A STUDY ON THE EFFECTIVENESS OF DIFFERENT TEACHING METHODS AND MATHEMATICS ACHIEVEMENT LEVELS ON ACHIEVEMENT, RETENTION, AND ATTITUDE TOWARD MATHEMATICS AND SELECTED TOPIC.

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ABSTRACT

The purpose of the study is to investigate the effects of different teaching methods on immediate and retained mathematics achievement and attitude toward mathematics; and the topic by mathematics achievement level for tenth grade students.

The research is conducted on 120 tenth grade students who received instruction by Lecture, Lecture with Computer Supported Drill and Practice, and Discovery methods; for 18 hours in three weeks. The topic selected was the Areas of Polygonal Regions.

For measuring the immediate mathematics achievement and retained mathematics achievement, Mathematics Achievement Test developed by the researcher was used. Attitude Toward Mathematics was assessed by the Mathematics Attitude Scale of Aiken (1979). To asses the Attitude Toward the Topic, a modified version of Aiken's Mathematics Attitude scale is used as the Scale of Attitude Toward the Topic. A questionnaire was used to find out the opinions of the students on the different methods and materials used.

In the study, the data are analyzed by the statistical method "Analysis of variance: Two way classification". The results of the study are as follows: In the low mathematics achievement level, the students taught by Discovery method and Lecture with Computer Supported Drill and Practice method scored significantly higher than the students taught by the Lecture method with respect to immediate mathematics achievement. Also the students taught by Discovery and Lecture with Computer Supported Drill and Practice methods scored significantly higher than the students taught by Lecture method in all mathematics achievement levels (low, middle, high) with respect to retained mathematics achievement. The students taught by the Lecture with Computer Supported Drill and Practice method scored significantly higher than the students taught by the lecture method with respect to attitudes toward mathematics. The students in the high achievers group showed significantly higher attitudes toward mathematics than the students in the middle and low achievers group. The students taught by Lecture with Computer Supported Drill and Practice method scored significantly higher than the students taught by Discovery and Lecture methods in middle mathematics achievement level with respect to attitudes toward mathematics. The students taught by Lecture with Computer Supported Drill and Practice method and Discovery method scored significantly higher than the students taught by the Lecture method with respect to attitude toward the topic. Also in the low mathematics achievement level the students taught by Discovery and Lecture with Computer Supported Drill and Practice methods showed significantly higher attitudes toward the topic than the students taught by Lecture method.

When all the findings are considered, this research might have significance in being among the pioneer studies performed with Turkish sample to investigate the effects of instructional method with achievement level on immediate and retained mathematics achievement and attitude toward mathematics. Also the results of this study might have address to a previously untouched area of the effects of the instructional method on the attitude toward the topic, for future researches.

ÖZET

Bu çalışmanın amacı, farklı öğretim yöntemlerinin onuncu sınıf öğrencilerinde, kısa süreli matematik başarısı ve uzun süreli matematik başarısı ile matematiğe ve konuya karşı tutumları üzerindeki etkilerini araştırmaktır.

Araştırma, geleneksel Anlatım Yöntemi, Anlatım ve Bilgisayar Destekli Alıştırma Yöntemi , ve Keşif Yöntemi ile, üç hafta, haftada 18 saat eğitim alan 120 onuncu sınıf öğrencisi denek ile yürütülmüştür. Seçilen konu ise "Çokgensel Bölgelerin Alanları" dır.

Matematik başarısını ölçmek için araştırmacı tarafından geliştirilen Matematik Başarı Testi kullanılmıştır. Matematiğe yönelik tutumu ölçmek için ise Aiken'in 1979 yılında geliştirdiği Matematik Tutum ölçeği kullanılmıştır. Konuya yönelik tutumu ölçebilmek için Aiken'in matematik tutum ölçeğinin uyarlanmış bir şekli konuya karşı tutum ölçeği olarak kullanılmış, ayrıca öğrencilerin değişik yöntem ve gereçler hakkındaki görüşlerini toplamak için bir bilgi formu verilmiştir.

Araştırmanın verileri "iki yönlü Varyans Analizi" istatistiksel yöntemi ile analiz edilmiştir. Araştırmadan

çıkan sonuçlar şöyledir: Alt matematik başarı düzeyinde Keşif yöntemi ve Anlatım ile Bilgisayar Destekli Alıştırma yöntemi ile eğitilen öğrenciler kısa süreli matematik başarısında, Anlatım yöntemi ile eğitilen öğrencilerden manidar derecede yüksek başarı puanı elde etmişlerdir. Ayrıca tüm matematik başarı düzeylerinde (alt, orta, üst) de Keşif ve Anlatım ile Bilgisayar Destekli Alıştırma yöntemleri ile eğitilen öğrenciler, uzun süreli matematik başarısında Anlatım yöntemi ile eğitilen öğrencilere göre manidar derecede yüksek başarı puanı elde etmişlerdir. Anlatım ile Bilgisayar Destekli Alıştırma yöntemi ile eğitilen öğrencilerin yalnızca Anlatım yöntemi ile eğitilen öğrencilere göre matematiğe yönelik tutum puanları manidar derecede yüksek bulunmuştur. Üst matematik başarı düzeyindeki öğrencilerin matematiğe yönelik tutum puanları, orta ve alt matematik başarı düzeyindeki öğrencilere göre manidar derecede yüksek bulunmuştur. Anlatım ile Bilgisayar Destekli Alıştırma ile eğitilen öğrencilerin matematiğe yönelik tutum puanları, Keşif ve Anlatım yöntemleri ile eğitilen öğrencilere göre, orta matematik başarı düzeyinde manidar derecede daha yüksek bulunmuştur. Konuya karşı tutumda ise Anlatım ile Bilgisayar Destekli Alıştırma ve Keşif yöntemi ile eğitilen öğrencilerin tutum puanları, anlatım yöntemi ile eğitilen öğrencilere göre manidar derecede yüksek bulunmuştur.

Araştırmadaki tüm bulgular düşünüldüğünde, bu araştırmanın Türk denekler ile, eğitim yönteminin kısa süreli ve uzun süreli başarı ile matematik ve konuya yönelik tutuma etkilerini araştıran ilk araştırmalardan olma önemi bulunmaktadır. Ayrıca bu araştırma sonuçlarının da daha önce hiç çalışılmamış olan eğitim yönteminin konuya karşı tutuma olan etkileri konusunda gelecek araştırmalara yönelik göndermelerde bulunabileceği düşünülmektedir.

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CHAPTER ONE

INTRODUCTION

The famous philosopher Bertrand Russell described mathematics as "the subject in which we never know what we are talking about nor whether what we are saying is true."

The mathematicians and educators are not as pessimistic as Russell. We have seen different approaches in searching "What is mathematics?" The Grolier Webster Dictionary (1973) describes mathematics as "the science dealing with quantity, form, measurement, and arrangement; and in particular with the methods for discovering by concepts and symbols, the properties and interrelationships of quantities and magnitudes."

Marjoram (1974) stated that mathematics is an activity concerned primarily with argument, with spotting patterns and posing premises, and investigating their implications and consequences. It may in this process play a purely utilitarian role as a tool of the sciences, it may be concerned with more generalized properties of number and space - with the discovery and invention of number/space relations in both the natural and man-made worlds, or it may be unashamedly concerned with the structures of pure logic and deduction from premises to conclusions which may be in no direct way related to the real world.

The answers to the question " What is mathematics?" vary according to the relation of people to mathematics. Baykul et al (1986) stated that thoughts regarding mathematics can be grouped as follows:

1) mathematics is counting, calculation, measuring and sketching used to solve daily problems.
2) mathematics is a language that uses certain symbols.
3) mathematics is a logical system, that develops logical thinking in human beings.
4) mathematics is a tool that is used to understand the world and to develop the environment.

According to Cornelius (1982) mathematics is:

- a set of techniques to be tested by an examination,
- a body of knowledge to be learnt,
- a study of underlying logical structure,
- an artificial game played by mathematicians,
- the construction of models useful in science,
- the calculating procedures needed for applications.

Mathematics is something that people do as well as something that people learn. It must be viewed as a complex social activity within the context of society as a whole. Thus the mathematics education does not only involve mathematicians, but educators, sociologists, psychologists, pedagogs as well.

Mathematics is probably the oldest organized discipline of human knowledge with a continuous line of development spanning 5000 years and every major culture. Because mathematics is a body of ideas structured by logical reasoning, the facts, principals and methods developed by in early Mesopotamia, Egypt and Greece play central roles in the subject as it is learned and used today.

According to Butler (1970) the objectives of mathematics education are as follows

1) To be competent in understanding and using numbers. (The number concept is emerging from sets and continuing with natural numbers, integers, rational numbers real numbers and complex numbers.)

2) To have habits of analytical thinking and reasoning.

3) To gain communication of thought through symbolic expressions and graphs.

4) To develop the ability to make relevant judgements through the discrimination of values.

5) To develop the ability to distinguish between relevant and irrelevant data.

6) To develop intellectual independence. (This objective, perhaps, is one of the definitions of mathematics.)

7) To develop aesthetic appreciation and expression. (The visual parts of mathematics like graphs or geometry help the attainment of this objective.)

8) To realize the significance of mathematics alone, and its relation to the total physical and social structure. (This objective sets the interface of mathematics to other applied science.)

9) To learn and apply deductive and inductive reasoning. (In mathematics, everything has a reason and every individual thing is a combination of the previous information.)

Throughout the whole mathematics curriculum the students are consistently required to base every statement to previously stated definitions, axioms and theorems to apply inductive reasoning and they are taught to reduce the problems to simpler sub-problems to apply deductive reasoning.

Due to this chain-like logical structure of mathematics, mathematics education starts with primary schools and goes consistently to the highest level of education.

All over the world mathematics has been presented in two major strands. Arithmetic and its everyday uses is the core of common elementary mathematics education. Whereas general mathematics education, advanced topics in algebra, geometry and calculus in secondary school is an intermediate education that prepares the students for professional, scientific and technical careers for the university.

The change in the Secondary School Mathematics Curriculum can be discussed in two major periods.

From the early secondary schools to the 1920's, the content of the mathematics curricula was dominated by the goal of preparing students for higher education, heavily based on algebra and geometry.

Between the 1920's and the 1950's, the mathematics curricula started to address students who did not intend to prepare for or attend higher education. The curricula started to include practical mathematics for general, vocational, applied and consumer-oriented uses.

After the 1950's, the "new-mathematics" era was started. The new curricula which included many different topics and structure, out-dated the existing ones. The new-mathematics programs always stressed the "basics" of every topic, and stressed the basic computational skills and their applications to daily life.

In the early years of the century, mathematics education was heavily based on the teacher centered methods. Formal mathematics teaching was concentrated largely on the mastery of knowledge and skills without any concern for the interest, enjoyment or relevance of the students. With the advances in educational theory during the 1960's "discovery learning", "concept acquisition" and "learning by doing" became part of the fashionable mathematics teacher's vocabulary and basic skills, relevance and involvement became key goals.

Aksu (1985) reported that in the modified programs of the second half of the 1950, the importance of computational abilities were declined and "Why" and "How" questions in learning of mathematical concepts gained importance. This shows that rote memorizing is replaced by judgement, in other words instead of "spoon-feeding", the active participation of the students by individual investigation and discovery are stressed in mathematics programs. The changing ideas led to new methods and educational tools which would facilitate and accelerate learning.

Developing technology first provided the educational tools specially for the laboratory media. In the late 1970's mathematics instruction started to be based on the technological products. The American National Council of Teachers of Mathematics (NCTM, 1981) put some recommendations for school mathematics for 1980's as:

- Problem solving must be the focus of school mathematics.
- The concept of basic skills in mathematics must encompass more than computational facility.
- Mathematics programs must take full advantage of the power of calculators and computers at all levels.

Posamantier & Stepelman (1981) stated that computers are an increasingly valuable aids in mathematics education. Whether they are used for remediation, recreation or as an integral part of the curriculum, they can greatly expand a student's knowledge of and perspective on mathematics. Bork (1987) also declared that computers and associated technology (video-disc, compact disk, sound) can stimulate major changes in the educational system.

In Turkey, the traditional mathematics curriculum was used from the early years of the republic to 1964. In 1964 the pilot "modern mathematics" curriculum study adapted the mathematics program and material prepared by "school mathematics study group" (SMSG) of Yale and Stanford Universities. This pilot program started to be applied in 1968 and completed its 3rd year in 1970. In 1976 this program was applied in all secondary Turkish schools. The content of this modern mathematics program was mainly contained within the old program. The structure and format of presentation is based on the set theory and an axiomatic structure; some new subjects were added to constitute a base for university mathematics, such as logic, mathematical systems, sets, vector algebra, linear algebra, probability and statistics.

In Turkey, mathematics education is applied around teacher centered methods. Although in mathematic education games, discovery method and tools like calculators, computers, overhead projector, television and video recorder have gained much attention, it is being observed that these methods are not being utilized enough by mathematics teachers. This can be explained through the teachers not knowing how, when and for which objectives they should utilize these methods, and their conservative personalities. Their objections are mainly based upon the belief that these methods are expensive and luxurious and that they have insufficient time to apply these methods. On the other hand, it is obvious that the discovery method does not require any expense but the teachers need to be patient and make extensive planning.

The benefits of using these new technologies in mathematics education can be stated as; increased achievement, decreased fear and anxiety towards mathematics, and last but not least, developing analytic and critical thinking habits. (Aksu, 1985)

Another benefit of new technologies is decreasing the teacher's workload and offering the possibility of individualized learning. Researchers prove that microcomputers decrease anxiety and increase interest and develop positive attitudes toward mathematics and specially develop problem solving abilities. The use of this technology in Turkish schools has become inevitable. Parallel to the developments in educational technology worldwide, the Turkish Ministry of Education is planning 1.000.000 microcomputers for Computer Aided Education (CAE) to be used in primary and secondary schools for the year 2000. At the time this study was completed, the Ministry was extending the pilot CAE classes by 6500 more personal computers.

Despite the dense studies on mathematics education worldwide, the studies on mathematics education in Turkey are very few.

When we investigate the studies on educational technology we can see that most of the studies report the outcomes of some new educational technologies as compared to instructor centered methods.

The selection or development of teaching methods and materials is one of the most complex components of the process of curriculum design (Weston & Cranton, 1986). The teaching method can be thought as a vehicle or technique for instructor-student communication and can be categorized as :

- Instructor centered
- Interactive
- Individualized
- Experiential teaching methods.

In the instructor centered methods, the teacher is the primary responsible person for conveying information or abilities to the students. This method is generally unidirectional communicationwise, from the teacher to the student. The most familiar of these methods is the lecture method in which one instructor speaks directly to a group of students. The lecture is an efficient and effective method for instruction at lower levels of cognitive domain, specially in large classes. In such strategies, the attention and activities revolve around the teacher.

According to Saylor, Alexander and Lewis (1981) and Weston and Cranton (1986), the lecture method refers to the teaching procedure involved in the clarification or explanation to the students of some major ideas cast into the form of a question or a problem. Today a great deal of teaching still takes the form of solo performance.

The teachers often launch into monologues in presenting, explaining, pointing out the relationships, giving examples or correcting errors. That means that in addition to a variety of teaching strategies, the lecture method is still widely used in all levels of education and especially in secondary and post-secondary education.

The objectives of the lecture method can be defined as:

a) To introduce the student to the subject matter.

b) To serve, where there is no book or source available.

c) To give a framework, overview and criticism unlike that in many written/printed material.

d) Lectures can be better prepared and more carefully planned than the extemporaneous remarks made to students in discussion.

According to Gage and Berliner (1984) lecture is suitable when:

1) The main purpose is to discriminate the information
2) The material is not available elsewhere
3) The material must be organized and presented to a particular group.
4) It is necessary to arouse interest in the subject
5) The material need to be remembered for a short time.

and the lecture method is inappropriate when:

1) Objectives other than the acquisition of information are sought.
2) Long term retention is desired
3) Learner participation is essential to the achievement of the objectives
4) Higher cognitive objectives are being sought
5) The students are average or below average in intelligence or educational experiences.

Hartley (1977) reported that the traditional instruction was definitely superior to individual learning packages and programmed instruction.

There is another class of teaching methods, which is Interactive Teaching methods. These methods utilize the communication between the instructor and student , and the communication between the students as well. In these methods the active involvement of students in learning is the aim.

There are some practical limitations that come out with interactive methods. Among these are the size of the class and preparation of the content are considered primarily.

Discovery learning is an interactive method in which the learning is facilitated. Kersh (1962) defined discovery learning as learner's goal-directed behavior when he is forced to complete a learning task without help from the teacher. This type of instruction takes place with the teacher and in a class environment. The teacher guides the students by asking purposeful questions and have them discover the facts or phenomena that the curriculum aims to give.

Bruner (1966) concluded that discovery settings present opportunities to draw for themselves relationships between things they know and the learning task at hand. In addition, discovery methods built on problem solving skills by providing experience in pushing ideas to their logical limits and in effectively forming conscious hypotheses. Bruner, like Davis (1966) suggested that thinking acts are reinforced by the discovery accomplished and that a reflective attitude is developed in students. According to Bruner, education should be planned to teach people how to learn independently. So that discovery approaches have advantages that enable the learner to exercise his problem solving and solution seeking skills as a by-product of his learning of the actual content presented.

In discovery learning, as Kieren (1969) has stated, the student becomes actively involved in the learning process and is presumably more highly motivated than a student who is merely a passive recipient of information. This method helps more for the students with low learning ability. Kuhfittig (1974) reported that low ability students benefit more from aids in mastering abstract skills than high ability students. On the other hand, Kleckner (1968) McClintock (1974) and Monnen and Marie (1983) reported no significant differences in favor of discovery instruction over traditional instruction in the transfer of learning.

One other major group of instruction is Individual Learning Methods. These methods are based on the fact that the students have different learning abilities and speeds. In these methods, the students work directly with prepared material at their own pace and receive information as to their progress at regular intervals.

One of the most important individualized instruction methods is Computerized Instruction, which takes a variety of forms. It is based on a computer program which provides the lecture, administers the tests, drills and evaluating the feedback, repeats the lessons until the student reaches a pre-specified level of proficiency. Since each student progresses at his own pace, the individual differences are compensated.

Although computers are newly emerged, specially in the last couple of decades, it is worth noting Pressy's teaching machine in the 1920s and Skinner's programmed instruction in the 1950s as pioneers of Computer Aided Instruction.

The early researches demonstrated increased motivation, but not necessarily improved student learning. However, with the introduction of microcomputers and their consistently decreasing costs and increasing capabilities, computerized instruction is available with various hardware and software varieties. The branching techniques used in programmed instruction can easily be implemented in a much more sophisticated manner with a computer and different versions of an instructional program can easily be designed for students with different learning styles or abilities. An increasingly common use of computers in instruction is the instructors' writing their own computer programs for instruction in a variety of subject areas.

Bork (1981) described Computer Aided Instruction programs as "dialogues" in which the information is presented to students in a variety of ways: simulations, graphic and textual. Student responses are also used to enhance the program by providing different presentations to students of various abilities. A student who has difficulty on a particular part of the program, might see the section of the program - sometimes called a branch - that presents the same material in a different manner.

Kulik et al (1980) in their meta-analysis, reported that computer based education is found to increase the student achievement. Kulik et al (1983) also reported that the students who were taught on computers showed very positive attitudes toward the computers and toward the course as well.

Niemec and Walberg (1987) reported similar generalizations as to the effects of computerized instruction being found to increase the instruction outcome; also another interesting outcome from this research is that the effects of CAI on achievement has increased over time from 1980 to 1987. One point to stress is the introduction of microcomputers during the 1980's and their rapid development together with lowering costs; which has almost removed the practical limitations on establishing computer aided instruction laboratories in a considerable number of schools.

Computerized instruction introduced a variety of terms to education literature. "The most general and oldest term is Computer Assisted Instruction (CAI)" reports Kinzer, Sherwood and Bransford (1986). Other terms found in the literature are Computer Managed Instruction (CMI), Computer Based Instruction (CBI) and specially European Studies refer to Computer Based

Learning (CBL). Although these terms have some differences, they all cover an emphasis on computers focusing on instruction.

Taylor (1980) uses the terms tutor, tool and tutee to define the position of computers in schools. According to this researcher, computers can be tutor to teach students, an educational tool for students and a tutee that students can teach.

In tutor applications, computer performs a teaching role. The procedure takes place as:

1) The computer presents some information,
2) The student is asked to respond to a question or problem related to the information,
3) The computer evaluates the student's response according to a specified criterion,
4) The computer determines what to do next based on the evaluation of this response. Tutor application can be further divided into categories drill and practice, tutorial, simulations and games.

The available CAI-Drill and Practice programs provide a supplement to the students' regular instruction in mathematics.

In drill and practice applications, the computer is used to help the student memorize the appropriate response to some stimulus. Specifically, the computer asks a question, waits for the answer, the response is evaluated and an appropriate response is given to the student. If an incorrect response comes, the correct answer is displayed and a new question is presented. A good program should provide positive motivation for correct answers. By keeping track of how each student responds to each item, the computer can tailor the drill and practice sessions to each individual student. The record of the answers kept might also be used for students' grading.

Drill and practice generally do not include instruction on how to do a particular task. Any necessary demonstration or expository instruction usually comes before the drill and practice.

Computer based drill and practice programs are often considered to be trivial when compared with CAI programs, but this should not lead to an underestimation of the potential value of computer aided drill and practice. There is considerable evidence in the recent research in modern cognitive theory to suggest that drill and practice sessions are valuable when used appropriately.

Vinsonhaler and Bass (1972) surveyed over 30 separate experiments that compared traditional instruction with traditional instruction augmented by CAI drill and practice, and reported strong evidence for the effectiveness of CAI over traditional instruction where effectiveness is measured by a standardized achievement test.

The tutorial applications resemble a programmed textbook. A relatively small piece of information is presented, the level of learning is tested by an exercise and the computer provides necessary feedback based on the student's response and the cycle continues with more information, exercise and feedback. Merril et al (1986) explained that the tutorial computer applications seek to place the computer in the role of a tutor, one that carries the complete instruction for guiding the student to the achievement of a specified set of objectives.

Tool applications of computers are designed to aid students in their use of the subject matter. The computer is an instructional tool in this case. With the computer, the students utilize the speed and accuracy of computers and their storage capacity, especially in preparations of reports, papers, etc.

This type of application is also useful to the school managers and instructors.

In tutee applications, the student teaches the computer to do a certain task, in a language or form that the computers can understand.

Alfred Bork (1987) stated the main advantage of computer as a way of learning that allows us to make learning interactive for all students; we can pay attention to the needs of each student by individualizing the learning experience. Four possible strategies were suggested by Bork, which could be supplemented in educational settings: drill and practice, simulation, problem solving and programming.

Drill and practice software dominated early computer learning situations and are still offered today by many companies in a variety of forms. Students are given the opportunity to work with any topic, set free to choose the difficulty level of the problems and the type and speed of the presentation. This permits the program to be utilized by a variety of students with different ability levels.

Another important factor with computer supported drill and practice is to keep the record of scores for each student within the computer; to provide a serious interaction even in the absence of a superior authority over the student.

Malone (1981) in his study of computer games reported that having scores kept by the computer did increase the popularity of games over identical games with no score.

When we turn our attention from instructional methods back to the design of the curriculum, it could be indicated that the goals are a structured part of curriculum planning and they emerge from a point of view or a platform (Leithwood, 1981). The goals are put forward, according to Saylor, Alexander and Lewis (1981), to prepare individuals to be productive members of society and enable individuals to develop their own potential.

Although the different curriculum designers set their goals differently according to various factors such as content, age level and social structure, the course objectives always contain three common factors to maximize their outcomes:

- Increased attitude toward the course and subject
- Obtain higher level of achievement
- For the content to be available in the

students' mental structure in the long term.

This objective refers to the maximization of retention.

These objectives should be indicated as instructional outcomes. McNeil (1981) has listed the philosophical, psychological, technological, political and practical criteria for selecting learning activities.

Foley (1984) designed a study on the effects of using the personal computer in two mathematics course at high school level. Results indicated that personal computers would not make a significant difference in mathematics achievement and attitude toward mathematics.

Bell (1970) reported significantly higher attitude toward mathematics with CAI, on the contrary Ibrahim (1970) reported no significant difference in attitude toward mathematics with CAI. In the 1980-1987 synthesis, Roblyer (1988) reported that CAI applications have small positive effects over non-computer methods in most content areas and with most types of students.

Kulik et al (1983) in their meta-analysis, reported most of the studies found better achievement levels for CAI over other methods. Also Niemiec and Walberg (1987) in their synthesis study, reported the significant effect of CAI on student achievement.

Kulik et al (1983 reported that retention scores were significantly lower in CBI groups. Ibrahim (1970), Proctor (1968), and Tsai and Pohl (1980) reported no statistically significant difference in retention between CAI and other groups.

According to Aksu (1985), the achievement differences of individual students, specially in mathematics, result from insufficient prerequisite learning, since mathematics is a sequential subject in which every topic is built over the previous topics; also from the negative attitudes developed toward mathematics; and from the quality of instruction.

The purpose of this study is to investigate the effects of different teaching methods on immediate and retained mathematics achievement, and attitude toward mathematics and topic, for students in different achievement levels.

The results of this study might contain valuable considerations for curriculum designers to interpret teaching methods in connection with students in different achievement levels and the long term impacts of the methods over different achievement levels of students by the consideration of the retention results.

CHAPTER TWO

STATEMENT OF THE PROBLEM

Introduction

In the previous chapter, the background for the specific research problem of this study was presented. The purpose of this chapter is to clarify the problem statement, definition of terms and the significance of the study.

The Problem Statement

What are the effects of different teaching methods and mathematics achievement levels on immediate and retained mathematics achievement and attitude toward mathematics; and selected topic ?

Definition of Terms

The following terms will be commonly employed in the present study.

Immediate Mathematics Achievement(IMAT): refers to the scores of the students obtained from the mathematics achievement test which was administered immediately after the treatment

Retained Mathematics Achievement Test(RMAT): refers to the scores of the students obtained from the mathematics achievement test, which was administered three months after the treatment.

