THE EFFECTS OF COMPUTER-ASSISTED INSTRUCTION ON THE ACHIEVEMENT, ATTITUDES AND RETENTION OF FOURTH GRADE MATHEMATICS COURSE

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Approval of the Graduate School of Social Sciences

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ABSTRACT

THE EFFECTS OF COMPUTER-ASSISTED INSTRUCTION ON THE ACHIEVEMENT, ATTITUDES AND RETENTION OF FOURTH GRADE MATHEMATICS COURSE

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The purpose of this study was to examine the effects of the computer software *Frizbi Mathematics 4* on 4th grade student's mathematics achievement, retention, attitudes toward mathematics and attitude toward computer assisted learning. Two groups (experimental and control) of primary school students from "Sht. Osman Ahmet" primary school in Gazimagusa, North Cyprus were used in this study. Control group was taught using a lecture-based traditional instruction and experimental group was taught using educational software, namely *Frizbi Mathematics 4*. The control group consisted of 26 students where the experimental group consisted of 29 students. The groups were compared on achievement of mathematics, retention, and attitude toward mathematics and computer assisted learning. The study was conducted in spring semester of 2006-2007 academic year and included three units, Multiplication of Natural Numbers, Division of Natural Numbers, and Fractions. Scores on achievement tests were collected three times; at the beginning of the study, immediately after the intervention, and 4 months later. Mathematics attitude scale and computer assisted learning attitude scale were administrated only two times; at the beginning of the study and immediately after the completion of the study. A series of ANOVAs for repeated measures revealed significant difference between the groups on the post achievement tests and attitude scales in favor of experimental group. However, statistically significant differences in favor of treatment group, on the retention tests was attained on the multiplication and division units but not on fractions. The evidence indicates that *Frizbi Mathematics 4* for learning and teaching mathematics at the primary school level in Turkish Republic of Northern Cyprus (TRNC) is an effective tool.

Keywords: Educational Software, CAI, Mathematics Achievement, Retention, Attitude towards Mathematics, Attitude towards Computer Assisted Learning, 4^{th} grade Mathematics Course, and TRNC.

ÖZ

BİLGİSAYAR DESTEKLİ ÖĞRETİMİN 4.SINIF MATEMATİK DERSİNDEKİ BAŞARI, TUTUM VE KALICILIĞA ETKİSİ

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Bu çalışma, bilgisayar destekli bir öğretim uygulaması olan *Frizbi Matematik 4* eğitsel yazılımının, ilköğretim 4. sınıf öğrencilerin matematik dersindeki akademik başarısına, bu başarının kalıcılığına ve matematik ve bilgisayar destekli öğrenmeye karşı tutumlarına etkisini incelemeyi amaçlamıştır.

Çalışmaya, Kuzey Kıbrıs Türk Cumhuriyeti, Gazimagusa bölgesinde, bir devlet okulunda bulunan 4.sınıf öğrencileri dahil edilmiştir. Kontrol grubundaki öğrenciler geleneksel yöntemle ders işlerken, deney grubunda *Frizbi Matematik 4* eğitsel yazılım kullanılmıştır. Kontrol grubu 26, deney grubu ise 29 öğrenciden oluşmaktadır. Çalışma 2006-2007 öğretim yılı bahar döneminde, doğal sayılarda çarpma, bölme ve kesirler üniteleri üzerinde yürütülmüştür.

Uygulama öncesi, sonrası, ve 4 ay sonrasında tüm gruplara her üniteyle ilgili çoktan seçmeli başarı testi uygulanmıştır. Matematiğe ilişkin ve bilgisayar destekli öğrenmeye ilişkin tutum ölçekleri sadece uygulama öncesinde ve sonrasında uygulanmıştır. Başarı testlerinden elde edilen veriler 3 X 2 tekrarlı ölçümler varyans analizi (ANOVA) kullanılarak değerlendirilmiştir. Tutum ölçeklerinden elde edilen verilerin değerlendirlmesinde ise, t-test kullanılmıştır.

Araştırma sonunda deney grubu ile kontrol grubunun çarpma, bölme ve kesirler ünitelerindeki akademik başarı sontest puanları arasında deney grubu lehine anlamlı farklar bulunmuştur. Kalıcılık puanları açısından yalnızca çarpma ve bölme ünitelerinde deney grubu lehine anlamlı bir fark bulunmuştur. Bunun yanısıra, deney grubunda bulunan, Frizbi Matematik 4 ile bilgisayar destekli öğretim alan öğrencilerin matematiğe ve bilgisayar destekli öğrenmeye karşı tutumlarında, kontrol grubuna göre anlamlı farklar oluşmuştur. Elde edilen sonuçlar, Frizbi Matematik 4 eğitsel yazılımının Kuzey Kıbrıs Türk Eğitim Sisteminde ilköğretim matematik derslerinde geleneksel eğitime katkı koyacak şekilde uygulanmasının olumlu sonuçlar ortaya çıkaracağını destekler niteliktedir.

Anahtar Kelimeler : Eğitim Yazılımı, Bilgisayar Destekli Öğretim, Matematik Başarısı, Kalıcılık, Matematiğe Karşı Tutum, Bilgisayar Destekli Öğrenmeye Karşı Tutum, 4.sınıf Matematik dersi, ve Kuzey Kıbrıs Türk Cumhuriyeti.

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TABLE OF CONTENTS

LIST OF TABLES

TABLES

LIST OF FIGURES

FIGURES

LIST OF ABBREVITIONS

ABBREVIATION

CAI	: Computer Assisted Instruction
TI	: Traditional Instruction
MAT	: Mathematics Achievement Test
PMAT1	: Students' pretest scores on unit 1: "Multiplication of Natural Numbers" achievement test
PMAT2	: Students' pretest scores on unit 2: "Division of Natural Numbers" achievement test
PMAT3	: Students' pretest scores on unit 3: "Fractions"
MATP1	: Students' posttest scores on unit 1: "Multiplication of Natural Numbers" achievement test
MATP2	: Students' posttest scores on unit 2: "Division of Natural Numbers" achievement test
MATP3	: Students' posttest scores on unit 3: "Fractions" achievement test
MATR1	: Students' retention scores on unit 1: Multiplication of Natural Numbers" achievement test
MATR2	: Students' retention scores on unit 2: "Division of Natural Numbers" achievement test
MATR3	: Students' retention scores on unit 3: "Fractions" achievement test
MAS	: Mathematics Attitude Scale
CALAS	: Computer Assisted Learning Attitude Scale
PMAS	: Students' pretest scores on Mathematics Attitude Scale
MASP	: Students' posttest scores on Mathematics Attitude Scale
PCALAS	: Students' pretest scores on Computer Assisted Learning Attitude Scale
CALASP	: Students' posttest scores on Computer Assisted Learning Attitude Scale
TRNC	: Turkish Republic of Northern Cyprus

F	: F statistic
N	: Sample size
M	: Mean
SD	: Standard deviation of the sample
df	: Degree of freedom
t	: T statistic
p or Sig.	: Significant level
ANOVA	: Analysis of variance
ANCOVA	: Analysis of covarian

CHAPTER I

INTRODUCTION

This study is designed to examine the effectiveness of the educational software *Frizbi Mathematics 4* compared to the traditional instruction in mathematics lessons. In this study, the first chapter provides a background, the purpose and the significance of the study. The second chapter presents the related literature and the research methodology of the study is provided in the third chapter. The fourth chapter is devoted to the results of the study while the conclusion and the recommendations for practice and further research are presented in the last chapter.

This chapter contains the theoretical background, the purpose and the significance of the study. Definition of the important terms is also included at the end of this chapter.

1.1 Background

The roots of mathematics education is mainly based on the history of mathematics, and it has played an important role in the development of society from prehistoric times to the present. The history of mathematics education is similar to the history of mathematics, and it plays a crucial role in the education context. Until the 1980s, efforts at change came out of a common perspective or paradigm in which mathematics was viewed as a disembodied set of objective truths to be communicated to students. Barbeau (1989) suggests that, "people perceive mathematics from an absolutist perspective and undoubtedly this is what reflected from the mathematics they studied in school rather than an insight into the discipline" (cited in Baykul, 1999). According to him, "people think that mathematics is a cold and austere discipline that provides no scope for judgment or creativity”. The traditional models for mathematics education such as Thorndike’s Stimulus-Response Bond Theory, the progressive movement’s effort to make learning vocationally relevant and schooling more efficient, the curricular changes associated with New Math, and the emphasis on rote facts, skills, and procedures of back-to-basics movement was found within the revisions of the past century and all developed within the perspective “procedural-formalist paradigm” (Ellies & Berry III, 2005). Much of the teaching and learning of mathematics in the first half of the twentieth century was based on Thorndike’s principles of strengthening bonds through stimulus-response activities (Thorndike, 1922, cited in Willoughby, 2000). Thorndike and his colleagues contended that mathematics is best learned in a drill and practice manner and viewed mathematics as a “hierarchy of mental habits or connections” (Thorndike, 1923, p.52, cited in Ellies & Berry III, 2005) that must be carefully sequenced, explicitly taught, and then practiced with much repetition in order for learning to occur.

When Willoughby, the president-elect of National Council of Teachers of Mathematics [NCTM] in the year 1981, he proposed the creation of NCTM standards for instructional materials based on the principles and experiences of recent innovative programs. However, the 1989 Curriculum and Evaluation Standards for School Mathematics had the most far-reaching effect of the standards published by NCTM (Willoughby, 2000).

Many cognitively oriented mathematics researchers were changing on the way of constructivist theory starting from the mid-1980 till the end of the 1980s. Constructivists tried to offer a detailed picture of how learning takes place in context by drawing on philosophical, anthropological, and social psychological point of views. The publication of the NCTM standards was accompanied by a growing awareness of and interest in research examining the significance of culture, specifically the interaction of student culture and classroom culture, to the construction of meaningful mathematical understanding.

In the 1990s there was broad recognition that teaching mathematics to all students required something other than the transmission of objective and incorporeal content, there was a shift from seeing mathematics as apart from human experience to mathematics as a part of human experience, interaction an emphasis on seeing. More to say, the challenge is no longer how to get mathematics into students, but instead how to get students into mathematics. In this context, again Ellies and Berry III proposed a name for this blending of cognitive psychological and (socio) cultural research perspective: cognitive-cultural paradigm (CCP). The CCP takes mathematics to be a set of logically organized and interconnected concepts that come out of human experience, thought, and interaction-and that are, therefore, accessible to all students if learned in cognitively connected and culturally relevant ways (Ellies & Berry III, 2005).

In the last thirty years, a noticeable and extensive research in many areas has contributed to major shifts in fundamental views of how learning occurs as well as developing rich knowledge basis for effective instruction. As we have passed into the new millennium, as mentioned above, the mathematics education community is making dramatic changes in curriculum, instruction, and assessments. These changes mainly include a number of organizational decisions which need to be made regarding how to segment and sequence the mathematical topics, what kinds of student activities to suggest, and how to develop student's mathematical thinking abilities.

John Dewey emphasized over 100 years ago for changes that would move schools away from authoritarian teacher-directed classrooms, to environments in which learning actualizes through active participation and real-life based experiences (Dewey, 1916, cited in Arbuckle, 2005, p.8). Over this same period, learning is considered as a process where students receive information passively, store it in easily as a result of repeated exercise and reinforcement in most of the classrooms. The general perception of what mathematics is today appears to be calculating to obtain one unique and correct answer. The procedure gives the importance of students'memorization of mathematical facts and the application of these ideas in order to solve daily mathematics needs.

Mathematics education is changing as it seeks new ways to improve mathematics instruction quality for learners. This shift is occurring simultaneously as mathematics education research is experiencing both new methods emerging and a widespread implementation of several information technology advancements. In today's "Information age", the growth of the technology and computer oriented education systems guide educators to explore new teaching methods that can be used at university, elementary, secondary and college classroom environments as an alternative to teacher-directed techniques.

Within the last twenty years, although there is a great potential of the computer technologies to the mathematics teaching practices, some of the developed and most of the developing countries are unaware of this potential. There are lots of reports in the national arena which supports the necessity of the integration of computer technologies into mathematics teaching (Cockcroft, 1982; NCTM, 2000; NCTM, 2005; TIMSS, 2003). The NCTM technology principal states that "mathematics instructional programs should use technology to help all students understand mathematics and should prepare them to use mathematics in an increasingly technological world" (NCTM, 2000, p. 40). Beside this, using the computers in interesting problem contexts can facilitate students' achievement of a variety of higher-order learning outcomes, such as reflection, reasoning, problem posing, problem solving, and decision-making (NCTM, 2004). Since the teachers are the major elements of mathematics curricula, NCTM technology principals adds, "teachers must be prepared to serve as knowledgeable decision makers in determining when and how their students can use these tools most effectively" and also "they should make informed decisions about the appropriate implementation of technologies in a coherent instructional program". There are some recommendations that are available on-line at http://www.nctm.org. These include:

- Every school's mathematics program should provide students and teachers with access to tools of instructional technology, including appropriate calculators, computers with mathematical software, Internet connectivity, handheld data-collection devices, and sensing probes.

- Preservice and in-service teachers of mathematics at all levels should be provided with appropriate professional development in the use of instructional technology, the development of mathematics lessons that take advantage of technology-rich environments, and the integration of technology into day-to-day instruction.
- Curricula and courses of study at all levels should incorporate appropriate instructional technology in objectives, lessons, and assessment of learning outcomes.
- Programs of preservice teacher preparation and in-service professional development should strive to instill dispositions of openness to experimentation with ever-evolving technological tools and their pervasive impact on mathematics education.

Technology integration is one of the growing areas in every country; several project-based activities are being developed with the integration of computer environments into mathematics lessons. For instance in France at the beginning of 2000s there was one personal computer for each student and placement of those technologies into mathematics curriculum was actualized (Benzie, 1997). Beside this in Australia using computers and calculators in schools has been an educational policy (Ersoy, 2005). In the UK, the new National Curriculum for schools was introduced in the late 1980s. The definition of students' Information Technologies (IT) capability was mentioned for the first time in this National Curriculum and it gives importance on student's ability to use IT tools to examine, process and present information (Benzie, 1997). A survey of nineteen eastern countries including China, India, Israel, Japan, and New Zealand indicates that they are using computers to support the teaching traditional subjects as well as learning about computers through the acquisition of operational skills (Pelgrum & Plomp, 1993). However, innovation efforts for mathematics education in Turkey and TRNC, reform efforts were slower in emerging.

