mathematics Achievement Test was used before and after the instruction as data collection instrument for the quantitative part of the study. Interviews and video-taped classroom observation used for the qualitative part of the study.

3.2.1 Mathematics Achievement Test

This test was prepared by the researcher to determine the students' performance on linear functions. Mathematics Achievement Test was used as both pre-test and post test.

The test was comprised of 22 multiple choice items. The first, second, fifth, sixth, tenth, nineteenth and twentieth items were developed by the researcher. The third and the fourth items were taken from website about mathematics (Pierce, 2006). The seventh, eighth and ninth items were also taken from a website (Roberts, n.d.). The eleventh, twelfth, thirteenth, fourteenth, fifteenth and sixteenth items were taken from a website which prepares online study tools for mathematics ("Graphing Linear Equations," 2001). The seventeenth, eighteenth, twenty-first and twenty-second items were taken from the study of Gasque (2000) which was a comparative study on student understanding and interpretation of slope with graphing calculators. The items taken from the web pages and the study of Gasque (2000) were translated into Turkish by the researcher.

There were nine items in the test were directly related to the concept of slope. The fifth and the sixth questions were about the relation between the direction of the graph and the slope. The seventh, eighth, ninth and twentieth items were about the calculation of the slope. The eighteenth, twenty-first and twenty-second items were about comparing the slope of different line graphs. The third, fourth, thirteenth, fourteenth and sixteenth items were related to the graphs of linear equations. The eleventh and fifteenth items include interpretation of tables of linear graphs. The seventeenth item was about the graphical solution of the linear equation systems. The nineteenth item was related to the perpendicular linear graphs. Students had to compare the slopes of the linear graphs so as to solve that question. Students had to know the fact that the slopes of parallel lines were equal and they were able to find the slope of a given linear equation in order to answer the tenth question. The twelfth item was about the definition of linear equations. Finally, the first two questions were included general expressions about linear equations and graphs.

The objectives of the items are suitable for the 8^{th} grade mathematics curriculum in Turkey as represented in table of specifications (Appendix D). The content related validity of the instrument was established by the three mathematics teachers in the three different elementary schools in Orhaneli in Bursa. They remarked that the test was suitable for the eighth grade mathematics curriculum, and the items represented the objectives in 8^{th} grade Turkish mathematics curriculum. The test was out of 100. Each item was scored as either correct or incorrect and given 5 points for correct answers and 0 for incorrect ones. No partial credit was given. Since there were 22 items in the test, the maximum possible score was 110. For easiness of data analysis, all scores were scaled so they were out of 100. The post-test reliability of the instrument calculated by Kuder Richardson 20 was found to be .72 (N=54).

3.2.2 Qualitative Data Collection

3.2.2.1 Interviews

The researcher organized semi-structured interviews with the six students from the experimental group and the teacher. The interviews with the six students were conducted at the beginning of the study, at the middle and at the end of the study. The teacher was interviewed by the researcher at the beginning of the study and at the end of the study. The questions asked to the participants and the teacher during the interviews was shown in appendix C.

3.2.2.2 Video-taped Classroom Observation

For supporting the results of the analysis of the interviews, students in the experimental group were recorded by camera while they were using graphing calculators.

3.3 Procedure

The study was carried out during the spring semester of 2006-2007 academic-year. There were two groups in the study: one experimental group and one control group. While the students in the control group were taught linear equations concept with graphing calculators, the students in the experimental group were taught linear equations concept (see Appendix A for lesson plans) by traditional methods. Both groups used the same text-book (Yaşaroğlu & Sertoğlu, 2006). Before the study Mathematics Achievement Test (MAT) was administered to both groups as pre-test and at the end of the study the same test was administered to both experimental and control groups as post-test. The two groups taught by their mathematics teacher. She was interviewed before the study and at the end of the study by the researcher. She has three years of teaching experience and she has been teaching eighth grade students for two years. The study was completed in 12 class hours. Two of them were devoted for the administration of Mathematics Achievement Test (MAT). There were two class hours (i.e., 2 x 40 = 80 minutes) of lessons in each day.

3.4 Treatments for the Groups

3.4.1 Treatment of the Control Group

The control group was taught linear graphs concept without the use of graphing calculators. Before and after the treatment, students were administrated MAT. The students were instructed by the same mathematics teacher. The researcher observed four class hours of the control group to be aware of the differences between control group and the treatment group. Two of those class hours were recorded by the camera. The group received 12 class hours of instruction like the experimental group. Two of those class hours were dedicated to administration of PREMAT and POSTMAT. The duration of each class hour was forty minutes. The same objectives were taught to the students with the students in control group and the same lessons plans (see Appendix A) were used. However, because of without having graphing calculators, they drew the graphs by hand on their notebooks and they did not have the opportunity of drawing graphs as many as the students in the control group drew. Instead, they solved multiple-choice questions from different books prepared for high school entrance examinations.

The teacher used direct instruction most of the class time and did not use any technologic device during the instruction period. An example for the flow of lessons in the control group was given in that part. The teacher began the lesson on 30 April by asking the last subject which she instructed in the last lesson. Students answered that they taught writing the linear equations when one coordinate and the slope were given. They also added the negative and positive slopes and the direction of the graphs in each case. Then the teacher wrote an example to the board:

Example: Write the equation of the line which pass through A (0, -3) and has a slope of $= -\frac{1}{2}$?

Four of the students raised their hands to solve the question before the teacher finished writing the question and one of them solved the question at the board. Then, the teacher began to teach a new subject by writing the heading "Writing Linear Equations When Two Points on the Graph were given". She drew the formula at the board by the tangent of a line. Next, she wrote a question to the board.

Question: Write the equation of the line which pass through the points A (2, 1) and B (-2, -4).

Again, one of the questions came and solved the question at the board and the other students wrote the solution to their notebooks. After that question, the teacher wrote another similar example:

The points A (-3, 3), B (a, 5), C (-8, 4) are given. If C is on the AB line, find a?

The teacher explained the question, since it was different from the previous ones.

Teacher: What happens when the point is on the line? It proves the equation of the line.

Students: Will we write 8 instead of a?

Teacher: The point C is on the line. (She drew a figure to the board).

What should I do, they are on the same line?

One of the students: -13

Teacher: It is not midpoint.

Students began to discuss the questions among themselves.

Teacher: Are the lines are the same which pass from AB and which pass from AC?

One of the students discovered the solution and began to solve the question at the board.

$$\frac{x+3}{-3-a} = \frac{y-3}{3-5}$$

$$\frac{x+3}{-3-a} = \frac{y-3}{-2}$$

Teacher: You don't need to continue. This is the equation of the AB line. If the point C is one the line, it proves the equation.

$$\frac{-5}{-3-a} = \frac{1}{-2}$$

$$10 = 3 - a$$

$$a = -13$$

The student who solved the question at the board told that the answer was the same by their method.

It increased one by one and decreased 5 so $-8 - 5 = -13$.

Another student: Can we say this linear equation which one point is known?

Other students: Three points are known

Then the teacher moved to another subject she wrote the topic to the board "Parallelism Condition of Two Lines". She drew two parallel lines to the board

Teacher: There is a rule which we learned last year about two parallel and one intersecting line. What is the kind of the angles ß and α?

Students: Corresponding angles

Teacher: What are the features of corresponding angles?

Students: Their measurements are the same.

Teacher: $s(\alpha) = s(\beta)$.

Slope of the line d_1 $m1 = \tan\alpha$

Slope of the line d_2 $m2 = \tan ß$

$\tan\alpha = \tan ß$

$m1 = m2$

$d1//d2 \longrightarrow m1 = m2$

3.4.2 Treatment of the Experimental Group

Treatment group was taught linear equations concept with the help of graphing calculators. Before and after the treatment, students were administrated MAT. The treatment completed in 12 class hour. The duration of each class hour is 40 minutes. Two of those class hours were dedicated to administration of PREMAT and POSTMAT. The teacher instructed by the researcher about the use of the graphing calculator. The teacher instructed students about the use of the graphing calculators in one class hour. Since, students just used table and graph properties of the graphing calculator; one class hour was adequate for them for learning the usage. The researcher recorded students while they are using graphing calculators and joined almost all the class sessions. Researcher did not interfere with the lessons; but sometimes help the students when they have problems with the use of graphing calculators. The lesson plans were prepared according to 8^{th} grade Mathematics Curriculum in Turkey and included all the objectives of the Curriculum. Students in the treatment group had the opportunity of doing more examples than control group and discovered some of the properties of line graph their selves. The lesson plans were presented in Appendix A. The students in the experimental group used the graphing calculators for drawing graphs and checking the x and y values. Therefore, mostly the graph and table functions of the graphing calculators were used. The features of Cartesian plane, how to find the given points in the Cartesian plane and how to draw the graphs of the functions in the form of $x = a\,(a \in R)$ and $y = a\,(a \in R)$ are the subjects of the lesson on 20 April. The students drew the graphs of linear functions in the form of $y = a$ and $x = a$. First of all, they drew the graphs with graphing calculators and then reached conclusions about the line graphs. On 27 April, they learned the graphs of the functions in the form of $y = mx$ where m is a real number. They draw the lines of $y = x$, $y = 2x$ and $y = -2x$ with the graphing calculator and realized that the graphs of the functions in the form of $y = mx$ pass through the origin. On 3 and 4 May, the students drew the graphs of linear equations such as $y = 2x + 1$, $y = -x + 1$ and $y = 3x + 2$ with graphing calculator and look at the table of those graphs. They concluded that the graphs of functions in the form of $y = mx + n$ cut of the axes. Additionally, solving linear functions with graphical methods was taught on those lessons. Lastly, the concept of slope was taught with the help of graphing calculators. They were able to make comments about the effects of slope on the graph of functions after the lessons. And on the final lesson, the students completed a work sheet about linear functions. This paper includes questions which the students draw the graphs and make comments about their drawing. Therefore, the researcher aimed to increase the time which students spend with graphing calculators

An example of mathematics lessons of experimental group may be given here: The teacher began the lesson on 3 May by reminding what they had learned in the last lesson.

Teacher: We learned the definition of slope, how to find the slope. We drew graphs and made comments on graphs of parallel lines. Now, we will draw the graphs of $y = 2x + 1$ *and* $y = 2x + 4$.

The students began to draw the graphs by graphing calculator. After they drew, the teacher asked how the graphs were. Most of the students answered as the graphs were parallel. Then,

Teacher: Now I want you to open the tables of these graphs. How will we open the table?

Students: We press yellow and graph keys.

Teacher: Yes, we press yellow and graph keys.

Student_1: Yes, we did.

Student_2: There are 1, 6, and 3

Teacher: How can we say where these lines cut the y axis?

Students could not answer that question. Then, the teacher explained the question. She drew coordinate axis to the board and:

Teacher: How are the coordinates of the points on y axis? If here is 1, the other coordinate is.

Students: Zero

Teacher: I mean, what do you find when you look at the point x equals to zero?

Students: y

Teacher: You find the point where it cuts the y axis.

She wrote to the board what they found while they were speaking.

$y = 2x + 1$ the point the graph cuts the y axis (0, 1)

$y = 2x + 4$ the point the graph cuts the y axis (0, 4)

The teacher wrote another pair of linear equations to the board ($y = 2x - 5$ and $y = 2x + 2$) and wanted students to draw them by graphing calculator and asked them to find the points of the lines cutting the y axis. She also reminded them to use the minus key in parenthesis. The students drew the lines quickly and some of them discussed the answer by their friends. For the first line, students answered as (0, -5) and for the second line they answered as (0, 2). While answering the questions, students used the table key of the graphing calculator. The teacher wrote those to the board.