Attitude Toward Mathematics(ATM): is the scale which measures the attitudes of subjects toward mathematics.

Attitude Toward the Topic (ATT): is the scale which measures the attitudes of subject toward the topic (areas of polygonal regions).

Mathematics Achievement Level (MAL): refers to the mathematics achievement levels of the students as classified by the subject's previous year mathematics term grade averages on the grade report forms. The classification intervals are ; out of 10, as 1-5 low, 6-7 middle, and 8-10 high.

Teaching Method (TM): Refers to the method of instruction; namely lecture, discovery or lecture with computer supported drill and practice.The Teaching method can be defined as the vehicle or technique for instructor- student communication.

Significance of the Study

As educational technology develops, educational theorists are increasingly faced with many alternatives and undertake studies to incorporate different factors in order to the highest level of efficency in education.

Especially at a time when major changes and reorganizations are being sought in the Turkish educational system, it is hoped that the results of this study will be taken into account in the consideration of instructional methods and achievement levels of the students as factors in the attainment of objectives in the educational system.

CHAPTER THREE

REVIEW OF THE LITERATURE

Introduction

In this chapter, the theoretical background of instructional methods and a review of the research studies related to the effectiveness of the instructional methods in terms of achievement, attitudes and retention are summarized.

THEORETICAL BACKGROUND:

As has been stated earlier, this study will concentrate on the computer assisted instruction, lecture and discovery methods. Since Discovery method of instruction is based on Bruner's theory of instruction and Computer Assisted Instruction which emerged from Skinner's and Thorndike's approaches, these theories will also be discussed here.

According to Hosford (1973) learning is not a mere accumulation of knowledge but is a process of growth. Many factors influence the outcome of learning, as well as the nature of the instructional method itself.

Lecture method has been widely used for many years as a well-known and common method of transmitting information. Saylor, Alexander and Lewis (1981) stated that this method may mainly develop the knowledge and comprehension level objectives.In this method most of the teaching revolves around the solo performance of the teacher.

As electronics technology developed, computers emerged as one of the most efficient tools which facilitate most of the activities of today. As computers are widely used in every aspect of our daily lives, we can not think of educational technology without utilizing computers. Computer Assisted Instruction is actually based on the Behavior Modification Theory of Skinner.

Behavior modification refers to the utilization of modern learning principles in the design and improvement of educational and clinical practices. Programmed instruction is an example of an educational application of these principles.

Behavior modification constitutes a venture which in many respects is related to operant conditioning but which in addition has developed an identity of its own. Operant conditioning is related to behavior modification in two major ways. Firstly, operant reinforcement learning principles are extensively used as a basis for instructional procedures. Secondly, behavior modifiers share with operant conditioners the emphasis on inductive theory construction and a major commitment to using research results for involving their principles.

There are four aspects which can be considered in the development of behavior modification instructional principles and procedures. These are: The "teaching machine" phase; The "programmed instruction" phase; The "token economies" and "contingency management" phase; and the fourth phase which involves wider concern about educational problems and is typically referred to as The "behavioral engineering" phase.

Skinner (1968) states that instruction involves arranging contingencies of reinforcement under which students learn. He acknowledges that students can learn without any special assistance in the natural environment, but he contends that learning can best be assured and expedited if teachers make appropriate provisions so that gradual changes in behavior in desired directions are systematically reinforced.

The term "program" was subsequently used to refer to specially arranged educational materials. "Teaching machine" was defined as any device which presents the educational materials and which provides feedback (reinforcement) to the learner as to his progress.

By the early 1960's it was recognized that it was the program rather than the teaching machine which was the more important aspect of the behavior modification approach to instruction. The success of the approach was based on specially sequenced educational materials and the arrangements of contingencies of reinforcement so that students were being reinforced as they made progress in reaching delineated objectives. The educational materials which are arranged in the best possible sequence for the students are referred as the " program".

Certain procedures are followed in programmed instruction;

1) A program is composed of relatively easy-to-take steps, beginning with tasks which the student can initially handle and gradually leading up to those which are either too difficult or unfamiliar prior to the instructional sequence.
2) It is generally expected that the most efficient and effective learning will occur

when the student has an active role in the educational process.

3) Positive reinforcement should be immediate and should follow each correct response.

4) A program should provide for individualization of instruction at least in that students should be able to work at their own pace. It is contended that the attainment of the educational objectives should be held constant and that students should be permitted to take as much time as they need in order to complete those educational objectives.

5) A final and very important principle is that of student testing or validation of the educational materials.

Additional changes were made in behavior modification concepts of instruction. Some led to the use of computers as more flexible teaching machines. Others explored the use of specially designed workbooks which provided the opportunity for immediate knowledge of results without the use of a teaching machine.

The third facet is described as "contingency management" or "token economies." In the application of operant learning principles the focus is on a somewhat wider range of activities than was typically true of the teaching machine and programmed instruction phases. Some psychologists felt that, despite other aspirations initially held by Skinner , there had been too great a tendency to restrict operant applications to verbal behavior and that other more important aspects like reading, talking, writing, etc., had been ignored. The contingency management-token economy phase was especially stimulated by the work of several investigators in psychiatric hospital situations and in special education classrooms.

There are two general ways in which operant procedures have influenced behavior modification. First, Skinner's laboratory operant learning research resulted in the refinement and extension of principles drawn from Thorndike's law of effect. Second, operant researchers emphasize direct experimental analysis of an individual subject's behavior, with the response rate or probability of response as a major dependent variable. Both emphases have been prominent in each of the three aspects of behavior modification that has been stated.

Behavioral engineering, the fourth and most eclectic facet of behavior modification, emphasizes the research-measurement aspect. There is considerable variation in the extent to which behavioral engineers attach importance to reinforcement principles.

Skinner's " Teaching Machine" approach in the 1960s adressed the equipment and procedures of instruction combined to achieve learning with the considerations of feedback and reinforcement. While computers are becoming more widespread in all aspects of modern daily life, it should not be thought that educational technology fails to find the means to implement computer technology in education.

The development and expansion of computers provided a vast amount of possibilities to implement the teaching machine, instructional rules and procedures in one kind of equipment. These possibilities started the development of Computer Assisted Instruction. Computers and associated technology can stimulate major changes in our educational system. In the last few years, schools and universities in many parts of the world have acquired large numbers of computers. It is time to assess the situation. The impact of the computer on education has been felt in several areas, for example administration, research, computational aids, and the learning process.

We will concentrate our attention on computer assisted learning. We can divide computer assisted learning into three main categories:

- Computer Managed Instruction (CMI)
- Computer Assisted Instruction (CAI) and
- Computer Based Learning Aids (CBLA)

CMI encompasses a wide range of computer uses in education that involve the gathering and managing of the information necessary to develop flexible and individualized learning strategies. In CMI the computer is used to assist teachers and administrators in managing the instructional offerings, which are keeping students' reports, preparing some lesson plans, analyzing data from student tests, and providing feedback to students, instructors and administrators.

CAI helps the student and teacher during their teaching/learning activities. Instruction may be administered by a computer in several different ways, or modes. The instruction provided by drill and practice is supplementary to the regular curriculum taught by the classroom teacher. The uses or applications of CAI can be classified as follows:

- Drill and practice
- Tutorials

- Simulations/games
- Inquiry/dialogue
- Information retrieval
- Testing
- Problem solving

CBLAs use the computer as a supportive tool in the learning process, but do not use the computer either to perform the functions of a CMI system or to provide the primary instruction required for the student to master the instructional goals.

Computer use in education is not new in the world, so there are many applications of Computer Assisted Instruction. Naturally there are many research studies and meta-analytic studies about the evaluation of the effectiveness of computer use in education.

Another instructional method which has proved to facilitate learning is the "Discovery Method". The emergence of the discovery method is based on Bruner's theory of instruction. According to Bruner (1971) instruction is an effort to assist or to shape growth. There are so many aspects of growth that any theory can find something that it can explain well.

Bruner delineated four themes about education. He acknowledges that they specifically reflect his own views of education. The first theme noted the importance of how the knowledge is organized or structured. In the second theme the readiness for learning is stressed. Bruner contended that if the teacher understands how the student conceptualizes his world, it is possible to understand the fundamental foundations of any topic. This led him to suggest the use of the spiral approach to the curriculum.A key to this approach is the notion that one can start with fundamental notions about a topic and expand into more details and more abstract descriptions. In the third theme he emphasizes the value of intuition in the educational process. The fourth and the final theme involves motivation or the desire to learn and the means available to instructors to stimulate such motivation.

Bruner explained the four principles of his theory of instruction:

- motivation
- structure
- sequence
- reinforcement

Motivation (predisposition to learning): He mainly focuses on the cultural motivational and personal factors that affect the desire to learn. For Bruner it is only the intrinsic motivation that the will to learn is sustained. His important and famous concept is the term "built in will" to learn, a drive with which the individual was born. Bruner claims that intrinsic motivation is rewarding in itself and is therefore self-sustaining.

Since learning and problem solving depend upon the exploration of alternatives, instruction must facilitate and regulate the exploration of alternatives on the part of the learner. There are three such aspects to the exploration of alternatives, each of them related to the regulation of such behavior. These are: activation, maintenance and direction.

> Activation: in order to activate exploration, children must experience a certain level of uncertainity.

> Maintenance: One should assure the child, that the exploration is not going to be a dangerous or painful experience. It should have a greater advantage than the risk. The teacher should guide the situation and make sure that the child will benefit from the experiences he is going to be involved in.

Direction: It is a function of two factors, one is knowledge of the goal and the other is achievement of the goal. The students should be familiar with what the goal is and how close they are to achievement.

Structure: Any given subject can be organized in some optimal fashion so that it can be transmitted to and understood by almost any student. According to Bruner, the structure of any body of knowledge can be characterized in three ways; mode of presentation, economy and power of presentation. Mode of presentation indicates the technique or method by which the information is communicated. Economy of presentation depends on the amount of knowledge that a learner must keep in mind in order to continue learning. The fewer the bits of information that the learner should keep in mind, the greater the economy. Power of presentation is a presentation that is simple and easy to understand. The learner should be able to understand the new relationships and the connections between the facts.

Sequence: Instruction consists of leading the learner through a sequence of statements and restatements of a problem or a body of knowledge that increase the learners ability to grasp, transform and transfer what he is learning. In short, the sequence in which the learner encounters materials within a domain of knowledge effects the difficulty he will have in achieving mastery. There is no unique sequence for all learners, and the optimum in any particular case will depend upon variety of factors, including past learning, stage of development, nature of material, and individual differences.

Reinforcement: Learning depends upon knowledge of results at a time when and at a place where the knowledge can be used for correction. Knowledge of results is useful or not depending upon when and where the learner receives the corrective information, under what conditions such corrective information can be used, even assuming appropriateness of time and place of receipt, and the form in which the corrective information is received.

Bruner's Discovery Model:

In both the discovery model and in the instructional theory proposed by Bruner the main concept or the key concept is the structure. According to his view, it is the structure that the student should grasp, and the purpose of instruction is to help children to grasp the inherent structure of the subject. The child will grasp the inherent interrelationship that constitutes the basic structure of a discipline, such an emphasis facilitates the more advanced learning, minimizes forgetting and facilitates transfer. In the discovery approach one would specify the followings:

- Experiences to be learned.
- The way a body of knowledge is to be structured.
- The way the experiences of the instruction should be structured.
- The way and the pacing of the reward and feedback.

These four elements are the main points to be noted in Bruner's discovery model. For Bruner, learning is a process of forming categories (coding system) as to the similarities and differences that exist among objects and events. For him, it is more important what the child can do with the things he learns than what he learns. These events are possible through the discovery model which has the following advantages:

- Increased transferrability.
- Increased retention.
- A shift from extrinsic to intrinsic motivation.
- Training the heuristics of the discovery.

The study of Bruner can be summarized in a single statement that is "any subject can be taught effectively in some intellectually honest way to any child at any stage of development, as far as it is well structured and organized" (Mouly, 1982).

RESEARCH STUDIES

In this part, the research studies that are considered to be within the compass of the current study are presented as groups of related studies.

This review of literature concerning the research studies can be divided into three groups:

1-) Group of studies dealing with Computer Assisted Instruction.

2-) Group of studies dealing with the Discovery method of instruction

3-) Group of studies conducted on Turkish samples

Group of studies dealing with Computer Assisted Instruction

The educational uses of computers goes back to 1920s, with Pressy's teaching machine. As computers became more and more available in the last decade, we can see an increasing interest in this area of education.

Visonhaler and Bass (1972) summarized results from 10 independent studies of computer-supported drill and practice, involving more than 30 separate experiments with about 10,000 subjects. Results indicated a substantial advantage for computer-augmented instruction. Elementary school children who received Computer Assisted Instruction generally showed performance gains of 1.8 months over children who received only traditional instruction.

De Boer (1973) designed a research project to measure and evaluate the effects of computer-oriented methods of teaching a beginners course in analytic geometry and calculus for freshman engineering students. The study involved two classes of analytic geometry and calculus, each taught by a different method. The experimental group used the computer as an instructional aid, the control group followed a traditional pattern of instruction. The experimenter taught both groups using a traditional textbook. The same course syllabus, with some exceptions, was used by both sections. The subjects were administered to pre and post tests of calculus achievement. To measure any changes in attitudes toward mathematics, pre and post attitude scales were administered. The findings of this study imply that a computer-oriented approach to teaching calculus has little effect on calculus achievement or student attitudes toward mathematics.

Ibrahim (1970) compared the Computer Assisted Instruction (CAI) with other instructional methods in the teaching of the concepts of limits in freshman calculus. The other instructional methods were: the instructor centered (traditional) approach and the eclectic approach (a combination of traditional instruction and CAI). The study was designed to investigate differences in students' immediate and retained achievement and their attitudes toward CAI as an instructional medium and toward mathematics attributable to the teaching method. The researcher reported the findings, with students' immediate achievement as the criterion, that CAI students did significantly better than traditionally taught students. With retained achievement as the criterion, CAI students were neither superior nor inferior to the traditionally taught students. Most students had a favorable attitude toward CAI; however the majority were uncertain if they would prefer CAI to traditional instruction. Students' attitudes toward mathematics were not significant, regardless of the method.

Bell (1970) investigated the effectiveness of teaching introductory calculus using a computer-oriented approach. The control group studied a researcher-written calculus text, while the experimental group studied the same text plus six computer oriented problem sets. The researcher reported that a computer oriented approach to calculus is an effective method of promoting understanding of concepts and increasing students' interests in calculus, and does not interfere with students' learning to apply the techniques of calculus.

Byers (1973) studied to determine the effect of computer-supported instruction upon the attitudes and performance of students enrolled in a college introductory quantitative analysis course. The overall impact was that computer-supplemented approaches appeared to be superior to traditional methods, and the extensive computer supported method of teaching was better than a limited style of computer-supported instruction.

Edwards, Norton, Taylor, Weiss, and Dusseldorp (1975) in their review of the researches also concluded that traditional instruction supplemented by computer-based teaching was more effective than the traditional instruction alone. The finding was strongly evident in the end-of-course examinations, but not on retention examinations. This finding was especially clear when CBI was used to supplement conventional teaching. To present in more detail, studies showed that normal instruction supplemented by CBI was more effective than was normal instruction alone. Nine studies showed that the CBI students achieved more than non-CBI students, whereas eight studies found little or no difference and three studies showed mixed results.

Jamison, Suppes and Wells (1974) also concluded that Computer Assisted Instruction was effective as a supplement to regular instruction at the elementary school level. On the other hand at the college level, they came to the conclusion that CAI was about as effective as traditional instruction when used as a replacement. They also pointed out that it is broadly correct to conclude that, at the college level, most alternative methods of instruction are equally effective.

Hartley (1977), who was the first to apply meta-analysis to findings on computer-based instruction, focused on mathematics education in elementary and secondary schools. The researcher reported that the average effect of computer-based instruction in this area was to raise student achievement by 0.41 standard deviations, or from the 50th percentile to the 66th percentile. Hartley also reported that the effects produced by CBI was not better than that of peer teaching or cross-age teaching, but they were far better than the effects of programmed instruction or the use of individual learning packages.

Tsai and Pohl (1977) studied the differences in student learning achievement as measured by four different types of common performance evaluation techniques in a college level computer programming course under three teaching/learning environments: lecture, Computer Aided Instruction, and lecture supplemented with Computer Aided Instruction. The findings of the study suggest that a CAI or lecture supplemented with CAI teaching/learning environment is at least equal to and quite possibly is more effective than, the traditional lecture format for college students learning a computer programming language.

Tsai and Pohl (1980) studied the differences in student learning achievement and retention in a college-level statistics course taught in a variety of teaching/learning environments. Statistical test results revealed that students experiencing a CAI environment performed no differently on achievement or retention tests than students experiencing a traditional lecture/discussion environment. However students experiencing an "enriched" CAI environment (CAI plus planned teacher/student contacts) perform significantly better on achievement tests than students experiencing any of several other environments, including: lecture/discussion, lecture/discussion supplemented with planned teacher/student contacts, programmed instruction texts, PI texts supplemented with planned teacher/student contacts, and CAI.

Burns and Bozemann (1981) presented a meta-analysis of research studies of computer-assisted mathematics instruction in elementary and secondary schools. This report further supported the earlier conclusions; mathematics instructional programs supplemented with CAI were more effective in fostering student achievement.

Another meta-analysis (Kulik,Kulik and Cohen, 1980) synthesized the findings of 59 independent studies of computer based college teaching. The meta-analysis showed that Computer-Based Instruction made small but significant contributions to the course achievement of college students and also produced positive, but again small, effects on the attitudes of the students toward instruction and toward the subject matter they were studying. Computer-Assisted Instruction also reduced substantially the amount of time needed for instruction.

Kulik (1981) reviewed evidence from his own quantitative synthesis of findings and from Hartley (1977) concluded that the effectiveness of Computer Based Teaching is a function of instructional level at least in mathematics education.

Kulik, Bangert and Williams (1983) made a meta-analysis to integrate the findings from 51 independent evaluations of computer-based teaching in grades 6 through 12. The 51 studies contained findings on effects of CBI in six major areas: final examination performance, performance on retention examinations, attitude toward the subject matter taught in the experiment, attitude toward computers, attitude toward instruction, and time to learn. In 39 of the 48 studies with results from final examinations, students from the CBI class received the better examination scores; in the other nine studies, students from the conventional class got the better scores. A total of 25 of the studies reported a statistically significant difference in results from the teaching approaches. Results of 23 of these studies favored CBI, and results of two studies favored conventional instruction. The analysis showed that Computer-Based teaching raised students' scores on final examinations by approximately 0.32 standard deviations, or from the 50th to the 63rd percentile.

The five studies with follow-up examinations investigated retention over intervals ranging from 2 to 6 months. In 4 of the studies retention examination scores were higher in the CBI class, but none of these 4 retention effects was large enough to be statistically significant. In the remaining study retention examination scores were significantly higher in the control class. Computer-Based Instruction also had smaller, positive effects on scores in follow-up examinations given to students several months after the completion of instruction.

In addition, students who were taught on computers developed very positive attitudes toward the computer and positive attitudes toward the courses they were taking. Finally, the computer reduced substantially the amount of time that students needed for learning.

Berenson (1985) focused on the use of the computer to examine certain cognitive factors of 134 eight grade mathematics students. She concluded that high mathematics achievers tend to be field independent and more impulsive than lower mathematics achievers. Low mathematics achievers tend to be field dependent and reflective. The results demonstrated that the computer can be used as a research and diagnostic tool for studying and evaluating cognitive behavior.

Hurts (1986) conducted a study to investigate the effects of a computer-assisted instruction tutorial program on the academic performance and attitudes of college students. Pre-post experimental design was used, samples were randomly assigned to experimental and control groups. The experimental group was exposed to a series of CAI tutorial lessons for three months, while the control group was tutored by the traditional method within the same period of time. Findings of the study indicated that CAI had a significant effect on academic performance and attitudes toward CAI.

Canino (1986) discussed the differential effects of algorithmic and discovery computerized instruction on students' mathematics achievement and their reactions to these treatments. No significant difference between the effectiveness of treatments on students' achievement and reactions were found.

Robliyer (1988) summarized 38 studies and 44 dissertations in all content areas reported from 1980 to 1987 by meta-analysis. Effects on achievement and attitudes are reported for mathematics, reading/language, and cognitive skills, as well as for specific applications within these areas such as word processing and LOGO use.

The summary data support the following general observations:

While past reviews found that elementary levels seemed to profit most from use of computer applications, the researcher found the highest effects in college and adult populations. While only a few science studies could be included in the meta-analysis, the results indicate that computer applications yield higher effects than any other area, followed by mathematics and cognitive skills. While boys tended to achieve slightly more than girls with computer applications, and lower ability students did better than higher-achieving ones, these differences were not statistically significant indicating that there was no substantial difference between these groups. Little evidence supports the widely-held belief that good attitudes toward computers result in better attitudes toward school work and higher achievement.

Cook (1988) studied to determine whether the use of LOGO and computer to teach informal geometry to high school general mathematics students affected: a) geometry achievement, b) male/female geometry achievement, c) attitudes toward mathematics, d) attendance. The results revealed that: 1) students receiving LOGO instructions exhibited significant gains in attitude toward mathematics, 2) Attitudes of students in the traditional group decreased significantly, 3) there were no significant differences between groups on geometry achievement and on attendance, 4) no significant differences were found between gender and geometry achievement.

Perez (1985) investigated the effectiveness of two instructional treatments: lecture versus lecture plus microcomputer use in an accounting course. Subjects instructed with the use of the microcomputer performed significantly higher than those instructed by the classroom lecture method. There was no significant difference in academic performance between males and females, and there was no significant interaction between teaching methods and gender.

Imboden (1985) studied to determine whether or not computer enhanced instruction (CEI) could be used to present instruction dealing with percents to low achieving college students in such a way that achievement would be similar to that from a lecture method (LM), CEI would require less active time on the part of the instructor, and the use of CEI or LM would result in a difference in attitude either toward computers or toward percent. The results showed no differences in achievement or in attitude based on the treatment mode or on the sex of the subject. Three benefits from the use of the CEI program were suggested: student achievement should be at least as high as it would be with a lecture/discussion method, the instructor find more discretionary time available during classes, and the students should be more highly motivated.

Gesshel-Green (1987) conducted research to determine the effect of a microcomputer based, interactive, graphics program on retention and conceptual learning of Algebra II students. The control group received traditional instruction while the experimental group received traditional instruction plus computer demonstrations and computer laboratory. It was reported that the use of interactive computer graphics had no significant effect on achievement based on the scores of the formative and achievement tests, but the students who were unsuccessful using symbol manipulation methods were successful when using interactive computer graphics.

Franke (1987) made a quasi-experimental study to measure the effectiveness of CAI mathematics program at the seventh grades. The experiment was performed with two groups, one of which received CAI. The results indicated that student willingness to use computers, the environment around the student, and the method of presentation of the program play a major role in determining the effectiveness of the CAI program.

Hannafin and Swander (1987) designed a study to examine the similarities and differences in computer related attitudes between sixth grade boys and girls of different mathematics achievement levels. Subjects for the study were 32 random selected students. They were divided into two groups according to sex and high and low mathematics achievement. A significant effect was found for mathematics achievement. This effect was characterized by high achievement students expressing greater agreement with statements related to confidence in their computer abilities than low achievement students. No main effects were found for either sex of student or mathematics achievement.

Pflug (1987) made a comparison of the effect of computer assisted instruction and same age peer-tutoring on math achievement of fourth grade students. The study had pretest-posttest design to compare the effectiveness of CAI drill and practice with the effectiveness of same age peer tutor drill and practice on promoting mastery of multiplication facts. The study did not identify either CAI or same-age peer-tutoring drill and practice as more effective than the other, but the researcher reported same-age peer-tutoring to be more cost-effective than CAI drill and practice.

Lawson (1988) investigated the effects of computer assisted mathematic instruction on low achieving students to determine whether identified low-achieving students receiving computer assisted instruction would show significant mathematics gains in computation, concepts and application. The study compared low achieving students receiving CAI with a similar group of students not receiving CAI in mathematics. The results indicated that low-achieving students receiving Computer Assisted Instruction would show increased academic gains in mathematics computation, concepts and applications as compared to a similar population not receiving CAI.

Payton (1987) made a study to determine the effects due to 1) treatment, 2) ability, 3) interaction of treatment and ability that the use of mathematics software had on achievement and attitudes of students in college level basic mathematics. The subjects were randomly assigned to the experimental (Computer) group and control (non-computer) group. Both the experimental and control groups were taught by the investigator using the lecture/discussion method of instruction. Both groups were given comparable assignments. The experimental group used selected mathematics software to complete assignments whereas the control group used paper and pencil only. Results indicated that there were significant differences in achievement at the 0.05 level in favor of the experimental group in the area of graphs, relation and functions. Significant differences were found due to ability for word problems in favor of the low ability group. There were positive differences in attitudes toward mathematics and computers for the experimental group, however the differences were not significant.

Whalen (1988) in his study to compare instruction via computer with the traditional teacher-directed instruction in computational estimation, had the experimental group trained with a researcher-developped CAI program versus the control group trained with traditional instruction. The results reported were: 1) CAI students did not significantly improve their scores on the achievement test, 2) boys performed significantly better than girls in both groups, 3) a significantly positive relation existed between California Achievement Test and post-test scores, 4) students did not appear to transfer estimation skills to tasks which did not specifically direct them to use estimation.

Sally (1987) investigated the effect of Computer Assisted Instruction on mathematics achievement and attitudes toward mathematics and computers in grades four and seven. The results indicated that 1) CAI influenced mathematics achievement positively and significantly for the experimental groups, more so for grade four than for grade seven, 2) CAI did not influence attitude toward mathematics and computers significantly, but it did affect some individual attitudes toward computers by both treatment groups.

Niemick and Walberg (1987) made a synthesis on the comparative effects of Computer Assisted Instruction.