Computer assisted instruction has been gaining acceptance as one of the technologies used effectively in the educational systems. This is true for mathematics education as well, this is the reason why all the essential innovations in science and technology of last years influences mathematics teaching and learning activities. In this sense, integration of computers into mathematics education is one of the controversial issues in mathematics education research. A body of literature has been advocating positive outcomes of this integration however there are a thumping majority of studies which make the point that computers damage the social and intellectual development of school children (Cook, 2000; Lei & Zhao, 2005). However it is underestimated that this negative posture is directly related to the improper application of computers and/or computer technologies in educational settings, deficient research studies, and the untrained stakeholders and teachers. Furthermore, even computers are powerful tools for improving the effectiveness of instruction, inappropriate usage and preference of any technology and improper technology planning usually cause loss of time, energy and fiscal resource (Gülbahar. 2006). For instance, the results of the study prepared by Özar and Aşkar (1997) indicated that attempts made since the 1980s to integrate computers into Turkish Education System were not properly organized and they outlined three important mistakes made in the process of integrating computers into the education system of Turkey. First, the existing system, in terms of physical and human resources, was not really well considered and evaluated before computer technologies were introduced into Turkish education system. Second, since the 1980s, the emphasis has been on hardware issues rather than software and finally, third, computers seem to have been kept locked in many schools because of a lack of understanding of the fact that technology is changing rapidly and the products will be out of date soon. From that time on, a number of project and research studies started to be published from the relation of ICT and teaching. In a recent study of ICT integration Gülbahar (2006) illustrated how technology planning process was carried out in a private K-12 school in Turkey and the results positively confirmed in Özar and Aşkar's study. The findings of Gülbahar's study showed that Turkish teachers, administrators and students believe in the importance of developing a technology plan for using technology in an effective and efficient manner for teaching and learning. In addition results indicated that using up-to date hardware and software resources is a key feature to diffusion of technology and besides in-service training and equity of access to resource were also mentioned in the study.

Turkey's centralized education system began using computers more than twenty years ago. In 1984, Turkey's Ministry of National Education (MONE) first introduced computers to secondary schools and focused on hardware and then schooling teachers in Basic programming (Akbaba, 2006). The development of courseware for 37 subjects, additional hardware and supplementary in service training were appointed in the pilot project of 1988-89. The major Computer Assisted Education (CAE) project was initiated in 1990-91 as part of the World Bank National Education Development Project, which comprised a program for introducing computer literacy and computer aided instruction in grade 10 of chosen secondary schools. The MONE also invited some universities to take part by training teachers in programming and computer literacy. There are lots of research studies and educational project in the literature that support the effectiveness of computer assisted instruction in Turkey (Akkoyunlu, 2002; Ersoy, 2002a, 2002b, 2002c; Uşun, 2006). Unfortunately, the conditions (the front-end training, the on- going in-service training, support positive outcomes of research studies and provision of hardware and software) connected with successful initiations were not fully fulfilled at the schools involved in the CAE project (Orhun, 2004).

On the Greek side of Cyprus, technology integration has been considered for more than one decade (Drenoyianni & Selwood, 1998). The launch of an ICT policy by the Southern Cyprus Ministry of Education and Culture (MOESC) took place in the early 1990s; some of the primary schools were then equipped with computers at an experimental level. Also, a Departmental IT group was created as a part of the Department for Programs Development of the MOESC, while the governmental Pedagogical Institute started offering an optional training program for teachers at the end of the 1990s. 'Evagoras' (1999) was the first formal ICT policy document, and describes the action plan for the embedding of new technologies in primary education from 2000 to 2005. It includes economic, pedagogical, and national reasons according to which the embedding of computers in education is necessary. Evagoras provides five gateways: (1) the update of the national curriculum that will include computer technology applications; (2) teachers' professional development in three levels: computer literacy, use of computer applications as teaching and learning tools, and use of other technological methods and mediums; (3) the use of computers for school management; (4) the integration of Internet applications in primary education, and (5) the continuous provision of hardware, software, as well as provision of support and maintenance within schools. According to ‘Evagoras’ document, “the students should not learn how to use the computer applications as an end in themselves (computer skills as a subject) but learn how to use them as tools that help them to execute their tasks and projects” (District Curriculum Developers & Evagoras Team, 1999 cited in Eteokleous, 2007).

However there are still deficiencies in the integration of computer technologies in the education system of Southern Cyprus. For example, Karagiorgi and Charlbous (2004) stated that there is an unclear sense of understanding about the role of ICT, and the findings indicated that the challenge is on the policy makers to make a decision for the model integration in order to specify the role of ICT in the National Curriculum. Similar problems have emerged in just the same way in Turkey and the other developing countries.

In the education system of Turkish Republic of Northern Cyprus (TRNC), mathematics education is as important as the other subject matters: science and language teaching. For this reason, there has been a constant urge to increase the quality of mathematics instruction as well as students’ mathematics achievement scores of the university entrance exams (ÖSS) which leads to quality of education. In doing so, new mathematics curricula and text books are developed in cooperation with the committees set up by the Department of Educational Planning and Program Development which is located under the Turkish Republic of Northern Cyprus Ministry of National Education and Culture (NCMONE) in the year 2005. Subject matter knowledge, skills, aims and objectives are described in detailed in the booklet of new “TRNC Education System”. Mathematics curricula are designed within the understanding of pupil-centered and constructive education. These innovative movements are considered as a reform in the history of Mathematics education in the TRNC Education System. Within this, it is the first time that terms such as “student-centered”, “contemporary instructional technologies”, “critical and creative thinking skills” are mentioned. In addition to these, there is one objective in the new “TRNC Education System” booklet that indicates the technology integration “computer, educational technology and its methods are used parallel to the objectives" and also in the pupil's qualities section "knows how to use computer technology and uses it in/out of the school" is proposed in the new system. However in the elementary schools these innovative movements failed to acknowledge in the real classroom environment. That is to say, in spite of the contemporary teaching methods that were mentioned in the new "TRNC Education System" booklet, the majority of teachers still carried out their lessons based on the old-fashion, traditional teaching methods such as presentation or direct instruction. The reasons behind this could be the lack of agreement on the needs, the inappropriateness and a missing "shared" vision concerning the content and theory of educational change by the people involved in innovations (Fullan, 1992).

TRNC can not stay away from the challenge of integrating computer technologies into its educational plan as new technologies are promoted out of expectancy and consistency to international obligations and the prospect of the 21st century. There are new attempts for the technology integration. One of them is called "Informatics Project-(Bilişim Projesi)" which was funded by the Turkish Government and also supported by the United Nations Office for Project Services (UNOPS) within the United Nations systems in the year 1997. The aim of the project was to develop a technology oriented educational system in TRNC which leads a shift to the information society. At the beginning phase of the project, 44 secondary schools equipped with 13 pilot laboratories and 30 computer-assisted education systems were established within this project. The following tasks are aimed to achieve with the actualization of the "Informatics Project": interactive education, computer-assisted education, distance education, television-based education and measurement and evaluation systems in education (Milli Eğitim ve Kültür Bakanlığı, 2005). Although the "Informatics Project" provided the infrastructure for computer-based education, there is no evidence how teachers use those technologies in the preparation of lesson materials and the benefits of usage of technologies.

As mentioned above, Turkey and Southern Cyprus, neighbor countries of TRNC both geographically and culturally were equipped with computers for more than a decade, they have started to discuss the solutions of problems that may arise during the integration process and they came up with the same factors that effect the computer technologies integration: planning, in-service training, student-teacher education and technical supports. Similar to other countries, TRNC should have the national goal to determine versatility effects and opportunities of computers to mathematics education. Furthermore, there is a need to train the teachers, and reorganize the education departments in order to gain the benefits of computers in mathematics teaching. Thus, in mathematics instruction permanent and meaningful learning acquisition is an important concern and there is a possibility that this may happen with the integration of computers.

The field of educational studies is fairly new in TRNC. There are few studies that are related with technology integration (Bekiroğulu, Paralik, & Hüseyin, 2006; Işman, Yaratan, & Caner, 2007; Uzunboylu, 2007). These studies mostly concentrated on the perceptions, attitudes and the readiness of teachers and students for the computer use in educational settings (Silman & Gündoğdu, 2006). Results indicated positive outcomes but there is a need for more organized research studies or project to be able to draw the general portrait. Beside this, the new TRNC Education System contains the goals about technology integration however none of the specific subject-matter curriculum reflects this integration, in fact this is a contradictory situation. One can say this can be solved by simply those projects like “Informatics Project” or with the provision of sufficient hardware, software and computer literacy in-service training. But the reality is not that straightforward.

Of equal importance that information technologies are just now beginning to enter the TRNC education system, TRNC educators have no experience with the integration of computers into mathematics instruction. In TRNC, there is no study on the integration of computers into teaching and learning of mathematics. Therefore it is essential to conduct research regarding the use of computers in mathematics classes. The researcher of this study experienced the inefficient, inadequate and unplanned applications of computer integration into the school education in the TRNC education system especially compared the south side of the Cyprus. Beside this, in order to integrate computer technologies there is a need to investigate the possible outcomes of computer-assisted learning environment into the students’ subject-matter achievements and attitudes towards computer-assisted subject- matter teaching.

In order to understand the possible outcomes of CAI on student's mathematics achievement, attitudes toward mathematics and attitudes toward computer-assisted learning, the researcher of this study utilized a CAI program *Frizbi Mathematics 4* that teaches focused math concepts: multiplication, division, and fractions to the 4th grade students in TRNC. While it was hoped that this study would be useful to many audiences, its primary target is informed K-12 practitioners in TRNC.

1.2 Purpose

In the case of traditional methods in mathematics teaching, it is obvious that mathematics concepts are usually being taught by using abstract examples and words. This way of teaching, which needs highly cognitive skills to assimilate the taught subjects, creates a high pressure on the students leading them to lose their self-confidence and lower their use of capacities. Lecturing and questioning are the most common teaching methods in most of the traditional mathematics classrooms in Turkey (Pesen, Odabaşı, & Bindar, 2000). Especially in middle and high school, students are exposed mainly to subject matters and they generally cannot understand why they learn those subjects, when they are not interested in them, or when they know that this knowledge will never be of any use to them throughout their life. Like Dewey (as cited in Can, 2004) stated Turkish school system has become so much more subject matter centered than experience centered. In this transition from experience based to symbol based education, Turkish students have been facing the problem of formal education that is 'abstract', 'artificial', and 'bookish'. After several decades, the education system in Turkey still contains highly controversial examples, applications and practices with Dewey's ideas of education documented with "My Pedagogic Creed" (1897). Dewey (as cited in Can, 2004) proposed to use materials that promote experiential learning so that the balance between experiential learning and abstract symbolic information should be created in the formal education system in Turkey. Similar to Turkey, most of the mathematics contents in the TRNC' primary education are provided in a traditional manner. Thus the students encounter many difficulties in acquiring what is taught, and more importantly, causing them to memorize most of the mathematical concepts without understanding (Cankoy & Tut, 2002). The problems arise in the students' secondary and post-secondary education, when the new mathematical concepts are being constructed. In those grade levels, the basic knowledge of mathematics, which is thought to be acquired in the former grades is surprisingly missing and/or misunderstood (Baki, 2000). This creates problems for both teachers and students in achieving their goals when the new subjects come into the agenda. Learning by doing is one of the proposed teaching models to the mathematics, in this way of learning students engage in experiences and experiments from which they derive their own knowledge and meaning (Baykul, 1999). Constructivist models of instruction propose to create environments in which learners actively construct their own knowledge, rather than receiving the teacher's explanation of the world. Increasing technological developments highly influence educational activities such as cognitive tools, teaching machines, computers, and calculators. The constructive learning environments can be created with the help of some cognitive computer-based tools such as databases, spreadsheets, and multimedia construction software where learners can participate in active, mindful, and purposeful interpretation and the reflection of the external world.

Computer Assisted Instruction (CAI) is one of the earliest applications of computers in education. Drill and practice, tutorial, problem-solving, and simulation are the kinds of CAI. Some Computer Assisted Instruction types provide learning environments that engage students in creative tasks and problem solving mostly reflects the real-world assumptions (Hoyles & Noss, 1992; Kapa, 1999). Besides, CAI could be used as a supplemental to traditional instruction or as replacement for traditional instruction (O'Reilly, 1987).

Although in the year 2005, some innovative approaches were incorporated into school curricula by publishing a new "TRNC Education System" booklet, currently, traditional teaching techniques, such as lecturing, are commonly used in TRNC, (Milli Eğitim ve Kültür Bakanlığı, 2005). These methods are known to be completely far away from the contemporary learning theories that enable students to explore critique and construct their own knowledge. Whereas, the constructive model of learning suggests learners must actively construct their own individual experiences and understandings (Forcier, 1999). For instance, students who followed the geometry instruction with computer-augmented activities do achieve stronger benefits in terms of knowledge of geometry concepts than students who receive more traditional geometry instruction (Fankhouser, 2003). With the powerful growth of the computer technology in the recent years, most of the mathematical concepts can be redefined and simulated by means of software use (Ploger, Klinger, & Rooney, 1997). In this way, many mathematical concepts, electronically, can become concrete, clear, and encouraging for the primary education students.

The evolution of the information technologies causes the rapid changes in societies. As we consider the inadequacy of conventional teaching methods to overwhelm the obstructions in the instruction process, one of the best solutions is the use of information technology. Although there are enough research studies that indicate the effectiveness of the technology usage in mathematics classes, the current mathematics curriculum in the TRNC educational system does not include the usage of such materials (Milli Eğitim ve Kültür Bakanlığı, 2005). What is less obvious nowadays is what influence the use of educational software has on students in elementary schools. There is a need to find out what if students contact with algebra theory through the software instead of having limited experience of the formal aspects of algebra because it might be especially valuable in providing a foundation for further research on developing technology-oriented mathematics programs. Similar to TRNC a case in Hong Kong, Mok (2000) suggested the use of the technology, the graphics calculators, to eliminate the problems in secondary school algebra where the major teaching activities are carried out in the conventional style of teaching in the classroom which do not provide sufficient opportunities for students to develop conceptual understanding.

Integration of computers in mathematics classrooms in TRNC can provide an effective learning environment for students to enhance their mathematical skills by engaging them with “real world” conditions to make the abstract concepts concrete and clear. In this way, students can have a meaningful and retentive learning and they will be much more ready for their future education life such as university education or even their professional life. According to the NCTM (2004) technology is fundemental: “Electronic technologies - “computers”- are essential tools for teaching, learning, and doing mathematics” (p.24). As Ersoy (2003) stated, at this stage, it is needed to integrate technology in mathematics curriculum by reconsidering its goals and objectives regarding with the latest innovations in the field of mathematics education. It is believed that this integration will help to eliminate the problems such as misconceptions of some basic concepts that occur during the mathematics teaching and learning activities in TRNC.

This study intends to focus on the how educational software, namely, *Frizbi Mathematics 4* influence the achievement, attitudes, and retention of fourth grade students in mathematics lessons in TRNC.

1.3 Significance

Even though there are a number of research studies examining the effectiveness of traditional instruction with computer-based instruction (Kiboss, 2000), none have been sighted that are specific to the area of Turkish Republic of Northern Cyprus primary mathematics education. Although there are enough research studies about integration of technologies into education in Southern side of Cyprus (Eteokleous, 2007), there is not any interference to conduct any research study to investigate the integration of computers in TRNC education system. In this framework, this study sets out to be a pioneering research in TRNC as it proposes to analyze the usage of computer based education in primary mathematics classrooms in TRNC. By using the computer software as a tool for modeling, conjecturing, analyzing and generalizing, students are enabled to learn conceptually, visually and meaningfully in mathematics lessons (Ball, 1990). In TRNC, mathematics teaching mostly emphasizes on repetition, drill, and converging to right-answer thinking (Milli Eğitim ve Kültür Bakanlığı, 2005). With the usage of the multimedia educational software, described in the Method section, the researcher aims to enable students to bridge the gap between reality and abstract concepts during mathematics lessons. *Frizbi Mathematics 4* helps in developing a greater understanding of multiplication, division, and fractions by focusing on the concrete level of basic concepts and increasing their understanding to multiplication, division, and fractions using interactive learning environment through visuals, sounds, and games.