$y = 2x - 5$ the point the graph cuts the y axis (0,-5)

$y = 2x + 2$ the point the graph cuts the y axis (0, 2)

Teacher: Did everyone see these?

Students: Yes, teacher.

Teacher: How do we name those kinds of graphs? There is a general expression.

Most of the students: Intersecting the axes.

Teacher: What is the general form of the equation of linear graphs which intersects the axis?

Student$_3$: $y = mx + n$

Teacher: Yes, all of the lines we have drew now are in the form of $y = mx + n$*. We have found the points where they cut the y axis.*

She wrote to the board: the lines which have the equation in the form of $y = mx + n$, intersects the y axis (0,...).

Teacher: What must I write to the blank?

She summarized the writings on the board in order to give hint to the students.

Student$_4$: It intersects the y axis at n.

Teacher: How do I write the coordinates?

Students: (0, n)

The teacher summarized and added the coefficient of y had to be 1; if it was not, they had to make it 1 by dividing. Then, she asked to students whether they understood and let them pass the writings from board to their notebooks. Next, she wrote two equations to the board and wanted students to draw the graphs of them with graphing calculator. One of the students raised her hand and told that both of them were (0, 3). While they were drawing, the teacher checked what they did. After a while, the same student wanted to answer.

Student: They intersects each other perpendicularly, the multiplication of their slopes is –1.

Teacher: Yes, but what can I say about the direction of these lines?

Students: They are crisscross

Teacher: What you mean by saying crisscross? What is the direction of the first line?

A few students: It slanted to the right

Teacher: What about the other line?

A few students: It slanted to the left.

Then, the teacher wanted them to draw the graphs of $y = -2x + 3$ and $y = 2x + 3$ with the graphing calculator. The students draw the graphs quickly this time and they showed what they drew to their teacher. The teacher told that this time the graphs steepened in contrast to previous ones.

Teacher: When I look at the direction, again

Students: It slanted to the right

Teacher: The other one

Students: It slanted to the left.

The teacher wrote the equations and their directions to the board and asked the slopes of the equations. Students told the slopes of the graphs without difficulty.

$y_1 = x + 3$	slanted to the right	$m_1 = 1$
$y_2 = -x + 3$	slanted to the left	$m_2 = -1$
$y_3 = 2x + 3$	slanted to the right	$m_3 = 2$
$y_4 = -2x + 3$	slanted to the left	$m_4 = -2$

Teacher: Which generalization can I make about those lines?

One of the students: The lines which slant to the left have negative slope and the lines which slants to the right have positive slope.

The teacher confirmed the explanation of the student and summarized what they found and the lesson finished.

3.5. Analysis of Data

In order to examine the effect of graphing calculators on 8th grade students' mathematics achievement and attitude, both quantitative and qualitative analyses were used.

3.5.1. Quantitative Data Analysis

Quantitative data analyses were classified as descriptive and inferential statistics. All the statistical analysis was carried out by using SPSS 15.

3.5.1.1. Variables

Types, names and scales of all the variables included in the study were given in Table 3.2

Table 3.2 Characteristics of Variables

Type of variable	Name	Type of Value	Type of Scale
Independent	PREMAT[a]	Continuous	Interval
Independent	gender	Discrete	Nominal
Independent	MGS[b]	Continuous	Interval
Independent	group	Discrete	Nominal
Dependent	POSTMAT[c]	Continuous	Interval

[a] Pre-implementation of Mathematics Achievement Test scores

[b] Mathematics Grades of Second Semester of Seventh Grade

[c] Post-implementation of Mathematics Achievement Test scores

3.5.1.2. Descriptive and Inferential Statistics

Data were initially examined to obtain descriptive statistics (mean, median, standard deviation, skewness and kurtosis values). Additionally, Analysis of Variance (ANOVA) and independent samples t test was used to test the null hypothesis.

3.5.2. Qualitative Data Analysis

The results of interviews and video recordings were used for supporting the quantitative results and they were used for learning the opinions of students towards graphing calculators. First of all, the interviews were transcribed and then organized as first, second and the third interview. Then it was written in each question which answers were given by the six students. By doing so, common answers, words and phrases used by the students were determined for all the questions of the interviews. Then, conclusions were drawn from those answers. The video recordings were watched by the researcher and the parts which will be included were transcribed. The transcribed parts were used for supporting the results obtained from the interviews. The detailed analysis of the data collected was presented in chapter 4.

3.6. Assumptions and Limitations

3.6.1 Assumptions

The main assumptions of the present study can be listed as:

1. There was no interaction between the experimental and control groups to affect the results of the study.
2. The administration of the tests and scales were completed under standard conditions.
3. All subjects of the control and experimental groups answered the measurement instruments accurately and sincerely.

3.6.2 Limitations

The limitations of the present study can be listed as:

1. The study was limited to 8th grade students in a public high school in Bursa in Turkey during the spring semester of 2007-2008 academic year.
2. The study was limited to unit of linear functions concept.

3. The researcher observed classroom as a non-participant observer, being in the classroom through observation would have some effect on the behaviours of teachers and students.
4. The test included in the study constituted of multiple choice items, since the evaluation procedure will be more objective and easy, it is also possible with multiple choice tests to ask more questions in shorter time. However, multiple choice items increase the risk of finding the correct answer by chance.

CHAPTER 4

RESULTS

In the previous chapters, the theoretical background of the study, the review of the previous studies and the method of the present study were stated. This chapter presents the results of the study. It begins with the restatement of the purpose of the study and the hypotheses tested in the study. Then, descriptive analysis, inferential analyses and qualitative analysis were presented respectively.

4.1 Descriptive Statistics

In Table 4.1 means, standard deviations, kurtosis, skewness scores for the treatment and control groups for Mathematics Achievement Test (MAT) and Mathematics Grades in the Second Semester of Seventh Grade (MGS) are summarized. As presented in Table 4.1 mean scores favour boys more than girls both in experimental and control groups. In control group, female had a mean of 40.92 in POSTMAT, while male had a mean of 30.21. MGS scores also support those results. Mean of MGS scores for female was 64.62 and for male was 55.00 in control group. Similar results hold in experimental group, too. However, in experimental group the scores of females are closer to the scores of males. In POSTMAT, females had a mean of 50.00, while males had a mean of 43.29. The difference between MGS scores of females and males is smaller. It is 56.43 for males and 58.41 for females. Table 4.1 indicates that MGS scores of control group is slightly higher than the experimental group. However, PREMAT and POSTMAT mean of the control group is smaller than the experimental group.

Table 4.1 Descriptive Statistics

Groups	Gender	Variable	N	Mean	SD	Skewness	Kurtosis
CG	Female	PREMAT	13	32.23	15.60	.72	.56
		POSTMAT	13	40.92	21.53	.56	-1.38
		MGS	13	64.62	22.21	.40	-1.59
	Male	PREMAT	14	23.43	8.00	1.08	4.21
		POSTMAT	14	30.21	11.13	.30	-1.04
		MGS	14	55.00	23.85	.35	-1.42
	Total	PREMAT	27	27.67	12.82	1.25	2.89
		POSTMAT	27	35.37	17.48	1.01	0.15
		MGS	27	59.63	23.15	.28	-1.31
EG	Female	PREMAT	13	35.39	17.34	1.17	1.83
		POSTMAT	13	50.00	16.53	.10	-.99
		MGS	13	60.54	25.02	.07	-.89
	Male	PREMAT	14	33.36	13.12	.66	-.73
		POSTMAT	14	43.29	18.69	-.20	-1.35
		MGS	14	56.43	26.39	.31	-1.24
	Total	PREMAT	27	34.33	15.03	1.02	1.14
		POSTMAT	27	46.33	17.86	-0.14	-1.03
		MGS	27	58.41	25.33	.18	-1.14

PREMAT: Pre-test scores of Mathematics Achievement Test

POSTMAT: Post-test scores of Mathematics Achievement Test

MGS: Mathematics Grades of Second Semester of Seventh Grade

4.2 Inferential Statistics

4.2.1 Independent Samples t-test

Independent Samples t-test has three assumptions which are independency of scores, normality and homogeneity of variances. For the first assumption, scores were independent since data were collected from two different groups. For normality assumption skewness and kurtosis values were used. The values for skewness and kurtosis of PREMAT and MGS were given in Section 4.1. The skewness and kurtosis values except kurtosis of PREMAT in control group can be assumed in approximately acceptable range for a normal distribution. Levene's Test of Equality was used to determine the equality of variance assumption. As indicated in Table 4.2, the variances of the variables PREMAT and MGS were equal.

Table 4.2 Levene's Test of Equality of Variances

Variable	F	p
PREMAT	1.01	.32
MGS	.20	.66

PREMAT: Pre test scores of Mathematics Achievement Test

MGS: Mathematics Grades of Second Semester of Seventh Grade

The results of the independent samples t test were given in Table 4.4

Table 4.3 Independent Samples Test

Variable	t	df	p
PREMAT	-1.75	52	.09
MGS	.19	52	.85

PREMAT: Pre test scores of Mathematics Achievement Test

MGS: Mathematics Grades of Second Semester of Seventh Grade

The fourth null hypothesis was "There will be no significant mean difference between the Pre Test Scores of Mathematics Achievement Test (PREMAT) of experimental group and control group." With respect to the results showed in Table 4.7, the fourth hypothesis was failed to reject, $t(52) = -1.75, p = .09$. There was no significant mean difference between PREMAT scores of experimental group and the control group.

The fifth null hypothesis was "There will be no significant difference mean difference between the Mathematics Grades of the Second Semester of Seventh Grades (MGS) of experimental group and control group." That hypothesis was failed to reject as indicated in Table 4.7, $t(52) = .19, p = .85$. There was no significant mean difference between MGS of experimental group and control group.

4.2.2 ANOVA

Analysis of quantitative data collected during the study is presented in this part. Assumptions of ANOVA and t test are presented. There were no missing data on the administration of the pre test and post test.

4.2.2.1 Assumptions of ANOVA

Normality, equality of variances and independency of observation are three underlying assumptions that need to be verified in analysis of ANOVA.

1. Normality

For normality assumption skewness and kurtosis values were used. Skewness and kurtosis of PREMAT, POSTMAT and MGS were presented in table 4.1. The skewness and kurtosis values except kurtosis of PREMAT scores in control group can be assumed in approximately acceptable range for a normal distribution.

2. Equality of variances

Levene's Test of Equality was used to determine the equality variance assumption. As indicated in Table 4.4, the error variances of the dependent variables PSTMAT across groups were equal.

Table 4.4 Levene's Test of Equality of Error Variances

	F	df1	df2	p
POSTMAT	2.32	3	50	.08

POSTMAT: Post test scores of Mathematics Achievement Test

3. Independency of observations

To validate independency of the observations assumption, experimental group and control group were observed by the researcher during the administration of pre test and post test. It was concluded from the observations that the participants did all the tests by themselves.

4. 2.2.2 Findings Related to Hypothesis Testing with ANOVA

For ANOVA analysis, POSTMAT was taken as dependent variable. Group membership and gender were taken a fixed factor of this study.

The results of ANOVA analysis were showed in Table 4.3

Table 4.5 Tests of Between Subjects Effects

Source	df	F	p	η^2	Observed Power
Corrected Total	3	3.06	.04	.16	.68
Intercept	1	303.93	.00	.86	1.00
Gender	1	3.41	.07	.06	.44
Group	1	5.52	.02	.10	.63
gender*group	1	.18	.67	.00	.07
error	50				
total	54				

The first null hypothesis was "There will be no significant effect of graphing calculators on the 8th grade students' Post Test Scores of Mathematics Achievement Test (POSTMAT)." Table 4.6 indicates that, the first null hypothesis was rejected, $F(1,54) = 5.52, p = .02$. Graphing calculators had significant effect on the 8th grade students' POSTMAT

The second null hypothesis was "There will be no significant main effect of gender on the 8th grade students' Post Test Scores of Mathematics Achievement Test (PSTMAT)." As seen in Table 4.6, the second null hypothesis was failed to be rejected, $F(1,54) = 3.41, p = .07$. So, gender had no significant effect on the 8th grade students' POSTMAT.