The study considered and evaluated a total of 16 researches, of which three were traditional and thirteen were quantitative. The meta-analysis revealed that a typical effect of CAI was to raise the outcome measures moderately by 0.42 standard deviations, that places the average student on the 66th percentile of the control group distribution.

After the studies related to CAI are summarized, the group of studies dealing with the Discovery method of instruction will be presented.

Group of Studies Dealing with Discovery Method of Instruction

Bittinger (1968) suggested that discovery attitudes can be sustained via didactic teaching. Backer and Macleod (1967), in reviewing literature relating to discovery and transfer, found no conclusive research evidence that the discovery method fosters transfer. This finding suggests that discovery methods might not facilitate the acquisition of superior problem-solving capabilities.

Meconi (1967) worked with a sample of 45 high-ability ninth grade students. He used three methods:

rule-example, guided discovery using leading examples, and pure discovery. Meconi found no differences in learning or retaining problem-solving ability; however, the pure discovery group was significantly more efficient at learning to solve new problems.

Bittinger (1968) cited studies in which he found superiority for discovery tests; he also found that students learning via an expository approach were significantly more fluent in generating potential solutions to problems.

Glennon and Callahan (1968) cited a study by Carlow on the effects of consolidation of discovery learning. Carlow used a random sample of 36 college-preparatory ninth graders. Each student was taught individually and given a sequence of hints as he needed them while learning generalizations in probability. Half of the group was given consolidation work with exercises on learned materials. Since initial learning was to a criterion, Carlow employed a retention-transfer test on generalizations in probability. On this test there was a significant mean difference favoring the group given the consolidation work.

Two approaches have been researched on discovery and its effects on low achievers' achievement in and attitudes toward mathematics. Price (1967) used three classes of tenth grade students to examine the effects of two discovery methods on low achievers in mathematics. One class was guided to make discoveries of generalizations while a second class received the same instruction but was guided in applying generalizations to practical problems. The third class served as a control group in which more traditional patterns of instruction were used. All classes had the same teacher. All classes showed gains in algebra achievement. However, the discovery and transfer classes were significantly better than the control class. Price concluded that the discovery approach had in itself no significant transfer-generating capacity. In attitude measured by student ranking of mathematics with other subjects, the two treatment groups showed a positive attitude change while the control groups exhibited a negative attitude change.

Vance (1972) reported a research study done with urban junior high school students in a mathematics laboratory setting. The study involved students from grade seven and grade eight classes in a large urban junior high school, randomly assigned to one of three groups.

Mathematics laboratory group: students grouped in twos and using written instructions worked directly with the physical materials accompanying each lesson.

Class discovery group: the laboratory activities adapted as "discovery" lessons were presented to whole classes of students by their teachers who demonstrated with the concrete materials.

Control group: students in this group continued to study the regular program the full time allotted for instruction in mathematics.

In order to assess the effects of the two experimental settings over the three month experimental period, a large number of tests and information gathering instruments were administered to the students, before, during, and after the experiments.

The results: there were no significant differences among the three groups at either grade level on an achievement test based on work covered in the regular mathematics program during the study. Following each laboratory or class discovery activity, the students completed a brief set of exercises based on material contained in that lesson. These review sheets were intended, in part, to provide the student with feedback regarding the kinds of things he might have learned during an activity. It was found that students in both experimental groups did quite well in terms of immediate achievement.

Analysis of the total scores obtained by students on the ten review sheets indicated no significant difference between learning in the laboratory and class discovery settings except for average and low ability seventh graders. For these samples the class discovery group scored significantly higher than the lab group. But the grade 8 students and high ability grade 7 students who worked in pairs from written instructions appeared to have learned as much as those in the teacher-directed class setting.

The lab students rated highest in feeling that learning mathematics is fun or enjoyable. In addition, the laboratory group appeared to have a slightly better attitude toward mathematics than the other groups. Although students from both experimental groups reacted positively to their respective programs, the reaction of the lab students was more highly favorable than that of the class discovery students.

Kufhittig (1974) investigated the relative effectiveness of concrete aids in discovery learning. The subjects were 40 seventh grade students. The subjects were randomly assigned to one of four groups, with five low ability subjects in each. The groups were designated: 1) abstract training - immediate guidance, 2) abstract training - maximal guidance, 3) concrete training - intermediate guidance, 4) concrete training - maximal guidence. The methods of teaching were called concrete and abstract on the learning aids dimension and maximal and intermediate guidance on the discovery dimension. No significant differences were reported for retention, but high ability subjects did significantly better than low ability subjects on achievement.

Kleckner (1968) investigated the effects of discovery - laboratory type teaching-learning strategies as they pertain to achievement, work-study skills, and attitudes of low achievers in Basic Mathematics I. The 127 ninth and tenth grade students used in the study were selected on the basis of previous mathematics achievement, ability, and reading comprehension. The discovery-type classes were held in the mathematics laboratory, and the conventional-type classes were held in traditional classrooms.

The researcher concluded that the conventional (non-discovery) ninth and tenth grade classes of slow learners achieved significantly more general mathematics content than the discovery classes at the 0.01 level. No support was found for the superiority of discovery-type teaching-learning strategies over conventional teaching methods in the development of work study skills in teaching basic mathematics to low achievers as defined. There were no statistically significant greater positive gains (than for non-discovery methods) in achievements, work study skills, or attitudes toward mathematics.

McClintock (1974) investigated transfer of learning as mediated by three instructional methods of teaching selected mathematical generalizations. The experiment compared expository, rule and example, and discovery methods of teaching selected mathematical principles on dependent variables of transfer of learning involving representational, contextual, and difficulty level components of the domain transfer.

No significant differences were reported to suggest that a particular method affects the transfer of learning from a particular set of generalizations to another set of generalizations better than any other method.

Munyofu (1984) studied the effects on achievement, retention and attitude of using expository and discovery approaches in teaching factoring to adult slow learners. Eighty-eight adult students at a community college were randomly assigned to four classes which were randomly assigned to two teachers. At the end of four weeks of instruction an achievement test was administered to all students. Then three weeks later a retention test was given. The results showed that students taught by the discovery method had significantly higher mean scores on the achievement and retention tests than students taught by the expository methods with $p<0.04$ for achievement and $p<0.03$ for retention. The teacher variable did not effect the differences in the mean scores.

Holdan (1985) designed a study to compare the effects of traditional, exploratory, distributed, and a combination of distributed and exploratory practice on initial learning, transfer, and retention of verbal problem types in first year algebra. Students in the traditional group received massed practice with exercises related only to the current lesson. Students in the distributed group received spaced review practice with exercises on topics previously encountered. Students in the exploratory group received intuitive practice with future topics. Students in the combination of distributed and exploratory group received both spaced review practice with previous topics and intuitive practice. The combination of distributed and exploratory practice was found to be at least as good as traditional massed practice and at best as good as their combination. The interaction between type of verbal problem and degree of transfer indicated that students performed better on the easier near transfer value problems and the more difficult far transfer motion problems.

Howerton (1987) made a comparative analysis of the guided discovery method versus the traditional lecture-laboratory method in teaching introductory computer science. The evaluation instrument was a forty question multiple-choice test which was administered as a post treatment retention achievement test and 8 sub-tests to determine whether either method was better suited for presenting certain topics. No significant differences were found by an analysis of covariance with the teaching method as the independent variable. Significant differences between the two methods were found by an analysis of covariance. The only sub-test which appeared to be uniquely linked to the teaching method was "ability to read programs" in which the guided discovery groups scored significantly better than the lecture laboratory group.

Mulpo and Fowler (1987) examined the differential effectiveness of traditional and discovery methods of instruction for the teaching of science concepts and principles. Subjects were 120 eleventh grade males. Sixty of these were concrete reasoners and the other sixty subjects were formal reasoners. Each of these two groups was randomly separated into two sub-groups with 30 subjects. The traditional and discovery approaches were randomly assigned to the two sub-groups of formal reasoners and two sub-groups of concrete reasoners. The result of the study indicated that, for formal reasoners, the discovery approach was more effective than the traditional approach in promoting understanding of science and scientists. For concrete reasoners, mode of instruction had no significant effect on the subjects understanding of science.

Mitchel (1987) in the meta-analysis study, investigated the effectiveness of innovative instructional methods utilized in lower division mathematics as measured by student achievement. Seven instructional methods were investigated in terms of student achievement: programmed instruction (PI), individualized instruction (II), computer based instruction (CBI), laboratory and discovery methods (LAB), television (TV), audio-tutorial (AT), and tutoring. A meta analytical approach was used. Studies comparing an innovative method to the lecture or to another innovative method were located. The meta-analysis found that: 1) relative to the lecture method six of the innovative methods produced a positive effect on student achievement. The ranking of the methods in order of decreasing effectiveness was tutoring, CAI, AT, II, PI, LAB, TV. 2) The most effective methods by level of course were:

a) Pre-calculus level: CAI, AT, and tutoring

b) Calculus level: tutoring, II, PI, and AT.

c) Foundation of mathematics (elementary education majors): PI

d) Descriptive geometry: TV

The most effective methods by ability level of the students were:

a) high ability: CAI and LAB,

b) middle ability: CAI, II, PI

c) low ability: PI and AT.

3) the lack of empirical studies prevent the determination of the relative effectiveness of combinations of the innovative methods.

There are some studies which have been conducted by Turkish researchers with Turkish student samples.

Group of Studies Conducted on Turkish Samples

Öztürel (1987) studied to determine the effects of education with computers, on mathematics achievement. The sample was 70 students selected from Ankara Yükseliş College secondary school. Subjects were randomly assigned to two groups as experimental and control groups. As a measure of the initial cognitive behavior of the students' mathematics course final grades of the previous year and those of the first semester of the research period were taken. The instructional materials, questionnaire and tests were prepared by the researcher.

The experimental group of students was taught with the computer system and network readily mounted in the school. Control group students were taught by traditional methods in the class. Both groups received the same concepts in mathematics. The treatment lasted two weeks.

No significant differences were found between the groups at the start of the experiment. Thus the differences between the groups related to the post test scores considered as the product of the treatment.

The results of the study indicated that the final achievement of the students who were subjected to a treatment with computer were significantly higher than those who were taught by traditional methods.

Köksal (1988) studied to explore the effect of Computer Assisted Instruction (CAI) on college students' mathematics achievement, attitude toward computer and mathematics as a subject matter and also investigated the unique contribution of cognitive and affective entry characteristics of students and instruction on the mathematics achievement of the students. The sample consisted of 30 freshman students who took an introductory mathematics course from the Department of Management and Economics at the Middle East Technical University. The students were divided into two groups, 14 students were randomly assigned to CAI as an experimental group, and remaining students were posted to a traditional instruction (TI) as a control group.

The analysis showed that students who were exposed to CAI had significantly higher mean scores on mathematics achievement test than the students who were exposed to TI at alpha=0.05 level. Although the difference between the mean scores in terms of attitude toward computer and mathematics were not significant, the gain scores of the students in the CAI group were significantly higher than those of the students in the TI group at alpha=0.05 level. The unique contribution of the cognitive entry behavior and instruction on mathematics achievement was significant.

Geban (1990) studied to investigate the effects of the Computer Simulated Experiment (CSE) approach and Problem Solving approach on students' chemistry achievement, science process skills, and attitudes toward chemistry at the high school level. For this purpose these two experimental groups were compared with a control group that used the conventional approach. The sample consisted of 200 ninth grade students. The treatment for all groups was carried out over a period of nine weeks. Four instruments were utilzed in this study: Chemistry Achievement test; Science Process Skill Test; Chemistry Attitude Scale; Logical Thinking Ability Test. Results indicated that the computer simulated experiment approach and the problem solving approach produced significantly greater achievements in chemistry and science process skill than the conventional approach. The CSE approach produced a significantly greater attitude toward chemistry than the other two methods. Also, the problem solving approach produced a significantly greater attitude toward chemistry than the conventional approach.

In conclusion, when the research studies in related literature are examined it is seen that there are studies which investigated the effects of the instructional method on immediate and retained achievement and attitude toward the course.

In most of the studies, Computer Based Instruction and LCDP instruction were found to be superior to traditional instruction in attainment of immediate mathematics achievement, while some of the researchers reported no significant difference in achievement results between Computer Assisted Instruction and traditional instruction. Very few studies reported that the students in conventional groups got better final scores.

The majority of the studies on Discovery instruction reported that Discovery instruction was superior to traditional instruction in the attainment of immediate achievement, although there are some studies which reported no significant difference with respect to achievement test results.

For retained achievement, studies reported higher retained achievement in discovery groups when compared to expository methods. Some studies, although not statistically significant, reported higher retained achievement levels in favor of Computer Assisted

Instruction, than traditional methods. Some of the studies reported no significant difference in retained achievements of Computer Assisted Instruction / Lecture with Computer Supported Drill and Practice and traditional instruction.

Except for one study, studies reported that Computer Assisted Instruction, Lecture with Computer Supported Drill and Practice and Discovery groups developed significantly positive attitudes toward the subject.

The researcher has failed to find the studies which investigated the effects of the achievement level on the above mentioned parameters, and effects on the attitude toward the topic as well; which are investigated within this study.

This study is designed to investigate the effects of some independent variables on various achievement and attitude measures.

CHAPTER FOUR

METHOD OF THE STUDY

Introduction

This chapter is devoted to the presentation of the procedures utilized in this study. It includes the problem, hypotheses, sample, instrumentation, research design and the analyses of the data of the study.

Problem and Hypotheses

What are the effects of different teaching methods and mathematics achievement levels on immediate and retained mathematics achievement and attitude toward mathematics; and the selected topic?

Subproblem 1 (S_1)

What are the effects of different teaching methods and mathematics achievement levels on immediate mathematics achievement?

Hypothesis 1.- $H_o(1)$ The main effect of the teaching method on immediate mathematics achievement is not significant.

Hypothesis 2.- $H_o(2)$ The main effect of the mathematics achievement level on immediate mathematics achievement is not significant.

Hypothesis 3.- $H_o(3)$ The effect of interaction between the teaching method and the mathematics achievement level on immediate mathematics achievement is not significant.

Subproblem 2 (S_2)

What are the effects of different teaching methods and mathematics achievement levels on retained mathematics achievement?

Hypothesis 4.- $H_o(4)$ The main effect of the teaching method on retained mathematics achievement is not significant.

Hypothesis 5.- $H_o(5)$ The main effect of the mathematics achievement level on retained mathematics achievement is not significant.

Hypothesis 6.- $H_o(6)$ The effect of interaction between the teaching method and the mathematics achievement level on retained mathematics achievement is not significant.

Subproblem 3 (S_3)

What are the effects of different teaching methods and mathematics achievement levels on attitude toward mathematics?

Hypothesis 7.- $H_o(7)$ The main effect of the teaching method on attitude toward mathematics is not significant.

Hypothesis 8.- $H_o(8)$ The main effect of the mathematics achievement level on attitude toward mathematics is not significant.

Hypothesis 9.- $H_o(9)$ The effect of interaction between the teaching method and the mathematics achievement level on attitude toward mathematics is not significant.

Subproblem 4 (S_4)

What are the effects of different teaching methods and mathematics achievement levels on attitude toward the selected topic?

Hypothesis 10.- $H_o(10)$ The main effect of the teaching method on attitude toward the topic is not significant.

Hypothesis 11.- $H_o(11)$ The main effect of the mathematics achievement level on attitude toward the topic is not significant.

Hypothesis 12.- $H_o(12)$ The effect of interaction between the teaching method and mathematics achievement level on attitude toward the topic is not significant.

Subjects

The subjects were selected from the 10th grade science major students of the Ankara Yükselis Lycee, Turkey, where the medium of instruction is English for science and mathematics courses. Yükseliş Lycee is a private school. The experimental study was carried out during the fall semester of the academic year 1989-1990.

The 10th grade science major students are randomly distributed to 15 classes by the school administration prior to the academic year.

3 classes among these 15 science classes are randomly selected for the experimental treatment of this study. These three classes were randomly assigned to instructional treatments (Lecture, Discovery, Lecture with computer supported drill and practice).

The subjects consisted of 120 students, with 40 students in each of these 3 classes. The 9th grade mathematics achievement scores of the subjects were obtained from the grade report forms of the school records. Each student was assigned to one of the high, middle and low achievement levels according to their previous year mathematics grades.

The mean previous year's mathematics achievement scores of these 3 classes were not significantly different at t=.05 level.

The distribution of subjects into the indicated groups is in the Table-1.

TABLE 1
Distribution of the Sample

	Lecture	Lecture with CAI	Discovery
Low Achievers	11	12	16
Middle Achievers	18	16	11
High Achievers	11	12	13

Variables

There are six variables in this study. Four of them are dependent variables,two of them are independent variables. The dependent variables of this study are: (1) mathematics achievement, (2) retained mathematics achievement, (3) attitude toward mathematics, (4) attitude toward the topic. The independent variables of this study are: (1) Teaching methods: Discovery, Lecture with Computer Supported Drill and Practice, Lecture, (2) Mathematics Achievement Levels : low, middle, high.

Instrumentation

The hypotheses of this study are tested by the following measuring instruments. They are:

- scale of attitude toward mathematics
- scale of attitude toward the topic
- two parallel tests of mathematics achievement

A questionnaire on areas of polygonal regions is also used to evaluate the differences between the instructional methods used in this study.

Scale of attitude toward mathematics

The mathematics attitude scale (MAS) was developed by Aiken (1979) and administered to Iranian students. This Likert-type scale of attitudes toward mathematics consists of 24 statements to be answered as Strongly Disagree (SD), Disagree (D), Undecided (U), Agree (A), or Strongly Agree (SA).

MAS measures attitude toward mathematics in four dimensions, which are Enjoyment of Mathematics (E), Motivation in Mathematics (M), the Importance of Mathematics (I) and the Freedom from Fear of Mathematics (F). The scoring of responses to each of 24 items is considered as 0,1,2,3 or 4 in the direction from the most negative to most positive.

The E (Enjoyment of Mathematics) score is the sum of scores on items 1,5,9,13,17 and 21. The M (Motivation in Mathematics) score is the sum of scores on items 2,6,10,14,18 and 22. The I (Importance of Mathematics) score is the sum of scores on items 3,7,11,15,19 and 23. The F (Freedom from Fear of Mathematics) score is the sum of scores on items 4,8,12,16,20 and 24. Three of the six items on each of the four part scales (E,M,I and F) are worded in a positive direction and 3 in a negative direction. The total (T) score consists of the sum of scores on the E,M,I and T scales. Each of the E,M,I and F scores ranges from 0 to 24, while the total score ranges from 0 to 96.

When this Mathematics Attitude Scale was developed it was administered to 300 subjects. The reliabilities of the five MAS variables (E,M,I,F and T), the alpha coefficients were computed separately by grade level and sex, ranged from 0.50 to 0.86 for partial scores (E,M,I and F), and from 0.81 to 0.91 for partial scores. Intercorrelations among the 24 items and five subscores on the scale suggested that 3 factors were being measured: Enjoyment or Interest, Perceived Importance or Value, and Freedom from Fear or Anxiety toward specific subject. The Motivation variable was too closely related to the other three variables and specially to Enjoyment or Interest, to be considered as a separate factor.

Aksu (1985) administered the same Mathematics Attitude Scale on 126 Turkish University Freshman Students. (54 Females, 72 Males). Aksu scored the responses as (1,2,3,4,5) from the most negative to most positive. The coefficient alphas were computed to determine reliabilities of the five MAS variables, due to the probable effects of differences in culture and age level of students. The computed Cronbach's alpha and standardized item alpha were found to be 0.77 and 0.80 respectively. The alpha coefficients for part scores (E,M,I and F) ranged from 0.70 to 0.78. Intercorrelations among the five scores on MAS suggested that all factors were being measured. These results on the reliabilities of the instrument (MAS) were fairly consistent with the results obtained by Aiken on the Iranian sample (Aiken, 1979).

Besides the arithmetic means, an attitude index was obtained for each scale by totalling the response values and dividing by the number of items in the scale. Thus, an attitude index close to 5 indicates a very positive attitude, and value close to 1 a negative attitude. The study of Aksu (1985) showed that Aiken's MAS could confidently be used with Turkish samples. The author of this study decided to use Aiken's MAS to assess the attitudes toward mathematics of the subject of the current study.

The reliability coefficient (Cronbach's alpha) is found as 0.90 in the present study. The result of the present study on the reliabilities of the instrument (MAS) is consistent with the results obtained by Aiken (1979) and Aksu (1985).

Scale of Attitude Toward the Topic

To assess the attitudes of the students toward the topic selected in this study the Scale of Attitude Toward the Topic (Areas of Polygonal Regions) is used. This scale was constructed by replacing the items addressing mathematics by "Areas of Polygonal Regions". The breakdown of the test into the parts and the scoring scheme is exactly the same as with the scale of Attitude Toward Mathematics. The reliability coefficient (Cronbach's alpha) has been found to be 0.93 in the present study. The result of the present study on the reliabilities of the instrument (SATT) is consistent with the results obtained by Aiken (1979) and Aksu (1985).

Mathematics Achievement Tests (MAT)

The Mathematics Achievement Test (MAT) has been developed by the researcher. This test is constructed according to the objectives of the course content. The behavioral changes which are expected to develop after the treatment are covered in the test. The topic covered in the test is areas of polygonal regions. The test covers the following particular subjects.

- Area of a triangle
- Area of a parallelogram
- Area of a rectangle
- Area of a square
- Area of a rhombus
- Area of a trapezoid

The procedure used in the development of the mathematics achievement test was as follows. First, the instructional objectives of the subject content were stated according to the categories in the cognitive domain of Bloom's taxonomy (see Appendix A.1). Then, 60 questions covering the subject content were prepared by the researcher.

The content validity evidence of this test was checked by a review of the course content and course objectives. For the content validity of the test a table of specifications (see Appendix A.2) was prepared. According to this table of specification the questions which are compatible with the content were selected. These 60 questions were examined and reduced to 40 questions to form two 20 parallel questions to address course content and objectives best, and for the degree of discrimination, by a group of experts in mathematics education and course instructors including the researcher.

In order to conduct an item analysis procedure on this reduced 40 questios test, the test was administered to 79 10th grade students from TED Ankara Lycee (which is another private school showing a similar breakdown of the subjects and educational system). These students have just completed the subject of Areas of Polygonal regions. Their responses to these 40 questions were analyzed by the use of MicroCAT Item and Test Analysis Program. The analyses revealed that one of the alternatives of two questions were not working. It was recognized that these two alternatives had typographical errors and the test was then corrected. The alpha reliability coefficient was found to be 0.92.

These 40 questions which consisted of two groups of 20 parallel questions were divided into two parallel tests, one of which was to be used as the pre-mathematics achievement test and retained mathematics achievement test and the other as the post-mathematics achievement test.

Questionnaire on Areas of Polygonal Regions (QAPR)

This questionnaire (QAPR) was developed by the researcher to get the opinions of the students about the different instructional methods used in this study. The questionnaire consists of two parts. The first part is aimed at assessing the quality of instruction according to the four elements of Bloom's conceptualization of "quality of instruction" (Bloom,1976). Bloom stated that the cues, participation, reinforcement and feedback correctives are the essentials of the instructional quality. The QAPR contains questions regarding:

- cues given
- participation of students
- reinforcement given by the instructor
- feedback provided
- opinions about the subject
- sufficiency of instructional time
- preferences of students on the instructional method; and reasons

In the second part an attempt was made to determine the out of school time the student devoted to learning the course. The questions that addressed:

- The time that the student allotted to studying this subject
- The sources or source persons used for learning this subject.

The full (Turkish) questionnaire is presented in the Appendix (E).

Analysis of Data

In the present study, the collected data were analyzed by the statistical techniques called "Analysis of variance: Two-way classification", "Multiple Range Analysis", "Table of Means". The study is interested in two independent variables, teaching methods and mathematics achievement levels. Analysis of variance is used to compare the effects of the three different instructional treatments and mathematics achievement levels on the dependent variables.

Research Design

The design of the study is randomized control-group pretest-posttest design (Isaac & Michael, 1982).

Group	Pretest	Treatment	Posttest	Retention
EG1	T1,T2,T3	D	T4,T2,T3	T1
EG2	T1,T2,T3	LCDP	T4,T2,T3	T1
CG	T1,T2,T3	L	T4,T2,T3	T1

EG1 represents the experimental group 1, which received instruction with the Discovery method(D); EG2 represents the experimental group 2 which received instruction by Lecture with Computer Supported Drill and Practice (LCDP); and CG represents the control group which received instruction by the Lecture method (L).

T1 and T4 are two parallel forms of mathematics achievement test (MAT), T2 is the Scale of Attitude Toward Mathematics (SATM), T3 is the Scale of Attitude Toward Areas of Polygonal Regions (SATAPR).

T1, T2, T3 were administered as pretests, T4, T2, T3 were administered as posttests and T1 was administered as a retention test.

Procedure

The experimental part of this study was conducted in the fall semester of the academic year 1989-1990.

The following steps were accomplished for the current study:

1) The selection of the subjects was completed as presented earlier in this chapter, at the beginning of 1989-1990 academic year. 120 tenth grade students from Yükseliş Lycee, Ankara, Turkey who were distributed into 3 classes constituted the subjects of the study. Before the treatment, pretests were administered to each class in order to determine if there were any significant differences among the classes, due to mathematics achievement, attitude toward mathematics and attitude toward the topic "areas of polygonal regions". The statistical analyses showed no significant differences among classes prior to the treatment.

2) These 3 classes were randomly assigned to 3 instructional treatments (Lecture, Discovery, Lecture with Computer Supported Drill and Practice).

3) All three treatment groups were taught with the same content to reach exactly the same objectives that are presented in Appendix (A1).

The topic "Areas of Polygonal Regions" was preferred for this study since it could be applied with all instructional methods effectively.

All three classes received instruction by the researcher to eliminate the differences that may occur because of different instructors. For the class which received instruction by the Lecture method, the lecture notes that were prepared before the treatment were followed. The subject content was presented to the class in a teacher-centered way, and the examples were solved by the instructor. There was no interaction and no discussion, the communication was one way from the instructor to the students. If there were any questions coming from the students, necessary explanations were given. This class received 3 weeks of instruction for a total of 18 class hours, with 6 class hours per week.