In the absence of research, in developing countries and in TRNC particularly, this study will report on a major topic relating to the impact of the usage of computer software on the primary students' mathematics achievement. Actually, in the last two decades the argument is not on whether to integrate computers or not into the educational systems in developed countries, they are concentrating more on how computers should be used to gain more effective results (Hoyer, 2005; Lou, 2004; Zhang, Watson & Banfield, 2007).

The need for an improvement in all the fields of education has become more important with the accession of Southern part of Cyprus into European Union (EU). As it is known there have been some studies related to the Computer Assisted Instruction carried out on the South side of the island for the same purpose (Anastasiades, 2003). Thus, it is necessary that the North side should also carry similar studies in order to adopt the conditions of teaching and learning to the European Standards. That is to say, bridging the gap between the two parts of the Island and harmonizing the education system of TRNC with EU norms is essential for the former's smooth accession of northern part into EU in the coming years.

Among the other aims of school education, it should also prepare students to make effective use of technology which they will need in the future. When the students left the school for work, they require a broad variety of skills such as; strong communication and interpersonal skills and math and technology skills (Stintson, 1993). Thus, schools must make new technologies accessible to students that are already available at the further education level in order to have a successful education system. Therefore, students should become actively participated, and educators must be given the resources and training needed to properly implement technology and to properly occur transition. In spite of the research on the significance of technology in schools, numerous educational institutions are limited by the charge of latest technologies. For the reason of the high cost of the purchasing and execution of these technologies, it is essential to check the readiness of technology accomplishment in the classroom environment and to decide what effect this would have on student achievement. When this issue is solved, teachers would then have the needed knowledge and research to conclude the cost benefit of technology acquisitions.

For this rationale, the utilization of computers in all fields of education in TRNC should be thoroughly investigated. In this regard, this study provides a preliminary basis for the feasibility analyses, which is particularly focused on the use of computers in primary mathematics education. The study is supposed to reflect valuable results that will, in turn, encourage the administrators, principals and educators to focus on the use of computer assisted instruction techniques not only in mathematics but in any field of education in TRNC. This study is therefore potentially significant and of particular pertinency in that it reacts to the annulled data in this domain.

1.4 Definition of Terms

To clarify the research questions posed above, several terms should be defined in detail:

Computer Assisted Instruction (CAI): Computer-assisted instruction (CAI) is a narrower term and most often refers to use of computers to present drill-and-practice, tutorial, or simulation activities offered either by themselves or as supplements to traditional, teacher directed instruction (Batey, 1986 cited in Uşun, 2004; Grimes, 1977). In this study, CAI refers to the instruction that is carried out by using the educational software *Frizbi Mathematics 4* to facilitate learning and teaching through the direct interaction between the student and the computer individually.

Traditional Instruction (TI): Traditional Instruction (TI) refers the use of current standard methods and tools of mathematics in the classroom such as rulers, pencils, and paper to carry out content of the subject. Learning takes place in the standard classroom where work is presented on the board and the use of text book is common practice. Since the instruction is teacher oriented, question answer method was mostly used with the immediate feedback.

Mathematics achievement: successfully accomplishment of mathematical content, especially by means of skills, practice, or per-severe. In this study three achievement tests (one for each unit: “Multiplication of Natural Numbers”, “Division of Natural Numbers” and “Fractions”) developed by researcher were used to assess what students have learned.

Mathematics retention: an ability to remember or recognize the mathematical content what has been learned or experienced. In this study, three retention tests (one for each unit: “Multiplication of Natural Numbers”, “Division of Natural Numbers” and “Fractions”) developed by researcher were used to assess what students have remembered the mathematical content that have been learned.

Attitude towards mathematics: student’s self-reported enjoyment, interest and level of anxiety toward mathematics. In this study, attitude towards mathematics was defined by the students’ level of enjoyment toward mathematics as measured by Mathematics Attitude Scale (MAS) developed by Aşkar (1986).

Attitude towards computer assisted learning: student’s self-reported enjoyment, interest and level of anxiety toward computer assisted learning. In this study, attitude towards computer assisted learning was defined by the students’ level of enjoyment toward computer assisted learning as measured by Computer Assisted Learning Attitude Scale (CALAS) developed by Aşkar, Yavuz, and Köksal (1991).

CHAPTER II

REVIEW OF THE LITERATURE

This chapter begins with the historical perspectives of computers and the roles of computers in education and then continues with the theoretical aspects of computer-assisted instruction. Following this, roles of the computers in mathematics classrooms are discussed. Later, the effects of the computer assisted instruction on student attitudes toward mathematics, attitudes toward computer assisted learning, and retention are considered. In doing so, the latest research studies both world-wide and in Turkey reviewed the consideration of computer usage and its implication in education which are presented in the last part of the chapter.

2.1 Brief History of Computers in Education

Computers and related technologies are now in most of the schools in all around the world. Advancements in technology are inevitably reflected in educational systems. In most of the developed countries education has been penetrated by information technologies (IT); schools have computers, a large numbers of teachers use computers and new technologies while teaching, and more over textbooks have some parts devoted to new technologies.

New technologies are integrated into disciplines and more disciplines are being influenced by the new technologies in an integrated way. Most of the educators and researchers try to use technologies in various subject matters, and this integration changes the nature, concepts and methods of work in each subject. For example, in mathematics education, the way of teaching and learning, the roles and functions of the most concepts have changed with the use of technology.

Although the wide-spread interest in computers as an instructional tool did not occur until the 1980s, computers were first used in education and training at a much earlier date. Much of the early work which computers introduced in education was done in the 1950s by researchers at IBM, who developed the first Computer Assisted Instruction (CAI) author language and designed one of the first CAI programs to be used in public schools. Students followed the commands on the computer screen receiving rewards for correct answers within the framework of behaviorist approaches. In 1959, PLATO, the first large-scale project for the use of computers in education was implemented by Donald Bitier at the University of Illinois (Carter, 2003). Atkinson and Suppes' (1959) work led to some earliest applications of computers at both the public school and university levels during the 1960s. By the early 1980s many educators were attracted to microcomputers because they were relatively inexpensive, compact enough for desktop use, and could perform many of the functions performed by the large computers that had preceded them.

The dominant use of computer-based instruction in the 1980s was typified by the employ of "behavioral-based branching" software that based greatly on drill-and practice to teach programmed content and/or skills. The educational software that ran on the computers of the early 1980s were at first based on Skinner's "methods of branching": first separating into small sections, rewarding combined responses, and teaching disconnected facts. Although the learning is passive where learners do not work together with problems and content, research studies indicate that learner did advantage from the technology when the learning objectives were behavioral.

During the 1990s, computers eventually started to have a major impact on instructional practices in schools. With the help of advances in technology and learning, science researchers consider learning with technology as means for construction problem-solving skills and for achieving learner independence. The cognitive approach to instructional technology emphasized "looking at how we know rather than how we respond, and analyzing how we plan and strategize our thinking, remembering, understanding, and communicating" (Saettler, 1990, cited in http://www.ncrel.org/_tplan/cbtl/toc.htm, 2003). Besides, students would also to learn through playing games and simple simulations with the help of cognitive school of thought. The worth of using a word processor has been discovered by writing teachers and almost immediately students were using the advantages of word processor by writing, deleting, formatting and revising with effortlessness. Other subject matter teachers perceived the importance of the computer in creating a rich learning environment by using databases, spreadsheets, presentation, and research tools. Since 1995, rapid advances in computer and other digital technology, as well as the Internet, have led to a rapidly increasing interest in and use of these media for instructional purposes (Reiser, 2001). Swiftly there was a volume of information obtainable to students with a network of people all through the world that improved communication and the exchange of thoughts. Additionally, distance education courses are offered and in this way students in geographically isolated schools have extended learning opportunities in a diversity of subject areas. For example in United Nations, Kalu (2006) states “the proportion of instructional rooms with Internet access increased from 51 percent in 1998 to 93 percent in 2003” (p.3). Theoretical explanations could now be demonstrated and manipulated with the help of technology innovations. A complete innovative learning environment became possible.

Since the advent of the personal computers in the mid 1980s, computers have rapidly become one of the key instructional technologies used in both formal and informal education. The computer’s role has changed because of two factors: first, it can provide rich learning experiences for students and secondly, computer giving students the power to manipulate depth and way of their learning. Furthermore, teachers can use the computer as an aid to manage classroom activities; it has a multitude of roles to play in the curriculum which can range from tutor to student tools.

2.2 Roles of Computers in Education

At this point, I thought that it would be helpful to offer some descriptions of learning activities involving computers. In the domain of instruction there are four broad classes of computer applications:

- as an object of instruction,

- as a tool,
- as an instructional device,
- as a means of teaching logical thinking.

The computer may itself be the object of instruction such as in computer literacy course students can learn about how computers are used in society and in computer programming course they can learn how to construct a program by using programming languages. In its role as a tool, the computer assists both teachers and students, such as calculator, typewriter, and presentation aid. Students can use computers to solve complex mathematical calculations as a pocket calculator or students can use word processing programs to complete term papers and assignments. Both teachers and students can use data presentation software which incorporates with computers to present the content of the subject-matters. In addition to this, students can use a database for inquiry of specific information. Computer-assisted instruction (CAI) is the representative application of computers as an instructional device in instruction. For example, Math Blaster assists students in learning math facts (addition, subtraction, multiplication, and division) through drill-and-practice using an arcade game format. Finally, computers can be used as a means of teaching tool. For example, in his book, The Children's Machine, Seymour Papert (1993) offered that, the computer should be an "object to think with" not a dispenser of information.

Kulik, Kulik, and Bangert-Drowns (1985) defined the terminologies used by educators and researchers "computer-assisted instruction, computer-based education, computer-based instruction, computer-enriched instruction, computer-managed instruction" that can easily become puzzled by educators. The following definitions are a combination of those offered by the literature represent commonly accepted (although surely not the only) definitions of these terms:

Computer-based education (CBE) and computer-based instruction (CBI) are the broadest terms and can refer to virtually any kind of computer use in educational settings, including drill and practice, tutorials, simulations, instructional management, supplementary exercises, programming, database development, writing using word processors, and other applications. These terms may refer either to stand-alone computer learning activities or to computer activities which reinforce material introduced and taught by teachers.

Computer-assisted instruction (CAI) is a narrower term and most often refers to drill-and-practice, tutorial, or simulation activities offered either by themselves or as supplements to traditional, teacher directed instruction. In a traditional approach one can say that Computer Assisted Instruction (CAI) is an expression of any subject matter by using computers, or in general sense it is an acquisition of knowledge in a more simple way to the student by the learning-teaching activities with the help of computers.

Computer-managed instruction (CMI) can refer either to the use of computers by school staff to organize student data and make instructional decisions or to activities in which the computer evaluates students' test performance, guides them to appropriate instructional resources, and keeps records of their progress.

Computer-enriched instruction (CEI) is defined as learning activities in which computers (1) generate data at the students' request to illustrate relationships in models of social or physical reality, (2) execute programs developed by the students, or (3) provide general enrichment in relatively unstructured exercises designed to stimulate and motivate students.

After providing a short reminding of the applications of computers, there is a need to mention the computer assisted instruction and the utilization of CAI methods.

2.2.1 Defining CAI

Computer assisted instruction is concerned with the use of computers not only as a choice but to mediate the flow of information in the instruction process and the complementary means (Rushby, 1989; Uşun, 2000). CAI was utilized in the education as an educational medium in which delivers instructional activities in the late 1950s. Papert (1993) stated that "…programming the computer to administer the kinds of exercises traditionally given by a teacher at blackboard, a textbook, or a worksheet" (p. 5). Although the technology has been changing rapidly over the twenty years, computer-assisted instruction is still utilized in education. Drill-and practice, Tutorial, Games, and Simulation are commonly used CAI applications for educational purposes. Drill-and-practice programs lead learners through a series of examples to increase dexterity and fluency in a skill. Drill-and-practice is used predominantly for math drills, foreign language translation and vocabulary building. In these programs student is allowed several tries before the computer presents the correct answer. In computer-assisted tutorial applications that provide student different methods of answering a problem and immediate answers, exploratory software programs allow students opportunities to engage in mathematical investigations, and programming skills that develop logical reasoning in students.

Another type of computer application in education is simulating experimentations. In the simulation environment, students investigate simulations on the computer screen as a replacement for of observing and doing something real, either in a laboratory or in the field. For instance, one program popular in the early '90s was simulated a natural ecosystem. In this ecosystem simulation software, the students could change a number of characteristics of the habitat, the consequences of which were then played out for them to observe and from which they were to draw conclusions (Setzer & Monke, 2001).

In the tutorial mode, computers act as the teacher by presenting information in small units to the students and then reinforcing it with questions or tasks. Then computer analyzes the student's responses and gives feedback or remedial instruction based on his or her response. For example *Mavis Beacon Teaches Typing* is a tutorial program which guides students to learn touch-typing skills (Smaldino, Russell, Heinich, & Molenda, 2005)

The final mode is games. Smaldino et al. (2005) defines game as "…an activity in which participants follow prescribed rules that differ from those of real life as they strive to attain a challenging" (p. 121). Therefore, a game may or may not be instructional. If it contains academic skill practice then it is defined as an educational game. Game software provides elements of competition into learning activities. With computer games, students are competing against their own previous scores or against the designer of the game as they indicate their understanding of educational content. Game assumes that students have already gained the knowledge of the content and generally it is designed based on the time-limitation to encourage students to respond quickly (Ugwu, 2005). As an example, *King Arthur's Magic Castle* educational game was designed based on the problem solving strategies to emphasize entertainment (Smaldino et al. 2005).

The above modes of CAI are the ones that are widely used in the educational practices. However there are other utilization methods of CAI: such as Discovery and Problems solving programs. The goal of quality education seems to have the computers as new learning/teaching resource rather than a teacher's aid in the future. With the usefulness of Internet since 1990s, Distance Education, Virtual Reality (VR), Electronic-Books (e-Books), and Electronic Learning (e-Learning) have become the future of learning (Robertson, 2004).

2.2.2 Benefits of CAI

Although the research studies on the effectiveness of computers in the field of education reveals contradictory results, majority of the research studies indicates that CAI brings several possible advantages as a teaching/learning tool. The main strength of the computer as a learning medium is its ability to process information quickly. This makes it possible for the computer to accept and act upon a variety of different kinds of response from the learner and to provide information in textual, graphical, and animated form (Rushby, 1989). According to Kaput (1992), there are three advantages of usage of technology in teaching and learning mathematics; interactivity, connectivity and controlling of learning environments. Furthermore computer suggest opportunities for learner-control, improved enthusiasm, associations to the real world, and enhance student achievement as measured in variety of ways, including, but not exclusively limited to, "standardized achievement tests". Ertmer (1999) (as cited in Day, 2006) stated that "CAI benefits most students when compared with traditional instruction because it increases student interest, reduces anxiety, provides more time on task, and provides instant feedback for the student". Besides, CAI could also benefits students with the following: self-sufficient learning, independent learning, the exercising of various senses and the ability to represent content in a variety of media. In computer-assisted environment students can fix their pace of learning. That is to say, with self-paced learning, learners can progress as slowly or as quickly as they like through a program. In addition to this, if students want to replicate some task or review some material again, they can do so as many times as they wish. The program will not tire out or complain about repetitions as sometimes teachers do. Also, students can leave out a topic if content is already known or understood, making the learning process more efficient.