The third null hypothesis was "There will be no significant main effect of gender and group interaction on the 8th grade students' Post Test Scores of Mathematics Achievement Test (POSTMAT). This null hypothesis was failed to be rejected, $F(1,54) = .18, p = .67$. Consequently, gender and group interaction had no significant main effect on students' PSTMAT. There was no significant interaction between the gender of the participants and the group they belonged to.

4.3 Qualitative Data Analysis

This part includes the analysis of the interviews of six students from the experimental group and interviews with the teacher who instructed both of the groups.

4.3.1 Data analysis of the interviews with the students

The six students from the experimental group are interviewed by the researcher at the beginning, at the middle and at the end of the instruction with graphing calculators. There were three boys and three girls in the interviewing group. They were selected as participants in purposeful sampling. Their teacher offered them considering the fact that they would be good informants who could explain their ideas, beliefs and attitudes in a detailed way. The grades of the students in the previous semesters also regarded to form a sample representing whole class.

In the first interview, all the students confirmed that they did not use calculators in the lessons and they did not know anything about graphing calculators. Before the study five of the six students told that they could draw the graphs of linear equations. Just student F admitted that she could not draw graphs. Except student A, other five students thought that using calculators in mathematics lessons might be useful in some respects but calculators might be harmful for students in learning operations. However, student A thought that using calculators in mathematics lessons was useful and calculators did not damage their operation abilities.

R: Did you use calculators in the lessons at school till today?

A: No. We have never used.

R: Do you think using calculators in mathematics lessons would be useful?

A: Using is beneficial. For example, in long problems it is easier by doing with graphing calculators, in other words in shorter time, we save time.

R: May calculators are harmful for students' arithmetic abilities?

A: No, they may be more useful with respect to time.

In the second interview, all six students told that they could draw the graphs quickly by graphing calculators in mathematics lessons and using graphing calculators was easy for them. When it is asked that "Is it difficult for you using graphing calculators?" all the six students told that using graphing calculators were easy for them and they could able to draw the graphs quickly. Student E, confirmed that when she used the - key instead of the key (-), she had some difficulties. Additionally, student F said that when she used the wrong keys, she had difficulties.

R: Is it difficult for you using graphing calculators?

F: No, because we use computers, since there are enter, right, left keys, I think it is not difficult.

R: Do you mean you are used to technology?

F: Yes.

R: Do you have any difficulties while using graphing calculators.

F: Sometimes, it gives error, when we touched wrong keys, we are afraid, since we don't know all the functions/keys of the graphing calculator.

R: Can you draw the graphs quickly when your teacher wanted?

F: Yes.

R: Do you have any problems with drawing graphs?

F: No.

Student A and Student B thought that table and graph facilities of the graphing calculators helped them for understanding the subject easily. Student E and Student F thought that graphing calculators helped them for understanding the subject since they might draw the graphs wrong while drawing by hand. Therefore, they believed that they looked at he correct graphs on the screen and understand better.

One of the students commented that graphing calculators might obstruct learning to draw graphs by paper and pencil as a negative effect of graphing calculators. Two of the students thought not using graphing calculators in exams were a disadvantage for them. To illustrate:

Researcher: What are the negative effects of using graphing calculators in mathematics lessons?

Student B: Negative effects are little but still there are. For example ours...In exams, we do not have graphing calculators, we will draw ourselves; but *since we use graphing calculators in lessons, our ability of drawing by hand may not develop*

Researcher: Did your teacher make you draw graphs by paper and pencil?

Student B: She did, but when we do not use graphing calculators, I am bored and I wish to draw by graphing calculator

Additionally, three of the students commented that some of their friends who came from the villages of Orhaneli might have had difficulties about learning to use graphing calculators. However, their teacher told that in that study all the students helped the students who came from the villages and it improved their friendship.

All the students wanted to use the graphing calculators in other mathematics lessons in future. Except student D and F, other five students want to buy their own graphing calculator. Students D and F wants to buy a graphing calculator whether they choose a job requires studying mathematics since they find graphing calculators a bit expensive.

In the last interview, Students A, C, D, and F commented that they had understood the linear equations subject and there was no part of the subject that they could not learn. Student B told that she had difficulty with the questions in which slope and a point were given and asked to write linear equations. Students E reported that she could not understand calculating slope. Those indicated that they had no problems with the subjects they learned by the help of graphing calculators, they had just problems with calculations.

None of the students confirmed that they have problems about using graphing calculators. They reported that using graphing calculators were easy for them. For example in the second interview, student E had told that she had confused the minus symbols on the graphing calculator, but in the last interview she denoted that she overcome that problem.

It was asked that whether there were any trouble with that study and if we had applied that study again what we should have changed. Two of the students confirmed that there were no problems about the study for them. However, other students admitted that they had worried about not to complete the subjects on time since they would enter high school entrance examination.

All the students confirmed that graphing calculators made positive effects to their attitude towards mathematics. Additionally, they told that studying with graphing calculators were more enjoyable for them.

Researcher: Does your attitude change towards mathematics after that study with graphing calculators?

Student A: Yes, it increased my interest, when we studied with graphing calculators we adapted to the lessons more, since they were more enjoyable. For example, in other methods the teacher tells. To illustrate one question is asked, we did it quickly by graphing calculator, otherwise when we draw to our notebooks, it may be wrong and this may demoralize us, so this is wrong, Tables are easier with graphing calculators.

Student B: It did affect little, because it provided my attending to the lessons more. I did by looking from there; I understood from figures what emerged, and I attended lessons more.

Student C: I loved it since it was more enjoyable.

Student D: It has positive aspects, since we did a study which depended on experiment and observation. It was better. Mathematics lessons become more enjoyable for me.

Student E: Yes. I did not love mathematics lessons before. For example, now I want to enter mathematics lessons. I loved this subject. I can draw now, I do not know have difficulties like before, I think it is better.

Student F: It did not, but it did in linear equations, it helped with linear equations, I do better, I motivate myself better, but it does not help us with other subjects....

In POSTMAT, students A and B admitted that they had difficulty with the 17^{th} item. Student E found table questions difficult. Students C, D and F told that they did better in POSTMAT in contrast to the PREMAT and they did not have difficulty with any of the questions.

4.3.2 Data analysis of the interviews with the teacher

The teacher was interviewed by the researcher at the beginning and at the end of the instruction. She had been two years of teaching experience with 6th, 7th and 8th grade students. Computer and OHP were the technologic devices used sometimes by Mrs. Aslan. Before the instruction with graphing calculators, she had never used calculators in the classroom. Deciding on which linear equation represents the line graph passing through the origin and which represents the line graph cutting of the axes was the common problem of the students according to Mrs. Aslan. Before the study, she believed that the students would show more concern to lessons since they like using technology. However, she added they may problems with drawing methods when they used graphing calculators. Mrs Aslan commented that use of graphing calculators may be beneficial for the subjects like perpendicular and parallel lines.

After the instruction with graphing calculators, she confirmed that she did not have any problem about students' learning of usage of the graphing calculators, because they were used to technology. Additionally, Mrs. Aslan told that the students apprehended the characteristics of the graphs in perpendicularity and parallelism very well. She also commented that the attitude of the students towards mathematics was affected in a positive way. This result was consistent with the results of the interview of the students. In the interview it was asked whether she observed any changes in the attitude of her students towards mathematics lessons in experimental group. She answered as:

Teacher: Definitely, it was positive because some of my students were disinterested and they tend to not coming to lessons since it was afternoon. But when graphing calculators came into being....the eight graders were on duty at school at that time, nobody wanted to go to the duty since they wanted to use the graphing calculators. Actually they liked, they were interested in and everybody tried to be active in the lessons.

Researcher: So you have observed changes in the mathematics performance of some students?

Teacher: Certainly, I observed some students especially students who do not ask questions. Since they are aware of the fact that they need help while studying with graphing calculators, they act with solidarity with me. By doing so, they especially enjoyed studying on the activity sheet with graphing calculators.

She admitted that she had lived some difficulties in her lesson since that was the first time she used graphing calculators in the lesson, but she confirmed that it would be better next time she used graphing calculators. If there were graphing calculators at school she told that she would prefer using them in the lessons. However, she believed that graphing calculators should be used together with paper and pencil methods.

Researcher: Would you use graphing calculators in mathematics lessons, if there were graphing calculators at school?

Teacher: I prefer of course. Not all of the subject, since we program our lessons with respect to the high school entrance examination. Certainly, I want to dedicate some part of the lesson and some part of the subject, because there are some situations where we can not reify, when they see those situations by their selves they would understand better. To illustrate, if I had 16 hours lesson, I would dedicate 8 hours for graphing calculators.

Researcher: Do you mean first you will teach the lesson and then use the graphing calculator?

Teacher: Yes, in the form of practice, graphing calculator motivates the children, because finding something with graphing calculators is more easy from calculating something, this affects children in a useful way.

CHAPTER 5

CONCLUSIONS, DISCUSSIONS AND IMPLICATIONS

The main goal of this study was to investigate effect of graphing calculators on eighth grade students' mathematics achievement in graphs of linear equations and the concept of slope. Following sections include a brief summary of the experiment, conclusions drawn in the study, discussion of the results, internal and external validity of the study, implications of the study and recommendations for further research.

5.1 Summary of the Experiment

This research was conducted during the second semester of 2006-2007 educational year. There were two groups of 27 students who were selected by convenient sampling from eight grade students in an elementary school in Orhaneli district of Bursa province. Mathematics Achievement Test (MAT) was administered to students as a pre test and post test. The students in experimental group were taught the subject of line graphs with graphing calculators. However, the students in the treatment group were taught the subject of line graphs without graphing calculators. The research was quasi-experimental since it included interviews with the teacher and six students from the experimental group.

5.2 Conclusions

The results of the inferential statistics indicated that there was no significant effect of gender on the students' mathematics performance when the students in the experimental group taught the subject of graphs of linear equations and the slope with graphing calculators. Additionally, gender and group interaction has no significant main effect on students' mathematics performance. However, it was showed in the study that graphing calculators had significant effect on the 8th grade students' mathematics performance. Additionally, mean difference between PREMAT and MGS scores of students were not statistically significant. This may show that mathematics performance of the students in both groups were almost same before the instruction.

Analysis of the qualitative data showed that students learned the use of graphing calculators quickly and they had no problems about use of graphing calculators during the study. Additionally, graphing calculators affected their attitude towards mathematics in a positive way. Students found studying with graphing calculators enjoyable.

5.3 Discussion of the Results

Findings of the study indicated that graphing calculators had significant effect on the 8th grade students' mathematics performance in the subject of graphs of linear equations and the concept of slope. That result is in agreement with the results of previous research (Bucher, 2002; Chreim, 2006; & Shore, 1999). They examined the role of graphing calculators on students' mathematics performance on different grade levels and at different subjects, but concluded that graphing calculators increased the mathematics performance of the students. Additionally, with respect to the quantitative results, gender had no significant effect on the 8th grade students' mathematics performance wtih graphing calculators. Before the instruction, the mean score of the female students were higher than the male students in both groups. After the instruction, again , the mean score of the female students were higher than the male students in both groups.

Students had learned the graphs of linear equation at 7th grade. Some of the students also studied that subject at 8th grade since they were attending to special courses for high school entrance examination. However, analysis of the interviews showed that except one student other students had problems with that subject before the instruction with graphing calculators.