For the class receiving instruction by the Discovery Method, the discovery sheets were prepared by the researcher before the instruction. Since each class had 40 students, it was difficult to apply the Discovery method in such a crowded class. Hence the discovery sheets were prepared and handed to each student in order to compensate for the factor of populated classes. These discovery sheets are presented in Appendix (G). The discovery sheets were distributed at the beginning of each class hour.

In these discovery sheets, there were exercises which were presented step by step with questions and spaces where the students could write (in ink) the answers that they found in order to ensure each student could find the answer without being affected by the others. After each question had been answered by the students, the instructor stated the correct responses by interacting with the students. The examples in the sheets were organized in such a way that would the students would recognize that there was a rule and would be directed to predict or discover and express the rule. The structure of the instruction was designed to reach the rules from the examples, in which the rules were discovered by the students. This provided a highly interactive class environment where the factors which would influence the student, before the student discovered or found the answer, were minimized.

This class received 3 weeks of instruction for a total of 18 class hours with 6 class hours per week.

The class which received instruction with Lecture with Computer Supported Drill and Practice, received the lecture part of the instruction from the researcher. Before the treatment the instruction material was prepared and the drill and practice software was developed also by the researcher. The lecture content of this treatment was also common with the other two treatments.

This class received in total 18 class hours of instruction in three weeks. Each week they had 4 hours of lectures in the class and 2 hours of drill and practice in the computer laboratory.

The Computer Assisted Drill and Practice software was developed and tested by the researcher before the treatment. The software was prepared for color Commodore-64 personal computers. This selection of the hardware media was the result of the practical conditions at the Yükseliş Lycee, where the treatment took place. The school had a computer laboratory containing 22 Commodore-64s. These 22 computers had color-graphics monitors and were networked to the teacher's computer, so that the teacher could download the software onto the student computers and monitor students' screens without interrupting the student's program.

The software was written by the researcher with Commodore-BASIC, based on a graphics library that was written by a computer scientist, which provided sophisticated color graphics that would make the presentation of the exercises attractive. First the scenario of each drill was planned along with the appearance orders of question text, question figures, color graphics, alternatives, possible responses, hints and graphical enhancements of original figures, sound effects, cues and reinforcements. After the story-boards of all questions had been prepared, the program was actually coded in BASIC. Coding and testing of each question took about 1-1.5 hours due to the practical limitations of the hardware and software used.

In the computer drill and practice program, at each exercise, the problem text was typed onto the screen, the figures related to the problem were drawn and labelled on the screen. The questions were multiple choice with 5 alternatives. Then the student response was asked for together with the sound effect. If the student response was correct, a smiling face appeared on the screen together with a nice melody. If a wrong response was chosen, the student was informed that his response was "not correct" with a warning melody and a hint that would address the most probable mistake was given, if necessary the original figure was enhanced further, and the student was asked to try again. If this response was then correct, the student was reinforced with a smiling face and music. If this response was again incorrect, another hint was given and the student was again asked for the response. If this response was correct, the student was reinforced with a smiling face, if an incorrect response was made, the solution of problem was displayed step by step.

The software was prepared as 3 question banks, each bank consisted of 20 questions.

Before each laboratory session, the students' computers were powered up and loaded with the Computer Assisted Drill and Practice program. The students were given a response information form to mark at which attempt they have found or if they have not found the correct answer, for each question.

The students were seated two to a computer because of the limitations of the laboratory. First the topic was presented by the Lecture method in the class by the researcher, then the students had the laboratory session to complete the exercises about the subject by the above-presented Computer Aided Drill and Practice Program. The evaluation sheets were collected after each laboratory session.

4) After the treatment had been completed, all three classes received the post Mathematics Achievement Test, which is a parallel form of the Pre-Mathematics Achievement Test, the Scale of Attitude Toward Mathematics (SATM) and Scale of Attitude Toward the Topic (Areas of Polygonal Regions) (SATT), to assess the effects due to the treatment on the mathematics achievement and attitudes toward mathematics and areas of polygonal regions. Also all three classes were given a questionnaire on areas of polygonal regions to get their opinions on the different instructional methods used in the study.

5) Three months after the completion of the treatment, the students were given the retained achievement test which was the same as Pre-Mathematics Achievement Test, to assess the differences in retained achievement due to the different instructional treatments.

6) After the retention test, the collected data were evaluated and analyzed.

Limitations

1) This study is limited to 10th grade high school students in Yükseliş Lycee, Ankara, Turkey, during the fall semester of the 1989-1990 academic year.

2) Since there were only 20 student computers in the computer laboratory, two students were using the same computer and program.

3) It is difficult to apply the Discovery method in a class of 40 students. In order to overcome this difficulty, the discovery sheets were used.

CHAPTER FIVE

RESULTS OF THE STUDY

Introduction

This chapter is devoted to the presentation of the results obtained from the testing of the hypotheses stated previously. The hypotheses were tested for the level of significance at $p = .05$. Two-way Analysis of Variance (F-test) was used to test the hypotheses. The results obtained by analyzing the data for each hypothesis and arrived conclusions are given in this chapter

Results Concerning the Immediate Mathematics Achievement Test (IMAT)

No significant difference was found among the mean scores of the three groups with respect to pre-mathematics achievement test scores.

Hypothesis1-$H_o(1)$: The main effect of the teaching method on immediate mathematics achievement is not significant.

Hypothesis2-$H_o(2)$: The main effect of the mathematics achievement level on immediate mathematics achievement is not significant.

Hypothesis 3-$H_0(3)$: The effect of interaction between the teaching method and the mathematics achievement level on immediate mathematics achievement is not significant.

In order to test these hypotheses the F-Test was used. The results are shown in Table-2.

Table-2:

Analysis of Variance of Data Obtained From Immediate Mathematics Achievement Test:

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F-Ratio	Sig. Level
Teaching Method(TM)	185.69	2	92.85	12.61	.0000
Maths Ach. Level(MAL)	536.05	2	268.03	36.41	.0000
Interaction of TM and MAL	12.40	4	3.10	.42	.7931
Residual	817.15	111	7.36		
Total	1567.47	119			

Analysis revealed that different teaching methods (Lecture, Discovery, Lecture with Computer Supported Drill and Practice method) caused differences in all mathematics achievement levels(low, middle, high) with respect to IMAT scores. Also there was a significant difference among the mean scores of the students taught by the Lecture method, by the Discovery method and by the Lecture with Computer Supported Drill and Practice method with respect to IMAT scores.

It was also found that there was a significant difference among the mean scores of the students who were in low, middle, high achievers group with respect to IMAT scores. No interaction was found between teaching method and mathematics achievement level with respect to IMAT scores.

In order to find out which groups were different the multiple range analyses was performed. The results are shown in Table-3.

Table-3:
Measures obtained from Multiple Range Analysis for showing pairs of groups that were significantly different on Immediate Mathematics Achievement Test.

Teaching Method	95 Percent Confidence Intervals Count	 Average	 Homogeneous groups	
Lecture grp.	40	10.40	*	
Discovery grp.	40	13.10		*
Lecture with Computer Supported Drill and Practice grp.	40	13.20		*

From Table-3 it can be seen that the students taught by the Discovery method and by the Lecture with Computer

Supported Drill and Practice method scored significantly better than the students taught by the Lecture method with respect to IMAT scores.

Also the mean scores of the students taught by the Discovery method and by the Lecture with Computer Supported Drill and Practice method are not significantly different to each other with respect to IMAT scores.

Table-4:

Multiple Range Analysis For Immediate Mathematics Achievement Test by Mathematics Achievement Level

Mathematics Achievement Level	Count	95 Percent Confidence Average	Homogeneous Groups		
Low	42	9.83	*		
Middle	42	12.12		*	
High	36	15.17			*

From Table-4 it can be seen that the mean scores of the students in the low achievers group, the students in the middle achievers group, and the students in the high achievers group are significantly different to each other with respect to the IMAT scores.

Furthermore, to find out the answer from which pairs of groups this difference comes at 95 percent confidence for mean, the table of means for immediate mathematics achievement was examined.

Table-5:
Table of Means for Immediate Mathematics Achievement

Level	Count	Average	Stnd Error (internal)	Stnd Error (pooled)	95 Percent Confidence for mean	
Teaching Method						
LCDP grp.	40	13.20	.52	.43	12.35	14.05
LEC grp.	40	10.40	.56	.43	9.55	11.25
DISC grp.	40	13.10	.54	.43	12.25	13.95
Maths Ach. Level						
Low	42	9.83	.47	.42	9.00	10.66
Middle	42	12.12	.50	.42	11.29	12.95
High	36	15.17	.40	.45	14.27	16.06
TM by MAL						
LCDP-Low	12	11.25	.79	.78	9.70	12.80
LCDP-mid	16	13.06	.88	.68	11.72	14.41
LCDP-high	12	15.33	.64	.78	13.78	16.89
LEC-Low	14	7.79	.76	.73	6.35	9.22
LEC-Mid	15	10.40	.75	.70	9.01	11.79
LEC-High	11	13.73	.69	.82	12.11	15.35
DISC-Low	16	10.56	.66	.68	9.22	11.91
DISC-Mid	11	13.09	.72	.82	11.47	14.71
DISC-High	13	16.23	.60	.75	14.74	17.72
TOTAL	120	12.23	.25	.25	11.74	12.72

The interpretation of this table is based on the fact that there is a significant difference between two cells if the respective confidence intervals are distinct. For example for the Lec-low group the confidence interval for mean is [6.35,9.22], for the Disc-low group is [9.22,11.91] and for the LCDP-low group is [9.70,12.80]. Among these intervals, the intervals of Lec-low and Disc-low and the intervals of Lec-low and LCDP-low are distinct from each other. On the other hand the intervals of Disc-low and LCDP-low are not distinct from each other since they have a non-empty intersection.

From the table it can be seen that the Discovery group [9.22, 11.91] and the Lecture with Computer Supported Drill and Practice group [9.70, 12.80] in the low achievement level appeared to be significantly different to the Lecture group [6.39, 9.22]. The confidence intervals of the remaining cases are not distinct. In other words, the difference found in mean scores of IMAT between the groups taught by three different instructional methods came mainly from the groups in the low achievement level. Furthermore, within the low achievement group the group taught by Lecture with Computer Supported Drill and Practice and by Discovery was significantly different to the group taught by the

Lecture method, in the immediate mathematics achievement test.

Results Concerning the Retained Mathematics Achievement Test(RMAT):

Hypothesis-4 $H_o(4)$: The main effect of the teaching method on retained mathematics achievement is not significant.

Hypothesis-5 $H_o(5)$: The main effect of the mathematics achievement level on retained mathematics achievement is not significant.

Hypothesis-6 $H_o(6)$: The effect of interaction between the teaching method and the mathematics achievement level on retained mathematics achievement is not significant.

In order to test these hypothesis the F-Test was used. The results are shown in Table-6.

Table-6:

Analysis of Variance of Data Obtained from Retained Mathematics Achievement Test (RMAT)

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F-Ratio	Sig. Level
Teaching Method(TM)	298.11	2	149.05	25.45	.0000
Maths. Ach. Level(MAL)	416.98	2	208.49	35.60	.0000
Interaction of TM and MAL	17.264	4	4.32	.74	.5686
Residual	650.01	111	5.86		
Total	1401.47	119			

Analysis revealed that different teaching methods (Lecture, discovery, Lecture with Computer Supported Drill and Practice method) caused differences in all mathematics achievement levels (low, middle, high) with respect to RMAT scores. Also there is a significant difference among the mean scores of students taught by the Lecture method, by the Discovery method and by the Lecture with Computer Supported Drill and Practice method with respect to RMAT scores.

It was also found that there is a significant difference among the mean scores of the students who are in low, middle, and high achievers groups with respect to RMAT scores. No interaction has been found between the teaching method and the mathematics achievement level with respect to RMAT scores.

In order to find out which groups are different, the multiple range analysis was performed. The results are shown in Table-7.

Table-7:

Measures Obtained from Multiple Range Analysis for showing pairs of groups that are significantly different in the retained mathematics achievement test (RMAT).

Teaching Method	95 Percent Confidence Intervals			
Groups	Count	Average	Homogeneous	
LEC grp.	40	7.48	*	
DISC grp.	40	11.08		*
LCDP grp.	40	10.75		*

From Table-7, it can be seen that the students taught by the Discovery method and by the Lecture with Computer Supported Drill and Practice method scored significantly better than the students taught by the Lecture method with respect to RMAT scores. Also the mean scores of students taught by the Discovery method and the Lecture with Computer Supported Drill and Practice method are not significantly different to each other with respect to RMAT scores.

Table-8:
Multiple Range Analysis for Retained Mathematics Achievement Test(RMAT) by Mathematics Achievement Level

Mathematics Achievement Level	Count	Average	95 Percent Confidence Homogeneous Groups		
Low	42	7.81	*		
Middle	42	9.38		*	
High	36	12.50			*

From Table-8 it can be seen that the mean scores of the students in the low achievers group, the students in the middle achievers group, and the students in the high achievers group are significantly different to each other with respect to the RMAT scores.

Furthermore, to find out the answer from which pairs of groups this difference comes at 95 percent confidence for mean, table of means for retained mathematics achievement is examined.

Table-9:
Table of Means for Retained Mathematics Achievement

Level	Count	Average	Stnd Error (internal)	Stnd Error (pooled)	95 Percent Confidence for mean	
Teaching Method						
LEC grp	40	7.48	.46	.38	6.72	8.23
DISC grp	40	11.08	.56	.38	10.32	11.83
LCDP grp	40	10.75	.41	.38	9.99	11.51
Maths Ach Level(MAL)						
Low	42	7.81	.42	.37	7.07	8.55
Middle	42	9.38	.44	.37	8.64	10.12
High	36	12.50	.52	.40	11.70	13.30
TM by MAL						
LEC-Low	14	5.71	.74	.65	4.43	7.00
LEC-Mid.	15	7.40	.55	.62	6.16	8.64
LEC-High	11	9.82	.76	.73	8.37	11.26
DISC-Low	16	8.69	.54	.60	7.49	9.89
DISC-Mid.	11	10.55	.97	.73	9.10	11.99
DISC-High	13	14.46	.68	.67	13.13	15.80
LCDP-low	12	9.08	.53	.70	7.70	10.47
LCDP-Mid.	16	10.44	.54	.60	9.24	11.64
LCDP-High	12	12.83	.74	.70	11.45	14.22
TOTAL	120	9.77	.22	.22	9.33	10.20

From Table-9 it can be seen that the Discovery group and the Lecture with Computer Supported Drill and Practice group appeared to be significantly different to the Lecture group in low (Lec-low:[4.43,7.00], Disc-low: [7.49,9.89], LCDP-low: [7.70,10.47]), middle (Lec-mid: [6.16,8.64], Disc-mid: [9.10,11.99], LCDP-mid: [9.24,11.64]), and high (Lec-high: [8.37,11.26], Disc-high: [13.13,15.80], LCDP-high:

[11.45,14.22]) mathematics achievement levels with respect to RMAT scores.

Results Concerning The Post Attitudes Toward Mathematics (PATM)

No significant difference was found among the mean scores of the three groups with respect to pre-attitudes toward mathematics scores.

Hypothesis-7 $H_o(7)$: The main effect of the teaching method on attitude toward mathematics is not significant.

Hypothesis-8 $H_o(8)$: The main effects of the mathematics achievement level on attitude toward mathematics is not significant.

Hypothesis-9 $H_o(9)$: The effect of interaction between the teaching methods and the mathematics achievement level on attitude toward mathematics is not significant

In order to test these hypotheses F-Test was used. The results are shown in Table-10.

Table-10:

Analysis of variance of data obtained from scale of Attitude Toward Mathematics (PATM)

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F-Ratio	Sig. Level
Teaching Method(TM)	2463.32	2	1231.66	9.93	.0001
Math. Ach. Level(MAL)	1491.60	2	745.80	6.01	.0033
Interaction of TM and MAL	383.70	4	95.92	.773	.5448
Residual	13767.86	111	124.03		
Total	18187.47	119			

Analysis revealed that different teaching methods (Lecture, Discovery, Lecture with Computer Supported Drill and Practice) caused differences in all mathematics achievement levels (low, middle, high) with respect to PATM.

Also there is a significant difference among the mean scores of the students taught by the Lecture method, by the Discovery method, and by the Lecture with Computer Supported Drill and Practice method with respect to scores obtained from scale of attitude toward mathematics. It was also found that there is a significant difference among the mean scores of the students who are in low, middle and high achievers groups with respect to PATM. No interaction has been found between the teaching method and the mathematics achievement level with respect to PATM scores.

In order to find out which groups are different the multiple range analysis was performed. The results are shown in Table-11.

Table-11:

Measures obtained from multiple range analysis for showing pairs of groups that are significantly different on Post Attitudes Toward Mathematics Scale (PATM)

Teaching Method	95 Percent Confidence Intervals Count	Average	Homogeneous Groups
Lecture grp.	40	86.18	*
Discovery grp.	40	91.10	**
Lecture with Computer Supported Drill and Practice grp.	40	97.43	*

From Table-11 it can be seen that the students taught by the Computer Supported Drill and Practice method scored significantly better than the students taught by the Lecture method with respect to PATM scores. Also it can be seen that the mean scores of the students taught by the Lecture method and by the Discovery method are not significantly different to each other with respect to PATM scores. The mean scores of the students taught by the Computer Supported Drill and

Practice method and by the Discovery method are not significantly different to each other with respect to PATM scores.

Table-12:

Multiple Range Analysis for Post Attitudes Toward Mathematics by Mathematics Achievement Level

Mathematics Achievement Level	95 Count	Percent Average	Confidence Homogeneous	Interval groups
Low	42	88.90	*	
Middle	42	89.50	*	
High	36	97.08		*

From Table 12 it can be seen that the mean scores of the students in the low achievers group and students in the middle achievers group are not significantly different to each other with respect to PATM scores. However, the mean scores of the students in the low and middle achievers groups are significantly different to those of the students in high the achievers group with respect to PATM scores.

Furthermore, to find out from which pairs of groups this difference comes at 95 percent confidence for mean, the table of means for Post Attitudes Toward Mathematics was examined.

Table-13:
Table of Means for Post Attitudes Toward Mathematics

Level	Count	Average	Stnd Error (internal)	Stnd Error (pooled)	95 Percent Confidence for mean	
Teaching Method						
LEC grp.	40	86.18	1.78	1.76	82.68	92.31
DISC grp.	40	91.10	1.94	1.76	87.61	94.59
LCDP grp.	40	97.43	1.75	1.76	93.93	100.92
Maths Ach. Level(MAL)						
Low	42	88.90	1.86	1.72	85.50	92.31
Middle	42	89.50	2.09	1.72	86.09	92.91
High	36	97.08	1.57	1.86	93.40	100.76
TM by MAL						
LEC-low	14	84.43	3.13	2.98	78.53	90.33
LEC-mid.	15	83.27	2.75	2.88	77.57	88.96
LEC-high	16	92.36	3.00	3.36	85.71	99.02
DISC-low	16	90.38	3.18	2.78	84.86	95.90
DISC-mid.	11	85.82	4.27	3.36	79.16	92.47
DISC-high	13	96.46	2.22	3.09	90.34	102.58
LCDP-low	12	92.17	3.17	3.22	85.79	98.53
LCDP-mid.	16	97.88	2.94	2.78	92.36	103.39
LCDP-high	12	102.08	2.48	3.22	95.71	108.46
Total	120	91.57	1.02	1.02	89.55	93.58

From Table-13 it can be seen that the lecture group [77.57,88.96] and the Discovery group [79.16,92.47] in the middle achievement level appeared to be significantly different to the Lecture with Computer Supported Drill and Practice group [92.36,103.39].

Results Concerning the Post-Attitudes Toward the Topic (PATT)

No significant difference was found among the mean scores of the three groups with respect to pre-attitudes toward the topic.

Hypothesis 10-$H_o(10)$: The main effect of the teaching method on attitude toward the topic is not significant.

Hypothesis 11-$H_o(11)$: The main effect of the mathematics achievement level on attitude toward the topic is not significant.

Hypothesis 12-$H_o(12)$: The effect of interaction between the teaching method and the mathematics achievement level on attitude toward the topic is not significant.

In order to test these hypothesis the F-Test was used.The results are shown in Table-14.

Table-14: Analysis of variance of data obtained from the scale of Post Attitudes Toward the Topic(PATT).

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F-Ratio	Sig. Level
Teaching Method(TM)	8395.18	2	4192.59	18.17	.0000
Math Ach. Level(MAL)	1956.72	2	978.36	4.24	.0168
Interaction of TM and MAL	1002.42	4	250.61	1.09	.3670
Residual	25612.20	111	230.74		
Total	37209.70	119			

Analysis revealed that different teaching methods (Lecture, Discovery, Lecture with Computer Supported Drill and Practice) caused differences in all mathematics achievement levels (low, middle, high) with respect to PATT scores. Also there was a significant difference among the mean scores of the students taught by the Lecture method, by the Discovery method, and by the Lecture with Computer Supported Drill and Practice method with respect to attitudes toward the topic.

It was also found that there is a significant difference among the mean scores of the students who are in low, middle, and high achievers groups with respect to PATT scores. No interaction has been found between teaching methods and mathematics achievement levels with respect to PATT scores.

In order to find out which groups are different, the multiple range analysis was performed. The results are shown in Table-15.

Table-15:

Measures Obtained from Multiple Range Analysis for showing pairs of groups that are significantly different on Post Attitudes Toward the Topic Scale (PATT)

Teaching Method	95 Percent Count	Confidence Average	Intervals Homogeneous Groups	
Lecture grp.	40	68.63	*	
Discovery grp.	40	84.60		*
Lecture with Computer Supported Drill and Practice grp.	40	88.13		*

From Table-15 it can be seen that the students taught by the Lecture with Computer Supported Drill and Practice method and by the Discovery method scored significantly better than the students taught by the Lecture method with respect to PATT scores.

Also it can be seen that the mean scores of the students taught by the Discovery method and by the Lecture with Computer Supported Drill and Practice method are not significantly different to each other with respect to PATT scores.

Table-16: Multiple Range Analysis for Post Attitudes Toward the Topic by Mathematics Achievement Level

Mathematics Achievement Level	Count	Percent Average	95 Confidence Homogeneous Groups
Middle	42	75.67	*
Low	42	80.19	* *
High	36	86.33	*

From Table-16 it can be seen that the mean scores of the students in the low achievers group and the students in the middle achievers group are not significantly different to each other with respect to PATT scores. Also the mean scores of the students in the low achievers group and the students in the high achievers group are not significantly different to each other with respect to PATT scores. However, the mean scores of the students in the middle and high achievers groups are significantly different to each other with respect to PATT scores.

Furthermore, to find out from which pairs of groups this difference comes at 95 percent confidence for mean, the table of means for post attitudes toward the topic is examined.

Table-17:
Table of Means for Post Attitudes Toward the Topic

Level	Count	Average	Stnd Error (internal)	Stnd Error (pooled)	95 Percent Confidence for mean	
Teaching Method(TM)						
LEC grp.	40	68.63	2.81	2.40	63.86	73.89
DISC grp.	40	84.60	2.54	2.40	79.84	89.36
LCDP grp.	40	88.13	1.99	2.40	83.36	92.89
Maths Ach. Level(MAL)						
Low	42	80.19	2.39	2.34	75.54	84.84
Middle	42	75.66	3.29	2.34	71.02	80.31
High	36	86.33	2.28	2.53	81.32	91.35
TM by MAL						
LEC-Low	14	67.00	4.51	4.06	58.95	75.05
LEC-Mid.	15	65.20	4.33	3.92	57.43	72.97
LEC-High	11	75.36	3.90	4.58	66.29	84.44
DISC-Low	16	88.75	2.53	3.80	81.22	96.28
DISC-Mid.	11	74.91	4.20	4.58	65.83	83.98
DISC-High	13	87.69	2.88	4.21	79.3	96.04
LCDP-Low	12	84.17	2.41	4.39	75.48	92.86
LCDP-Mid.	16	86.00	6.26	3.89	78.47	93.53
LCDP-High	12	94.92	3.18	4.39	86.23	103.61
Total	120	80.45	1.39	1.39	77.70	83.20

From Table-17 it can be seen that the Discovery group [81.22,96.28] and the Lecture with Computer Supported Drill and Practice group [75.48,92.86] appeared to be significantly different to the Lecture group [58.95,75.05] in the low mathematics achievement level with respect to PATT scores.

In the middle mathematics achievement level the lecture group appeared to be significantly different to the Lecture with Computer Supported Drill and Practice group with respect to PATT scores.

Also it can be seen that the mean scores of the students taught by Lecture method and the Discovery method are not significantly different to each other and the mean scores of the students taught by the Discovery method and the Lecture with Computer Supported Drill and Practice method are not significantly different to each other with respect to PATT scores.

Conclusions

In the light of the above findings obtained by the statistical analysis of each hypothesis, the following conclusions can be deduced:

1) The students in the low mathematics achievement level, taught by the Discovery method and the Lecture with Computer Supported Drill and Practice method scored significantly higher than the students taught by the Lecture method with respect to IMAT scores.

2) The students taught by the Discovery method and by the Lecture with Computer Supported Drill and Practice method scored significantly higher than the students taught by the Lecture method in all(low, middle, high) mathematics achievement levels, with respect to RMAT scores.

3) The students taught by the Lecture with Computer Supported Drill and Practice method scored significantly higher than the students taught by the Lecture method with respect to attitudes toward mathematics.

4) The mean scores of the students in the high achievers group are significantly higher than the mean scores of the students in the middle and low achievers groups with respect to attitudes toward mathematics.

5) The students taught by the Lecture with Computer Supported Drill and Practice method scored significantly higher than the students taught by the Discovery and Lecture methods in the middle mathematics achievement level with respect to attitude toward mathematics.

6) The students taught by the Lecture with Computer Supported Drill and Practice method and by the Discovery method scored significantly higher than the

students taught by the Lecture method with respect to attitude toward the topic.