CAI provides a self-directed learning to students, and allows learners to become empowered to take increasingly more responsibility to choose, control, and evaluate their own learning activities which can be pursued at any time, in any place, through any means, at any age. Simply put, learners can decide what they want to learn and in what order.

According to Fletcher (1990), "people remember 20% of what they hear, 40% of what they see and hear and 75% of what they see, hear and do". Therefore, the more senses are used through which we obtain information, the easier to keep in mind. The fact that the computer can exercise various senses and present information in a variety of media can enhance the learning process. As a result, students can retain knowledge.

Further, CAI is visually attractive, when it presents concepts using demonstrations that are made attractive by animation, color, and sound. Besides this, computer-assisted instruction captures and holds the students' attention by providing opportunities for competition where the opponent is the student's previous performance (Mahmood, 2006). CAI also eliminates the misconceptions by providing immediate feedback, since immediate feedback prevents learning concepts incorrectly.

As Cotton (2001) indicated teachers can benefit from CAI since it can be programmed with concept, level and ability specificity; that is, the students are not challenged outside his or her demonstrated ability range, nor are they allowed moving to a higher level until they have mastered the level on which they are working.

2.2.3 Limitation of CAI

Although the computer-assisted instruction has been used in the educational systems of developed and developing countries over twenty years, there are limitations that have restricted the effective use of computers. These issues include: finance, lack of hardware and software, lack of teacher preparation and competency, limited number of educational software, and the lack of curriculum integration.

One of the important concerns of the implementation of CAI is how to finance it. Hardware and software are expensive entries for most of the poor school institutions. In the under developed and developing countries case this could be a big obstacle for the effective use of computers in the educational settings.

A significant concern for integration of technology into mathematics education is the teacher's negative attitude and the incapability to use it. Successful teachers in technology integration regularly make considerable changes in their teaching methods and in students' achievement (Roschelle, Pea, Hoadley, Gordin, & Means, 2000). Roschelle et al. (2000) also added, "One of the biggest barriers to introducing effective technology applications in classrooms is the mismatch between the content of assessments and the kinds of higher-order learning supported most effectively by technology" (p. 91). Beside this, there are limited numbers of qualified educational software in the markets.

As a last barrier to effective use of CAI is the curriculum integration. Curriculum integration is the use of computers to support and enhance learning and teaching in the mathematics lessons. Thus, computer-assisted instructional activities should be incorporated into national mathematics curriculum in order to have the benefits of CAI.

2.3 Mathematics Teaching on CAI

Technology has become a part of most of our activities in our daily life. Eventually it entered into educational arena as well as other fields. The use of technology in schools is growing in both technological tools such as computers and related software. Moreover, the new technological tools and related environments is growing in the general reform in mathematics education to provide more enjoyable and effective learning opportunities to students. In recent years much concentration has been focused on the improvement of mathematics education with the help of technology. However, there is a lack of agreement on why and how technology should be incorporated into the educational programs, what students should be taught and how to train educators to use technology. Before discussing how to integrate technology, it is necessary to talk about why technology should be integrated into mathematics. Two major reasons are the Curriculum and Evaluation Standards for School mathematics (NCTM, 2000) and the research. There are numerous research findings about the effectiveness of appropriate use of technology (Dybdahl, Donna, & Emily, 1997; Hsiung, 2003; Kulik, 1994; Laub, 1995; Roblyer, Castine & King, 1988)

Before integrating the computers and related technologies into education, teachers require to distinguish what is different about the new technology and what those differences mean in terms of cognition, learning, and teaching (Kaput & Rochelle, 1996). This procedure may lead to a better agreement among teachers as to the role technology should play in mathematics education.

Computers are used more widely in mathematics than in any other subject (Kober, 1992). The different potential of visually representing abstract mathematical ideas appears to offer promise to educators who comprehend the computer's capacities (Fey, 1989). Most of the applications of information technologies in daily life are related directly with mathematics such as computers used in supermarkets to produce a bill that provide a detailed information about the goods to the customers. Similar to this, one can find various types of integrations of computers in our life. Since the usefulness of computers and calculators to mathematics are inevitable then it is not surprising that the mathematics educators have to strive to make use of computers and calculators in their teachings.

Technology has the potential to expand and extend learning, affecting every aspect of a mathematics classroom. A description of 21st century mathematics classroom is a place where whiteboards are used for demonstrations and graphing calculators can be programmed to simulate transformations, evaluate computations and simplify calculations which could potentially make mathematics meaningful and accessible to all students (Robinson, Robinson, & Maceli, 2000, p.117).

Computer-based mathematics learning was emerged in 1960s from behaviorist principles and programmed instruction. Most of the educational software has been influenced by the behaviorist psychologist B.F. Skinner. Many educational psychologists found the behavioral approach unsatisfying and then there was a shift from behaviorism to cognitive approaches. This shift affects how computers are used as an instructional tool. This in turn allowed the computer to monitor the student progress and to pursue the development of higher order thinking skills and this relation between computers and students became more interactive (Breunlin, 1999).

“Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning" (NCTM, 2000). This statement is one of six principles of high quality mathematics education in the *Principles and Standards of School Mathematics* the NCTM. The use of the word “essential” in the statement has many suggestions for school mathematics, as well as preservice and in-service mathematics teacher education. Teachers are not the only stakeholders who charged with a vision of transforming their teaching and students' learning of mathematics, but teacher educators are challenged with the task of preparing teachers who can make use of technology as a crucial tool in developing a deep understanding of mathematics, for themselves and for their students. Beside this, IT is given a significant role in the National Curriculum for Mathematics of England (Ball, 1990). However, the role of the computer is always a controversial issue for the educators. Regularly computers are used inadequately, as a sort of electronic flash card, which does not make good use of the capacities of either the computer or the learner; though, computers can be used to help students develop mathematical practice of mind and build mathematical ideas.

Compared to traditional teaching methods such as lecture and discussion, Computer-Assisted Instruction (CAI) offers the important advantage of being able to adapt materials to the needs of each student. By this way, context can be varied to increase its meaningfulness to individuals (Ross & Anand, 1987; Ross, Mccormik, Krisak & Anand, 1985). This adaptation is further applied as learner's needs change over the course of a lesson.

The CAI models can be designed effectively to provide powerful and practical means of adapting context to student interests. A typical model's objectives can be to (Ross et al, 1985):

- personalize the context so that each student would receive a unique presentation
- orient the adaptive contexts to many different types of background and interest variables rather than to educational variables only
- automate the tasks of lesson preparation and administration

Mathematics teachers' knowledge about and experience with computers lead to provide concrete suggestions for the use of computers in mathematics teaching.

In order to represent, the comprehensive international comparison regarding student achievement and other factors related to science and mathematics performance, The International Association for the Evaluation of Educational Achievement (IEA) published a report namely *The TIMSS 2007 Assessment Frameworks* which was organized into three frameworks to explain the assessment design that served as the basis for implementing TIMSS 2007 at fourth and eighth grades. In the Contextual Framework section of the report, there were several parts that mentioned the importance and requirement of computers on the mathematics lessons. They also added;

> Computers and the internet provide students new ways to explore concepts at a depth that has not been possible in the past. These technological tools can trigger a new enthusiasm and motivation for learning, enable students to learn at their own pace, and provide students with access to vast information sources. (IEA, 2005, p.93)

Thus, it was planned to assess the computer and internet usage in mathematics classrooms and whether or not the curriculum document include policies about using technology on fourth and eight grades in the participated countries (IEA, 2005).

2.3.1 CAI in Mathematics Curriculum

The term "curriculum" is defined as "an -operational plan- for instruction that details what mathematics students need to know, how students are to achieve the identified curricular goals, what teachers are to do to help students develop their mathematical knowledge, and context in which learning and teaching occur" (NCTM 1989; Romberg, 1991). Mathematics is widely regarded as one of the most significant subjects in the school curriculum. Indeed, it is likely that more lessons of mathematics are thought in schools and college throughout the world than any other subject.

The decisions about what mathematics society wants students to acquire in schools and the assumptions made how students come to know that mathematics in classrooms constitute to one problematic area. The choice of mathematics to teach has varied with cultures. In classical Greek society, geometry and the logic of deductive arguments were emphasized (Heath, 1956); arithmetic calculations became important in 15^{th}-century Italy for commercial accounting (Swetz, 1987), algebra and calculus, for engineering in the 19^{th} century in Western countries (Freudentahal, 1973), and now mathematical modeling and computer-based computational and graphical procedures for our emerging information age (Steen, 1981). Mathematics has grown into a stupendous amount of subject matter. The largest branch builds on what is collectively called the real number system, which includes the ordinary whole numbers, fractions, and the irrational numbers. Arithmetic, algebra, elementary functions, calculus, differential equations, and other subjects that follow calculus are all developments of the real number system. Similarly, projective geometry and several non-Euclidean geometries are branches of mathematics, as are various other arithmetics and their algebras (Romberg, 1991).

Most of the studies that were related with the effectiveness of the computers are limited with the instruction. According to McCaffrey (2001), any changes to instructional practices have to be connected to the curriculum to obtain the effects on the students' achievement. Integration of technology into the mathematics curriculum is becoming more common in the schools. Although the currently available research studies provide the definite conclusions about the effectiveness of the integration of the technology in mathematics curriculum (Howard & Ann, 1998; Kapa, 1999; Noss, 1990; Wexler, 2000), there are many schools that are not using technology at all in the mathematics curriculum. At this point one question might arise inevitably: "How should the mathematics curriculum change to best make use of this new technology?"

Students use computers primarily as individualize tutorials activities which are exactly same with traditional paper and pencil exercises. In the case of traditional methods in mathematics teaching, it is obvious that mathematical concepts are usually being transferred in an abstract way.

The needed and the desired usage of the computers in mathematics classrooms are based on the using of the computer as a tool to promote student learning within the regular curriculum. To make the significant differences in the effectiveness of mathematics teaching, computers have to be integrated into the basic life of the mathematics lessons in a meaningful ways. Then, the only way to get the effective results of the utilization of the computers in mathematics lessons is the tying computer use to major curriculum goals.

The NCTM's Curriculum and Evaluation Standards for School Mathematics (1989) emphasizes about the subject matter topics and teaching methods that are desired in a contemporary mathematics curriculum for all students. NCTM's Standards document represented a new teaching material that makes likely and useful the vision of the rich computer-technology-enhanced mathematics curriculum. The council also included recommendations for the use of the available technology in the mathematics curriculum. Specifically,

> Technology, including calculators, computers, and videos, should be used when appropriate. These devices and formats free students from tedious computations and allow them to concentrate on problem solving and other important content. They also give them new means to explore the content. (NCTM, 1989, p. 67)

In general, research on integrating computer technology into the mathematics curriculum has shown many positive outcomes. The use of computers or educational software in the mathematics curriculum has enhanced students' understanding of mathematical concepts, increased their problem solving abilities, and improved their attitudes towards mathematics. Ball (1990) stated that usage of computers is appropriate within the National Mathematics Curriculum by giving the some reasons for using calculators and computers such as

- Computers and calculators can encourage an exploratory approach to the learning of mathematics.
- Computers and calculators can motivate and support problem solving.
- Computers and calculators can encourage both collaborative and independent learning.
- Computers and calculators can encourage students to talk about mathematics.

The use of technology and computer software in the classroom allows the students to discover and solve more real-world based problem situations, and beside this it also allows for extra time to be devoted to the development of higher order cognitive abilities, such as problem solving and conceptual understanding. It is believed that what is needed in a school mathematics curriculum is to take advantage of computer technology to assist students in becoming powerful and thoughtful "problem solvers." Moreover, it is hoped that computers can offer a connection between hands-on experiences and abstract learning. Thus children can learn about a topic through exploration and experimentation (Papert, 1980).

Shade and Watson (1990) affirmed that “only when computers are integrated into the curriculum as a vital element for instruction and are applied to real problems for a real purpose, will children gain the most valuable computer skill--the ability to use computers as natural tools for learning” (p. 12). By keeping computers isolated in separate rooms by removing them from the classroom and relegating them to labs, as Papert (1993) stated “schools have effectively minimized the potential impact computers can have on children's learning by turning the technology into a separate, unrelated subject area called *computer literacy*" (p.6). Proper incorporation emphasizes the interrelationships of the subject matters such as language, mathematics, science, as expected and essential for achieving the goal of becoming knowledgeable about a particular topic.

2.3.2 Role of Mathematics Educators

The integration of the new technologies to the education should be considered on the different bases; disciplines, teachings, teachers, learning, education environments and teacher training. According to Fouts (2000) the technology can be a main component for creating attractive new learning environments for students, depending on factors such as: teacher training, clear purpose, lower student to computer ratio; teacher ownership of the reform efforts; extensive teacher training and planning time; and high levels of technological support.

The mathematics teachers play a significant role to the integration of computers in mathematics education and teaching. There is a need to prepare teachers to integrate technology in their teaching activities. However, studies have indicated that mathematics teachers have been slow to introduce computers into their classrooms activities even when computers have been accessible (Rosen & Weil, 1995). Experienced teachers have some philosophical and educational reasons for rejecting the integration of computers into mathematics teaching (Norton, McRobbie, & Cooper, 2000). This is due to teachers’ beliefs and attitudes towards use of computers in mathematics learning and teaching play a significant role in the integration of computers into education (Yaghi, 1996).

A great deal of money has been spent on computers and software for schools and there is extensive concern for the lack of training for teachers to use these tools effectively. Even if suitable hardware and software are now available for private schools, one of the main ingredients is still missing: teacher training is far from sufficient. More computers and curricular materials related to the use of technology are being planted in schools.

Regardless of many research articles reporting the effectiveness of integrating instructional technologies with mathematics teaching, teachers are still not consistently using the technologies. The teacher training programs are expected to produce computer literate teachers since the effective use of technology in the classroom has received much attention in education. Recent tendency in teacher education have highlighted the value of learning with technology rather than learning about technology. This implies that teachers should learn to use a computer as a cognitive tool to enhance student learning of subject matters (e.g., mathematics, social studies, or science) rather than obtaining isolated skills in basic computing applications (e.g., word processing, database, spreadsheets, or hypermedia) or simply learning a specific programming language (Abramovich & Nabros, 1998). Therefore, to encourage the utilization of computers for students' conceptual development, mathematics teachers should learn how to use widely available software, such as spreadsheets, as a conceptual teaching and learning tool.

Niederhauser and Stoddart (2001) conducted a state-wide questionnaire survey in USA and examined the types of software that elementary school teachers used in their teaching, and their ratings of the effectiveness of computer use for different types of instructional purpose. Although the study was conceptualized in terms of a contrast between ‘didactic’ and ‘constructivist’ pedagogy, around half the respondents reported using both ‘skill-focused’ software (such as drill-and-practice) and ‘open-ended’ software (such as mathematical games, spreadsheets and Logo). Similarly, analysis identified teachers who viewed computer use as effective both in providing drill, practice and reinforcement, and in supporting analytic, creative and independent thinking (Ruthven & Hennessy, 2002).