Almost all the students were comfortable with using graphing calculators, when they drew the graphs they showed the screen of the graphing calculator to their teacher and to the researcher happily. However a few students who came from the villages of Orhaneli had difficulty with using graphing calculators at the beginning. Their teacher commented that those students' mathematics grades were lower than the other students' and they generally did not ask questions even though they could not understand. In the first lessons, it was possible to notice them easily in the video recordings, since they did not join the lesson and did not show the screen of the graphing calculator to their teacher. However, after the first two lessons, they began to ask questions to their teacher and their friends during the instruction. Sometimes, their friends came and helped them. In other words, studying with graphing calculators increased their relationship with their friends and teacher which supported the result of Allen (2006). With respect to the results of Allen (2006), graphing calculator provided support for social activity and it facilitated the communication of students' thoughts.

Analysis of the qualitative data showed that graphing calculators affected students' attitude towards mathematics in a positive way. To illustrate, even though mathematics lessons were the last two lessons of 3 May and it was a very hot day, all the students joined the lessons and none of them seemed bored or commented that they were tired. They enthusiastically joined all the activities. That may show their attitudes towards mathematics were positive. Additionally, the results of the interviews with the teacher and the students supported that result. Furthermore, those findings were in agreement with the previous research (Hollar& Norwood, 1999; Mancilla, 2004; Wong, 1998), which indicated that graphing calculator changed students' attitude towards mathematics in a positive way. Additionally, students found studying with graphing calculators enjoyable which is similar to one of the results of the experimental study conducted by Lesmeister (1996).

Interview results revealed that graph facilities of the graphing calculators helped students for understand the subject easily. They claimed that they might draw the graphs wrong while drawing by hand. However, when they studied with graphing calculators, they looked at the graphs on the screen and understand better. Those results emphasize the role of the graphing calculator as a visualization tool (Clark, 2006; Doerr & Zangor, 2000; Lesmeister, 1996; Ocak, 2006).

Additionally, students wanted to use graphing calculators in other mathematics lessons. However, they thought that calculators might be harmful for students in learning operations. This may show that they want paper-pencil methods and graphing calculators to be used together in mathematics lessons. This idea is relevant with Ocak (2006) which indicated graphing calculator and mathematical understanding must work together for the solution of the task.

The teacher commented that she had difficulty since that was the first time she used graphing calculators in her lesson. She had been just instructed by the researcher before the study. She completely depended to the lesson plans developed by the researcher and did not discover any other situation or example where she could use the graphing calculator in the graphs of linear functions and the concept of slope. However, if she had any training with graphing calculator, that would affect her performance positively. This result is consistent with the research of Arvanis (2003), since he had listed lack of training as one of the factors which limited the use of graphing calculators. Additionally, Heller at all (2005) indicated that student scores significantly higher for teachers who reported participating in trainings on how to use a graphing calculator or other computerized technology.

The only difficulty students confronted while using graphing calculators was that they mixed – and (-) keys, since when they used minus key without parenthesis, the graphing calculator gave error. In video recordings, it was seen that when they confronted such a problem they ask their teacher and sometimes to the researcher. Additionally, it was seen that the teacher often warned them about not to mixing the minus keys.

5.4 Internal Validity of the Study

Possible threats to internal validity and the methods used to cope with them are discussed in this section. First of all, there were no missing data in the study. Next, two classrooms were designed with the same characteristics such as lighting, equipment and resources and both groups administered the tests approximately at the same time, so history and location threats were controlled. Exposure to pre test might alter the participants' performance on post test. However, it is assumed that the pre test would affect both groups equally. The experiment duration (five weeks) helped to minimize the pre test effect on post test. Next, to cope with the implementer effect the researcher made observations of both groups through the study. Lastly, the names of the students were not used anywhere, so confidentiality was not a problem of that study. Participants' names were just taken for the sake of statistical analysis and the researcher only knows them.

5.5 External Validity of the Study

The accessible population was all eight grade students in Orhaneli in Bursa. The subjects were not randomly selected. They were students of a teacher from the same elementary school. Hence, convenient sampling method used and this limits the generalization of the results in the study. However, generalizations to students in similar populations might be acceptable.

In that study, all the treatment and testing procedure took place in ordinary classrooms during regular class time. Consequently, all the issues related to ecological validity were adequately controlled by the settings used in the study.

5.6 Implications of the Study

Most of the research focused on the effects of graphing calculators and obtained data about use of graphing calculators at high school, or college level. However, the results of that study showed that when graphing calculators used at elementary school level, they had positive effects on students' achievement and in some respects to their attitude. Therefore, graphing calculators might be used in the subjects such as Cartesian coordinate system, graphs of linear equations and the concept of slope at elementary school level. Consequently, graphing calculators should be included in the new Turkish mathematics curriculum and examples, activities or exercises about graphing calculators should be included in mathematics textbooks at elementary level.

As emphasized previous chapters, one of the benefits of graphing calculators is that they are economical and each elementary school may buy a set of graphing calculators to their school. In this way, students and teachers would have easy access to graphing calculators whenever they want to study.

In that study the teacher commented that she had difficulty since this was the first time she used graphing calculators and added she would be better at using graphing calculator in her lesson at next time. Therefore, in-service training should be given to teachers about how to use graphing calculators in mathematics lessons effectively.

5.7 Recommendations for Further Research

This research was carried out before the implementation of the new Turkish elementary mathematics curriculum. So, future research may be carried out with the new curriculum. How to implement graphing calculators in the new elementary mathematics curriculum may be the focus of another research. Additionally, the participants of the study were 8^{th} grade students, but another research can be carried out with 7^{th} grade students.

This study may be replicated with a larger sample and for a longer time. Additionally, views of mathematics teachers towards calculators can be investigated. Moreover, the difficulties that teachers and students confront while studying with graphing calculators may be investigated in future research. In addition to these, the role of gender on the use of graphing calculators in lessons may be investigated in future research. Finally, the use of graphing calculators in other lessons like science and technology may be searched scientifically.

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APPENDICES

APPENDIX A

Lesson Plans

DERS PLANI-1

Dersin Adı: Matematik

Sınıf: 8/A

Ünite: Orantılı Doğru Parçaları ve Benzer Üçgenler

Konu: Doğru Denklemi ve Grafiği

Önerilen Süre: 40 dk. + 40 dk.

Tarih: 20 Nisan

Davranışlar:

- Dik koordinat eksenlerini çizip adlandırma.
- Koordinat eksenlerinin ayırdığı bölgelerde koordinatları verilen bir noktayı, koordinat düzleminde bulup işaretleme.
- Koordinat eksenlerinin başlangıç noktasının adını söyleme.
- Koordinatlarından biri sıfır olarak verilen bir noktayı, koordinat düzleminde işaretleme.
- $x = a$ sabit ve $y \in R$ olmak üzere, (a, y) noktalarından geçen bir doğrunun grafiğini çizme.
- $y = b$ sabit ve $x \in R$ olmak üzere (x, b) noktalarından geçen bir doğrunun grafiğini çizme.

KARTEZYEN KOORDİNAT SİSTEMİ, ANALİTİK DÜZLEM

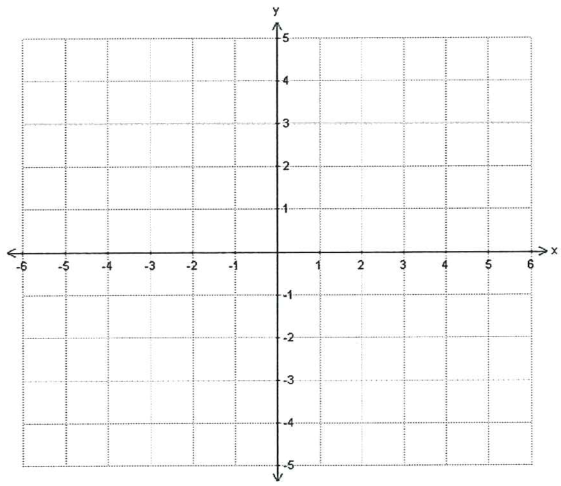
Apsisler ekseni: Yatay olan xx' sayı doğrusuna apsisler ekseni veya x ekseni denir.

Ordinatlar ekseni: Düşey olan yy' sayı doğrusuna ordinatlar ekseni veya y ekseni denir.

Orijin: Koordinat eksenlerinin kesim noktasına başlangıç noktası veya orijin denir.

Dik koordinat eksenlerinin oluşturduğu sisteme, **dik koordinat sistemi**; düzleme de **koordinat düzlemi** denir.

Örnek: Aşağıdaki noktaların koordinatlarını bulunuz.



Örnek: Aşağıdaki noktaları analitik düzlemde gösteriniz.

A (2, 5) B (-1, -2) C (-4, -5) D (-3, 3)

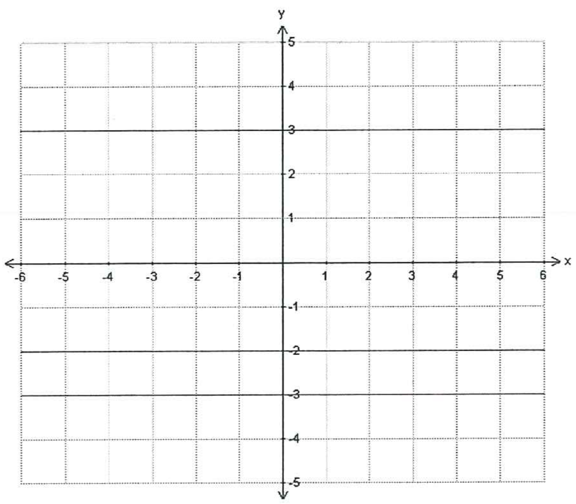
Örnek: Aşağıdaki noktaları analitik düzlemde göstererek birleştiriniz ve oluşan geometrik şekilleri adlandırınız.

a) (6, 4) (-6, 4) (-6, -4) (6, -4) **b)** (0, 5) (-6, 0) (0, -5) (6, 0)

DOĞRU DENKLEMLERİ

1. **($a \in R$ olmak üzere) $y = a$ şeklindeki doğrular**

Örnek: $y = 3, y = -2, y = 1, y = -3$ doğrularını grafiksel hesap makinesi ile çiziniz ve x, y tablosuna bakınız.



Bu doğrular hakkında nasıl bir genelleme yapabilirsiniz?

- x eksenine paralel
- y eksenin tek noktada keser

- y koordinatı sabit, x koordinatı değişiyor.

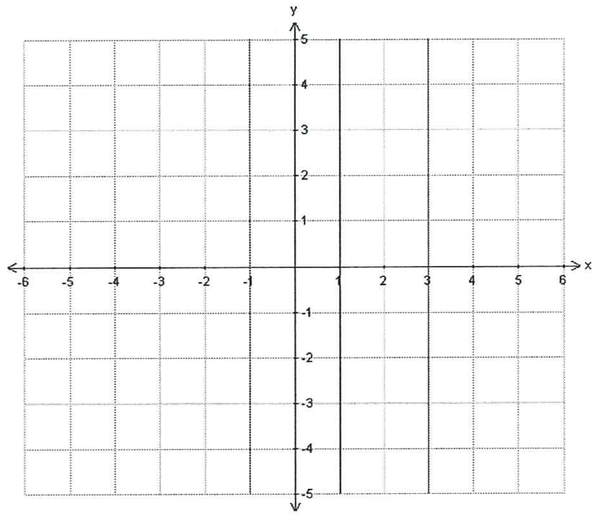
Örnek: $y = 0$ doğrusunu grafiksel hesap makinesi ile çiziniz.

$y = 0$ doğrusu için ne söyleyebilirisiniz

- $y = 0$ doğrusu x eksenini temsil eder.