7) The mean scores of the students in the high achievers group were significantly greater than the mean scores of the students in the middle achievers group with respect to attitude toward the topic.

8) In the low mathematics achievement level, the students taught by the Discovery method and Lecture with Computer Supported Drill and Practice scored significantly higher than the students taught by the Lecture method with respect to attitude toward the topic.

CHAPTER SIX

DISCUSSION, IMPLICATIONS AND RECOMMENDATIONS

Introduction

In this chapter, the interpretation and discussion of the results reported in the previous chapter are presented, and then some implications and recommendations for further researches are provided.

Discussion of the Results

This study aimed to investigate the effects of different teaching methods (discovery, lecture with computer supported drill and practice, lecture) on immediate and retained mathematics achievement, and attitudes toward mathematics and the topic, for students in different achievement levels. The results obtained from the immediate mathematics achievement test, retained mathematics achievement test, scale of attitude toward mathematics and scale of attitude toward the topic in connection with related hypotheses will be discussed one by one.

As mentioned in the previous chapters the Mathematics Achievement Test (MAT) was administered to all subjects at the beginning of the treatment. It was found that there were no significant differences among the mean scores of groups to be taught by the discovery method, the lecture with computer supported drill and practice method, and the lecture method with respect to pre-MAT scores.

The hypotheses one through three were related to the effects of different teaching methods and mathematics achievement levels on immediate mathematics achievement.

The main effect of teaching methods on immediate mathematics achievement, as measured by the Immediate Mathematics Achievement Test (IMAT) is found to be statistically significant at .05 level [$H_o(1)$] which indicates, the mean IMAT scores of the students taught by the discovery, the lecture with computer supported drill and practice and the lecture methods were significantly different. When it was further investigated to determine which groups were different, it was found that the students taught by the Discovery method and the lecture with computer supported drill and practice method scored significantly better than the students taught by the lecture method with respect to IMAT scores. But on the other hand the mean scores of the students taught by the discovery method and by the lecture with computer supported drill and practice method were not significantly different to each other with respect to IMAT scores.

The result of the present study is congruent with the results of the studies concerning computer assisted instruction and computer supported drill and practice which were reported by Visonhaler and Bass (1972), De Boer (1973), Ibrahim (1970), Bell (1970), Byers (1973), Edwards, Norton, Taylor, Weiss and Dusseldorp (1975), Hartley (1977), Foley (1984), Perez (1985), Hurts (1986), Tsai and Pohl (1980), Sally (1987), Niemic and Walberg (1987), Öztürel (1987), Köksal (1988), Geban (1990) and meta-analytic results of Burns and Bozemann (1981), Kulik, Kulik and Cohen (1980) and 39 of the 48 studies which were reported in the meta-analytic study of Kulik, Bangert and Williams (1983).

Computer Based Instruction or Lecture with Computer Supported Drill and Practice was superior to the conventional methods in the attainment of immediate mathematics achievement. Computer Based Instruction appears to raise student achievement in numerous settings. As Bork (1987) stated the main advantage of the computer as a way of learning is interactive for all students.

In Computer Based Instruction (at least the courseware written within this study) the feedback given to the students were more intensive than the other methods. When a student responded to the complex questions correctly or incorrectly, the courseware not only informed the student as to the correctness of the action mode , but also proceeded to tell him how to solve the problem and the correct response was indicated. At the end, the students could see the reason why the answer was right or wrong. In this way, the students could understand the concepts and the relationships among the concepts in the complex problems deeper when compared to the traditional approach. Another factor which can not be disregarded is the "Novelty Effect". Eisenberg (1989) stated that the novelty of Computer Based Instruction may have stimulated students to better performance, an effect that will fade as the novelty of Computer Based Instruction wears off. Since computers are rather new , specially in homes, in Turkey; this effect is expected to be stronger when compared to international studies.

The findings of the present study are also consistent with the studies regarding traditional and discovery methods of instruction which were reported by Meconi (1967), Price (1967), Munyofu (1984), Mulpo and Fowler (1987).

The probable reason for the superiority of the attained achievement of the students which received instruction by the discovery method over those who received the traditional method of instruction could be the spirit of the discovery method of instruction which directs the students to advance step by step on their own and to predict the rules behind the subject by themselves; and as a result it creates a more interactive class.

The present study contradicts the results of Jamison, Suppes and Welles (1974) who reported that Computer Assisted Instruction was about as effective as traditional instruction when used as a replacement. Also 9 of the 48 studies in the meta- analysis of Kulik, Bangert,and Williams (1983) reported that the students from the conventional classes got better final examination scores. Imboden (1985), Gesshel-Green (1987), Pflug(1987) and Whalen (1988) reported no significant difference for the achievement results between Computer Assisted Instruction and Traditional methods of instructions.

This contradiction may be attributed to the quality of courseware, quality of instructor, or the time span covered by the Computer Assisted Instruction approach may not be long enough to show the effects of this method.

Vance (1972), Kleckner(1968), Mc Clintock(1974), Holdan (1985), Howerton (1987) reported no significant difference between the groups taught by traditional and discovery methods with respect to achievement test results. Also Mulpo and Fowler (1987) reported that, the mode of instruction (traditional or discovery) had no significant effect on the students' understanding of science for concrete reasoners.But for formal reasoners, the discovery approach was more effective than the traditional approach in promoting understanding of science. But these results did not report that the traditional method of instruction was superior to the discovery method of instruction.These results may have oriented from the quality of instruction and the instructor, or the quality of lecturer in the traditional instruction, the class size or the time allotted for treatment may have not been enough to create a difference.

The main effect of mathematics achievement level on immediate mathematics achievement as measured by IMAT is found to be statistically significant at .05 significance level [$H_o(2)$] which indicates the mean scores of the students in low, middle and high achievers group are significantly different to each other with respect to IMAT scores. These findings are consistent with the results of Hannafin and Swander (1987). As has been mentioned previously, no statistically significant interaction has been found between the teaching method and the mathematics achievement level with respect to IMAT scores that has been hypothesized in [$H_o(3)$].

When it was further investigated to identify which pair of groups caused this difference at 95 percent confidence for mean, it was found that the discovery group and the lecture with computer supported drill and practice group in the low mathematics achievement level appeared to be significantly different to the lecture group. The difference found in the mean scores of IMAT between the groups taught by three different instructional methods came mainly from the groups in low mathematics achievement level. The results of the present study is congruent with the results of Meconi (1967), Price (1967), Kleckner (1968), Lawson (1988). No study has been found which contradicts the findings of the present study, among the studies which have been reviewed.

The findings could be interpreted as, the methods like Computer Assisted Instruction or the discovery method of instruction could be more effective in obtaining better achievement among low achievers.

When education is considered in its broadest sense, information transferred to the students needs to be durable. In other words, the methods and materials should facilitate the retention of the information that has been taught. To investigate the efficiency and differences of the different instructional methods the researcher made further analysis on the retained achievement.

As presented previously, the retained mathematics achievement test was administered to all subjects to measure the retained achievement.

The main effect of the teaching method on retained mathematics achievement as measured by retained mathematics achievement test is found to be statistically significant at .05 significance level [$H_o(4)$] which indicates the mean RMAT scores of the students taught by the discovery, lecture with computer supported drill and practice, and lecture methods were significantly different. A further analysis to identify which groups were different, showed that the students taught by the discovery method and the lecture with computer supported drill and practice method scored significantly better than the students taught by the lecture method with respect to RMAT scores. On the other hand the mean scores of the students taught by the discovery method and the lecture with computer supported drill and practice method were not significantly different to each other with respect to RMAT scores.

The findings of the present study are congruent with the results of Munyofu (1984) who reported a statistically significant difference in favor of the discovery method of instruction compared to expository methods on retained achievement. On the other hand the findings are also consistent with the results reported by Edwards, Norton, Taylor, Weiss, and Dusseldorp (1975) and the meta-analysis of Kulik, Bangert and Williams (1983) which have indicated a difference, although not statistically significant, in favor of Computer Assisted Instruction in retained achievement. Among the reviewed studies, Ibrahim (1970), Tsai and Pohl (1980) and Gesshel-Green (1987) reported no statistically significant difference in the retention scores of students which received instruction with Computer Assisted Instruction or Traditional methods of instruction. The reason for this inconsistency might be explained by the fact that the above indicated studies which reported no significant differences in retention compared only Computer Assisted Instruction with the results of traditional instruction. The present study found statistically significant differences in retention when comparing the traditional method of instruction with the lecture with computer supported drill and practice method, which contains a human (teacher) factor. A study which supports this statement was done by Tsai and Pohl (1980) that reported " students experiencing an enriched CAI environment (CAI plus planned teacher-student contact) performed significantly better on achievement tests than CAI alone".

However, in the present study in the Lecture with Computer Supported Drill and Practice group, every student attempted to solve every drill on his/her own. If a negative response was made, the students were presented purposeful hints more than once to stimulate students to deal with the question. If the student still failed to solve the question, the detailed solution of the question was presented. The students taught by the Discovery method received both individualized and interactive instruction. The instruction was individualized since the students were left to discover the rules and tried to solve the exercises on their own; and the instruction was interactive, since at every step of the Discovery instruction, the students discussed the responses with the instructor and their classmates. These factors in the instruction resulted in the course coverage being more readily retained when compared with the traditional methods.

The main effect of the mathematics achievement level on retained mathematics achievement which was measured by RMAT was found statistically significant at .05 significance level [$H_o(5)$] which indicates that the mean scores of the students in low, middle, and high mathematics achievers groups are significantly different to each other with respect to RMAT scores. No study has been found in the literature which investigated retained achievement according to the mathematics achievement levels of students.

As previously mentioned, no statistically significant interaction has been found between the teaching method and mathematics achievement level with respect to RMAT scores that has been hypothesized by [$H_o(6)$]. When it was further investigated to identify which pair of groups caused the difference related to retained mathematics achievement at 95 percent confidence for mean, results indicated that the groups taught by the discovery and lecture with computer supported drill and practice methods appeared to be significantly different to the lecture group in all (low, middle, high) mathematics achievement levels with respect to RMAT scores.

Different teaching methods had their effects on all achievement groups, which explains the absence of interaction in the retention results as compared by three instructional methods.

The curriculum and course designers are concerned with developing methods and techniques which would facilitate the students developing positive attitudes toward the course and the subject.

As has been presented in the results, no significant difference was found among the mean scores of the three groups with respect to pre-attitude toward mathematics scores.

The hypotheses 7 through 9 were related to the effects of different teaching methods and mathematics achievement levels on scores obtained from attitudes toward mathematics scale (PATM).

The main effect of the teaching method on attitude toward mathematics as measured by Post Attitude Toward Mathematics Scale (PATM), is found to be significant at .05 significance level [$H_o(7)$], which can be interpreted as the mean PATM scores of the students taught by the Discovery, Lecture With Computer Supported Drill and Practice and Lecture methods were significantly different.

When the factors which led the Lecture with Computer Supported Drill and Practice method to be superior over the discovery and traditional methods, to develop significantly better attitudes toward mathematics are considered, the key points from the nature of the Lecture with Computer Supported Drill and Practice appears to have prime importance.

The interaction between the computer and the student and the existence of continuous feedback in the courseware, leads the students to be highly active in the Lecture with Computer Supported Drill and Practice class. These factors may have contributed to the students' development of higher positive attitudes toward mathematics in the Lecture with Computer Supported Drill and Practice class.

Also the existence of reinforcement coming from the computer, accompanied by visual and sound effects, and the fact that the student would not feel ashamed when he/she failed to solve an exercise since no other student (and even the teacher at that moment) would understand if the student had made a correct or incorrect response could also be considered among the sources for this difference.

It was further investigated to find out which groups were different with respect to attitude toward mathematics. Results indicated that the students taught by the Lecture with Computer Supported Drill and Practice scored significantly higher than the students taught by the lecture method with respect to PATM scores. It was also found that there were no statistically significant differences between the mean PATM scores of the students taught by lecture and Discovery methods, and Discovery and Lecture with Computer Supported Drill and Practice methods.

The results of the present study are consistent with the findings of the studies by Price (1967), DeBoer (1973), Cook (1988), Geban (1990) and the meta-analyses by Kulik, Kulik and Cohen (1980), and Kulik, Bangert and Williams (1983). Besides these studies, Payton (1987), Sally (1987), Köksal (1988) reported that positive attitudes have been developed toward the subjects , although the results were not statistically significant.

Ibrahim (1970) and Foley (1984) reported that they had found no significant difference with respect to attitudes toward mathematics, regardless of the methods.

These inconsistencies may be due to insufficiency of the time-frame of the treatment for positive attitudes to be developed, or the teaching method may not have been applied properly.

The main effect of the mathematics achievement level on attitudes toward mathematics as measured by PATM is found to be statistically significant at 0.05 significance level [$H_o(8)$] which indicates the mean scores of the students in low, middle and high achievers groups are significantly different to each other with respect to PATM scores.

When it was further analyzed to distinguish which group caused this difference, it was found that the mean scores of the students in the low achievers group and in the middle achievers group were not significantly different to each other with respect to PATM scores. However the mean scores of the students in the high achievers group were significantly higher than those in the low and the middle achieving groups with respect to PATM scores.

No study has been found in the literature which considered attitude toward mathematics as compared to the mathematics achievement levels of the students.

As has been stated previously, no statistically significant interaction has been found between the teaching method and mathematics achievement level with respect to PATM scores as hypothesized by [$H_o(9)$].

When advanced one step further in the table of means for PATM, it can be stated that the Lecture with Computer Supported Drill and Practice group in the middle achievement level appeared to be significantly better than Discovery and Lecture groups in the middle achievement levels.

As mentioned previously, the scale of Attitude Toward the Topic (ATT) is administered to all subjects at the beginning of the treatment. It is found that there were no significant differences among the pre-mean scores of the students taught by lecture, discovery,and lecture with computer supported drill and practice methods of instruction. At the end of the treatment the ATT was administered as a post test.

The hypotheses 10 through 12 were related to the effects of different teaching methods and mathematics achievement levels on scores obtained from the scale of Attitudes Toward the Topic (ATT).

The main effect of the teaching method on Attitude Toward the Topic as measured by scale of Attitude Toward the Topic is found to be significant at .05 significance level [H_0(10)], which can be interpreted as the mean ATT scores of the students taught by the Discovery, Lecture with Computer Supported Drill and Practice and Lecture methods were significantly different. It was further investigated to find out which groups were different and concluded that the students taught by the discovery and lecture with computer supported drill and practice methods scored significantly higher than the students taught by the lecture method with respect to PATT scores. It was also found that there were no statistically significant differences between the mean ATT scores of the students taught by the discovery and lecture with computer supported drill and practice methods.

Among the studies reviewed, no study which investigated Attitude Toward Topic could be found. Another observation that could be stressed is that the discovery method failed to create a higher attitude toward mathematics over the lecture method, but the discovery method did create a higher attitude toward the topic when compared to the lecture method. The researcher could comment on this observation as it is easier to change the attitudes toward the topic than changing the attitudes toward whole mathematics, within a limited treatment time-frame.

The main effects of mathematics achievement level on attitudes toward the topic as measured by PATT was found to be statistically significant at .05 significance level [H_0(11)] which indicates the mean scores of the students in low, middle, high achievers groups are significantly different to each other with respect to PATT scores. When it was further analyzed to distinguish which group caused this difference, it was found that the mean scores of the students in the low achievers group and in the middle achievers group are not significantly different to each other with respect to PATT scores. However, the mean scores of the students in the high achievers group were significantly higher than the mean scores of the students in the middle achievers group with respect to PATT scores.

No study has been found in the literature which considers attitude toward the topic as compared to the mathematics achievement levels of the students.

As has been stated previously, there has been found no statistically significant interaction between the teaching method and the mathematics achievement level with respect to PATT scores as hypothesized [H_0(12)]. A further investigation to identify which groups caused this difference at 95 percent confidence for mean indicated that the Lecture with Computer Supported Drill and Practice group appeared to be significantly different to the lecture group in low, middle, and high mathematics achievement levels with respect to PATT scores.Also the discovery group appeared to be significantly different to the lecture group only in the low mathematics achievement level with respect to PATT scores. No significant difference was found between students taught by Lecture with Computer Supported Drill and Practice and Discovery methods in low, middle, high mathematics achievement levels with respect to PATT scores. It could be said that the Lecture with Computer Supported Drill and Practice method develops positive attitudes toward the topic in all achievement levels whereas the Discovery method created positive attitudes toward the topic specially on low achievers.

Although not included in the hypotheses in chapter four as mentioned, a questionnaire was also administered to get the opinions of the students' on the quality of the instruction provided through different instructional methods. The percentage of the distribution of the alternatives in the questionnaire according to the instructional method is presented in the Appendix (E).

Students in the lecture with computer supported drill and practice group stated that they were allowed to participate in the lesson most and the students in the lecture group stated least. For the teacher's effort to provide the interaction, the discovery group stated that their teacher spent effort most and the lecture group least. Students think that the most effort made for reinforcement was made at Lecture with Computer Supported Drill and Practice, and least in the Lecture group. Students in the Lecture with Computer Supported Drill and Practice group claim that they are informed of their mistakes and the reasons for these mistakes most, and in the lecture group least. Most of the students in the Lecture with Computer Supported Drill and Practice group found the topic interesting for the reason that they all participated in the lesson and for the attraction of the computer.

The students in the Discovery group also found the topic relatively interesting, again due to the interaction in the class, while most of the students in the lecture group found the topic boring.

Implications

Results of the present study have some implications for educational decision makers, curriculum planners, school administrators, mathematics teachers, educational software developers and researchers. The researcher would like to present the following implications from the findings of this study.

Some of the major goals of education could be stated as; to foster achievement, to ensure the durability of transferred information, and to develop positive attitudes in students toward the subjects and topics they are studying.

Numerous studies, as well as the present study have findings which showed different instructional methods and instructional materials could influence the level of achievement and attitudes. As Weston and Cranton (1986) have stated, the selection or development of teaching methods and materials is one of the most complex components of the process of curriculum design. As the findings of this study imply, along with the majority of reviewed studies agree, the existence of methods which could provide considerable improvements over the most valued parameters of education, are stressed. This could tell us that the key to meet some educational goals lies behind methods other than traditional lecturing. In the closure of this study, discovery instruction and computerized instruction have proved to provide considerably higher mathematics achievement, specially on low-achieving students. This could prove to us that interactive methods provide a higher level of achievement specially in the low achieving students.

Another fact that has been supported by the findings of this study is that these interactive methods have proven that they were effective in providing retention, more than the traditional instruction, in all achievement levels.

When we focus on mathematics education, we can see that mathematics is one of the most feared subjects and it is necessary to compensate for the prejudices for mathematics. As Aksu (1985) stated, mathematics, which has been called boring, disliked, abstract, even nightmare; is one of the disciplines which needs to utilize educational technologies most. On the other hand, talking about incorporating highest level of technology may not necessarily be the most efficient method in education. There is evidence within the literature (Tsai and Pohl, 1980) as well as the present study, that Computer Assisted Instruction enriched with the involvement of the human factors could facilitate better learning than the application of pure Computer Assisted Instruction. When the education planners consider incorporating technology into their curricula, hybrid approaches still remain as a valuable alternative.

The most important factor in the Computer Assisted Instruction is the quality of the Computer Assisted Instruction software (or to use the more popular term, courseware). The researchers could comment on the research studies and on the personal observations as well, the quality of the courseware could position the Computer Assisted Instruction in a very superior setting compared with the other methods, as well as at a setting worse than a low level traditional instruction.

To comment briefly on the specification of a good quality courseware, it should provide correct reinforcements, feedbacks, allow different paces, utilize color, video and audio effects, video animation, provide readable screens and last but not least it should leave a feeling of "sincerity" in the student.

The common denominator behind the efficiency of the Computer Assisted Instruction and the Discovery methods is that both of the methods were interactive. It was commonly reported in most of the studies that the interactive methods provided the development of positive attitudes toward the subject, since these methods activate the students and give them a chance to show their personality within these lessons. The same reason could be given for why interactive methods provide better retention.

Applying different technologies does not dictate having education without its prime factor: teachers. In order to apply various technologies in the most effective manner, the teachers should be well trained in details, and the pros and cons of each method. It should not be forgotten that the relation of having well trained teachers will help to raise a well trained new generation and well trained teachers for upcoming generations.

Recommendations

On the basis of the findings from the study, the researcher recommends that:

1) A similar study can be conducted by providing enough computers so that there could be one computer per student which could address individual differences more thoroughly.

2) A study can be conducted with a larger sample which could cover students from different schools, in order to constitute a heterogeneous structure in socio-economic level, cultural background, and academic background to reach a generalization for the Turkish student population.

3) A study can be conducted with different age groups.

4) A similar study can be conducted with different subject matters.

5) The treatment time duration can be increased in further research projects.

6) A similar study can be conducted which includes different instructional methods.

7) In this study, the instruction was in English. A study can be conducted to adress whether instruction is in the mother tongue would create different results.

8) A similar study could investigate the fading of the Novelty Effect in the Lecture with Computer Supported Drill and Practice method.

9) A similar study can be conducted to investigate the sex differences in different achievement levels, with a larger sample.

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APPENDIX A.1

Objectives for Mathematics Achievement Test

1-) Ability to apply formulas for area in finding the area of any triangle.

- To compute the area of a triangle with a given dimensions
- To compute the areas of triangles which have the same base and/or same height.
- To compute the area of triangles by using the relation between bisectors, medians, heights and sides of the triangle.

2-) Ability to apply rules of similarity in finding dimensions and areas of similar triangles.

- To apply rules of similarity in finding the dimensions of similar triangles.
- To find the areas of similar triangles by using the similarity constant.

3-) Ability to apply formulas for area in finding the area of any quadrilaterals.

- To compute the area of the given quadrilaterals.
- To find the area of the given quadrilateral in terms of another quadrilateral.
- To find the area of quadrilateral by using the area of triangles or vice versa.

APPENDIX A.2

The Content Outline for the Treatment

1. Area of a Triangle
   - 1.a. Area of any triangle
   - 1.b. Similarity of triangles

2. Area of Quadrilaterals
   - 2.a. Area of a parallelogram
   - 2.b. Area of a rectangle
   - 2.c. Area of a square
   - 2.d. Area of a rhombus
   - 2.e. Area of a trapezoid

APPENDIX A.3

Table of Specification for Mathematics Achievement Test

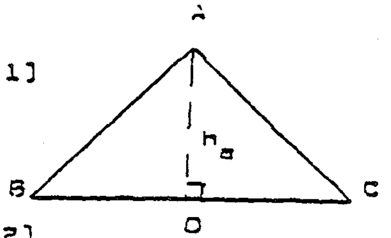
\Objectives \ Content\	Comprehension	Application	Analysis
1.a		1, 2, 4 3,5,7,8	
1.b		6, 9, 20	
2.a		10,11,13	
2.b		12, 14	
2.c		15	
2.d		16	
2.e		17,18,19	

APPENDIX B

MATHEMATICS ACHIEVEMENT TESTS

TEST (AREAS OF POLYGONAL REGIONS)

1)

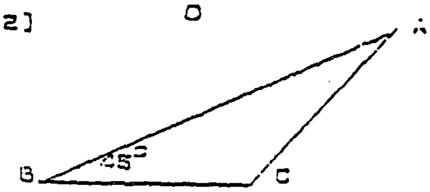


ABC is an isosceles triangle, $|DC| = 4$ Cm, $A(\widehat{ABC}) = 20$ Cm^2.

Find the length $|AD|$.

A) 8 B) 5 C) 10 D) 20 E) 4

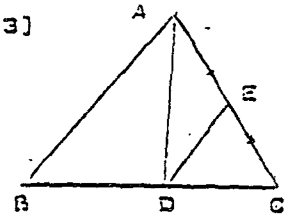
2)



In the figure, if $|AB| = 10\sqrt{2}$, $m\widehat{B} = 45°$, and $|BC| = 4$ Cm, then find the area of triangle ABC.

A) $4\sqrt{46}$ B) 10 C) $20\sqrt{2}$
D) 20 E) 40

3)



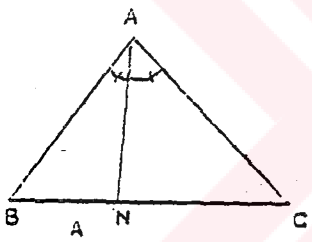
In the figure, $\widehat{ABC}$ is equilateral triangle. If $[AD] \perp [BC]$ and $|AE| = |EC|$ then find $\frac{A(\widehat{ABC})}{A(\widehat{DEC})}$

A) 3 B) 6 C) 4 D) 2 E) 16

4) What is the area of an equilateral triangle with a perimeter of 48 Cm ?

A) $48\sqrt{3}$ B) $54\sqrt{3}$ C) $81\sqrt{3}$ D) $144\sqrt{3}$ E) $256\sqrt{3}$

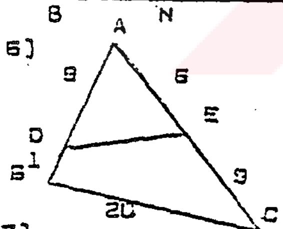
5)



In the figure, [AN] is angle bisector, $|AC| = 6$ Cm, $|AB| = 4$ Cm, $|NB| = 2$ Cm and $A(\widehat{ABC}) = 50$ Cm^2 are given. Find $A(\widehat{ANC})$

A) 30 B) 25 C) 20 D) 60 E) 15

6)

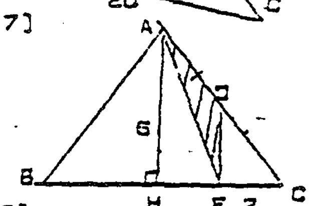


In the figure, $|AD| = 9$ Cm, $|AE| = 6$ Cm, $|EC| = 9$ Cm, $|DB| = 1$ Cm and $|BC| = 20$ Cm are given.

Find $|DE|$.