Similar with other nations' education systems, Turkish Ministry of National Education has been trying to train teachers in integrating computers in their teaching, by providing intensive in-service training courses. In combination with this, all education faculties in Turkey have been providing computer courses for student teachers during their pre-service training period regardless of their disciplines since 1998 (YÖK, 1998).

2.3.3 Educational Software in Mathematics Education

There are various kinds of software that were specifically created for mathematics teaching and learning such as LOGO, *Coypu*, *Derive*, and *Mathematica*. As an example, LOGO is an open-ended, general purpose, discovery-based programming language developed by Papert to offer accessibility to a wide range of users for use as a catalyst in the classroom (Subhi, 1999). It employs turtle graphics to allow children to move the "turtle" (i.e., triangular cursor) or the screen by giving simple instructions (e. g., forward, backward, left, and right). Logo is designed to teach powerful ideas such as procedural thinking, concrete and formal operations, problem decomposition, and debugging through discovery learning in a microworld (Papert, 1980). Debugging may prove to be an especially meaningful concept for special educators, because the negative notion of committing an "error" is replaced with the positive action of finding a "bug" and making a correction. Papert (1980) indicates that problem solving-based LOGO environment can facilitate the acquisition of knowledge in the specific domain in which children construct mathematical concepts. Empirical findings have shown the effects of a LOGO environment on students' understanding of mathematical concepts. For example, children construct mathematical concepts of ratio and proportion with more perception with LOGO tasks than with abstract algebra tasks (Kapa, 1999). Other similar example is EZ LOGO, which is often used to bring in young children to geometric concepts in a playful way that is instinctive to them, just as one might use blocks to teach size and shape relations. Fifteen years ago people had access to computers mostly as programmers in numerically oriented languages. So computing power was mainly used in secondary mathematics education for numerical algorithms in the form of short Basic programs. Twenty years ago, another step but still in the algorithmic spirit was taken with LOGO on various home computers with its underlying philosophy of exploring mathematics in specially designed micro worlds and of learning mathematics by teaching it to the computer; LOGO also included the use of geometry and symbolic manipulations. Primary education was involved with these ideas, even on kindergarten.

Geometer's Sketchpad is a computer software that was designed to help students to learn and understand geometric concepts and principles (Jackiw, 1991). It has ability to record students' constructions as scripts and provides the process of learning and teaching mathematics by a remarkable way because the power of GSP combined with the power of proof gives a complete illustration of the theorem involved and the aspects of "doing" mathematics (Giamatti, 1995). Farouq (2000) conducted a study to investigate the effects of using GSP on students' understanding of geometrical concepts. The results of the study indicated that the scores of the posttest of the students in experimental group were significantly different than control group of students' scores in favor of experimental group.

The explosion of standard software on personal computers in the last twenty years gave way to new deliberations and experimentations, especially with spreadsheets, programs for data representation, statistical and numerical packages, and databases. At the beginning such software was complex and not very user-friendly. The need soon became obvious for special school adaptations that allowed "easy for use" so that even users with little training and only occasional practice could successfully handle them. This led to the construction of common and didactical software tools which sometimes also had a tutorial component, thereby integrating some traditions of Computer-Aided Instruction (CAI). All these forms of using the computer came into being in sequence but can now be found simultaneously in discussions about mathematics teaching.

School mathematics has responded barely at all to curricular changes that suggested indirectly by the computer revolution, even though the close logical link between mathematics and computing. Curricula, texts, tests, and teaching practices are all products of the pre-computer age but not the students. With CAI societies have the advantages to gain (NAP):

- School mathematics can become more like the mathematics people actually use, both on the job and in scientific applications.
- Weakness in algebraic skills need no longer prevent students from understanding ideas in more advanced mathematics. Computer can help make higher mathematics more accessible.
- Mathematics learning can become more active and dynamic, hence more effective. Computers are useful to focus on important concepts rather than routine calculation.
- Students can explore mathematics on their own, to ask and answer countless "what if" questions. Student-generated mathematical ideas can thrive.
- Time invested in mathematics study can build long-lasting intuition and insight, not just short-lived strategies for calculation. The balance of learning can be shifted toward understanding, insight, and mathematical intuition.

Research findings related to the software used for the learning of mathematics are discussed later. Most of the research findings revealed that dynamic software can be used successfully to help students for identifying relationships and making conjectures. Researchers expressed very positive feelings about the use of the dynamic software in the courses. Utilization of this kind of software enabled students to move, draw and manipulate objects, moreover they could also have the chance of visualizing the relationships.

Healey and Sutherland (1991) believed that spreadsheets prepared with excel can offer the potential to encourage pupils to explore and express mathematical ideas. Mayes (1995) compared students in traditional lecture classes in college algebra with students in classes using DERIVE which is a kind of demonstration device. Results revealed that, students who used DERIVE outperformed the tasks over those who were engaging with the traditional lecture classes with respect to visualization, problem solving and inductive reasoning. Similarly, Forgasz and Prince (2000) indicate that the most commonly used mathematics-specific programs in grades 7–10 in Victorian schools were Geometer's sketchpad and the CD-ROMs accompanying textbooks (15 teachers), followed by *Graphmatica* and *Maths Blaster*. The students' responses to the types of software used for learning mathematics corresponded closely with their teachers' responses.

2.4 CAI and Achievement

The widespread usage of computers by educators to support teaching has been dramatic over the last thirty years. A lot of research has been conducted on the effects of computer use on student achievement, attitude, and other variables. However, many educational stakeholders still continue to search the evidence on the positive effects of CAI on student learning before implementing the computer technologies into educational settings. In the case of TRNC, the researcher of this study belived to examine the available literature on the effectiveness of computer-assisted instruction which is an area that needs a concrete evidence to show the effectiveness of computers in education. Thus, the following serves to represent a sample of the studies on the impacts of computer-assisted instruction on achievement and learning.

There is a large enough data to show the usefulness of educational technologies that they are capable to improve the students' achievement. Most of the studies of computer use in mathematics education have largely examined clearly pioneering situations, usually linked to development projects of same type. Equally, the focus of these studies has been mainly on student cognition and computer interaction.

The meta-analyses of the 1980s produced the conclusion that, programs of computer-based instruction have positive evidence in the evaluation literature (Kulik, 1994). Similarly, Burns and Bozeman (1981) provides the results of a meta-analysis of 40 studies that compared the effectiveness of traditional instruction alone with a combination of traditional instruction and computer-assisted instruction on students' mathematics achievement. Results showed that the combined traditional-CAI approach was significantly more effective. Specifically they drew the following conclusions:

1. A mathematics instruction combined with the CAI was significantly more effective in developing student achievement, than was an instruction only traditional teaching methods with raising arithmetic achievement by .37 standard deviation
2. CAI with drill and practice were significantly more effective in promoting increased student achievement among high achievers and low achievers and in both elementary and secondary graders. Whereas the moderate achievers were effected by the supplementary CAI. (p.37)

Likewise, Hasselbring (1984) summarized results of research studies and meta-analyses on the effects of computer-based instruction on student achievement and attitudes, where results favor the use of Computer Based Instruction over traditional instruction.

Mevarech and Rich (1985), conducted a three-year study on the effects of CAI on disadvantaged third, fourth, and fifth grade Israeli students. The study divided the participants into two groups; one group receiving traditional mathematics instruction supplemented by CAI and the other receiving traditional mathematics instruction only. Results which compared the type of instruction to grade level and gender on the Israeli Ministry of Education's Arithmetic Achievement Test, showed that at all three grade levels, CAI students scored significantly higher on arithmetic achievement than students who received traditional instruction only.

Mokros and Tinker (1987) conducted studies to conclude how middle school students learn graphing skills through microcomputer-based laboratories. Results of the study pointed out that the scores on graphing items were significantly improved in students' ability to interpret and use graphs from pretests to posttests when the microcomputer-based laboratory were used.

Ganguli (1990) explored the effectiveness of the microcomputer in the form of demonstration tool on the achievement and attitudes. Participants of the study were college students in the intermediate algebra class in which two classes were taught chosen units with teacher-demonstrated microcomputer graphs and two classes were taught the same chosen units with graphs drawn by the teacher on the chalkboard. After completion of five weeks of teaching, a 16-item multiple-choice posttest was conducted; at the end of the quarter, a two-hour comprehensive examination was administered. Results of the study indicated that the treatment effect was significant for the comprehensive examination but not for the posttest.

The results of Cotton's study in the year 1991 (cited in Tran, 2001) was that the use of computer-assisted instruction, as a supplement to traditional, teacher-directed instruction, produces higher achievement compared to those to traditional instruction. Moreover, results were also valid for students of different ages and learning abilities in different subject matters.

Randel, Morris, Wetzel, & Whithill (1992) examined 68 studies in their review research conducted before 1984 on the difference between games/simulation and traditional instruction in student performance. Among all of the studies, only eight studies focused on mathematics. Results revealed that, in seven out of eight studies, use of games in mathematics lessons is superior to traditional instruction for improving math achievement. Kulik (1994) indicated that use of certain computer-based instruction programs raised student achievement at least 1.4 years after 10 months of use.

Lee and Smith (1995, as cited in Croom, 1997), using the results from the National Assessment of Educational Progress (NAEP), found that at schools where nontraditional "restructuring" practices were implemented, students had higher achievement scores in mathematics than students in more traditional schools. Similarly, Wenglinski (1998) found that advanced way of utilization of computers caused to increased student achievement in mathematics for both forth and eighth grade students.

In Parr (2000)'s review report on computer-assisted learning indicated that ILSs or any form of CAI has a significant impact on basic math skills acquisition on secondary school students.

Kulik (2003), a researcher at the University of Michigan, reviewed the evaluation studies in elementary and secondary levels published during 1990s. His research integrated the findings in 61 controlled evaluation studies in six areas: (a) integrated learning systems; (b) reading management systems; (c) writing programs for teaching reading; (d) word processing and Internet resources; (e) microcomputer based laboratories; and (f) science tutoring and simulations. Only 16 studies are reviewed for conclusions about the effectiveness of CAI using integrated learning systems (ILSs) on reading and mathematics achievement of elementary and secondary grade students. Seven of those studies examined mathematics learning alone whereas the remaining nine studies examined effects in both mathematics and reading. Kulik found ILS was at least as effective as traditional instruction. Effect sizes were changes between 0.14 and 1.05 (see Table 2.1). Of all studies McCart (1996)'s study was large enough to be considered educationally meaningful.

In their project Reimer and Mayer (2005) uses virtual manipulation through computer screen in mathematics for 3rd grade students to investigate the effects of using several virtual manipulative computer applets on students' achievement and attitudes for instructing the fraction unit. Results of students' interviews and attitude surveys pointed out that the computer-based virtual manipulative

1. helped students in the experimental group understand the fractions with the help of immediate and specific feedback
2. were much more easier and faster than paper-pencil based manipulative
3. improved students' enjoyment while learning mathematics
4. increased positive attitudes toward mathematics. (p.17)

Table 2.1.

Study features and effect sizes in 7 evaluation reports on integrated learning systems (ILSs) in mathematics

(Source: Kulik (2003))

Study	Duration	Grade level	Location	Source of ILS	Sample size	Achievement effect size
Clariana (1996)	1 school year	5	Western U.S.	Jostens Learning Corporation	873 students	0.40
Fletcher, Hawley, & Piele (1990)	71 school days	3,5	Canada	Milliken Math Sequences	79 students	0.40
Howell (1996)	1 school year	6-8	Georgia	Jostens Learning Corporation	131 students	0.14
Laub (1995)	7 months	4-5	Pennsylvania	CCC Success Maker	993 students	0.56
McCart (1996)	6 months	8	New Jersey	WICAT Systems	52 students	1.05
Spencer (1999)	5 years	2-3	Michigan	Jostens Learning Corporation	92 students	0.37
Stevens (1991)	1 year	3-5	Texas	Jostens Learning Corporation	180 students	0.54

Nguyen, Hsieh, and Allen (2006) described an experimental study with combination of qualitative and quantitative methods that was conducted to determine whether middle-school children in rural areas of Southern Texas given the experience of web-based assessment and practice would acquire mathematics skills and positive mathematics attitude. Nguyen et al. reported that the experimental group showed more improvement on problem solving skills, reducement anxiety in test taking and more motivation to learn mathematics, while the control group showed no noticeable change neither in performance nor attitude.

Meta-analysis research by Liao (2007), synthesize fifty-two research studies comparing the effects of computer-assisted instruction (CAI) versus traditional instruction (TI) on students' achievement in Taiwan. Results of the study indicated positive effects of CAI in instruction compared to traditional instruction in Taiwan. The author added that the findings of the study revealed that CAI is benefical for the students in developing countries such as Taiwan.

2.5 Effects of CAI on Student Attitude toward Mathematics

Wlodkowski (1995) stated, "A useful functional definition of an attitude is that it is a combination of a perception with judgment that often results in an emotion that influences behavior." (p. 73). Several authors identified the relationship between attitude and learning (Allen, 1986; LeFrancois, 1994; Hamby, 1986). Wlodkowski (1995) added, "The learner attitudes towards the general learning environment, instructor, subject matter, and self" are main elements of learning process (Wlodkowski, 1995, p.21). Attitudes toward mathematics, refers to the level of like or dislike felt by an individual toward mathematics (Aiken, 1963).

A strong command of meaningful mathematical content and a positive attitude toward the subject are critical attributes for educators charged with teaching mathematics. Student's belief that mathematics has utility in his or her life and the teacher's belief that students should be active participants in learning and doing mathematics are important components in building an affinity to mathematics.

The assessment of attitudes toward mathematics would be of less concern if attitude were not thought to affect performance in some way. The connection between attitudes and performance is definitely the result of a mutual effect, in that attitudes influence achievement and achievement in turn influences attitudes (Neal, 1969).

Bernstein (1964) maintained that if certain feelings are experienced for a time they will lead to a particular self-image on the part of the student, a self-image which will influence his expectation of future performance and affect his actual performance. The relationship of attitudes, which are integrally related to expectations, to performance appears to be especially important in mathematics learning. Brown and Abell (1965) showed that the correlation between student attitude toward a subject and achievement in that subject was higher for arithmetic than for spelling, reading, or language (Aiken, 1970).

Extensive data was collected from an international study performed by Husen (1967) to assess the mathematics achievement of students in a dozen countries. In that study attitude of students towards mathematics is analyzed in relation with the personality and social factors such as anxiety, intellective factors, social factors, parental influences, and sex differences.

The literature published since 1992 also affirms that affective factors and beliefs impact on student learning: in general positive attitudes and beliefs and intrinsic motivation are reflected in increased effort in learning and greater persistence. McLeod (1992), who provides a careful analysis of previous research on affect in mathematics education, is adamant that affective matters play an essential role in mathematics learning. Besides, mathematics education research can be strengthened if researchers integrate affective issues into studies of cognition and instruction. In addition to this, newly published research reports have pointed out that changes are needed in the means of mathematics teaching. Conventional methods of instruction do not transmit mathematical problems to the reality of world, assist students think about pragmatic situations, or facilitate students to produce and pose their own explanations. Consequently, students may become unenthusiastic and unrelated with developing an overall negative attitude towards mathematics and technology.