2. ($a \in R$ olmak üzere) $x = a$ şeklindeki doğrular

Örnek: $x = 1, x = -1, x = 3$ doğrularını grafiksel hesap makinesi ile çiziniz ve x, y tablosuna bakınız.



Bu doğrular hakkında bir genelleme yapabilir miyiz?

- y eksenine paralel
- x eksenini tek noktada keser
- x koordinatı sabit, y koordinatı değişiyor.

Örnek: $x = 0$ doğrusunu grafiksel hesap makinesi ile çiziniz.

$x = 0$ *doğrusu için ne söyleyebilirsiniz.*

- $x = 0$ doğrusu y eksenini temsil eder.

DERS PLANI-2

Dersin Adı: Matematik

Sınıf: 8/A

Ünite: Orantılı Doğru Parçaları ve Benzer Üçgenler

Konu: Doğru Denklemi ve Grafiği

Önerilen Süre: 40 dk. + 40 dk.

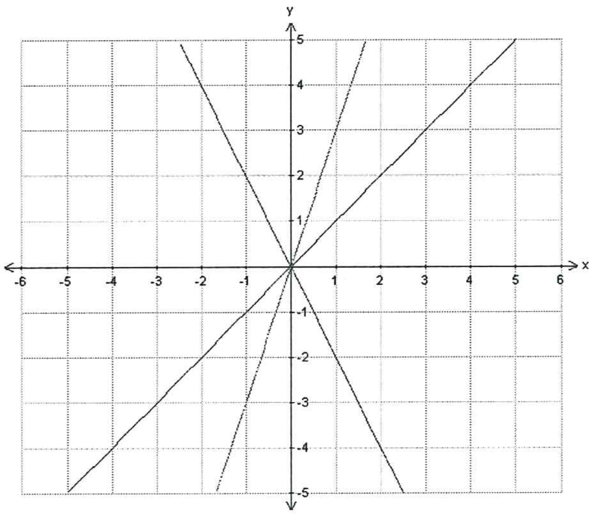
Tarih: 27 Nisan

Davranışlar:

- $y = mx$ denklemiyle verilen doğrunun grafiğini çizme.

3. $y = mx$ şeklideki doğrular

Örnek: $y = x, y = 3x, y = -2x$ doğrularını grafiksel hesap makinesi ile çiziniz ve x, y tablosuna bakınız.



Bu doğruların ortak noktası var mı?

- $y = mx$ şeklideki doğrular $m \in R$ olmak üzere, orijinden geçen doğrulardır.

DERS PLANI-3

Dersin Adı: Matematik

Sınıf: 8/A

Ünite: Orantılı Doğru Parçaları ve Benzer Üçgenler

Konu: Doğru Denklemi ve Grafiği

Önerilen Süre: 40 dk. + 40 dk.

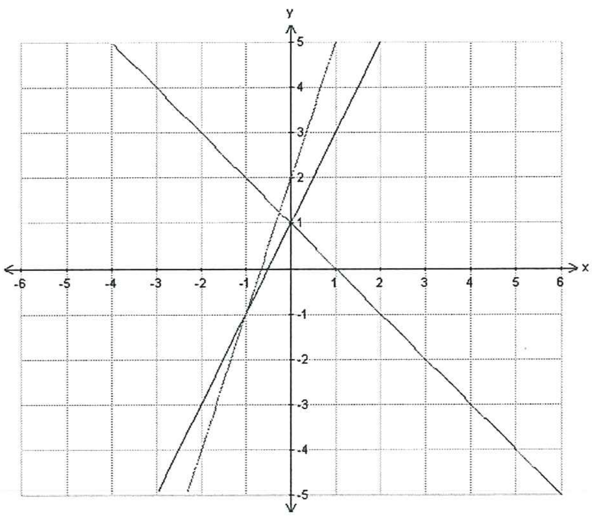
Tarih: 3 Mayıs

Davranışlar:

- $y = mx + n$ ($n \neq 0$) denklemi ile verilen bir doğrunun grafiğini çizme.

4. **y = mx + n şeklindeki doğrular**

Örnek: y = 2x+1, y = -x+1, y = 3x+2 doğrularını grafiksel hesap makinesi ile çiziniz ve x, y tablosuna bakınız.



Daha önce çizdiğiniz doğru grafiklerinden son çizdiklerinizin ne gibi farkı var?

- $y = mx + n$ şeklindeki doğru grafikleri $n \neq 0$ olmak üzere, eksenleri (x ve y eksenini) kesen doğru grafikleridir.

Grafiksel Metot Kullanarak Doğrusal Denklemlerin Çözümü

Örnek: $2x + 3y = 5$

$3x - y = 2$ denklem sisteminin çözüm kümesini bulunuz.

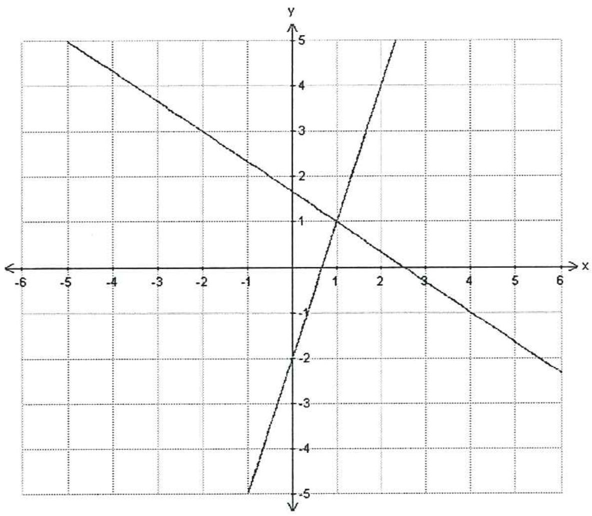
Çözüm: $2x + 3y = 5$

x	-2	1	4
y	3	1	-1

$3x - y = 2$

x	0	1	2
y	-2	1	4

- Grafikler grafiksel hesap makinesi ile çizilecek olursa, grafiklerin kesim noktası olan (1,1) noktasının bu denklem sisteminin çözüm kümesi olduğu görülür.



EĞİM

Eğim kavramını günlük hayatınızda duydunuz mu?

Eğim sizce nedir?

Eğimle doğru grafikleri arasında nasıl bir bağlantı vardır?

- Eğim bir doğrunun dikliğinin ölçüsüdür ve m ile gösterilir.
- Eğim bir doğru üzerindeki iki noktanın y koordinatları arasındaki farkın x koordinatları arasındaki farka oranıdır.

$y = mx$ şeklinde ise m eğimdir.

$y = mx + n$ ise m ise m eğimdir.

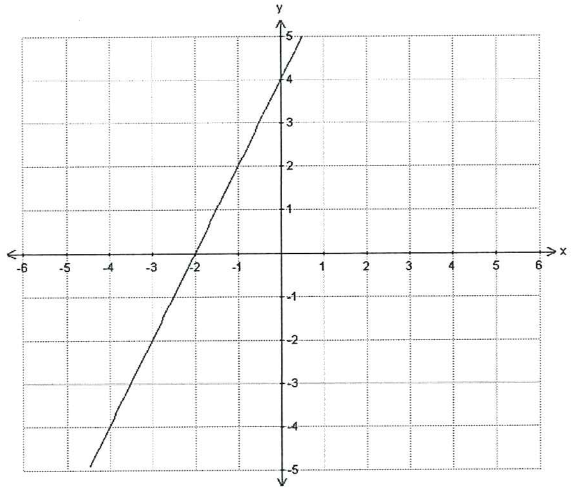
Örnek: $y = 2x, y = -3x, y = 2x + 1, y = -3x + 5$ doğrularının eğimini bulunuz.

Örnek: $2y - 4x + 4 = 0, 3y - 3x + 9 = 0, 4y = 2x + 6$ doğrularını eğimlerini bulunuz.

UYGULAMALAR

1. **Örnek:** $y = 2x + 4$ doğrusu çizdiğimiz doğru grafikleri içersinde hangi gruba girer?
   - Doğru denklemi $y = mx + n$ şeklindedir ve eksenleri keser.

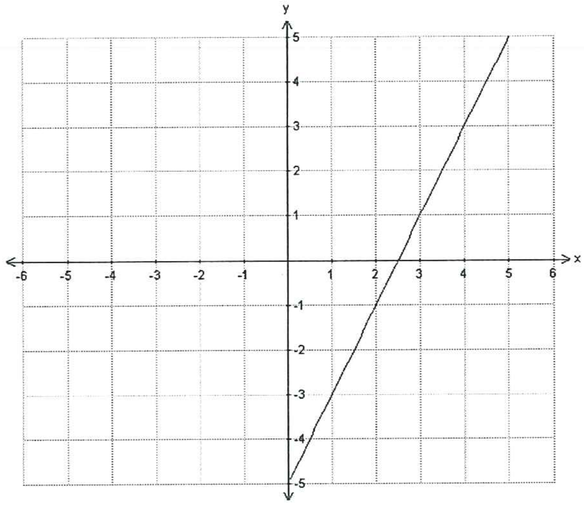
   Örnek: $y = 2x + 4$ doğrusunun grafiğini grafiksel hesap makinesi ile çiziniz.



$y = 2x + 4$ doğrusu y eksenini hangi noktada keser?

- (0, 4)

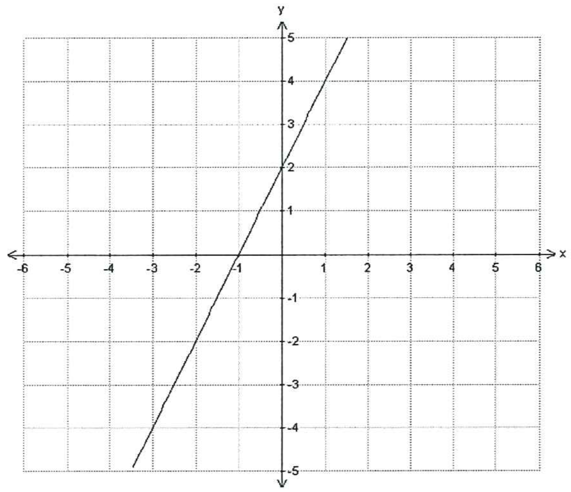
Örnek: $y = 2x - 5$ doğrusunun grafiğini grafiksel hesap makinesi ile çiziniz.



$y = 2x - 5$ doğrusu y eksenini hangi noktada keser?

- (0, -5)

Örnek: $y = 2x + 2$ doğrusunun grafiğini grafiksel hesap makinesi ile çiziniz



$y = 2x + 2$ doğrusu y eksenini hangi noktada keser?

- (0, 2)

y eksenini kesen nokta ve doğru denklemi arasında nasıl bir bağlantı kurabiliriz?

- Doğru denklemi y = mx + n şeklinde ise doğru y eksenini (0, n) noktasında keser.

DERS PLANI-4

Dersin Adı: Matematik

Sınıf: 8/A

Ünite: Orantılı Doğru Parçaları ve Benzer Üçgenler

Konu: Doğru Denklemi ve Grafiği

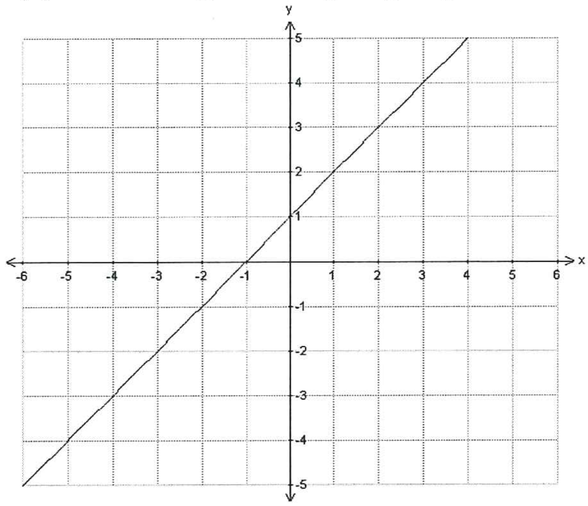
Önerilen Süre: 40 dk. + 40 dk.