A) 15 B) 16 C) 10 D) 12 E) 8

7)

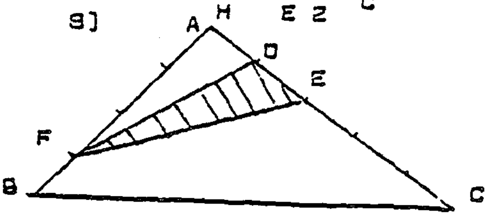


In the figure, $|AD| = |DC|$, $[AH] \perp [BC]$, $|EC| = 2$ Cm and $|AH| = 6$ Cm.

Find the area of triangle ADE.

A) 15 B) 4 C) 3 D) 6 E) 2

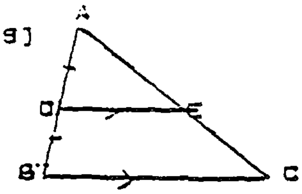
8)



In the figure, $|DE| = \frac{|AC|}{5}$, $|BF| = \frac{|AB|}{4}$ and $A(\widehat{ABC}) = 36$ Cm^2 are given.

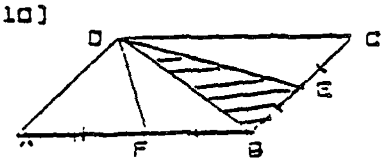
Find the area of triangle $\widehat{FDE}$.

A) 5 B) 9 C) $\frac{9}{5}$ D) $\frac{27}{5}$ E) $\frac{36}{5}$

9) 

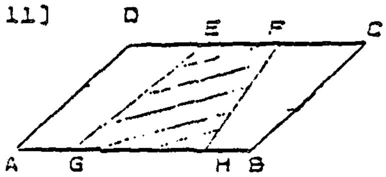
In the figure, [DE]//[BC] and $A(ADE) = 25$ Cm^2 are given. $|AD| = |DB|$.
Find the area of DECB.

A) 75 B) 50 C) 25 D) $50\sqrt{3}$ E) 100

10) 

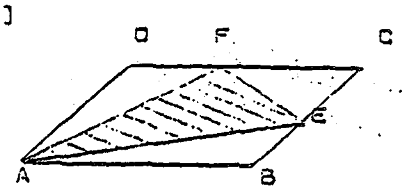
In the figure, ABCD is a parallelogram, E and F are the midpoints.
If $A(DEB) = 5$ Cm^2, then find A(ABCD).

A) 10 B) 15 C) 20 D) 25 E) 30

11) 

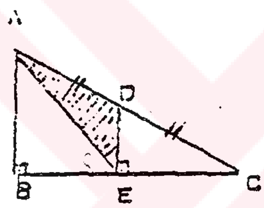
In the figure, ABCD is a parallelogram, $\frac{|EF|}{|DC|} = \frac{1}{3}$, $\frac{|GH|}{|AB|} = \frac{3}{5}$ and if $A(ABCD) = 45$ Cm^2 then find A(EFGH).

A) 12 B) 15 C) 18 D) 21 E) 24

12) 

In the figure, ABCD is a parallelogram, $|DF| = |FC|$ and $|EC| = |EB|$ are given.
Find $\frac{A(\overset{\triangle}{EFC})}{A(\overset{\triangle}{AEF})}$

A) $\frac{2}{3}$ B) $\frac{1}{2}$ C) $\frac{3}{4}$ D) $\frac{1}{4}$ E) $\frac{1}{3}$

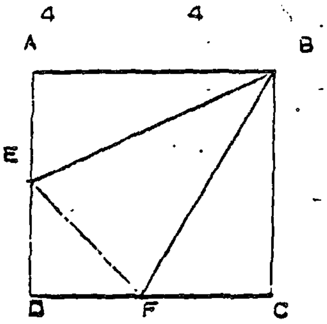
13) 

In the right triangle ABC, $m\hat{B} = 90^\circ$.
$|AD| = |DC|$ and $[DE] \perp [BC]$, then
Find $\frac{A(\overset{\triangle}{AED})}{A(\overset{\triangle}{ABC})}$.

A) $\frac{1}{4}$ B) $\frac{1}{2}$ C) $\frac{1}{3}$ D) $\frac{2}{3}$ E) $\frac{3}{4}$

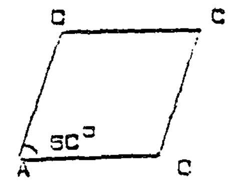
14) If we decrease the width of a rectangle by $\frac{1}{4}$, and increase its length by $\frac{2}{3}$, what would be the ratio of area of this rectangle to its original area ?

A) $\frac{1}{4}$ B) $\frac{5}{4}$ C) $\frac{3}{4}$ D) $\frac{1}{2}$ E) 2

15) 

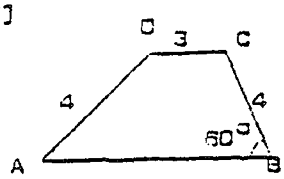
In the figure, ABCD is a square, $|AE| = |ED|$, $|DF| = |FC|$ and $|AB| = 10$ Cm are given.
Find $\frac{A(EBF)}{A(ABCD)}$

A) $\frac{1}{2}$ B) $\frac{3}{7}$ C) $\frac{5}{6}$ D) $\frac{4}{5}$ E) $\frac{3}{8}$

16) 

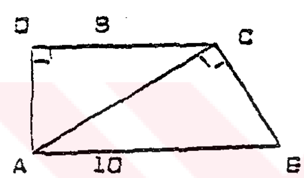
In the figure, ABCD is a rhombus, $m\widehat{BAD} = 60^\circ$ and $|BC| = 6$ Cm. Find A(ABCD).

A) $36\sqrt{3}$ B) 36 C) $18\sqrt{3}$ D) $36\sqrt{2}$
E) 18

17) 

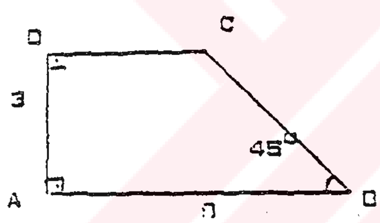
ABCD is an isosceles trapezoid, $m\widehat{B} = 60^\circ$, $|DC| = 3$ Cm, $|AD| = |BC| = 4$ Cm are given.
Find the area of isosceles trapezoid ABCD.

A) 6 B) $6\sqrt{3}$ C) 8 D) $10\sqrt{3}$ E) $8\sqrt{3}$

18) 

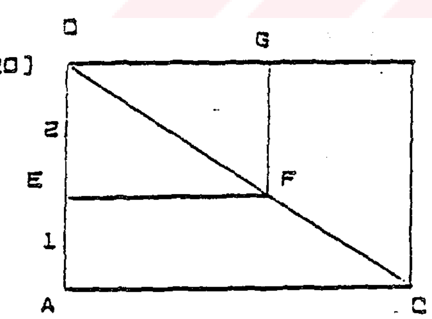
In the figure, ABCD is a right angled trapezoid and $|AB| = 10$ Cm, $|DC| = 8$ Cm are given.
Find the area of ABCD.

A) 36 B) 40 C) 40 D) 51 E) 60

19) 

In the figure, $|AB| = 9$ Cm, $|AD| = 3$ Cm and $m\widehat{B} = 45^\circ$ are given.
Find the area of the trapezoid ABCD.

A) 39 B) $\frac{39}{2}$ C) 15 D) 72 E) $\frac{48-3\sqrt{3}}{2}$

20) 

ABCD and EFGD are rectangles. If $|DE| = 2$, $|EA| = 1$ and $|GC| = 2$ Cm, then find $|DC|$.

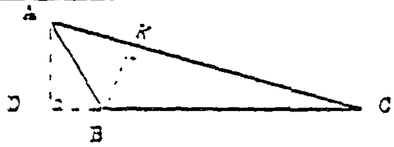
A) 1 B) 4 C) 2 D) 3 E) 6

APPENDIX B.2

Name: **Surname:** **Number:** **Class:**

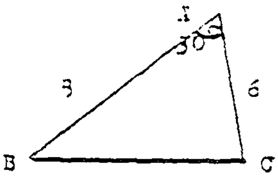
T E S T (AREAS OF POLYGONAL REGIONS)

Direction: Mark the correct choice in the answer sheet.

1) 

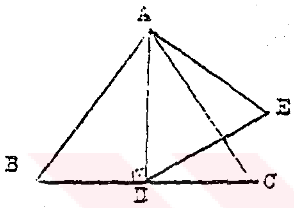
In the figure $|BC| = 6$Cm, $|BK| = 3$Cm, and $|AC| = 8$ Cm are given. Find $|AC|$.

A) 4 B) 3 C) 9 D) 12 E) 6

2) 

In the figure, $m\hat{A} = 30^\circ$, $|AC| = 6$Cm, $|AB| = 8$ Cm are given. Find the area of triangle $\widehat{ABC}$.

A) 6 B) 12 C) 24 D) $24\sqrt{3}$ E) $12\sqrt{3}$

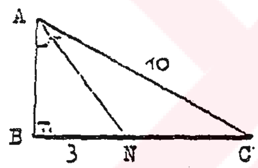
3) 

In the figure ABC and ADE are equilateral triangles. If $[AD] \perp [BC]$ then find $\frac{A(\widehat{ADE})}{A(\widehat{ABC})}$.

A) $\frac{3}{4}$ B) $\frac{4}{3}$ C) $\frac{5}{3}$ D) $\frac{4\sqrt{3}}{3}$ E) $\frac{5\sqrt{3}}{2}$

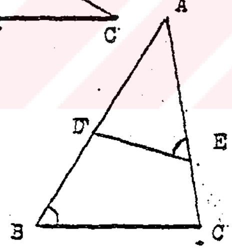
4) If the area of an equilateral triangle is $16\sqrt{3}$ Cm^2, find its perimeter.

A) 48 B) $24\sqrt{3}$ C) 16 D) $12\sqrt{3}$ E) 24

5) 

In triangle $\widehat{ABC}$, if [AN] is the angle bisector then find the area of triangle $\widehat{ABC}$.

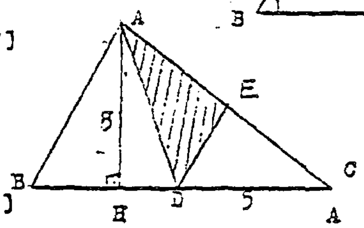
A) 5 B) 10 C) 15 D) 20 E) 25

6) 

In the figure, $m\widehat{AED} = m\widehat{ABC}$, $|DE| = \frac{3}{4}|BC|$ and $|AD| = 12$ Cm are given.

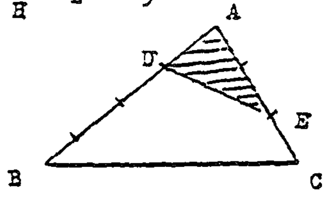
Find $|AC|$.

A) 18 B) 9 C) 15 D) 20 E) 16

7) 

In the figure, $[AH] \perp [BC]$, $|AE| = |EC|$, $|AH| = 8$ Cm, $|DC| = 5$ Cm are given. Find the area of triangle ADE.

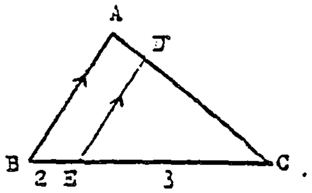
A) 3 B) 5 C) 10 D) 15 E) 20

8) 

In the figure, $|AD| = \frac{|AB|}{4}$, $|AE| = \frac{2}{3}|AC|$ and $A(\widehat{ADE}) = 7$Cm^2 are given.

Find A(BCED).

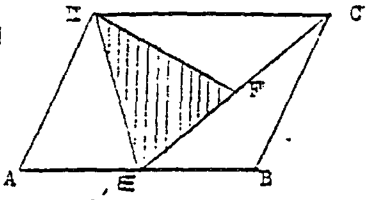
A) 14 B) 21 C) 28 D) 35 E) 42

9] 

In the figure [BA]//[ED] and |BE| =2, |EC| =3 Cm are given.

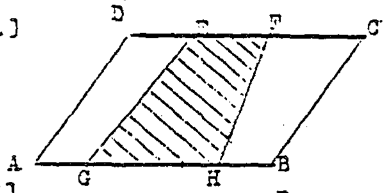
Find $\frac{A(\widehat{DEC})}{A(ABED)}$.

A] $\frac{4}{9}$ B] $\frac{9}{25}$ C] $\frac{25}{9}$ D] $\frac{4}{5}$ E] $\frac{9}{16}$

10] 

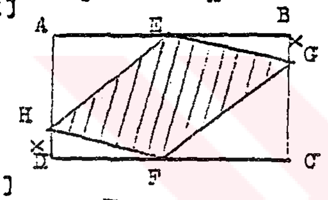
In the figure, E is the midpoint of [AC] and F is the midpoint of [EC]. Find the ratio of the shaded region to the area of the parallelogram ABCD.

A] $\frac{1}{8}$ B] $\frac{1}{4}$ C] $\frac{1}{6}$ D] $\frac{1}{3}$ E] $\frac{1}{2}$

11] 

In the figure, ABCD is a parallelogram, |DC| = 4|PQ| , |RS| = $\frac{2}{5}$|AB| and if A(ABCD)=80 Cm^2 then find A(PQRS).

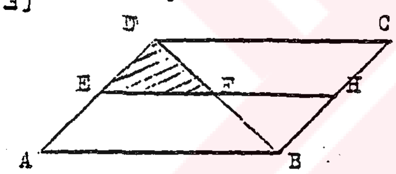
A] 16 B] 20 C] 24 D] 26 E] 28

12] 

In the figure, ABCD is a rectangle, |AB| =10 Cm, |AD| =8 Cm, |AE| = |EB|, |DF| = |FC|, |DH| = |BG| = x are given. Find the area of EGFH.

A] 20 B] 5(8−x) C] 40

D] 20(8−x) E] 10(8−x) + 8(5−x)

13] 

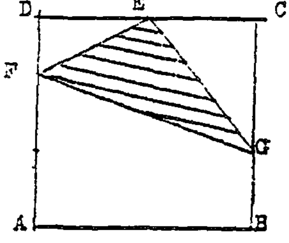
In the figure, ABCD is a parallelogram [EH]//[AB], |DF| =$\frac{1}{4}$|DB| and A(ABCD)= 192 Cm^2 are given.

Find $A(\widehat{DEF})$.

A] 6 B] 4 C] 8 D] 5 E] 10

14] The width of a rectangle is half of its length. If we increase its width by $\frac{1}{4}$ and decrease its length by $\frac{3}{4}$ what would be the ratio of the area of this rectangle to its original area?

A] $\frac{3}{8}$ B] $\frac{5}{16}$ C] $\frac{3}{16}$ D] $\frac{1}{2}$ E] $\frac{5}{8}$

15] 

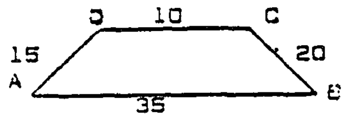
In the figure, ABCD is a square, |DE| =|EC| , |DF| = |DG| = $\frac{|AF|}{2}$ are given.

Find $\frac{A(\widehat{EFG})}{A(ABCD)}$

A] $\frac{1}{3}$ B] $\frac{1}{5}$ C] $\frac{2}{5}$ D] $\frac{3}{5}$ E] $\frac{1}{4}$

16] Length of a side of a rhombus is 8 Cm and the measure of one of its angles is 120°. Find the area of this rhombus.

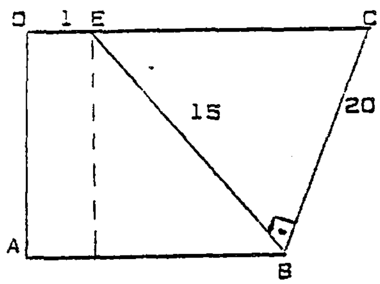
A] $16\sqrt{3}$ C] $18\sqrt{3}$ C] $28\sqrt{3}$ D] $32\sqrt{3}$ E] $46\sqrt{3}$

17) 

In the figure AB = 35 Cm, DC =10 Cm, AD =15 Cm, BC =20 Cm are given.

Find the area of the trapezoid ABCD.

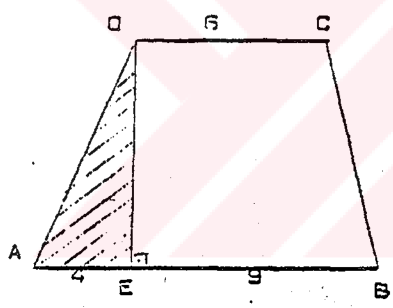
A) 540 B) 270 C) 135 D) 120 E) 80

18) 

ABCD is a trapezoid, |DE| =1 Cm, |EB| =15 Cm, |BC| =20 Cm are given.

Find the area of ABCD

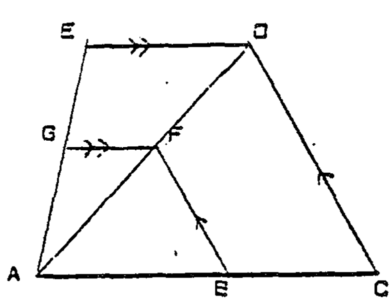
A) 216 B) 200 C) 184 D) 142 E) 108

19) 

In the figure ABCD is a trapezoid and the shaded area is 12 Cm^2.

Find the area of trapezoid ABCD.

A) 24 B) 30 C) 45 D) 57 E) 69

20) 

In the figure, [ED] // [GF], [FB] // [DC] and $\frac{AB}{BC} = \frac{3}{4}$

Find the ratio $\frac{|GF|}{|ED|}$.

A) $\frac{1}{4}$ B) $\frac{2}{5}$ C) $\frac{3}{4}$ D) $\frac{1}{6}$ E) $\frac{3}{7}$

APPENDIX C

Name: Surname:

Class: Sex:

SCALE OF ATTITUDE TOWARD MATHEMATICS

Directions: Provide the information in the upper right-hand corner. Then draw a circle around the letter indicating how strongly you agree or disagree with each statement.

SD : Strongly Disagree D : Disagree U : Undecided A : Agree SA : Strongly Agree

---

1. Mathematics is not a very interesting subject. SD D U A SA
2. I want to develop my mathematical skills and study this subject more. SD D U A SA
3. Mathematics is a very worthwhile and necessary subject. SD D U A SA
4. Mathematics makes me feel nerveous and uncomfortable. SD D U A SA
5. I have usually enjoyed studying mathematics in school. SD D U A SA
6. I don't want to take any more mathematics than I have to. SD D U A SA
7. Other subjects are more important to people than mathematics. SD D U A SA
8. I am very calm when studying mathematics. SD D U A SA
9. I have seldom liked studying mathematics. SD D U A SA
10. I am interested in acquiring further knowledge of mathematics. SD D U A SA
11. Mathematics helps to develop the mind and teaches a person to think. SD D U A SA
12. Mathematics makes me feel uneasy and confused. SD D U A SA
13. Mathematics is enjoyable and stimulating to me. SD D U A SA
14. I am not willing to take more than the required amount of mathematics. SD D U A SA
15. Mathematics is not especially important in everyday life. SD D U A SA
16. Trying to understand mathematics doesn't make me anxious. SD D U A SA
17. Mathematics is dull and boring. SD D U A SA
18. I plan to take as much mathematics as I can during my education. SD D U A SA
19. Mathematics has contributed greatly to the advancement of civilization. SD D U A SA
20. Mathematics is my most dreaded subjects. SD D U A SA
21. I like trying to solve new problems in Mathematics. SD D U A SA
22. I am not motivated to work very hard on Mathematics lessons. SD D U A SA
23. Mathematics is not one of the most important subjects for people to study. SD D U A SA
24. I don't get upset when trying to do Mathematics lessons. SD D U A SA

APPENDIX D

Name: Surname: Class: Sex:

SCALE OF ATTITUDE TOWARD AREAS OF POLYGONAL REGIONS

Directions: Provide the information in the upper right-hand corner. Then draw a circle around the letter indicating how strongly you agree or disagree with each statement.

SD : Strongly Disagree D : Disagree U : Undecided A : Agree SA : Strongly Agree

---

1. Areas of polygonal regions is not a very interesting topic. SD D U A SA
2. I want to develop my skills in polygonal regions and study this topic more. SD D U A SA
3. Areas of polygonal regions is a very worthwhile and necessary topic. SD D U A SA
4. Areas of polygonal regions makes me feel nerveous and uncomfortable. SD D U A SA
5. I have usually enjoyed studying Areas of polygonal regions in school. SD D U A SA
6. I don't want to study Areas of polygonal regions more than I have to. SD D U A SA
7. Other topics in mathematics are more important to people than Areas of polygonal regions. SD D U A SA
8. I am very calm when studying Areas of polygonal regions. SD D U A SA
9. I have seldom liked studying Areas of polygonal regions. SD D U A SA
10. I am interested in acquiring further knowledge of Areas of polygonal regions. SD D U A SA
11. Studying Areas of polygonal regions helps to develop the mind and teaches a person to think. SD D U A SA
12. Studying Areas of polygonal regions makes me feel uneasy and confused. SD D U A SA
13. Studying Areas of polygonal regions is enjoyable and stimulating to me. SD D U A SA
14. I am not willing to study more than the required amount of Areas of polygonal regions. SD D U A SA
15. Areas of polygonal regions is not especially important in everyday life. SD D U A SA
16. Trying to understand Areas of polygonal regions doesn't make me anxious. SD D U A SA
17. The topic Areas of polygonal regions is dull and boring. SD D U A SA
18. I plan to study the topic Areas of polygonal regions as much as I can during my education. SD D U A SA
19. The topic Areas of polygonal regions has contributed greatly to the advancement of civilization. SD D U A SA
20. Areas of polygonal regions is one of my most dreaded topics. SD D U A SA
21. I like trying to solve new problems in Areas of polygonal regions. SD D U A SA
22. I am not motivated to work very hard on Areas of polygonal regions. SD D U A SA
23. Areas of polygonal regions is not one of the most important topics for people to study. SD D U A SA
24. I don't get upset when working on Areas of polygonal regions. SD D U A SA

APPENDIX E

ADI, SOYADI:
SINIFI: NO:

ÇOKGENSEL BÖLGELERİN ALANLARI --- BİLGİ FORMU I

Bu bilgi formu "Çokgensel Bölgelerin Alanları" ünitesi ve işlenişi hakkındaki görüşlerinizi almak üzere hazırlanmıştır. Aşağıdaki soruları dikkatle okuyup herbiri için sadece bir seçenek işaretleyiniz.

İlginiz için teşekkürler.

1) Bu ünitede neleri öğreneceğiniz konusunda size yeterince bilgi verildi mi?

( ) Hiç ( ) Biraz ( ) Oldukça ( ) Çok

2) Bu ünitede (Çokgensel Bölgelerin Alanları) yapılan açıklamalar, verilen örnekler dersi anlamanıza ne derecede yardımcı oldu?

( ) Hiç ( ) Biraz ( ) Oldukça ( ) Çok

3) Bu ünitede (Çokgensel Bölgelerin Alanları) soru sorma, sorulan soruya cevap verme, açıklama yapma, açıklama isteme, v.b. yollarla derse katılmanıza ne derece fırsat verildi?

( ) Hiç ( ) Biraz ( ) Oldukça ( ) Çok

4) Bu ünitede (Çokgensel Bölgelerin Alanları) pasif kalan öğrencilerin sınıf içi etkileşimlere katılmalarını sağlamak için öğretmen ne derece çaba harcadı?

( ) Hiç ( ) Biraz ( ) Oldukça ( ) Çok

5) Bu ünitede (Çokgensel Bölgelerin Alanları) sorulan sorulara doğru cevap verdiğiniz veya öğrendiğinizi gösteren davranışlarda bulunduğunuz zaman bunun ne ölçüde farkına varıldı?

( ) Hiç ( ) Biraz ( ) Oldukça ( ) Çok

6) Bu ünitede (Çokgensel Bölgelerin Alanları) dersi iyi öğrenenleri uygun şekilde takdir etmek için ne derece çaba harcandı?

( ) Hiç ( ) Biraz ( ) Oldukça ( ) Çok

7) Bu ünitede (Çokgensel Bölgelerin Alanları) sorulara verdiğiniz cevaplar veya yaptığınız açıklamalarda yanlışınız olup olmadığı size ne derece ayrıntılı olarak belirtildi?

( ) Hiç ( ) Biraz ( ) Oldukça ( ) Çok

8) Bu ünitede cevabınız veya açıklamalarınızda yanlışınız olduğunda, bunun neden yanlış olduğu ne derece açıklandı?

( ) Hiç ( ) Biraz ( ) Oldukça ( ) Çok

9) Bu ünitede yaptığınız yanlışları nasıl düzelteceğiniz konusunda size ne ölçüde yardımcı olundu?

( ) Hiç ( ) Biraz ( ) Oldukça ( ) Çok

10) Bu ünitede, yaptığınız yanlışları düzeltmek için yapılan yardımlar ihtiyacınızı ne ölçüde karşıladı?

( ) Hiç ( ) Biraz ( ) Oldukça ( ) Çok

11) Çokgensel Bölgelerin Alanları ünitesi sizce ilgi çekici bir ünitemiydi?

( ) Hiç ( ) Biraz ( ) Oldukça ( ) Çok

(Vereceğiniz cevaba göre (i) veya (ii) şıklarını cevaplayınız)

i) Cevabınız HİÇ veya BİRAZ ise buna en önemli neden olarak aşağıdakilerden hangisini gösterebilirsiniz?

a) Matematik dersinin genelde sıkıcı olması
b) Konunun öğretmen tarafından anlatılması ve öğrencilerin derse katılmaması.
c) Konunun (Çokgensel Bölgelerin Alanları) sıkıcı olması
d) Bu ünitenin öğretilmesi sırasında bilgisayar kullanılması
e) Başka ....
(Lütfen belirtiniz)

ii) Cevabınız OLDUKÇA veya ÇOK ise buna en önemli neden olarak aşağıdakilerden hangisini gösterebilirsiniz?

a) Matematik dersinin genelde ilginç olması
b) Bu ünitenin öğretilmesi sırasında bilgisayar kullanılması
c) Bu ünitenin öğretilmesi sırasında tüm öğrencilerin derse katılması
d) Ünitenin ilginç olması
e) Başka ....
(Lütfen belirtiniz)

12) Bu üniteye (Çokgensel Bölgelerin Alanları) daha fazla zaman ayrılmasını istermisiniz?