In recent years much concentration has been focused on the restructuring of mathematics education with the help of technology. Students who can occasionally use computers as supplementary tools during the classroom hours in mathematics course developed more positive attitudes toward mathematics. As Cotton (1991) indicated the use of CAI compared to traditional instruction leads to more positive student attitudes. Shapiro (1962) found that perseverance toward solutions to arithmetic problems was higher in elementary school children who like mathematics more than in those who disliked it; girls as a group were more persevering than boys.

Foley (1987) designed a study on the effects of using a CAI model in the two general mathematics courses at high school level. Results of that study for a period of nine weeks on the achievement of students indicated that the CAI model used would not make a significant difference in mathematical achievement. But a similar study by Hurts (1986) stated just the opposite results with Foleys'. Hurts showed that CAI model applied for three months had a significant effect on academic performance of students in a mathematics lesson. Perhaps, the only difference between the two cases, that is a slight difference in the duration of the CAI model applied, may be considered as the main reason for the controversy of the results of the two studies. Another important reason can be considered as the previous background of students about computers and their attitudes towards the computers.

Glikman (2000) investigated student attitude toward mathematics that were exposed to CAI in a college level Intermediate Algebra course. Results indicated that CAI students had gained more confidence and had less anxiety towards mathematics whereas students in the traditional instructional group had no significant change in either confidence or anxiety at the end of the experiment.

Similarly, the study conducted by Akinsola and Animasahun (2007) comparing the achievement and attitudes in a secondary school mathematics course using a CAI group and traditional taught group, showed that CAI based simulation- game environment group had more positive attitudes towards mathematics when the experiment was completed.

2.6 Effects of CAI on Student Attitude toward Computer-Assisted Learning

In introducing computer-assisted instruction tools a method of teaching in schools, it becomes important to investigate what attitudes students have regarding computer-assisted learning. Looper (2006) defined the attitude as "...a mental position relative to a way of thinking or being". Shaw and Wright (1967) described attitude as "an enduring predisposition to behave in a consistent way toward a given class of objects".

According to Ruffin (2000), students' positive attitude toward CAI plays a key role for the success of CAI implementation. Most of the researchers were concentrated on the "attitude toward computers" as a demographic variable in the CAI related studies. For example, Kulik and Kulik conducted a meta-analysis study in 1991 to investigate the relation between computer-based instruction and achievement, attitudes. Results showed that CBI usually produced positive effects on learners of all ages, from children to adults. The authors also add, CBI produced small but positive changes in student attitudes toward teaching and computers.

In his dissertation study Bush (1991) hypothesized that "students utilizing CAI will have a significantly higher positive attitude-toward computer-attitude instruction than non-computer user" and the statistical analysis resulted in no significant differences between the groups which did not support the overall literature suggesting that attitudes towards computers will improve if subjects have experienced computer-assisted instruction as a form of treatment.

Szabo and Poohkay (1996) investigated the effects of animation in a geometry lesson and on the students' attitudes towards the CBI. Three groups of students were participated in the study: text-only group, text with static graphics group and texts with animated graphics group. The animation group outperformed both of the other group on the posttest scores. However, attitudes toward CBI were higher for both of methods including illustrations when compared to the text only format (as cited in Sundruck, 2003).

Ruffin (2000) investigated the relationship between demographic variables and student attitudes toward computer-aided instruction. Attitude toward computers, average daily exposure to computers and computer-literacy courses are the significant variables that influence the attitude toward CAI.

Another study which was conducted by Vale (2001) support Ruffin's study, results of the study indicated that the length of time using computer in mathematics and the nature of the learning environment are two factors that impact the students' attitude toward computer-based mathematics. Furthermore, analysis of the study revealed that girls who rate themselves highly in "achievement in computing" are more likely to have a positive attitude towards computer-based mathematics although the overall results showed that girls perceived the CBL environment less favorably than boys.

2.7 CAI and Retention

Duration of active learning and distributed practice of academic content has influenced the level of academic retention (Belfiore, Skinner & Ferkins, 1995). The level of retention of mathematical knowledge also depends on the type of teaching method. Instructional methods that allow students to participate actively to learning process are the only significant variables which has an impact on the long-term retention. Lecture continues to be the most prevalent teaching mode in secondary and higher education; despite overwhelming evidence that it produces the lowest degree of retention for most learners. According to "Dale's cone of experiences" the highest retention rates are devoted to discussion, practicing by doing, and teach others with the respective percentages 50%, 75% and 90% (Lalley & Miller, 2006).

In one of the earliest study Edwards, Norton, Taylor, Weiss and Dusseldorp (1975, as cited in Spies, 1997) stated that only three research studies among 33 investigated the retention as a research variable in the frame of computer-assisted instruction. Results indicated that traditional is superior to CAI.

Hawlwy (1984) indicated that computers had a short term impact on mathematics achievement which was not maintained one month later. Cartnal (1999) compared the two different teaching methods based on retention rate and results indicated that no significant difference in students' retention mean scores for traditional and computer-assisted mathematics course. A study by Tawfik (2005) supports these findings that there were no significant relation between method of instruction (tradition instruction vs. CAI) and retention.

Contrary to the above results, Brenluin (1992) conducted a study to examine the effects of computer-aided instruction on the understanding and retention of polygonal areas concepts in high-school geometry. The results of the study indicated that the rate of retention decay was significantly slower for the experimental group on all abiliy levels (remedial, average, and accelerated). Further statical analysis revealed that the experimental group posted higher overall retention scores. Similarly, Speis (1997) indicated that the generative approach with CAI is much more effective on the student's retention of multiplication facts over long term.

2.8 Research on CAI in Turkey

As mentioned above computers' use is in increasing all over the world. In the last three decades, computer technologies have developed rapidly and intensively. By this swift growth, integratation of information technologies into the teaching and learning activities has become possible and finacally manageable. These advancements of computer technologies have changed the instructional strategies that the teachers followed in their lectures and the ways students learn. Various schools, including those in Turkey, are now moving towards using computers to improve the quality of teaching and learning. Instructional technology is a newly developed field in Turkey. It was the last few decades that some attempts have been made both by graduates of universities and MONE.

There are many studies in Turkey's education system that support the effectiveness of computers at different grade levels and subject areas mainly science education, physic education and mathematics education. Several studies with different outcomes will now be explicitly shown. For example in science education case, a study conducted by Yalcinalp, Geban, and Özkan (1995) investigated the effectiveness of computer tutoring program on student achievement and attitudes in a secondary school in Ankara, Turkey. Subjects were the 101 eighth grade students in a general science course. Students were randomly assigned into two groups by researchers. The experimental group was consisted of 51 students and the control group was consisted of 50 students. Students in the experimental group exposed to the researcher-developed tutorial program about mole-number-mass interrelations in elements and compounds instruction. Computer-based tutorials were lasted two hours per week and the total intervention was lasted four weeks. On the other hand, students in the control group received the recitation sessions during the same period. Results of the study indicated that, the experimental group of students outperformed the control group of students on the achievement tests and the attitude scales. Addition to these, effect size of the chemistry concepts test was 0.42 and the effect size of the attitudes toward chemistry scale was 0.33.

Yıldırım, Özden, and Aksu (2001) conducted a study on chemistry education related to the acquisition of knowledge and retention. The study was compared the traditional teaching media and hypermedia learning environments in the chemistry lesons of the selected units. Pre, post test and delayed post test of the treatment-control group design were used in the study in order to investigate the effect of hypermedia learning environment on the stusnets' achievement in mathematics. Results of the study indicated that students' chemistry achievement increased with the hypermedia learning environment.

Similarly, an experimental study conducted by Altın (2002) to search the effects of using Computer Assisted Experimental Method and Concept Mapping Method in two different ways on the : in the separate classes and in the same class level of the high school students. The dependent variables of the study were the achievement, the concept learning and the retention. Results of the study revealed that using Computer Assisted Experimental Method while teaching physics had positive and significant effect on high school students' achievements. The results of post-test showed that mathematics achievement mean scores of the students who were exposed Computer Assisted Experimental method were significantly higher than the students in the control group where they followed the traditional teaching methods namely lecturing. The study also indicated that using Computer Assisted Experimental Method while teaching physics had positive and significant effect on students' concept learning. Additionally, a significant difference in the level of retention was found between the experimental groups and the control group in favor of the experimental groups.

Sezer (1989) investigated the effectiveness of the CAI on the mathematics achievement of 5^{th} grade mathematics students. The study concluded that the group of students, which was educated by computers, had higher achievements when compared to the group, which was educated traditionally.

Tanaçan (1994) compared the effects of CAI with the Traditional Based Instruction (TBI) in 7^{th} grade related to first degree equation with one unknown. He concluded that the gain scores of the mathematics achievement test on equations unit were significantly higher in the group of students who was exposed to CAI than the group of students who was exposed TBI.

A study conducted by Erdoğan (2000) revealed that computer-based concept mapping teaching method is highly effective in increasing the achievement of mathematics comparing to conventional teaching methods.

The qualitative study by Budak (2000) investigated the effects of computer-assisted instruction on the 9^{th} grade students' mathematics performance on the numbers. Based on the document analysis of the observations and interviews suggest that computer assisted instruction can be used to improve students' inquiry and problem solving abilities. The author added that computer-assisted instruction tool effect the experimental group of students' achievement on numbers compared to control group of students' achievement.

Nazlıçiçek (2000) aimed to improve problem solving performance of 8th grade students in probability using computer-assisted instruction. Instructional software that was developed for the study was used for solving probability problems in three knowledge bases: domain-specific, general and strategic knowledge. Results indicated that the mean score of post-test results were significantly higher than pre-test results both for the conceptual and algorithmic part. At the end of the study, it was shown that computer-assisted instruction was effective on increasing student's performance as well as fostering conceptual development on probability.

Önder (2001) assessed the effectiveness of computerized instruction compared to traditional instruction methods on the 7th grade students' achievement in geometry lessons. One group with 31 students was designated as the experimental group and one group as the control group, with a total sample consisting of 62 students. The experimental group was given CAI in geometry topics for a four lesson hour period using LOGO writer (version 2.0) and Ms Excel courseware. The control group was taught the same geometry topic using traditional instructional methods. An analysis of pretest and posttest scores revealed that the experimental group improved its achievement tests scores.

In another research carried out by Işıksal (2002), it was mentioned that the students who followed the Autograph Based Instruction had significantly higher achievement scores than students taught by traditionally based instruction. Likewise, Işıksal and Aşkar (2005) conducted a study to investigate the effectiveness of spreadsheet and dynamic geometry software on the mathematics achievement and mathematics self-efficacy of 7th grade students. The researchers explored two computer programs: Autograph and Excel and traditional instruction. They found that Autograph group of students and traditional group of students had significantly greater mean scores than the Excel group of students with respect to mathematics achievement. When they compared the Autograph based instruction and traditional instruction then the results revealed that Autograph group had significantly greater mean scores than the traditional group. However, there was no significant mean difference between the three groups with respect to mathematics self-efficacy.

Akoğlu (2003) conducted a similar study with the current study for 4^{th} grade students on the fraction unit. The experimental group of students was instructed with computer-assisted instructional tool by using computers. The control group of students did not use the computers and worked on more conventional teaching methods such as lecturing. Pretest and posttest were given to both groups. The results showed that the students in the CAI group scored significantly higher on the posttest. Additionally, Akoğlu indicated that CAI was also effective on the students' motivation and individual learning pace.

Yenitepe and Karadağ (2003) stated that Computer-Aided Teaching had significantly positive effect on students' achievement on trigonometry unit comparing to conventional teaching in mathematics lessons. Another study of similar type was conducted by Çoban in 2001 who found that utilizing CAI with handouts was more effective than both CAI without handouts and traditional instruction. However, Çoban indicated no significant change in attitudes towards mathematics for all groups.

Another study on the effects of computer-assisted instruction on students' achievement and retention was prepared by Akın Efendioğlu (Efendioğlu, 2006). Similar to current study Efendioğlu's subjects were 107 fourth grade primary students in Emine Sapmaz Primary School in Adana, Turkey. One classroom was randomly assigned as an experimental group to study geometry with computer based instruction tutorial (CBIT) method. The randomly assigned second classroom was served as a control group and they followed the same geometry unit with whole class teaching (WCT) method. Efendioğlu gave each group pretest and posttest. The intervention period lasted three weeks. The group that received the computer-based instruction with courseware on the geometry topics: triangle, square, rectangle scored significantly higher on posttest than the group that did not receive the computer-based instruction. The author draws the same conclusion with the current study that no significant difference on the retention test was found between those students who received the CBIT and those who received the WCT.

Baki and Guveli (2007) conducted a study to develop a web-based mathematics teaching (WBMT) material and to evaluate the effectiveness of the WBMT material for 9th grade students learning the concept of functions. Although the results of the posttest scores revealed no significant difference between the control group and the WBMT group, they concluded that the educational technology in the form of WBMT does not negatively affect learning.

A recent thesis study conducted by Yigit (2007) used a pretest-posttest design to evaluate the impact of educational computer games on 2nd grade students' mathematics achievement and retention. The educational software Tux Math Scrabble and Treasure Hunt Math were used in the experimental group and paper and pencil based traditional methods were used in the control group. Forty-seven students participated in the study. The experimental group of 22 students received 4 lesson hours of instruction using educational games. A control group of 25 students was taught four operations using traditional instruction methods for total 4 hours. At the end of the study, posttest compared achievement scores of both groups and indicated that the using educational games did not lead to higher test scores. Similarly with the current study, retention test conducted after two weeks of the completion of the intervention. Although the results of Yigit's study did not produce any significant differences, there was evidence that the educational games used mathematics lessons had a positive impact on students' mathematics performance.

A few examples of studies about CAI, which have been conducted to explore the effects of attitudes towards mathematics in Turkey, show an agreement with the other studies stated before. Köksal (1988), who performed a pre-test post-test control group design in a study that is conducted to investigate the effect of CAI on mathematics achievements of students and their attitudes toward computer and mathematics, find out that scores of the students in CAI group was significantly higher than the students in traditional instruction groups.

In his thesis study, Kılıç (2007) compared three instructional approaches: traditional instruction versus Webquest assisted cooperative learning versus cooperative learning method on teaching mathematics to fifth graders. The study lasted one academic year with 67 fifth grade students. Results of the study revealed that the Webquest assisted cooperative group's achievement and attitudes were significantly higher than those in traditional and cooperative learning method groups.

A similar study with the current research which was conducted by Gökcül (2007) investigated the effects of computer-based instruction that was designed according to Keller's ARCS motivational model on the academic achievement and retention in 6^{th} grade mathematics lesson. Results indicated similar findings with the current study that the control group (traditional instruction) outperformed the experimental group (CAI) on the retention test performance.

Since the advancements in technology are inevitably reflected in educational systems, some competitive schools in Turkey have completed their hardware and software needs to utilize the information technologies in education (Ertkin & Gülseçen, 2001). There is significant amount of research in Turkey that suggests computer-assisted instruction improved student achievement, in general, and in mathematics achievement, in particular. Similarly, much of this research has shown that CAI promotes more positive attitudes towards the subject matter being taught. In the case of retention, findings of research studies have been little bit problematic and varied. However, the use of computer software in Turkey's primary and secondary education is still at an early stage. The lack of financial resources, lack of appropriate planning, and lack of adequate software are some of the major problems that need to be overcome.