Tarih: 4 Mayıs

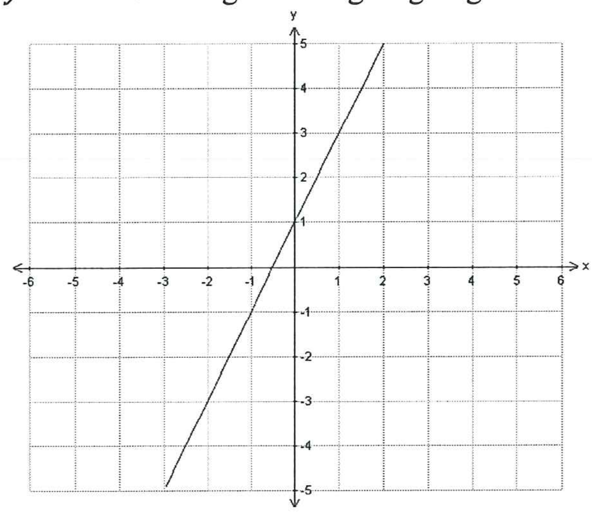
Davranışlar:

- $y = mx + n \ (n \neq 0)$ denklemi ile verilen bir doğrunun grafiğini çizme.

2. a) y = x + 1 doğrusunun grafiğini grafiksel hesap makinesi ile çiziniz.

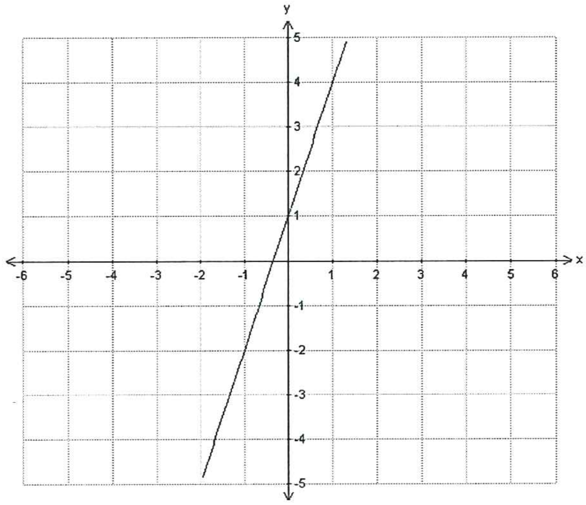


b) $y = 2x + 1$ doğrusunun grafiğini grafiksel hesap makinesi ile çiziniz.



İlk çizdiğiniz doğru grafiği ile arasında nasıl bir fark var?

c) $y = 3x + 1$ doğrusunun grafiğini çiziniz.



Son çizdiğiniz doğru grafiği öncekilerden hangi yönlerden farklı?

a, b ve c şıklarındaki doğru denklemlerinin birbirinden farklı yönü nedir?

- Denklemlerdeki x'lerin katsayıları farklı.

x'in katsayısının diğer adı nedir?

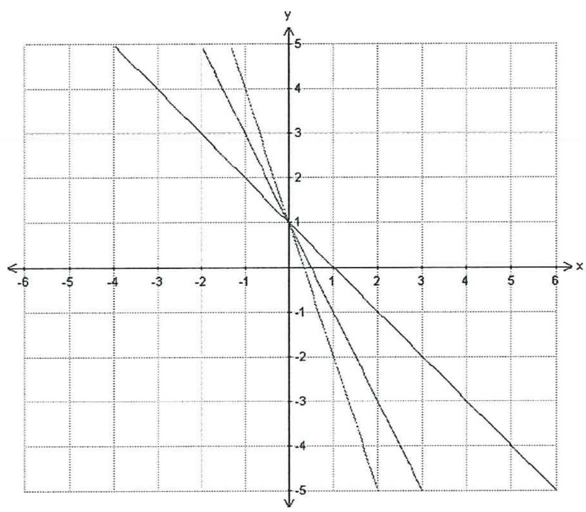
- Eğim

Eğim ve doğru grafiği arasında nasıl bir ilişki vardır?

- Eğim arttıkça doğru grafiği dikleşir.

Şimdi aynı grafiklerin negatif katsayılı olanlarını grafiksel hesap makinesi çiziniz ve grafikleri yorumlayınız?

$y = -x + 1 \quad y = -2x + 1 \quad y = -3x + 1$



Pozitif ve negatif katsayılı denklemlerin grafiklerinin yönü konusunda nasıl bir yorum yapılabilir?

- Pozitif eğimli doğruların grafikleri sağa yatık, negatif eğimli doğruların grafikleri sola yatık şekildedir.

3. *Eğim sıfır olursa doğru denklemimiz ne şekilde olur?*

- $y = a$ şeklinde olur. Örnek: $y = 3, y = 2$.
- x eksenine paralel olan doğruların eğimleri sıfırdır.

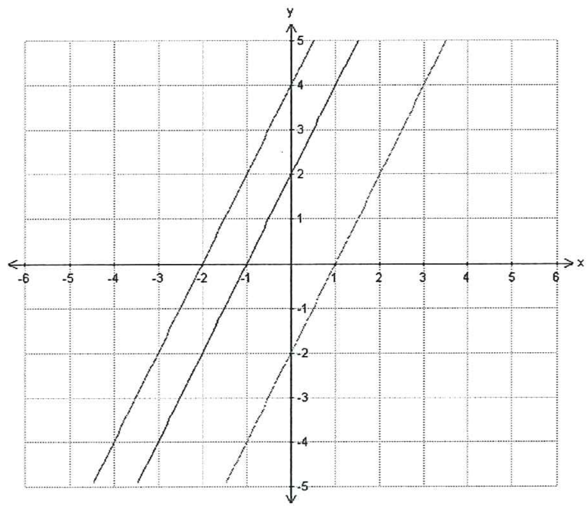
a bir reel sayı olmak üzere, $x = a$ şeklindeki doğruların eğimleri için ne söylenebilir?

- y eksenine paralel olan doğruların eğimleri tanımsızdır.

4. $y = 2x + 2, y = 2x + 4, y = 2x - 2$ *doğru denklemlerinin ortak noktaları nedir?*

- Eğimleri eşittir.

Bu doğruların grafiklerini grafiksel hesap makinesi ile çiziniz.



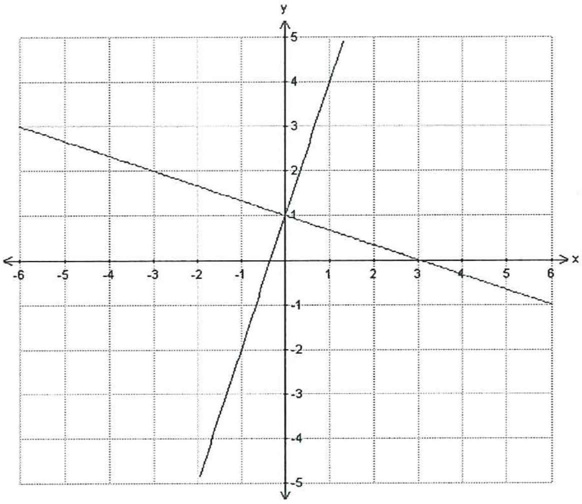
Bu doğrular hakkında nasıl bir genelleme yapabiliriz.

- Bu doğrular paralel doğrulardır ve paralel doğruların eğimleri eşittir.

5. **Örnek:** $y_1 = 3x + 1$ ve $y_2 = -1/3x + 1$ doğrularını eğimlerini bulunuz.

- $m_1 = 3$ ve $m_2 = -1/3$

y_1 ve y_2 doğrularının grafiklerini grafiksel hesap makinesi ile çiziniz.



- y_1 ve y_2 doğruları dik doğrulardır.
- Dik doğruların eğimleri çarpımı –1 dir.

DERS PLANI-5

Dersin Adı: Matematik

Sınıf: 8/A

Ünite: Orantılı Doğru Parçaları ve Benzer Üçgenler

Konu: Doğru Denklemi ve Grafiği

Önerilen Süre: 40 dk. + 40 dk.

Tarih: 11 Mayıs

Aşağıdaki çalışma kağıdı öğrencilere uygulanarak öğrencilerin geçmiş konuları tekrar etmeleri ve grafiksel hesap makineleri ile çalışarak geçirdikleri sürenin artırılması hedeflenmiştir.

DOĞRU GRAFİKLERİ ÇALIŞMA KAĞIDI

1. Aşağıdaki doğru grafiklerini grafiksel hesap makinesi ile çiziniz ve grafiksel hesap makinesinden yararlanarak verilen tabloları doldurunuz.

a.) $y = x$

x	-1	0	1	2	3
y					

b.) $y = -2x$

x	1	2	3	4	5
y					

c.) $y = x + 3$

x	0	1	2	3	4
y					

d.) $y = x - 2$

x	-1	0	1	2	3
y					

2. Aşağıdaki doğru grafiklerini grafiksel hesap makinesi ile çiziniz.
a) $y = x$ b) $y = 2x$ c) $y = -4x$
Bu doğru grafiklerinin ortak özelliği nedir?
....

3. Aşağıdaki doğru grafiklerini grafiksel hesap makinesi ile çiziniz.
a) $y = x$ b) $y = 2x$ c) $y = (1/2)x$ d) $y = (3/4)x$
Çizdiğiniz doğru grafiklerinin hepsi orijinden geçiyor mu?..
Hangi doğrunun grafiği diğerlerinden daha dik
görünüyor?...

4. Aşağıdaki doğru grafiklerini grafiksel hesap makinesi ile çiziniz.
a.) $y = x - 2$ b) $y = 2x - 2$ c) $y = 3x - 2$ d) $y = -x - 2$
Çizdiğiniz doğru grafiklerinin ortak özelliği nedir?
....

5. Aşağıdaki doğru grafiklerini grafiksel hesap makinesi ile çiziniz.
a) $y = 2$ b) $y = 6$ c) $y = 2x - 2$ d) $y = 2x - 6$
Çizdiğiniz doğru grafiklerinden hangi geometrik şekil oluştu?..................................
Oluşan geometrik şeklin köşe koordinatlarını yazınız.
....

6. Aşağıdaki doğru grafiklerini grafiksel hesap makinesi ile çiziniz.
a.) $y = -x + 6$ b) $y = x - 2$ c) $y = -x + 10$ d) $y = x + 2$
Çizdiğiniz doğru grafiklerinden hangi geometrik şekil oluştu?..................................
Oluşan geometrik şeklin köşe noktalarının koordinatlarını yazınız.
....

7. Aşağıdaki doğru grafiklerini grafiksel hesap makinesi ile çiziniz.
a) $y = (1/3)x$ b) $y = (1/3)x + 4$
c) $y = (-1/3)x + 4$ d) $y = (-1/3)x + 8$
Çizdiğiniz doğru grafiklerinden hangi geometrik şekil oluştu?..................................
Oluşan geometrik şeklin köşe noktalarının koordinatlarını yazınız.
....

8. Aşağıdaki doğru grafiklerini grafiksel hesap makinesi ile çiziniz.
a) $y = (-3/2)x + 9$ b) $y = (1/2)x + 5$
c) $y = (-1/2)x + 11$ d) $y = (3/2)x - 9$
Çizdiğiniz doğru grafiklerinden hangi geometrik şekil oluştu?..................................
Oluşan geometrik şeklin köşe noktalarının koordinatlarını yazınız.
....