( ) Evet ( ) Hayır

Cevabınız EVET ise bu üniteye daha fazla zaman ayırılması niçin gereklidir?

a) Bu ünite çok zor, öğrenmesi güç.
b) Bu ünite diğerlerinden daha ilginç, bu konuda daha fazla bilgi edinmek istiyorum.
c) Bu ünite Fen ve diğer derslerde kullanılıyor.
d) Bu ünitenin ileride işime yarayacağına inanıyorum.
e) Başka ....
(varsa belirtiniz)

13) Sizce çokgensel bölgelerin alanları ünitesi nasıl öğretilmelidir?

A) Öğretmen konuyu anlatmalı, öğrenciler anlatılanları not etmelidir.
B) Öğrencilerin konuyla ilgili genel kuralları kendi başlarına çıkarmalarına, kendi başlarına soru çözmelerine fırsat verilerek, soru-cevap şeklinde öğrencilerin de derse katılımı sağlanarak öğretilmedir.
C) Konu sınıfta anlatılıp alıştırmalar bilgisayar kullanılarak yapılmalıdır.
D) başka ....
(varsa belirtiniz)

cevabınız (A) ise bunun en önemli nedeni aşağıdakilerden hangisi olabilir?

i) Derslerde not tutmaktan hoşlanırım
ii) Öğretmen anlatınca daha iyi anlarım.
iii) Derse katılmaktan hoşlanmam
iv) Derste öğrencilerin soru sorması dikkatimi dağıtıyor
v) Öğrencilerin derse katılması, dersin soru-cevap şeklinde işlenmesi zaman kaybına yol açar.

cevabınız (B) ise bunun en önemli nedeni aşağıdakilerden hangisi olabilir?

i) Öğrencilerin derse katılması ünitenin daha iyi öğrenilmesini sağlar.
ii) Konuya ait kuralların öğrenciler tarafından çıkarılması, ünitenin daha akılda kalıcı olmasını sağlar.
iii) Öğrencinin derse katılması, anlayamadığı yerleri sorabilmesi, üniteye karşı olan kaygıyı azaltır.
iv) Öğrencinin anlayamadığı yerleri sorabilmesi, tartışabilmesi, öğrenciyi bu konuda daha fazla öğrenmek için teşvik eder.
v) Öğrencilerin kendi başlarına soru çözebilmeleri, kendilerine olan güvenlerini arttırır.

cevabınız (C) ise bunun en önemli nedeni aşağıdakilerden hangisi olabilir?

i) Alıştırmaların bilgisayarda yapılması öğrencilerin üniteye ilgisini artırır.
ii) Öğrenciler soruyu çözemezse, bilgisayarın ipuçları vermesi öğrenciyi düşündürerek sonuca daha çabuk ulaşmasını sağlar.
iii) Öğrenci kendi öğrenme hızında ilerleyebilir.
iv) Alıştırmaların bilgisayarda yapılması öğrenciyi daha fazla öğrenmeye teşvik eder.
v) Bilgisayarla çalışmak öğretmene soru sormaktan çekinen öğrencinin tedirginliğini ortadan kaldırır.

cevabınız (D) ise nedenini açıklayınız.

....

....

....

14) Çokgensel bölgelerin alanları konusunu bugüne kadar işlediğiniz matematik konuları arasında nasıl değerlendiriyorsunuz?
(Aşağıdaki ifadelerden en uygun olanlarını işaretleyiniz)

( ) Zevkli ( ) Zevksiz
( ) Kolay ( ) Zor
( ) Gerekli ( ) Gereksiz
( ) İlginç ( ) Sıkıcı

BİLGİ FORMU II

1) Çokgensel Bölgelerin Alanları ünitesine ders dışında çalıştınız mı?

( ) Evet ( ) Hayır

Cevabınız EVET ise, yaklaşık kaç saat çalıştınız?

( ) 0-2 saat ( ) 3-5 saat ( ) 6-8 saat ( ) 9-11 saat ( ) 12-14 saat

( ) 14 saatten fazla

2) Bu üniteyi öğrenirken başka kaynak ve kişilerden yararlandınızmı?

( ) Evet ( ) Hayır

Cevabınız EVET ise, hangi kişi ve kaynaklardan yararlandınız?

a) Kitaplardan
   ( ) Ders kitabı/notları
   ( ) Yardımcı ders kitapları
   ( ) Başka (belirtiniz) ....

b) Kişilerden
   ( ) Arkadaş
   ( ) Aile
   ( ) Başka matematik öğretmeni
   ( ) Okul kursu
   ( ) Özel dershane
   ( ) Özel öğretmen
   ( ) Başka (belirtiniz) ....

APPENDIX F:

PERCENTAGE DISTRIBUTIONS OF THE
QUESTIONNAIRE ON THE
AREAS OF POLYGONAL REGIONS

Name, Surname:
Class: School Number:

AREAS OF POLYGONAL REGIONS - QUESTIONNAIRE

This questionnaire is prepared to analyze your impressions about the topic "Areas of Polygonal Regions" and the teaching method used. Please read the following questions carefully and choose only one alternative.

Thank you for your cooperation.

1) Were you satisfied with the preliminary information you received about the contents of the lesson?

	( ) None	( ) Little	( ) Some	( ) Much
LECT:	**5.0%**	**37.5%**	**47.5%**	**10.0%**
DISC:	**2.5%**	**40.0%**	**45.0%**	**12.5%**
LCDP:	**5.0%**	**35.0%**	**50.0%**	**10.0%**

2) To what extent did the definitions and examples about the topic (Areas of Polygonal Regions) assisted you to learn the subject?

	( ) None	( ) Little	( ) Some	( ) Much
LECT:	**5.0%**	**60.0%**	**27.5%**	**7.5%**
DISC:	**2.5%**	**35.0%**	**50.0%**	**12.5%**
LCDP:	**5.0%**	**30.0%**	**32.5%**	**32.5%**

3) How many times during the session you were given the chance to interrupt and participate in the lesson by asking and answering questions, or giving or requiring explanations, etc?

	( ) None	( ) Little	( ) Some	( ) Much
LECT:	**32.5%**	**35.0%**	**30.0%**	**12.5%**
DISC:	**5.0%**	**27.5%**	**45.0%**	**22.5%**
LCDP:	**0.0%**	**17.5%**	**55.0%**	**27.5%**

4) How much effort was spent by the instructor to get passive students to be involved in in-class activities?

	( ) None	( ) Little	( ) Some	( ) Much
LECT:	45.0%	30.0%	15.0%	10.0%
DISC:	2.5%	25.0%	32.5%	40.0%
LCDP:	5.0%	30.0%	35.0%	30.0%

5) To what extent were your correct answers and comprehension noticed?

	( ) None	( ) Little	( ) Some	( ) Much
LECT:	25.0%	50.0%	20.0%	5.0%
DISC:	10.0%	25.0%	35.0%	30.0%
LCDP:	2.5%	12.5%	25.0%	60.0%

6) To what extent effort was spent to appreciate the ones who grasp the topic sufficiently?

	( ) None	( ) Little	( ) Some	( ) Much
LECT:	40.0%	35.0%	15.0%	10.0%
DISC:	10.0%	25.0%	37.5%	27.5%
LCDP:	0.0%	12.5%	40.0%	47.5%

7) Were you informed in detail about your wrong answers and/or definitions (misconceptions)?

	( ) None	( ) Little	( ) Some	( ) Much
LECT:	22.5%	50.0%	17.5%	10.0%
DISC:	7.5%	27.5%	47.5%	17.5%
LCDP:	2.5%	10.0%	50.0%	37.5%

8) Were you notified about your misconceptions wherever you had a wrong answer or definition.

	( ) None	( ) Little	( ) Some	( ) Much
LECT:	25.0%	35.0%	20.0%	20.0%
DISC:	5.0%	27.5%	50.0%	17.5%
LCDP:	2.5%	7.5%	45.0%	45.0%

9) To what extent were you instructed on how you can correct your mistakes?

	( ) None	( ) Little	( ) Some	( ) Much
LECT:	**15.0%**	**47.5%**	**32.5%**	**5.0%**
DISC:	**10.0%**	**27.5%**	**47.5%**	**15.0%**
LCDP:	**5.0%**	**7.5%**	**57.5%**	**30.0%**

10) To what extent, the instructions you have received on how to correct your mistakes, sufficient?

	( ) None	( ) Little	( ) Some	( ) Much
LECT:	**25.0%**	**55.0%**	**17.5%**	**2.5%**
DISC:	**10.0%**	**22.5%**	**55.0%**	**12.5%**
LCDP:	**2.5%**	**17.5%**	**50.0%**	**30.0%**

11) Was the topic Areas of Polygonal Regions interesting for you?

	( ) None	( ) Little	( ) Some	( ) Much
LECT:	**17.5%**	**47.5%**	**37.5%**	**37.5%**
DISC:	**7.5%**	**17.5%**	**37.5%**	**37.5%**
LCDP:	**5.0%**	**47.5%**	**27.5%**	**7.5%**

Mark the alternatives in (i) or (ii) according to your response:

i) If your response was NONE or LITTLE, which one of the followings could be the reason?

	LECT	**DISC**	**LCDP**
a) Mathematics is generally boring.	**0.0%**	**10.0%**	**5.0%**
b) The topis was presented by the instructor and students did not participate.	**17.5%**	**0.0%**	**2.5%**
c) Topic Areas of Polygonal Regions was boring.	**42.5%**	**15.0%**	**7.5%**
d) Usage of computer in teaching this topic.	**0.0%**	**0.0%**	**2.5%**
e) Other (please specify)	**5.0%**	**0.0%**	**2.5%**

ii) If your response was SOME or MUCH, which one of the followings could be the reason?

	LECT	DISC	LCDP
a) Mathematics is generally interesting.	15.0%	2.5%	5.0%
b) Usage of computers in teaching of this topic.	0.0%	0.0%	45.0%
c) Participation of all students in teaching of this topic.	0.0%	37.5%	25.0%
d) This topic was interesting.	15.0%	12.5%	5.0%
e) Other (please specify)	5.0%	0.0%	0.0%

12) Would you like more time to be allotted for this topic (Areas of Polygonal Regions)?

	( ) Yes	( ) No
LECT	67.5%	32.5%
DISC	75.0%	25.0%
LCDP	90.0%	10.0%

If your response was YES, why is it necessary to allot more time to this topic?

	LECT	DISC	LCDP
a) This topic is difficult and hard to learn.	22.5%	10.0%	7.5%
b) This topic is more interesting than the others, I want to learn more on this topic.	10.0%	22.5%	25.0%
c) This topic is used in science and in other courses.	5.0%	5.0%	2.5%
d) I believe that this topic could be useful in future.	17.5%	27.5%	50.0%
e) Other (please specify)	12.5%	10.0%	5.0%

13) According to you, how should the topic Areas of Polygonal Regions be taught?

		LECT	DISC	LCDP
a)	The teacher should tell the topic and student should take notes.	5.0%	7.5%	5.0%
b)	Students should be let to discover the general rules related to the topic, solve the exercises on their own and participate in the lesson by questions and answers.	47.5%	62.5%	55.0%
c)	The topic should be told in the class and exercises should be made with computer.	37.5%	25.0%	40.0%
d)	Other (please specify)	0.0%	5.0%	10.0%

If your response was (A), what could be the most important reason?

		LECT	DISC	LCDP
i)	I like to take notes in the class.	0.0%	0.0%	0.0%
ii)	I understant better when the teacher tells the topic.	5.0%	5.0%	0.0%
iii)	I don't like to participate in the lesson.	0.0%	0.0%	0.0%
iv)	The questions of the students breaks my attention.	0.0%	0.0%	0.0%
v)	Participations of students to the lesson and continuing the lesson by questions and answers are time consuming.	0.0%	0.0%	0.0%

If your response was (B), what could be the most important reason?

	LECT	DISC	LCDP
i) Participation of students to the lesson helps better understanding of the topic.	10.0%	2.5%	5.0%
ii) Discovery of the rules by the students provides the topic to be remembered more.	10.0%	35.0%	17.5%
iii) Participation of the students to the lesson and asking the points which were not understood, decreases the anxiety.	2.5%	2.5%	10.0%
iv) Possibility for students to ask points that they did not understand, and to discuss helps the students to learn more about the topic.	12.5%	7.5%	17.5%
v) Having students to solve exercises on their own increases the self-confidence of the students.	12.5%	5.0%	5.0%

If your response was (C), what could be the most important reason?

	LECT	DISC	LCDP
i) Making exercises by computer increases the interest toward the topic.	7.5%	10.0%	0.0%
ii) If the students cannot solve the question, getting hints by the computer provides the students to reach to the answer by thinking.	12.5%	7.5%	12.5%
iii) Students can advance by their own speed.	2.5%	2.5%	2.5%
iv) Making exercises by the computer promotes the students to learn more.	7.5%	0.0%	10.0%
v) Working with computer decreases the stress of students who refrain asking questions to the teacher.	7.5%	5.0%	7.5%

If your response was (D), please explain the reason:
....
....

LECT	DISC	LCDP
10.0%	5.0%	0.0%

14) How can you evaluate the topic (Areas of Polygonal Regions) among the topics that you have covered so far? (Please mark all expressions below, which you think appropriate)

	LECT	DISC	LCDP
( ) Funny	35.0%	87.5%	92.5%
( ) Dull	40.0%	12.5%	7.5%
( ) Easy	20.0%	62.5%	7.5%
( ) Difficult	55.0%	37.5%	25.0%
( ) Necessary	75.0%	82.5%	87.5%
( ) Unnecessary	25.0%	17.5%	12.5%
( ) Interesting	55.0%	85.0%	82.5%
( ) Boring	45.0%	15.0%	17.5%

15) Did you study the topic Areas of Polygonal Regions out of the lesson?

	( ) Yes	( ) No
LECT	85.0%	15.0%
DISC	75.0%	22.5%
LCDP	77.5%	25.0%

If your response was YES, for how long did you study?

	LECT	DISC	LCDP
( ) 0-2 hours	22.5%	15.0%	20.0%
( ) 3-5 hours	25.0%	45.0%	25.0%
( ) 6-8 hours	20.0%	7.5%	5.0%
( ) 9-11 hours	5.0%	0.0%	10.0%
( ) 12-14 hours	5.0%	5.0%	2.5%
( ) more than 14 hours	7.5%	5.0%	12.5%

16) Did you receive help from other sources or persons?

	( ) Yes	( ) No
LECT	**77.5%**	**22.5%**
DISC	**70.0%**	**30.0%**
LCDP	**65.0%**	**35.0%**

If your response was YES, which sources or persons?

a) Books

	LECT	DISC	LCDP
( ) Text book / course notes	**12.5%**	**10.0%**	**32.5%**
( ) Other books	**60.0%**	**45.0%**	**45.0%**
( ) Other (please specify)	**7.5%**	**7.5%**	**10.0%**

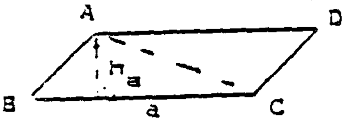
b) Persons

	LECT	DISC	LCDP
( ) Friends	**7.5%**	**30.0%**	**25.0%**
( ) Family	**2.5%**	**2.5%**	**7.5%**
( ) Another maths teacher	**12.5%**	**2.5%**	**0.0%**
( ) School course	**0.0%**	**0.0%**	**0.0%**
( ) Private course	**32.5%**	**32.5%**	**27.5%**
( ) Private teacher	**7.5%**	**5.0%**	**2.0%**
( ) Other (please specify)	**0.0%**	**0.0%**	**0.0%**

APPENDIX G

AREA OF TRIANGLE

Name, surname: ______________________
Class, no : ______________________



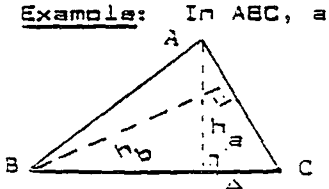
What is the area of the parallelogram?

....

Can we express the area of ABC in terms of the area of the parallelogram ABCD?

$A(\triangle ABC)$ = ... Why? ....

Example: In $\triangle ABC$, a=12 Cm, b=36 Cm, h_a=5 Cm is given. Find h_b.



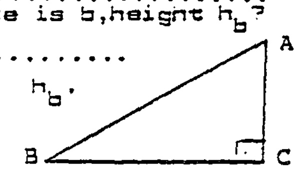
What is the area of $\triangle ABC$ when base is a, height h_a?

....

What is the area of $\triangle ABC$ when base is b, height h_b?

....

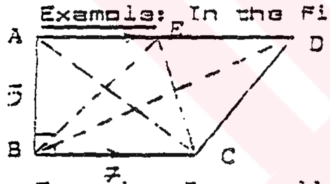
Example: In $\triangle ABC$ a=35 Cm., b=84Cm, c=91Cm, $m\hat{C}$=90°, Find h_b.



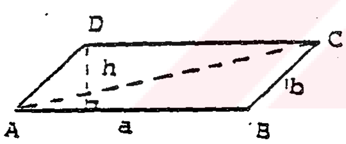
Can we generalize the area of $\triangle ABC$ when the base is a, b and c?

....

Example: In the figure, $m\hat{B}$=90°, [AD]// [BC] , |BC|=7Cm, |AB|=5 Cm are given. Find a) $A(\triangle ABC)$
b) $A(\triangle EBC)$
c) $A(\triangle DBC)$



Example: In parallelogram ABCD, find $A(\triangle ADC)$, and $A(\triangle ABC)$.



What are the base and height of $\triangle ADC$ and $\triangle ABC$?

....

What can we say about the areas of $\triangle ADC$ and $\triangle ABC$?

....

Why ? ....

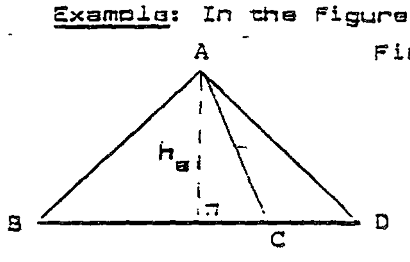
Can we make a generalization ? ....

....

Example: In the figure h_a=3Cm., |BC| =10Cm, |CD| =5Cm are given.

Find a) $\frac{A(\triangle ACD)}{A(\triangle ABC)}$=? ....

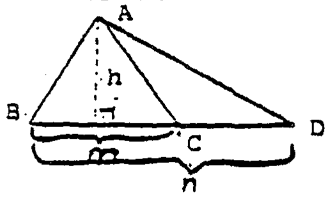
b) $\frac{A(\triangle ACD)}{A(\triangle ABD)}$? ....



If the heights are <u>same</u>, what is the relation between areas of triangles?

....

Example:



In the figure $|BC| = m$, $|BD| = n$ are given. Find $\frac{A(\overset{\triangle}{ABC})}{A(\overset{\triangle}{ABD})}$

What are the heights of $\overset{\triangle}{ABC}$ and $\overset{\triangle}{ABD}$?

$A(\overset{\triangle}{ABC}) =$

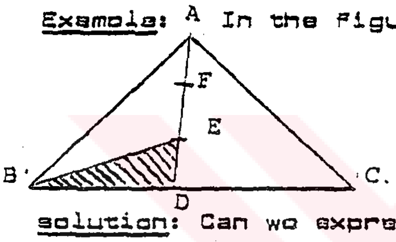
$A(\overset{\triangle}{ABD}) =$

$\frac{A(\overset{\triangle}{ABC})}{A(\overset{\triangle}{ABD})} =$

What is the ratio of areas?

Can we express this as a rule ?

Example: In the figure if $A(\overset{\triangle}{ABC}) = 36\ Cm^2$, $[AD]$ is the median and $|BD| = |DC|$ and $|DE| = |EF| = |FA|$. Find the area of the shaded region.



solution: Can we express $A(\overset{\triangle}{BED})$ in terms of the area of triangle ABC ?

What are the bases and heights of $\overset{\triangle}{BED}$ and $\overset{\triangle}{ABC}$?

Can we express $A(\overset{\triangle}{BED})$ in terms of $A(\overset{\triangle}{ABC})$?

What is the height of $\overset{\triangle}{BED}$ and $\overset{\triangle}{ABD}$?

$A(\overset{\triangle}{BED}) =$

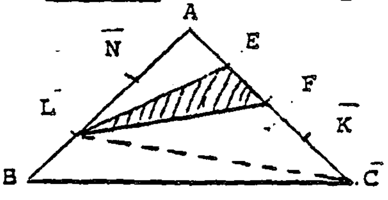
Can we express the area of ABD in terms of the area of $\overset{\triangle}{ABC}$?

$A(\overset{\triangle}{ABD}) =$

Can we express $A(\overset{\triangle}{BED})$ in terms of $A(\overset{\triangle}{ABC})$?

$A(\overset{\triangle}{BED}) =$

Example: In the figure, $|AE| = |EF| = |FK| = |KC|$ and $|AN| = |NL| = |LB|$.



$\frac{A(\overset{\triangle}{LEF})}{A(\overset{\triangle}{ABC})} =$?

solution: Can we express the area of $\overset{\triangle}{LEF}$ in terms of the area of $\overset{\triangle}{ABC}$?

Can we express the $A(\overset{\triangle}{LEF})$ in terms of $A(\overset{\triangle}{ALC})$?

$A(\overset{\triangle}{LEF})=$ ....

Can we express the $A(\overset{\triangle}{ALC})$ in terms of $A(\overset{\triangle}{ABC})$? ....

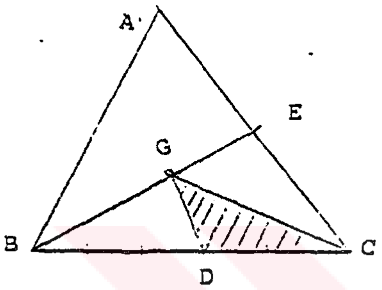
$A(\overset{\triangle}{ALC})=$ ....

Can we express $A(\overset{\triangle}{LEF})$ in terms of $A(\overset{\triangle}{ABC})$? ....

$A(\overset{\triangle}{LEF})=$ ....

$\frac{A(\overset{\triangle}{LEF})}{A(\overset{\triangle}{ABC})}=$ ....

Example: In the figure, G is the centroid, $A(\overset{\triangle}{GDC})=3$ Cm^2, $A(\overset{\triangle}{ABC})=$?



solution: Can we express the area of $\overset{\triangle}{BEC}$ in terms of $\overset{\triangle}{ABC}$? ....

$A(\overset{\triangle}{BEC})=$ ....

Can we express the area of $\overset{\triangle}{BGC}$ in terms of $A(\overset{\triangle}{BEC})$

$A(\overset{\triangle}{BGC})=$ ....

Can we express $A(\overset{\triangle}{GDC})$ in terms of $A(\overset{\triangle}{BGC})$?

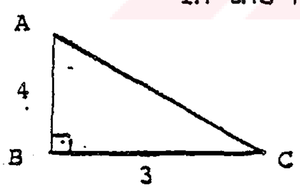
$A(\overset{\triangle}{GBC})=$ ....

Can we express $A(\overset{\triangle}{GDC})$ in terms of $A(\overset{\triangle}{ABC})$?

$A(\overset{\triangle}{GDC})=$ ....

What is the area of $\overset{\triangle}{ABC}$? ....

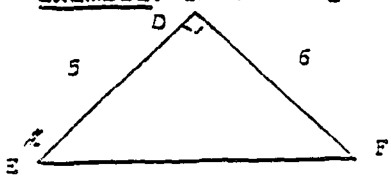
Example: In the figure, $m\hat{B}=90^\circ$, $|AB|=4$ Cm., $|BC|=3$Cm. Find $A(\overset{\triangle}{ABC})$.



solution: height= ...., base= ....

$A(\overset{\triangle}{ABC})=$ ....

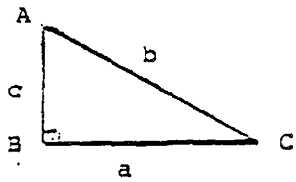
Example: In the figure, $m\widehat{D}=90^{\circ}$, $|DE|=5$ Cm, $|DF|=6$ Cm, find $A(\widehat{DEF})$.



solution: height= ...... , base= ....

$A(\widehat{DEF})=$ ....

RIGHT TRIANGLES:

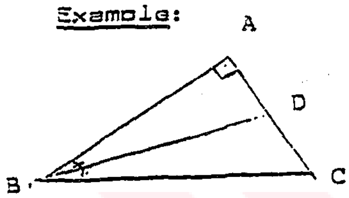


height= ....

base= ....

$A(\widehat{ABC})=$ ....

Example:



In the figure [BD] is the angle bisector, $|AB|=8$ Cm. $|BC|=10$ Cm. then find $\frac{A(\widehat{BCD})}{A(\widehat{ABC})}$

solution:

$A(\widehat{BCD})=$ ....

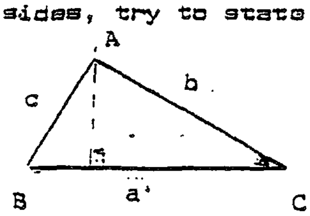
$A(\widehat{ABC})=$ ....

$\frac{A(\widehat{BCD})}{A(\widehat{ABC})}$ ....

Can we obtain $\frac{|CD|}{|AC|}$ by using angle bisector theorem?

....

If we know only two sides of a triangle and the angle between these sides, try to state a general rule for the area of this triangle.

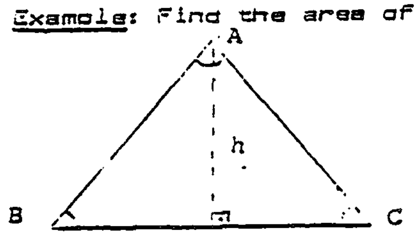


If we know sides a,b and mC then $A(\widehat{ABC})=$ ....

If we know sides b,c and mA then $A(\widehat{ABC})=$ ....

If we know sides a,c and mB then $A(\widehat{ABC})=$ ....

Example: Find the area of equilateral triangle with one side 5 Cm.