2.9 Summary

The above is a part of broad literature that is thought to be necessary to have a general theoretical and conceptual background on the computer usage and effectiveness in the field of education particularly in the mathematics teaching and learning activities. Technology has great impact on every dimension of our daily life.

Education is just one of these areas where computers were introduced as a teaching tool for the enrichment and support of subject matters. With the help of computers, students are expected to improve their understanding, creativity, problem solving skills, and retention. Thus they will have a chance to be more active learner.

Literature provides considerably much empirical findings about the effectiveness of computers against conventional style of teaching in the classrooms all over the world. Both the national and international studies strongly suggest that the positive relationship between the use of computer-assisted instruction and student achievement (Cotton, 1991; Ersoy, 2002a; Gökcül, 2007; Kulik, 2003; Papert, 1980; Parr, 2000; Uşun, 2006).

Unlike the broad evidence in the world wide context, there is no such a scientific study in TRNC to investigate the integration of computers in education. Based on the works of a number of studies in the world, it was hypothesized that the introduction of educational software in mathematics lessons will provide viable alternative for enhancing learning in mathematics lessons in TRNC mathematics lessons. In this way it is assumed to prevent the possible educational problems and to enhance the students' achievement, attitudes and retention in 4^{th} grade mathematics lessons.

CHAPTER III

METHOD

The purpose of this study was to examine the impact of computer assisted instruction with the software *Frizbi Mathematics 4* on fourth grade students' achievement, attitudes and retention in mathematics lessons. This chapter presents the methodology of the study. First, the overall design of the study is presented, and this is followed by research questions, hypotheses, sample of the study, variables of the study, and data collection instruments. Then, data collection and data analysis procedures are explained. Finally, limitations of the study are discussed.

3.1 Overall Research Design of the Study

In this study quasi-experimental research design was used in order to investigate the impacts of the *Frizbi Mathematics 4* educational software on the 4^{th} grade students' mathematics achievement, mathematics attitude, computer assisted learning attitude, and retention. A quasi-experimental research design was utilized becouse random assisgnment of subjects to the experimental and control groups was not possiple in the current study.

Similar to the great amount of research studies on the impacts of computer assisted instruction, this study is also based on the quasi-experimental research design where the researcher analyzes the effects of independent variable on one or more dependent variables (Fraenkel & Wallen, 2000). The computer-assisted instruction implemented in the experimental group was the independent variable and the dependent variables were: achievement, attitudes towards mathematics, attitudes towards computer assis- -ted learning and retention.

During the study in the experimental group computer-based instruction using computer-assisted, drill-and- practice software called *Frizbi Mathematics 4* was used as a supplementary teaching tool. On the other hand, the control group was instructed through traditional teaching method during the study.

The study was set in a state primary school, “Sht. Osman Ahmet” primary school in TRNC. Among 47 state primary schools, this school was chosen deliberately because this was the only state primary school with a computer laboratory. All fourth grade students (N = 55) were the participants of this study throughout the spring semester of the 2005-2006 academic year.

The students were assigned to two classes randomly by the school administration when they started the 4^{th} grade and the classes were heterogeneous. One of the classes was named “Yellow” with 28 students and the other class was named “Red” with 27 students with two different mathematics teachers, one for each class.

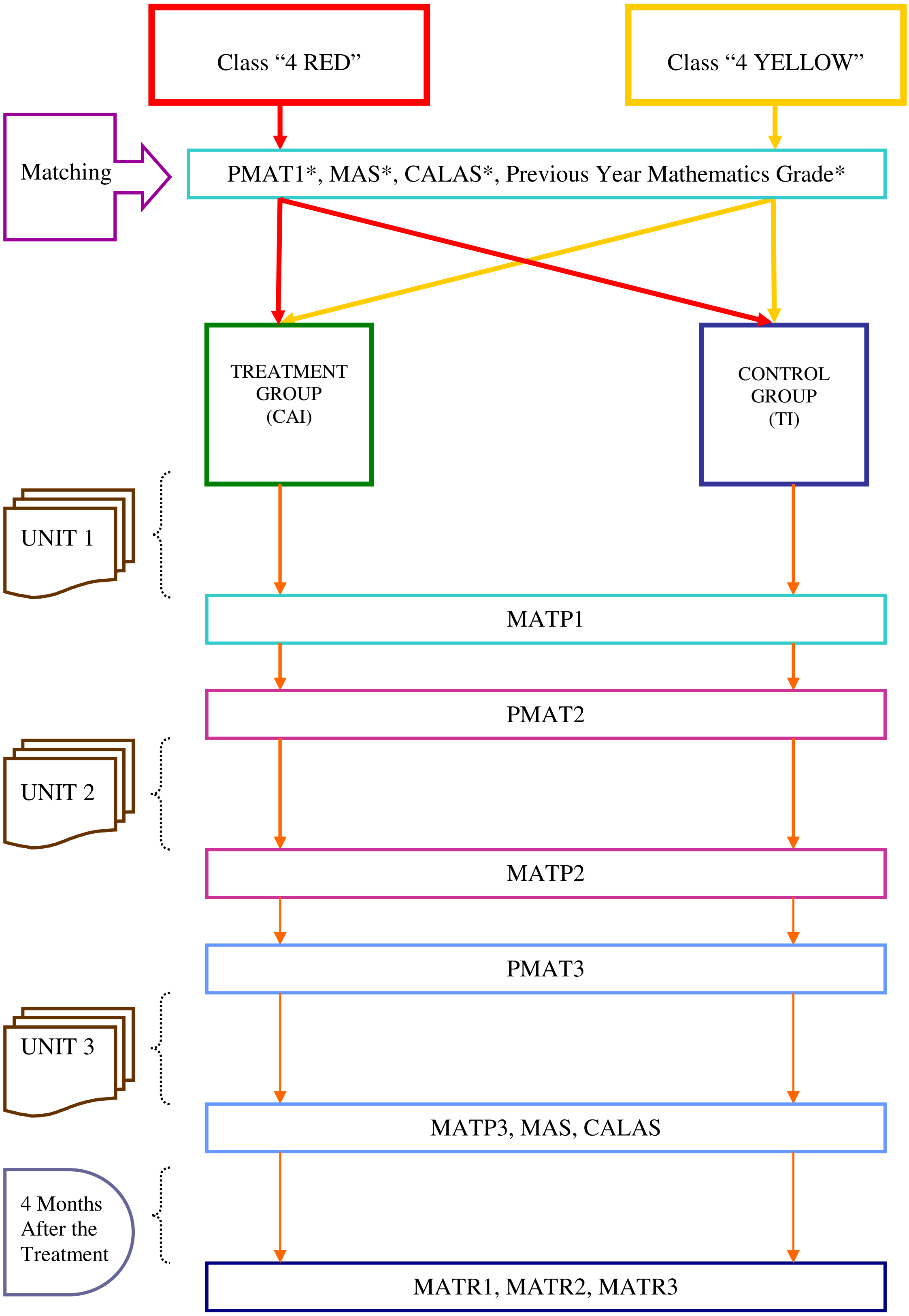
At the beginning of the spring semester, all the participants (students from the class “Yellow” and the class “Red”) were divided into two groups, experimental and control, by using the matching-only pretest-posttest control group design method to ensure the group equivalence (Fraenkel & Wallen, 2000). While selecting the members of each matched pair, the following matching variables were taken into consideration: students’ previous year mathematics achievement grades, pre-Mathematics Achievement Test 1 scores (PMAT1), Mathematics Attitude Scale (MAS) scores, Computer Assisted Learning Attitude Scale (CALAS) scores and the experience of the class teachers. In order to select students to be in the groups (experimental and control) matching variables were combined and put into a formula (*matching score* = 0.4 × (previous year mathematics grade) + 0.3 × (PMAT1) + 0.2 × (MAS) + 0.1 × (CALAS)) to obtain a standard score for each student. Then students who have the same score were assigned either to the experimental or to the control group. Therefore, based on pre-test results a group of students are formed for the experimental, which serves as the experimental group, and the matched pair of the students formed the comparison group, which serves as the control group. That is to say, each matched pair of student in each class (Yellow and Red) was assigned either to the experimental group (CAI) or to the control group (TI) according to their previous year mathematics grades, pre-test achievement scores, mathematics attitude scale scores, computer assisted learning attitude scale scores and the experiences of the class teachers. The 3rd grade mathematics achievement scores of the subjects were obtained from the grade report forms of the school records. The mean scores of *matching scores* of control and experimental groups were not significantly different at .05 level. After the mechanical matching was completed for the entire sample, equivalency of each group was checked on each matching variable (Fraenkel & Wallen, 2000).

The study was carried out during the spring semester of the 2005-2006 academic year. Spring semester commences in middle of February and continues till the beginning of June. The curriculum offers 15 weeks for teaching and 6 lesson hours in a week is devoted for mathematics lessons. Among 6 lesson hours of mathematics lessons, 4 hours were devoted to the unit explanation and both experimental and control group of students received the instruction on the treatment units by the teachers. All the students were taught the same mathematics content with the same textbook in the same period of time and the content of each unit was presented with traditional teaching methods based on the text-book “4.Sınıf Matematik Ders Kitabı” (Cankoy, 2005). After the unit was presented by class teachers, the experimental group did the exercises with the educational software *Frizbi Mathematics 4*, whereas control group with the text-book and/or teacher-made text materials. Experimental group was guided by the researcher twice a week however, the rest of the students which serves a control group was taught by the class teachers. The students in the control group were also allowed to work with the software *Frizbi Mathematics 4* after the retention tests were administrated in order to eliminate their deprivation and demoralization.

The study was carried on three units: “Multiplication of Natural Numbers”, “Division of Natural Numbers” and “Fractions”. At the beginning of each unit, a mathematics achievement test was given as a pretest (PMAT1, PMAT2, and PMAT3) and at the end of each unit; a mathematics achievement test was given as a posttest (MATP1, MATP2, and MATP3) to both the experimental and control groups. In addition to the achievement tests, mathematics attitude scale (MAS), and computer assisted learning attitude scale (CALAS) were also implemented to the students of both groups both at the beginning and at the end of the study.

Four months after the completion of the treatment, both groups were once more given the achievement tests (MATR1, MATR2, and MATR3) in order to assess the retained mathematics achievement.

Figure 3.1 summarizes the overall research design that was followed throughout the study and provides figural demonstration of the group structures and the implementation of instruments.



* administered at the beginning of the treatment and they were used to match subjects

Figure 3.1. Figural representation of research design of the study.

3.2 Research Questions

The purpose of this study was to find out the effects of computer assisted instruction on 4th grade students' mathematics achievement in immediate and retained periods. Additionally, the study also aimed to find out the effects of computer assisted instruction on students' attitudes towards mathematics and computer assisted learning. Particularly, this study aimed to answer the following research questions.

Research Question 1: Is there a significant difference between the achievement posttest scores of the students exposed to Computer Assisted Instruction with the *Frizbi Mathematics 4* and those who were exposed to traditional instruction with textbook?

Research Question 2: Is there a significant difference between the mathematics attitude scale post scores of the students exposed to computer assisted instruction with *Frizbi Mathematics* 4 and those who were exposed to traditional instruction with textbook?

Research Question 3: Is there a significant difference between the computer assisted learning attitude scale post scores of the students exposed to computer assisted instruction with *Frizbi Mathematics 4* and those who were exposed to traditional instruction with textbook?

Research Question 4: Is there a significant difference between the retention test scores of the students exposed to computer assisted instruction with the *Frizbi Mathematics 4* and those who were exposed to traditional instruction with textbook?

3.3 Hypotheses

The research questions stated above were tested with the following hypotheses that are stated in null form.

Null Hypothesis 1.1: There is no significant difference between the achievement post test scores of the students exposed to computer assisted instruction with the *Frizbi Mathematics 4* and those who were exposed to traditional instruction with textbook on unit 1: “Multiplication of Natural Numbers”.

Null Hypothesis 1.2: There is no significant difference between the achievement post test scores of the students exposed to computer assisted instruction with the *Frizbi Mathematics 4* and those who were exposed to traditional instruction with textbook on unit 2: “Division of Natural Numbers”.

Null Hypothesis 1.3: There is no significant difference between the achievement post test scores of the students exposed to computer assisted instruction with the *Frizbi Mathematics 4* and those who were exposed to traditional instruction on unit 3: “Fractions”.

Null Hypothesis 2: There is no significant mean difference between the mathematics attitude scale post scores of the students exposed to computer assisted instruction with *Frizbi Mathematics 4* and those who were exposed to traditional instruction with textbook

Null Hypothesis 3: There is no significant mean difference between the computer assisted learning attitude scale post scores of the students exposed to computer assisted instruction with *Frizbi Mathematics 4* and those who were exposed to traditional instruction with textbook

Null Hypothesis 4.1: There is no significant difference between the retention test scores of the students exposed to computer assisted instruction with the *Frizbi Mathematics 4* and those who were exposed to traditional instruction with textbook on unit 1: “Multiplication of Natural Numbers”.

Null Hypothesis 4.2: There is no significant difference between the retention test scores of the students exposed to computer assisted instruction with the *Frizbi*

Mathematics 4 and those who were exposed to traditional instruction with textbook on unit 2: "Division of Natural Numbers".

Null Hypothesis 4.3: There is no significant difference between the retention test scores of the students exposed to computer assisted instruction with the *Frizbi Mathematics 4* and those who were exposed to traditional instruction with textbook on unit 3: "Fractions".

3.4 Description of Variables

There are five variables in this study. One of them is independent variable, and four of them are dependent variables. These variables are as follows:

Independent variable: Treatment (Instructional Method): Computer Assisted Instruction (CAI) with *Frizbi Mathematics 4*.

Dependent variables*:* (a) Mathematics achievement, (b) Mathematics attitude, (c) Computer assisted learning attitude, and (d) Retention.

3.5 The Educational Software: Frizbi Mathematics 4

The *Frizbi Mathematics 4* was developed jointly by Halıcı Group and Koç System in 2003. This instructional software is a dynamic creation and investigation tool that enables students to explore and understand mathematics in alternatives ways, which is not so easy with the traditional tools. *Frizbi Mathematics 4* is an educational tool that was designed basically to support the 4^{th} grade mathematics teaching and learning activities. *Frizbi Mathematics 4* was created by considering basic teaching methods that respond to cultural, psychological and cognitive needs of target group, as well as the contemporary teaching and learning methods which help students to gain the positive attitudes towards mathematics.

Frizbi Mathematics 4 starts with an enjoyable animation-story and the overall design of the software is oriented around the general problem solving strategies, interactive exercises about mathematical problems and solutions based on adventure activities. In addition to the learning sections, in which children solve problems, this program contains video clips, creativity tools and games associated with real-life experiences.