9. Aşağıdaki doğru grafiklerini grafiksel hesap makinesi ile çiziniz.
a) $y = -2x + 10$ b) $y = x + 4$ c) $y = (1/4)x + 7$ d) $y = x - 2$
Çizdiğiniz doğru grafiklerinden hangi geometrik şekil oluştu?..................................
Oluşan geometrik şeklin köşe noktalarının koordinatlarını yazınız.
....

10. $2x + 3y = 5$ ve $3x - y = 2$ denklem sisteminin çözüm kümesini grafiksel hesap makinesi kullanarak bulunuz ve çözüm kümesini kullanırken kullandığınız stratejiyi açıklayınız.

Çözüm Kümesi:...

Strateji:...

....

11. $x + y = 1$ ve $3x + 3y = 15$ denklem sisteminin çözüm kümesini grafiksel hesap makinesi kullanarak bulunuz ve çözüm kümesini kullanırken kullandığınız stratejiyi açıklayınız.

Çözüm Kümesi:...

Strateji:...

....

12. $x + y = 3$ ve $3x + 3y = 9$ denklem sisteminin çözüm kümesini grafiksel hesap makinesi kullanarak bulunuz ve çözüm kümesini kullanırken kullandığınız stratejiyi açıklayınız.

Çözüm Kümesi:...

Strateji:...

....

APPENDIX B

Table of Specifications

Kazanım	Soru No	Soru Sayısı
Dik koordinat eksenlerini çizip adlandırma	3, 4, 5, 6, 13, 14, 15, 16	8
Koordinat eksenlerinin ayırdığı bölgelerde koordinatları verilen bir noktayı, koordinat düzleminde işaretleme	1, 2	2
Koordinat eksenlerinin başlangıç noktasının adını söyleme	1	1
Koordinatlarından biri sıfır olarak verilen bir noktayı, koordinat düzleminde işaretleme	1, 2	
x=a sabit ve y∈R olmak üzere, (a, y) noktalarından geçen bir doğrunun grafiğini çizme	1, 13	2
y=b sabit ve x∈R olmak üzere, (x, b) noktalarından geçen bir doğrunun grafiğini çizme	1	1
y=mx denklemiyle verilen doğrunun grafiğini çizme	14	1
y= mx+n(n≠0) denklemi ile verilen bir doğrunun grafiğini çizme	1, 3, 4, 16	4
ax+by+c=0(a≠0, b≠0, c≠0) denklemi ile verilen doğrunun grafiğini çizme	1, 17	2
ax+by+c denkleminin genel doğru denklemi olduğunu söyleyip yazma	12	1
Koordinat düzleminde verilen bir noktanın doğruya ait olu olmadığını söyleyip yazma	2, 15	2
Doğru üzerinde bulunan ve koordinat değerlerinden biri verilen bir noktanın diğer koordinatını bulup yazma.	1	1
İki bilinmeyenli iki denklemden her birinin grafiğinin koordinat düzleminde bir doğru olup olmadığını söyleme.	12, 17	2
İki bilinmeyenli bir denklem sistemindeki iki denklemden her birinin, aynı koordinat düzleminde grafiklerini çizerek, doğruların kesişim noktasının sistemin çözümüne karşılık gelip gelmediğini söyleyip yazma	17	1
Koordinat düzleminde başlangıç noktasından geçen bir doğrunun eğimini tanımlama	9, 20	2
Orijinden geçen bir doğrunun eğimini, doğru üzerinde alınan noktaların koordinatları cinsinden yazma	21	1
Orijinden geçen bir doğrunun denklemini ve eğimini söyleyip yazma. Orijinden geçmeyen bir doğrunun denklemini ve eğimini söyleyip yazma	7, 8, 18, 22	4
Denklemi ax+by+c=0(a≠0, b≠0, c≠0) ile verilen bir doğrunun eğimini bulup söyleme	5, 6	2
Orijinden geçen ve eğimi verilen doğrunun denklemini yazma. Düzlemde verilen bir noktadan ve orijinden geçen doğrunun eğimini bulup denklemini yazma	2	1

APPENDIX C

Interview Questions

Matematik öğretmeni ile başlangıçta yapılan röportajın soruları:

1. Ne zamandan beri matematik öğretmeni olarak çalışıyorsunuz?
2. Öğretmenliğiniz süresince hangi sınıflara ders verdiniz?
3. Derslerinizde teknolojiden faydalanıyor musunuz?
4. Peki, derslerinizde somut materyal kullanıyor musunuz?
5. Öğrencilerinizin kullandığınız bu teknolojik araçlarla ve somut materyallerle ilgili tepkileri nasıl? Teknoloji kullanmanın öğrencilerinize faydası olduğunu düşünüyor musunuz?
6. Doğrunun analitiği konusunda öğrencileriniz en çok hangi bölümlerde zorluk çekiyor?
7. Matematik derslerinde grafiksel hesap makinesi kullanılması konusunda görüşünüz nedir?
8. Sizce hesap makinelerinin öğrencilere sağladığı avantajlar ne olabilir?
9. Sizce matematik derslerinde hesap makinesi kullanmanın dezavantajları neler olabilir?
10. Grafiksel hesap makineleri matematikle ilgili hangi konularda kullanılabilir?
11. Yenilenen matematik müfredatı konusunda ne düşünüyor musunuz?
12. Grafiksel hesap makineleri yenilenen matematik müfredatında hangi bölümlere yerleştirilebilir?
13. Doğrunun analitiği konusunda grafiksel hesap makinelerini dersinizde kullanacaksınız, konuyla ilgili tereddütleriniz var mı?varsa neler?

Matematik öğretmeni ile çalışmadan sonra yapılan röportajın soruları :

1. Doğru grafikleri konusunda öğrencileriniz en çok hangi noktalarda zorluk çekiyor?
2. Bu zorlukları aşma konusunda grafiksel hesap makineleri ile çalışmanın faydası oldu mu?
3. Grafiksel hesap makinesi ile çalışmak sizin işinizi kolaylaştırdı mı?zorlaştırdı mı?
4. Grafiksel hesap makinesi ile çalışmak öğrencilerinize hangi yönlerden faydalı oldu?
5. Öğrencilerinizin matematik dersine karşı olan tutumunda, ilgisinde herhangi bir farklılık gözlemlediniz mi?
6. Herhangi bir öğrencinizin matematik performansında bir değişiklik gözlemlediniz mi?
7. Grafiksel hesap makinesinin kullanımı ile ilgili öğrencilerinizle herhangi bir problem yaşadınız mı? (kullanmayı öğrenmeleri konusunda)
8. Sizce grafiksel hesap makinesi kullanmanın dezavantajları neler?
9. Grafiksel hesap makinesi kullanmanın avantajları neler?
10. Grafiksel hesap makineleri başka hangi konularda/ derslerde kullanılabilir?

11. Okulda grafiksel hesap makineleri olsa, bahsettiğiniz konuları grafiksel hesap makineleri ile işlemeyi tercih eder miydiniz? Neden?
12. Genel olarak grafiksel hesap makineleri ile ilgili fikriniz nedir?

Öğrencilerle çalışmanın başında yapılan röportajın soruları:

1. Adınız soyadınız?
2. 6. ve 7. sınıf matematik notlarınız
3. 8. sınıf 1.dönem matematik notunuz
4. Matematik kursuna veya dershaneye gidiyor musunuz ya da matematikten özel ders alıyor musunuz?
5. Matematik dersini seviyor musunuz?
6. Kendinizi matematikte başarılı buluyor musunuz?neden?
7. Matematik dersleri nasıl daha eğlenceli hale getirilebilir?
8. Matematik dersini diğer derslerinle kıyaslayacak olursan önem bakımından neler söyleyebilirisin?
9. Matematik dersinde en kolay öğrendiğiniz konular neler?
10. En çok şimdiye kadar hangi konuda zorlandınız?
11. Sence bu konuda neden daha çok zorlandın?
12. Doğrusal denklemler hakkında neler biliyorsun?
13. Doğrusal denklemler konusunun en zor bölümü neresi?
14. Doğrusal denklemlerle ilgili bir test uyguladık size, testteki soruları cevaplarken en çok hangi sorularda zorlandın? Ne kadar çalışırsam çalışayım asla çözemem dediğin soru var mı?
15. Okuldaki derslerde hesap makinesi kullandınız mı hiç? Kullandıysanız hangi derste ve ne zaman?
16. Sence matematik derslerinde hesap makinesi kullanmak faydalı olur mu?
17. Derslerde hesap makinesi kullanmak aritmetik yeteneğine zarar verir mi?
18. Grafiksel hesap makineleri hakkında bu çalışmadan önce herhangi bir bilgin var mıydı?
19. Doğrusal denklemler konusunda grafiksel hesap makineleriyle çalışacaksın? Bu konuda herhangi bir tereddüdün var mı? Zorlanacağını mı düşünüyorsun, yoksa daha kolaylıkla öğreneceğini mi?

Öğrencilerle çalışmanın ortasında yapılan röportajın soruları:

1. Grafiksel hesap makinesi kullanmak zor mu/kafa karıştırıcı mı?
2. Grafiksel hesap makinesi kullanırken en çok hangi noktalarda zorlanıyorsun? (Öğretmenin istediği grafikleri hemen çizebiliyor musun?)
3. Grafiksel hesap makinesi ile doğru grafikleri konusunu öğrendiğin için memnun musun? (Yoksa klasik yöntemi mi tercih edersin?)
4. Doğru grafikleri ile önceki bilgilerinden farklı olarak neler öğrendin?
5. Grafiksel hesap makinesi hangi yönlerden konuyu anlamana yardımcı oldu?
6. Grafiksel hesap makinesinin hangi özelliklerinden faydalandın? (Hangi fonksiyonlarını kullandın?)
7. Bu çalışmadan sonraki derslerde de grafiksel hesap makinesi satın almak ister misin? Neden?
8. Grafiksel hesap makinesi matematik dışında hangi derslerde kullanılabilir?

9. Grafiksel hesap makineleri sence matematiğin hangi konularında kullanılabilir?
10. Kendine grafiksel hesap makinesi satın almak ister misin?
11. Matematik dersinde grafiksel hesap makinesi kullanmanın dezavantajları neler olabilir?

Öğrencilerle çalışmanın sonunda yapılan röportajın soruları:

1. Doğru grafikleri konusunda tam anlayamadığın, ya da zorlandığın noktalar neler? (Peki bu zorlukları aşmak için neler yaptın veya yapmayı düşünüyorsun?)
2. Grafiksel hesap makinelerinin kullanılmasıyla ilgili bir problem yaşadın mı? Yaşadıysan bu problemi nasıl çözdün?
3. En son uygulanan çalışma kağıdındaki soruları çözerken hangilerinde zorlandın?
4. Çalışma kağıdındaki soruları çözerken grafiksel hesap makinesi kullanmanın ne gibi faydaları oldu?
5. Çalışma kağıdındaki soruları çözerken daha önce bilmediğin ve yeni öğrendiğin noktalar oldu mu?
6. En son uygulanan sınavla ilgili neler düşünüyorsun?
7. Zorlandığın ya da yapamadığın sorular hangileri?
8. İlk uygulanan sınavla karşılaştırırsak, son sınavı çözerken grafiksel hesap makineleri ile çalışmanın sana ne gibi faydaları oldu?
9. Genel olarak grafiksel hesap makinelerinin matematik ve diğer derslerde kullanılması faydalı olur mu?
10. Grafiksel hesap makineleriyle ilgili sınıfta yapılan çalışmadan memnun musun?
11. Uygulamanın aksayan yönleri nelerdi?
12. Grafiksel hesap makineleriyle yapılan bu uygulama matematiksel olarak ve senin matematiğe olan tutumunla ilgili sende ne gibi değişiklere sebep oldu?