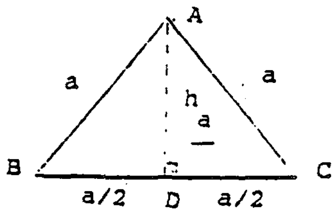
What are the measures of angles of an equilateral triangle ? ....

What is the height of an equilateral triangle? ....

What is the area?

....

AREA OF EQUILATERAL TRIANGLE:



What is the area of an equilateral triangle in terms of a side a ?

height=h_a= ....

$A(\widehat{ABC})$= ....

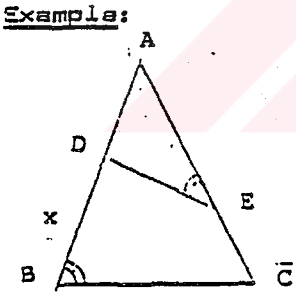
SIMILARITY OF TRIANGLES:

1] Two triangles are similar according to Angle-Angle-Angle (A.A.A.) if ....

2] Two triangles are similar according to Side-Angle-Side (S.A.S.) if ....

3] Two triangles are similar according to Side-Side-Side (S.S.S) if ....

Example:



In the figure, $m\hat{B}=m\widehat{AED}$
$|AE|=6$
$|EC|=2$
$|AD|=4$ are given.
$|DB|=x=?$

solution:

Are there any similar triangles in the figure?

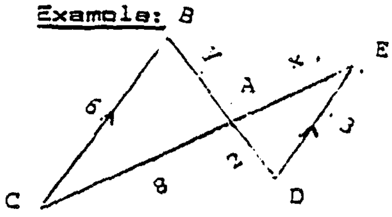
Why ? ....

....

What are the ratio of their sides ?

____ = ____ = ____

<u>Example:</u>



If [BC] // [ED] is given, find the values of x and y, according to the lengths that are given in the figure.

<u>solution:</u>
Can you see any similar triangles in the figure ? What are they ? ....

Why?

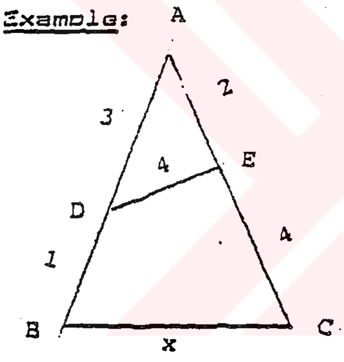
Which similarity rule can we apply for these two triangles ?

....

What are the ratios of their sides?

—— = —— = ——

<u>Example:</u>



Calculate the value of x by using the given lengths in the figure.

<u>solution:</u>
No angle values are given in the figure.
What else can we investigate for similarity?

Which triangles are similar?................

Why?

Write down the side ratios for these triangles.

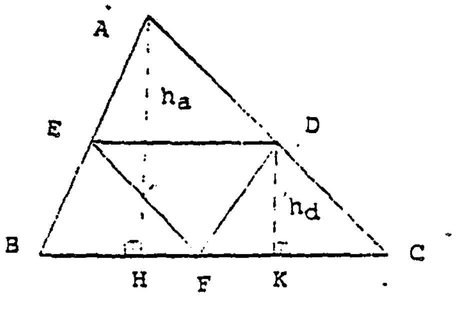
—— = —— = ——

SIMILARITY CONSTANT:

What can you say about the corresponding sides in similar triangles ?
The ratio of corresponding sides in similar triangles are ....

We call this ratio as similarity constant and denote by "k".

Example:



In the figure, if the points D,E,F are the midpoints of the sides of $\widehat{ABC}$, show that $\frac{A[\widehat{ABC}]}{A[\widehat{DFC}]} = 4$

solution:
There are two similar triangles in the figure. What are they?................

Why?

Write down the side ratios

___ = ___ = ___ = k

Do we know the value of k ?

Try to find the ratios of heights of $\overset{\triangle}{EFD}$ and $\overset{\triangle}{ABC}$.

Find the areas of $\overset{\triangle}{DFC}$ and $\overset{\triangle}{ABC}$.

$A[\widehat{DFC}]=$...........

$A[\widehat{ABC}]=$...........

Rewrite $A[\widehat{ABC}]$ in terms of FC and h_d.

$A[\widehat{ABC}]=$.......

$\frac{A[\widehat{ABC}]}{A[\widehat{DFC}]}=$............

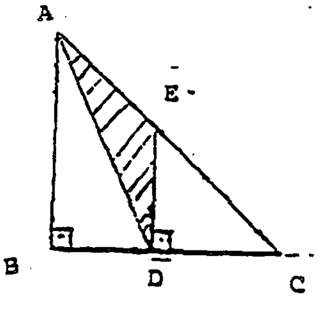
The ratio of the areas (4) is the square of the similarity constant (2).

How can you express the relation between the areas of two similar triangles in terms of the similarity constant a.

In similar triangles the ratio of the areas are ....

....

Example:



In the figure, point E is the midpoint of [AC]. Find the ratio of $\frac{A[\overset{\triangle}{ADE}]}{A[\overset{\triangle}{ABC}]}$

<u>solution:</u>
Can you see any similar triangles in the figure?

What are they? .... Why?

What are the side ratios and similarity constant?

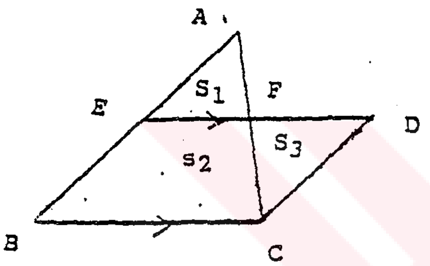
___ = ___ = ___ = k =

We don't have any information about the area of the triangle ADE.
Are there any triangles with equal bases and heights?................

.... and .... have equal base and height.
What can we say for their area? ....

Find $\frac{A[\overset{\triangle}{ADE}]}{A[\overset{\triangle}{ABC}]}$ = ...

<u>Example:</u>



In the figure EBCD is a parallelogram and $3\,|BE| = |AE|$. If $A[\overset{\triangle}{ABC}]=48$, then find the areas S_1, S_2 and S_3.

<u>solution:</u>
Which triangles are similar?.................
Why?

Can you write the side ratios?

___ = ___ = ___ = k =

Can you find the similarity constant k? [Remember $|AE| = 3\,|BE|$, and $AB = 3|BE| + |BE| = 4|BE|$

k=___

By using $A[\overset{\triangle}{ABC}]=48$, can you find S_1 and S_2 ?

$\frac{A[\overset{\triangle}{AEF}]}{A[\overset{\triangle}{ABC}]}$ = ...

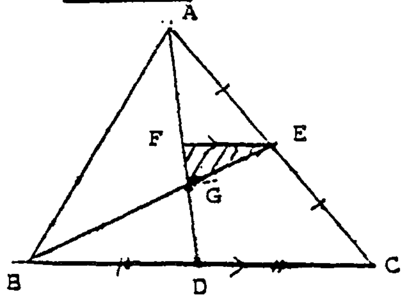
How can we find S_3 ? Is there any other triangle which is similar to $\overset{\triangle}{DCF}$? ....
Why ? ....
Write down the side ratios. ___ = ___ = ___ = k

k= ___

$\frac{A[\quad]}{A[\quad]}$ =

S_3= ......

<u>Example:</u>



In the figure, [AD] and [BE] are medians, [EF] // [BC]. If $A[\overset{\triangle}{FGE}]=S$ find $A[\overset{\triangle}{ABC}]$ in terms of S.

<u>solution:</u>

Which triangles are similar in the figure?

.... Why?

What are the side ratios and similarity constant?

___ = ___ = ___ = k

We are not given any numerical values or ratios for these sides.
How can we find the value of k?.

What is point G?

What is the position of the point G on the median?

Center of gravity divides the median to ....

|GE| = ...|BE| , |BG| = ...|BE|

k = ...

$\dfrac{A[\overset{\triangle}{FGE}]}{A[\overset{\triangle}{GDB}]}$ = ...   S = ...

Find $A[\overset{\triangle}{GDB}]$ in terms of S.

$A[\overset{\triangle}{GDB}]$ = ...

How can we find $A[\overset{\triangle}{ABC}]$ by using $A[\overset{\triangle}{GDB}]$?

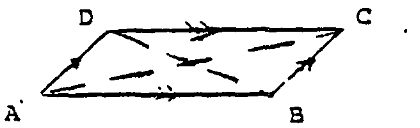
To how many triangles do the medians divide a triangle? ......

$A[\overset{\triangle}{GDB}]$ = __ $A[\overset{\triangle}{ABC}]$

$A[\overset{\triangle}{ABC}]$ = ...

QUADRILATERALS :

PARALLELOGRAM:



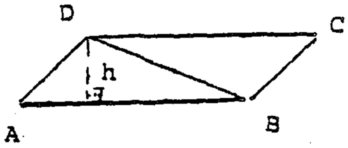
What can we say about the sides of the parallelogram?

What can we say about the angles of the parallelogram?

What can be said about the diagonals of the parallelogram?

Are the diagonals also bisectors of the interior angles?

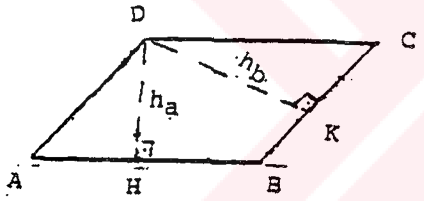
How can we calculate the area of parallelogram by using the area of triangle ?



$A(\overset{\triangle}{DAB}) = A(\overset{\triangle}{DBC}) =$ ....

A(ABCD)= ....

Example:



ABCD is a parallelogram, h_a and h_b are the heights drawn to sides a and b, respectively.
a= |AB|= 8, b= |BC| =6, h_a= |DH| = 6 find h_b= ?

solution:
How can you find A(ABCD)?

A(ABCD)= ....

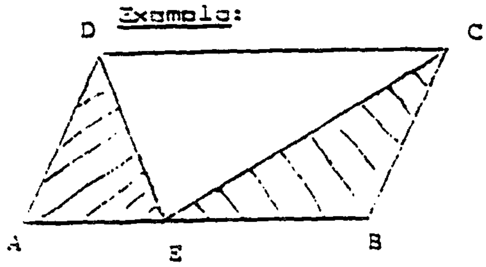
If the base of the parallelogram was(BC), and its height was(DK) what would be the area?

A(ABCD)= ....

|DK| = ...

What is the general area formula of the parallelogram?

Example:



ABCD is a parallelogram and E is an arbitrary point on [AB]. If A($\triangle$AED)+A($\triangle$EBC)=6 then find the area of ABCD.

solution:

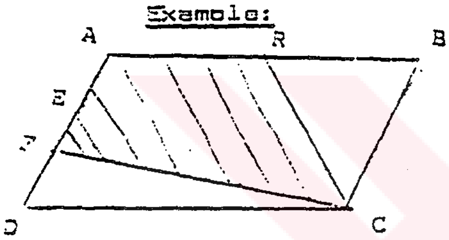
Can we find the area of $\triangle$EDC? .....

Try to draw a line [EF]//[AD]//[CB].

Can you find any triangle which has a relation to another? Why?

A(ABCD)= ......

Example:



ABCD is a paralelogram, R is the midpoint of [AB] and |AE|=|EF|=|FD|. If A(FARC)= 50 cm², then A(ABCD)= ?

solution:

Can we obtain A(ABCD) by using the shaded quadrilateral? ....

Draw the diagonal [AC], then

A($\triangle$ADC) ... A($\triangle$ACB) = ... A(ABCD)

A($\triangle$ARC)= ... A($\triangle$ACD) = ... A(ABCD)

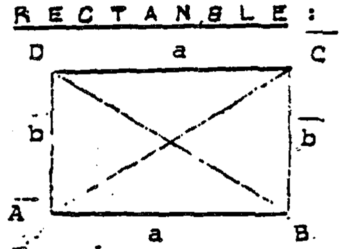
A($\triangle$AFC)= ... A($\triangle$FCD) = ... A(ADC)

= .... A(ABCD)

Can you express the shaded region in terms of A(ABCD) ?

A(FARC)= ....

RECTANGLE:

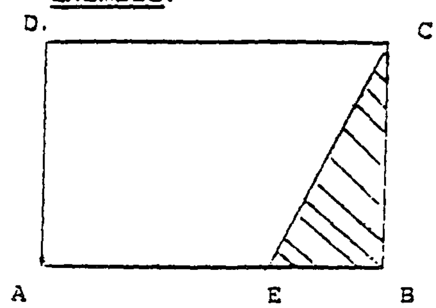


Can you see any similarity between parallelogram and rectangle ?.................................
....

The diagonals of rectangle are ....

Area of a rectangle is ....
Why? ....

Example:



ABCD is a rectangle and 3|EB| = |AB| .
If $A(\overset{\triangle}{CEB}) = 8\ Cm^2$ then A(ABCD)= ?

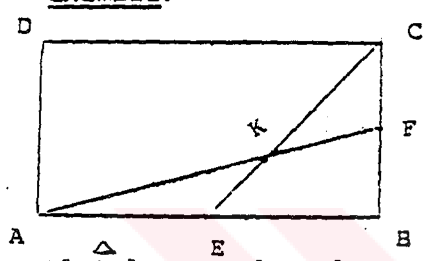
solution:
A(ABCD)= ....

What are the base and height of $\overset{\triangle}{CEB}$?
base=........... height=............

$A(\overset{\triangle}{CEB})$=..................

Can we use this to find A(ABCD)?.........

Example:



ABCD is a rectangle, E and F are midpoints of [AB] and [BC], respectively.
If A(ABCD)=m.A(BEKF), find the value of m.

solution:
If we draw the triangle ABC, what can we say for [CE] and [AF]?.They are ....

What can be said for point K ?
....

What can be said for $A(\overset{\triangle}{KEB})$ and $A(\overset{\triangle}{KBF})$?

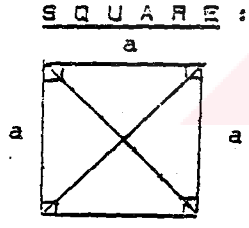
$A(\overset{\triangle}{ABC})$= ,... A(ABCD)

$A(\overset{\triangle}{KEB})$= ..... A(ABCD)

A(KEBF)= ....

m= ....

S Q U A R E :

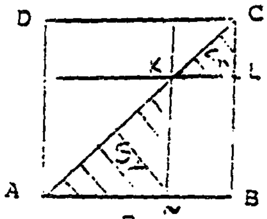


Can you see any similarity between square and rectangle? ....
....

What can be said about the diagonals?
....

Area of the square is ....

Example:



ABCD is a square with $|CL| = |KL|$ and $|KN| = |AN|$

If $S_1 = \frac{a^2}{18}$ then find $\frac{S_2}{A[ABCD]}$.

solution:

What type of triangle is KLC ?

KLC is a .... triangle.

Let $KL = LC = x$, find A[KLC] in terms of x

A[KLC]= ....

$S_1 = \frac{x^2}{2}$ was given. Find x in terms of a..............................

....

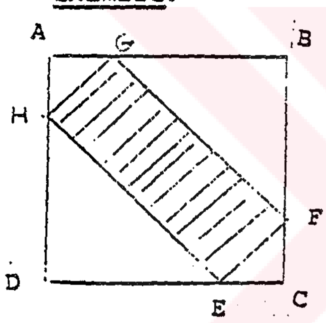
Find dimensions of $\widehat{KAN}$.

$|AN| = |NK| =$ ....

$S_2 =$ A[$\widehat{KAN}$] = ...

$\frac{S_2}{A[ABCD]}$ = ...

Example:



ABCD is a square, and EFGH is a rectangle.

If $\frac{|GH|}{|EH|} = \frac{1}{4}$ and $|AE| = |HE|$, what is the ratio of area of rectangle to area of the square?

solution:

Let $|HG| = x$, what will $|HE|$ be ?

$|HE| =$ ....

Find the shaded area.

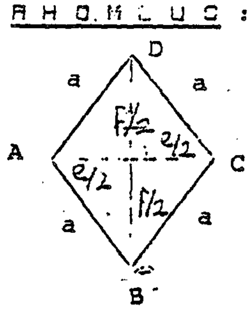
A[HEFG]= ....

$|AE| = |HE|$ was given.

A[ABCD]= ....

$\frac{A[HEFG]}{A[ABCD]} = \frac{\qquad}{\qquad}$ = ...

R H O M B U S :



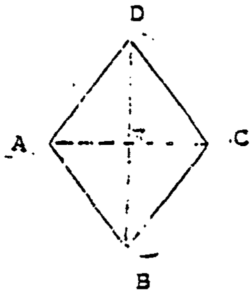
Can you see similarities between rhombus and parallelogram? ....

....

What about the diagonals? ....

....

Example:



ABCD is rhombus with f= |AC |= 8 Cm., e= |BD |=6 Cm. Find A[ABCD].

solution:

What can be said about the triangles made by the diagonals? They are ....

A[AKD] ... A[DKC] ... A[AKB] ... A[KBC]=....

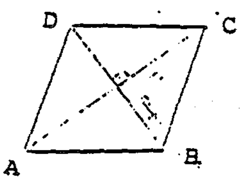
....

A[ABCD]=

What is the formula for area in rhombus?

....

Example:



ABCD is a rhombus with $\frac{|AC|}{|BD|} = \frac{3}{4}$,

If A[ABCD]=96 Cm^2., f= |BC| = ?

solution:

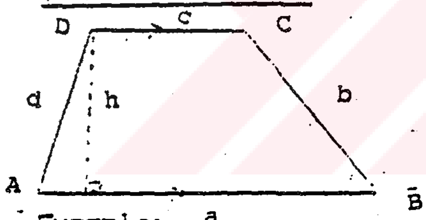
Find e in terms of f. e=.................

A[ABCD]=.................................

Find e and f.

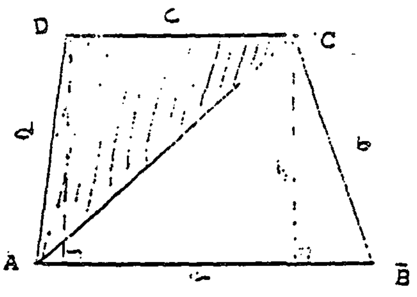
How can we find |BC| ?

TRAPEZOID:



What properties does the trapezoid have?

Example:



ABCD is a trapezoid, A[ACD]=6, A[ABC]=100m^2. A[ABCD]= ?

solution:

A[ACD]= ....

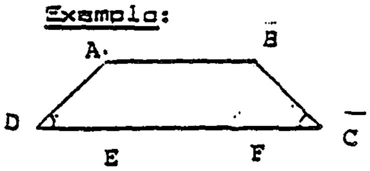
A[ABC]= ....

What makes up the area of ABCD?.............

A[ABCD]= ....

What is the formula for area of a trapezoid?

Example:



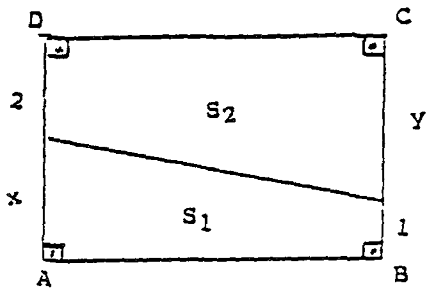
ABCD is a trapezoid with $m\hat{D}=45^\circ$, $m\hat{C}=60^\circ$,

|AB| = 8 Cm

|BC| = 6 Cm

A[ABCD]= ?

Example:



In the figure $\frac{S_1}{S_2} = \frac{1}{2}$ given. Find $x + y$.

solution:

What is S_1? ....

$S_1 =$ ....

What is S_2 ? ....

$S_2 =$ ....

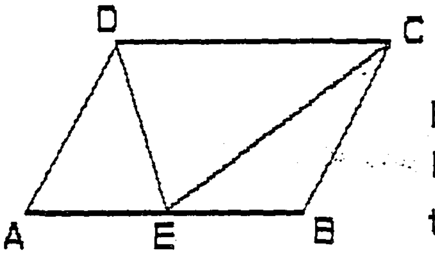
$\frac{S_1}{S_2} =$ ....

What can we say for the opposite sides of the rectangle ABCD ?

$x + y =$ ....

APPENDIX H

EXAMPLE FROM LECTURE WITH COMPUTER ASSISTED DRILL AND PRACTICE COURSEWARE



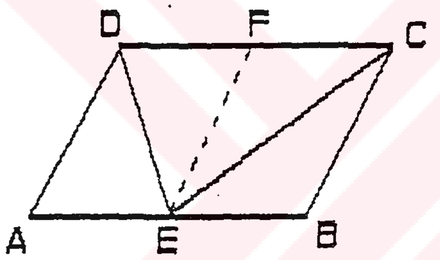
ABCD is a parallelogram and E is an arbitrary point on [AB]. If $A(\overset{\triangle}{AED}) + A(\overset{\triangle}{EBC}) = 6\sqrt{3}\,cm^2$ then find the area of ABCD

A) $14\sqrt{3}$ B) $18\sqrt{3}$ C) $12\sqrt{3}$ D) $6\sqrt{3}$ E) 12

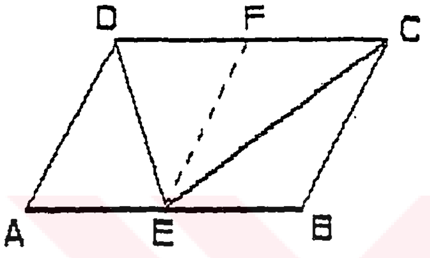
PLEASE ENTER YOUR SELECTION

Hint:

Draw a line |EF| // |AC| // |BC|



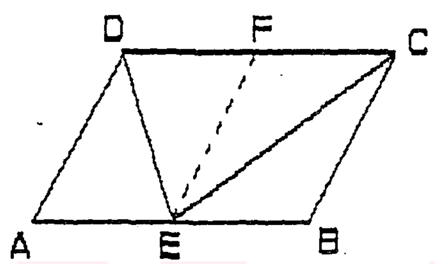
Hint:



$A(\overset{\triangle}{ADE}) = A(\overset{\triangle}{DEF})$ Because their bases and

$A(\overset{\triangle}{EBC}) = A(\overset{\triangle}{FEC})$ heights are same.

Solution:



$A(\overset{\triangle}{ADE}) = A(\overset{\triangle}{DEF})$ They have the same bases

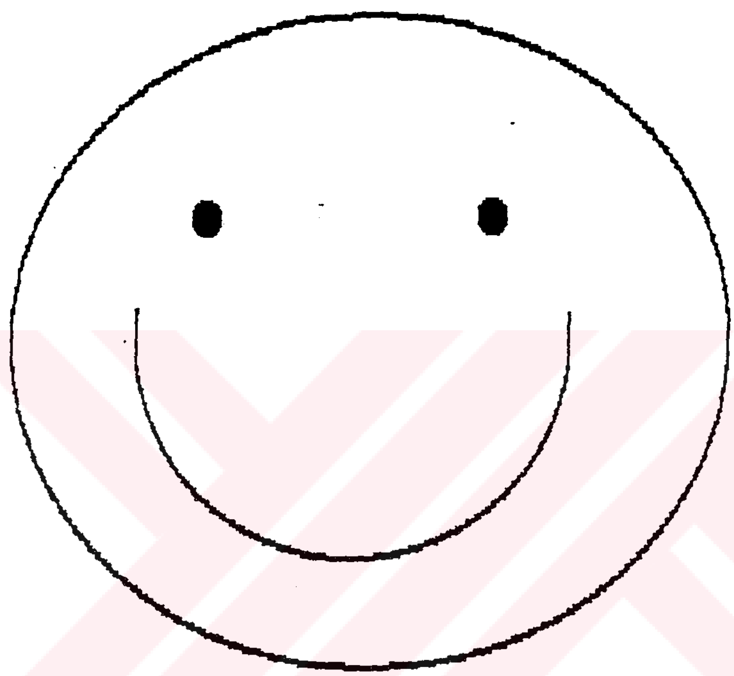
$A(\overset{\triangle}{EBC}) = A(\overset{\triangle}{FEC})$ and heights

$$A(ABCD) = A(\overset{\triangle}{ADE}) + A(\overset{\triangle}{DEF}) + A(\overset{\triangle}{EBC}) + A(\overset{\triangle}{FEC})$$

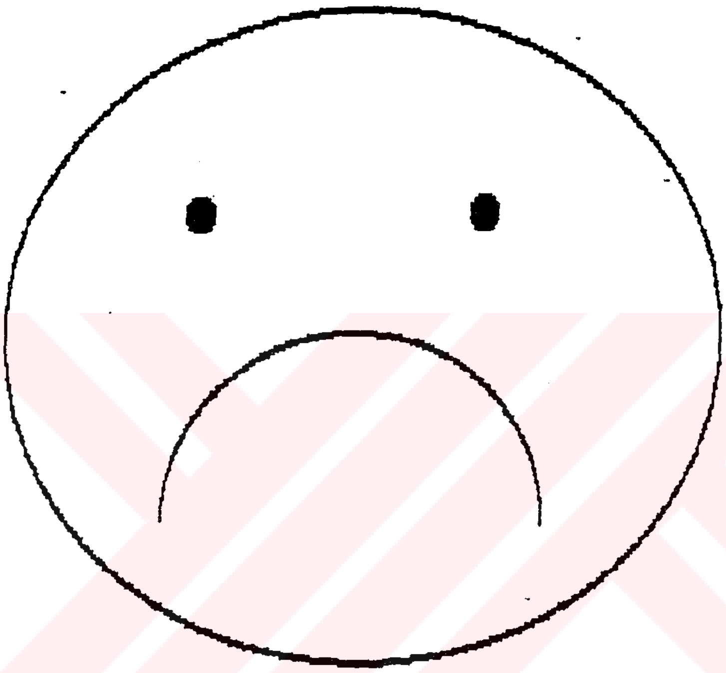
$$= 2\,[\,A(\overset{\triangle}{ADE}) + A(\overset{\triangle}{EBC})\,]$$

$$= 2 \times 6\sqrt{3}$$

$$= 12\sqrt{3}\ cm^2$$



CONGRADULATIONS
CORRECT ANSWER



YOUR ANSWER IS NOT CORRECT