APPENDIX D

Mathematics Achievement Test

1. Aşağıdaki ifadelerden hangisi doğrudur?

A) a bir reel sayı olmak üzere, y = a şeklindeki doğruların grafikleri x eksenine paraleldir.

B) a bir reel sayı olmak üzere, x = a şeklindeki doğruların grafikleri (0, a) noktasından geçer.

C) x = 0 doğrusu x eksenine paraleldir.

D) 2x - 4y + 1 = 0 doğrusu orijinden geçer.

2. Aşağıdakilerden hangisi yanlıştır?

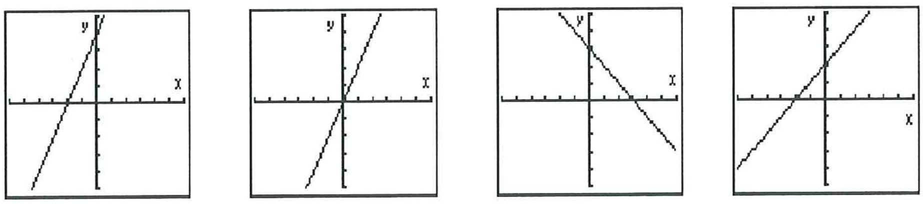
A) y = 2x doğrusu (0,0) noktasından geçer.

B) y = 2x + 1 doğrusu x eksenini (-2,0) noktasında keser.

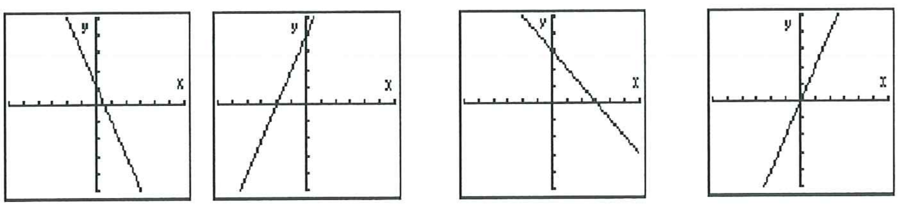
C) y = 4x - 1 ve y = 4x + 2 doğruları paralel doğrulardır.

D) 3x – y = 2 ve y = -3x - 2 doğrularının eğimleri eşittir.

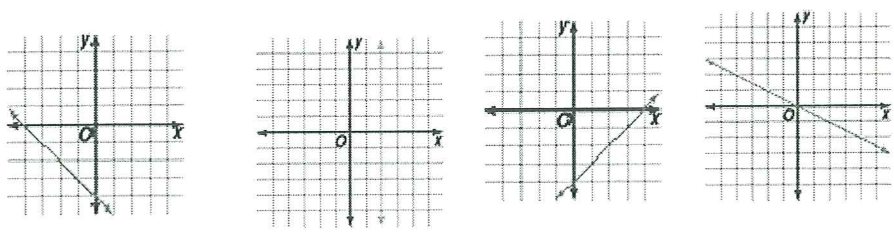
3. Hangi grafik y = 2x + 4 doğrusuna aittir?



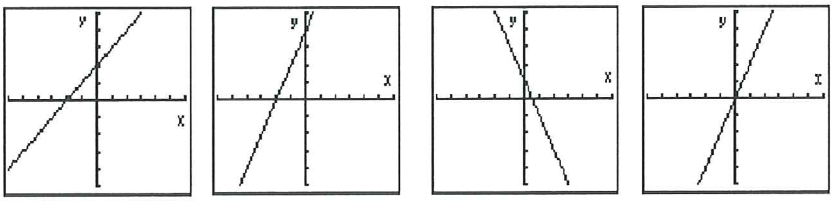
4. Hangi grafik y = 3 - x doğrusuna aittir?



5. Aşağıdaki doğru grafiklerinden hangisinin eğimi pozitiftir?



6. Aşağıdaki doğru grafiklerinden hangisinin eğimi negatiftir?



7. 3x+2y=12 doğrusunun eğimi aşağıdakilerden hangisidir?

A) 3 B) 3/2 C) -3/2 D)2

8.

x	1	3	5	7
y	2	5	8	11

Yukarıda x ve y koordinatlarının tablosu verilen doğrunun eğimi aşağıdakilerden hangisidir?

A) 1 B) 3/2 C) 3 D) 3/5

9. Aşağıdaki eşitliklerden hangisinin eğimi tanımlanamaz?

A) x = -5 B) y = 7 C) x = y D) x + y = 0

10. Aşağıdaki doğrulardan hangisi 2x+y=6 doğrusuna paraleldir?

▪ y = 2x + 3 B) y = -2x + 3 C) y = 3x - 2 D) y = -3x + 2

11. Aşağıdaki tablolarda yer alan x, y çiftlerinden hangisi x - 2y = 4 doğrusuna aittir?

A)

x	-2	0	2	4
y	-3	-2	-1	0

B)

x	-3	-2	-1	0
y	2	0	-2	-4

C)

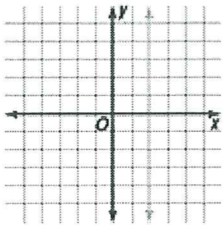
x	-3	-2	-1	0
y	-2	0	2	4

D)

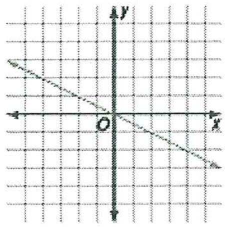
x	2	0	-2	-4
y	3	2	1	0

12. Aşağıdaki eşitliklerinden hangisi doğrusal fonksiyona ait değildir?

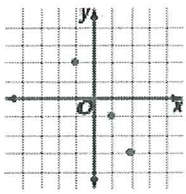
A) y = -4 B) x = 0 C) 3x = 4y + x D) $y - x^2 - 1 = 0$

13.  Aşağıdaki eşitliklerden hangisi yandaki grafiğe aittir?

A) y = -2 B) y = 2 C) x = 2 D) x = -2

14.  Aşağıdaki eşitliklerden hangisi yandaki grafiğe aittir?

A) y = -2x B) y = (-1/2)x C) y = (1/2)x D) y = 2x

15.  Aşağıdaki tablolardan hangisi yandaki grafiğe aittir?

A)

x	-2	-1	0	1
y	3	-1	0	-2

B)

x	2	1	0	-1
y	-3	-1	0	2

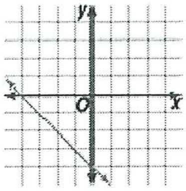
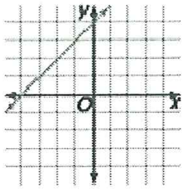
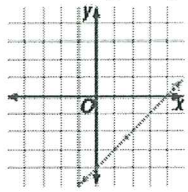
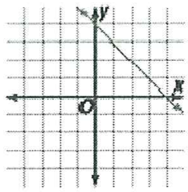
C)

x	3	1	0	-2
y	-2	-1	0	1

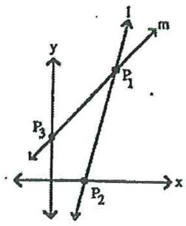
D)

x	-2	-1	0	1
y	3	1	0	-2

16. Aşağıdaki grafiklerden hangisi y = -x + 4 grafiğine aittir?

A)  B)  C)  D) 

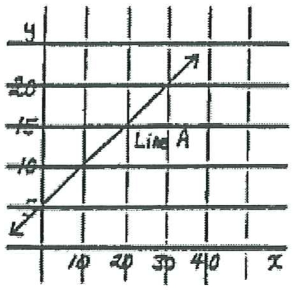
17.

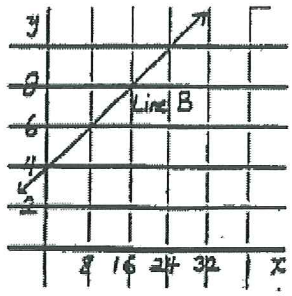


L doğrusunun denklemi y = 4x - 5 ve m doğrusunun denklemi y = 2x + 2 dir. Buna göre
y = 4x - 5
y = 2x + 2 denklem sisteminin çözümü aşağıdakilerden hangisidir?

A) P_1 noktasının koordinatları
B) P_2 noktasının koordinatları
C) P_3 noktasının koordinatları
D)P_2 noktasının x koordinatı ve P_3 noktasının y koordinatı

18.





Yukarıda iki doğrunun grafiği verilmiştir. Buna göre aşağıdakilerden hangisi doğrudur?

A) A doğrusunun eğimi B doğrusunun eğiminden büyüktür.
B) B doğrusunun eğimi A doğrusunun eğiminden büyüktür.
C) A doğrusunun eğimi B doğrusunun eğimine eşittir.
D) Verilen bilgiler A ve B doğrusunun eğimini karşılaştırmak için yeterli değildir.

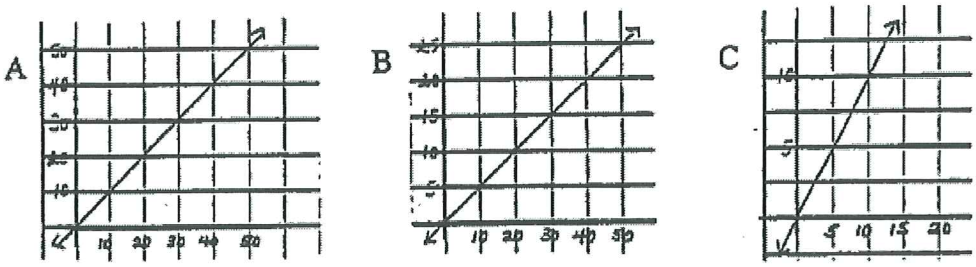
19. Aşağıda verilen doğru çiftlerinden hangisi birbirine diktir?

A)y = 2x + 1 ve y = 2x - 1 B) 2y - 4x + 2 = 0 ve y - 2x + 1 = 0
C) 3x - 2y = 0 ve 3y + 2x = 0 D) 2y + 3x = 0 ve 3y + 2x = 0

20. Aşağıda denklemi verilen doğrulardan hangisinin eğimi sıfırdır?

A) x = y B) y = -x C) y = 2 D) x = 2

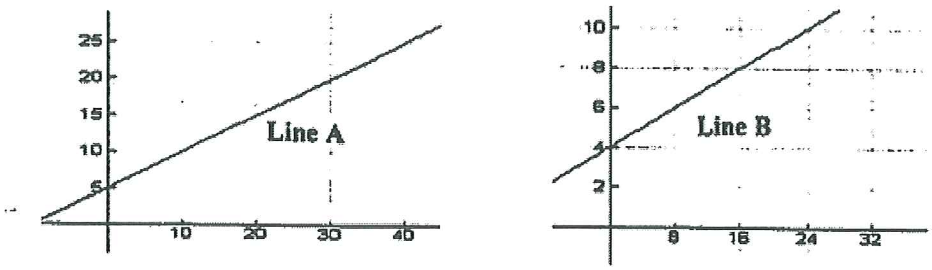
21.



Yukarıda grafikleri verilen doğrulardan hangilerinin eğimleri eşittir?

A) A ve B B) A ve C C) B ve C D) A, B ve C

22.



Yukarıda grafikleri verilen A ve B doğruları için aşağıdakilerden hangisi doğrudur?

A) A doğrusunun eğimi B doğrusunun eğiminden büyüktür.
B) B doğrusunun eğimi A doğrusunun eğiminden büyüktür.
C) A doğrusunun eğimi B doğrusunun eğimine eşittir.
D) Verilen bilgiler A doğrusun eğimi ile B doğrusunun eğimini karşılaştırmak için yeterli değildir.