The most important aspect of the educational software is the content of the software (Picciano, 1994). Thus, the "Frizbi Mathematic 4" matches curriculum content of the 4th grade National Mathematics Curriculum in an orderly and engaging manner. All of these form a comprehensive system suitable for average and gifted students, as well as for those having difficulty with mathematics. In all stages of the program, there are "task domains" that were designed based on the discovery learning principles to enhance students' mathematics skills. By clicking on areas of the screen, children can start one of the activities corresponding to one task. Another characteristic of these "task domains" is that they are providing real life learning environments for students. Besides, *Frizbi Mathematics 4* offers more than 40 interactive exercises for students in each phase of the program. When students have difficulty with a specific task, the program directs students to the subject matter explanation phase thus, the connection of "game" and "lesson" are attained. Feedback and exercises are included at the end of each unit that help students to evaluate their own knowledge learning. Furthermore, score keeping and performance reports are provided when needed and also useful information about student performance is stored for future retrieval. Useful diagnostic or prescriptive analysis of student performance is also available to both the teacher and the student.

Calculator is accessible in each page of the software except for the test screens since the program developers support the idea that students should be free to use this function while participating in the tasks throughout the program. However teacher should assist the students to use this function in an effective and proper way.

Frizbi Mathematics 4 was designed for utilization in computer laboratory environment together with teacher guidance. In addition to this, it can be used at home for individual learning purpose. The teacher can support the usual instructional strategies by utilizing *Frizbi Mathematics 4* in specified lesson hours with the games and interactive exercise. In this study, the researcher also, utilized the software in the proposed way. In addition to this, there are "teacher guide book" and "student guide book" that were prepared particularly to support the *Frizbi Mathematics 4* which is available in both soft and hard copy formats (http//www.frizbi.com, 2007). Before utilization, teacher can fix the corresponding phases to the classroom teaching schedule by checking "curriculum map" and then s/he can ask students to navigate the related sections in the software. Besides, in the teacher's handbook of the software, there are also eleven lesson plans which were prepared based on the 4th grade mathematics curriculum. (http://www.frizbi.com/dokuman/kilavuzlar/mat4/mat4kilavuz_ogretmen.pdf). The teachers can use these lesson plans while they are making use of the software.

Target group

Frizbi Mathematics 4 was designed for the target group who is following the 4th grade mathematics curriculum. The students only need basic reading and computer skills in order to use the software in an effective way. In other words, those students who have little computer competency can have a chance to use the software easily since it was designed in a simple and active interface format.

Teaching Methods

Frizbi Mathematics 4 was designed mainly based on problem solving strategies and discovery learning method throughout the software. According to the discovery learning method, there is no ready made knowledge, instead, subject content, teacher support and student participation are planned by means of the basic principles of student-centered learning.

Cooperative learning in Frizbi Mathematics 4

The software also covers the "chat" system that allows synchronous message communication among student-student, student-class and student-teacher if the software is used in the network environment. In this way, *Frizbi Mathematics 4* is good at cooperative learning applications as much as individual utilizations.

Subject Matter Presentation

The subject matter presentation pages were pre-stored in separate pages at the back side of the software, thus students; first, meet the subject by participating in interactive exercises. However, at this stage if the students' performance is poor then the software directs them to the subject presentation page that provides explanation of the units together with sufficient examples. In addition to the explanations, they can follow the exercises that enable them to reinforce the subject. There is an option for students to reach the interactive exercises from each unit explanation pages simply by clicking this option. In this way, it is aimed to gain a dynamic connection between the subject presentation and the interactive exercises.

The content

Frizbi Mathematics 4 was designed parallel to the curriculum content of the 4^{th} grade National Mathematics Curriculum and also the software was integrated in the goals of the curriculum. The content which was prepared by subject specialists reflects the reliable and contemporary subject knowledge.

Frizbi Mathematics 4 covers the following sections; (a) the broad "task track" page that includes interactive exercises, (b) "hints" that help students while participating in those exercises, (c) eleven "units" which contain the subject matter presentation pages that were parallel to the content of the 4^{th} grade national mathematics curriculum, (d) plenty of "exercises" for each unit, and (e) 10 multiple choice "tests". Moreover, students can reach the short and clear "help menus" easily from each page of the software.

Feedback

Voiced, graphical, and visual-thematic feedback were used throughout the software. Students' responses are always evaluated with the help of the feedback system. If their response is right, the program gives positive reinforcement and reward and if it is wrong it does not provide any reinforcement but explains why it is false.

Student Evaluation

The program starts with opening animation, and later, the program asks students to follow a "pre-test"; if the students take the test, responses are recorded, and in this way teacher can evaluate the student's pre knowledge. The student works with the program and after a while when they reach a specific level, "post-test" page will be activated automatically. If the students take this "post test" their performance between "pre test" and "post test" will be assessed easily.

Record Keeping

Different record keeping alternatives are presented to students throughout the software, such as the following:

(a) Name, last name, student number

(b) Interactive exercise performance

(c) Total performance

(d) Test results in respect to date and time

(e) Choices about system settings

The general description of the software and the screenshots are given in the Appendix A.

Usability of the Frizbi Mathematics 4

In order to assess how well students can use the software and to identify the major usability problems, usability testing was conducted for *Frizbi Mathematics 4*. Thus, this section gives details the usability testing of *Frizbi Mathematics 4*.

The market of instructional software is growing and the teachers and school administrators are having difficulties in choosing the appropriate software which suits their needs best. Among the vast amount of software, it is inevitably needed to investigate the usability and efficiency of the educational software. Reiser and Dick (1990) proposed an instructional software evaluation model. This model suggests basically making subjective judgments regarding the accuracy of the content and its consistency to school objectives and to the teaching and technical quality of the software. Therefore, the software can be evaluated in three different areas namely content, instructional and technical dimensions.

Within this research study, the software used *Frizbi Mathematics 4* was evaluated by the help of software evaluation rubrics (Picciano, 1994). See Appendix B for the software evalautaion rubric that was used in the current study.

In order to evaluate the educational usability aspect of the *Frizbi Mathematics 4* the usability test was performed in fall semester of the academic year 2005-2006. ISO 9241-11 (ISO, 1998) defines usability as “the extent to which a product can be used by specific users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use”. The usability test of the software had been examined with five volunteer 4th grade students in home environment of each student in different time periods in TRNC. In order to check whether there were any significant usability problems with the software, the student’s use of the software was observed by a researcher. While they were using *Frizbi Mathematics 4*, they were encouraged to talk about the software and their behaviors were observed by the researcher. When they finished playing, they were interviewed about their experience in software playing. In addition to this, to assess usability, users’ performance was measured, their difficulties with the interface were noted, and their opinions of the product were asked. The findings from these observations were used in the actual study to eliminate the possible problems that students might have during the intervention sessions.

3.6 The Context

The state primary school “Sht. Osman Ahmet” is situated in Gazi Magusa, TRNC which is equipped with a computer laboratory and located in a middle socio-economic neighborhood. The school was deliberately chosen for the study with the help of Talim Terbiye Directorate, Ministry of Education from among a group of primary schools (N= 47) by considering the availability of computer laboratory "Sht. Osman Ahmet" primary school was established in 1974 with the help of the government of Turkey and was equipped with a computer laboratory in 2005. Primary education lasts 8 years in TRNC. Primary education is followed by four years of high school education, leading to a university entrance exam. Like all schools in TRNC, "Sht. Osman Ahmet" primary school curriculum is also based on the TRNC National Curriculum. In the year 2005, new mathematics curricula and text books are developed in cooperation with the committees set up by the Department of Educational Planning and Program Development which is located under the Turkish Republic of Northern Cyprus Ministry of National Education and Culture (NCMONE). Mathematics curricula are designed within the understanding of student-centered and constructive education. Altough the new curriculum based on the student-centred approaches, the actual classroom instruction was mainly oriented around the traditional, examination-centred teaching methods. Integration of computer laboratories and new technologies into TRNC education system are not structured yet, and there are only 10 public primary schools which have computer laboratory all around the TRNC. Students in the schools which have computer laboratory only followed the computer literacy course. Additionally, there is no computer-assisted mathematics instruction in the current mathematics curriculum.

3.7 Participants

The subjects of this study were (N = 55) fourth grade students from a state primary school "Sht. Osman Ahmet" in Gazi Magusa, TRNC. In the spring semester of academic year 2005-2006, "Sht. Osman Ahmet" primary school had two classes ("4 Red" and "4 Yellow") of 4^{th} grade students which consisted of 55 students in total. Students in both classes were assigned as the subjects of the study; because both of the class teachers were eager to participate in the study. All the students in both classes were randomly assigned either to the experimental group or to the control group with matching. That is to say, the researcher of this study, checked students' *matching scores* (students' previous year mathematics achievement grades, pre-Mathematics Achievement Test 1 scores (PMAT1), Mathematics Attitude Scale

(MAS) scores, and Computer Assisted Learning Attitude Scale (CALAS) scores), matched students on basis of matching scores and assigned matched pairs (one of each pair to each group).

There were 29 students, 14 students from class “4 Red” and 15 students from class “4 Yellow”, in the experimental group which received the computer assisted instruction (CAI) with *Frizbi Mathematics 4*. The students in control group consisted of 26 students with 13 students from class “4 Red” and 13 students from class “4 Yellow”, were exposed with the traditional instructional method (such as questioning, solving exercises, etc.) during the same period of time with laboratory sessions. The experimental group carried out sessions with the researcher of this study. The following table (Table 3.1) summarizes the distribution of subjects.

Table 3.1

Subjects of the study

Groups	Class 4 Red	Class 4 Yellow	Total
Computer assisted instruction (CAI)	14	15	29
Traditional instruction (TI)	13	13	26
Total	27	28	55

All the students in the assigned school visit the computer laboratory regularly throughout the academic year. They have a computer literacy lesson once a week. Although there is no computer literacy course in the National Curriculum, the school administration provides computer literacy courses for each grade level. Therefore, all the participants of the study were capable of using computers properly.

Two primary grade teachers who were teachers regularly assigned for the 4th and 5th grade graders participated in the study. Teachers were Turkish Cypriot male with a four year elementray school teacher education degree from Atatürk Teacher Training Academy, TRNC. Class teacher of the class “4 Yellow” has 13 years of experience in teaching and class teacher of the class “4 Red” has 15 years of experience in teaching. They are both married and have children. They personally defined their instructional approach or technique as teacher-centred and examination-oriented.

3.8 Data Collection Instruments

In the present study, the following measuring instruments were used to test the hypotheses,

- Mathematics Tests: pre-tests (PMAT1, PMAT2, PMAT3), post-tests (MATP1, MATP2, MATP3), and retention tests (MATR1, MATR2, MATR3)
- Mathematics Attitude Scale (MAS)
- Computer Assisted Learning Attitude Scale (CALAS)

3.8.1 Mathematics Achievement Tests

Mathematics achievement was measured by the utilization of Mathematics Achievement Tests that were prepared by the researcher. The units “Multiplication of Natural Numbers”, “Divisions of Natural Numbers” and “Fractions” were included in this study. The rest of the 4th grade mathematics curriculum content was excluded from the study.

All three pretests were developed by the researcher to determine the students’ prior knowledge of the selected 4th grade mathematics units: “Multiplication of Natural Numbers”, “Division of Natural Numbers” and “Fractions”. Pre mathematics test 1 (PMAT1) (see Appendix C) covered the content of first treatment unit which was the “Multiplication of Natural Numbers”. PMAT1 was also used to equalize the groups of the study before the implementation: experimental and control groups.

Pre mathematics test 2 (PMAT2) (see Appendix D) and pre mathematics test 3 (PMAT3) (see Appendix E) covered the treatment units "Division of Natural Numbers" and "Fractions", respectively. Additionally, PMAT1, PMAT2, and PMAT3 were used to compare the scores of post tests (MATP1, MATP2, and MATP3) (see Appendix F, Appendix G, Appendix H) and retention tests (MATR1, MATR2, and MATR3) that were given after the implementation. The three parallel paper-and-pencil tests were constructed for each treatment units which were administrated to both groups. Each unit test is given both at the beginning (PMAT1, PMAT2, and PMAT3) and at the end of (MATP1, MATP2, and MATP3) every unit. Four months after experiment, the same achievement tests that previously served as pretests were given again to both groups as retention tests (MATR1, MATR2, and MATR3) to measure the level of retention in mathematics in the selected units. The pre, post and retention tests for each unit included the same problems with some variations in numbers and wording. In other words, these three (pre, post and retention) achievement tests were given to all subjects in different periods of the study: before, after and four months after the implementation.

Achievement tests covered all the learning outcomes of the corresponding units "Multiplication of Natural Numbers", "Divisions of Natural Numbers" and "Fractions" that were included in the intervention in the current 4th grade mathematics curriculum. When building achievement tests, first, test blueprint was developed for each unit based on the content analysis and then to ensure the content validity of the tests, each achievement test was checked by math teachers, class teachers, and a specialist in test construction.

During the test construction process, first, the total number of items of each test was decided by considering the age of the students and then by the use of test blueprint, topics and the learning outcomes were listed. Based on the importance of each unit and the instructional emphasis that was placed on each sub-topic, the number of items for each unit was determined (See Appendix J, Appendix K, and Appendix L).

The content and the learning outcomes of the three units were obtained from the 4th grade mathematics curriculum which was prepared by the Ministry of Education. The question selection for each unit was followed by the formation of an item bank.

Questions in the item bank were prepared and classified by the researcher according to topics, sub-topics, learning outcomes and levels in the cognitive domain of Bloom's Taxonomy in Turkish language (Ornstein & Hunkins, 1988).

Parallel forms of the achievement tests, which were used as post tests, were generated by selecting equivalent items from the item bank. Since the item bank contained more than one item for each objective, the items that were not used in pretests were included into posttests.

Mathematics Retention Tests (MATR1, MATR2, and MATR3) (See Appendix A, Appendix B, and Appendix C) were administrated four months after the treatment to obtain the retained mathematics achievement and attitude scores of students in both groups. All three retention tests were almost the same with the pretests and only the wording and the numbers of the items were changed.

The PMAT1 consisted of questions of Multiplication of Natural Numbers and initially 30 test items were selected around the specified objectives in the 4^{th} grade mathematics curriculum. Similarly, 25 questions of "Divisions of Natural Numbers" were selected for PMAT2 and also PMAT3 consisted of 25 questions of "Fractions".

All the mathematics achievement tests were piloted with a group of students with similar background and same grade level. There were two main reasons for the piloting of achievement tests; first to check the clarity and the understandability of the test items, and secondly to check the reliability coefficient of the tests. In order to conduct the item analysis, a pilot study was carried out on 75 students who were in 5^{th} grade. Two different school regions were used, 50 fifth grade students in "Şht. Osman Ahmet" primary school and the rest of the students were from another primary state school named "Alasya" primary school which has shown similar breakdowns of the subjects and educational system. The achievement tests were especially applied to 5^{th} grade students who had gained the specified objectives of the treatment units ("Multiplication of Natural Numbers", "Divisions of Natural Numbers" and "Fractions"). During the piloting period, first, the PMAT1 was administrated in one class hour in both of the school districts and one week later, MATP1 and MATR1 for the first unit were completed by the same piloted group of students. After one month, the same procedure was followed for the achievement tests of the second and third unit respectively. In other words, all the achievement tests (pre, post and retention) were piloted individually and they were administrated during the class hours with the help of the class teachers of the selected classrooms.

Tests results were analyzed by using the ITEMAN test analysis program. Based on the test analysis program and the suggestions from the experts, all the tests items were examined and some of the questions were disregarded or corrected since their mean scores were low.

The alpha reliability coefficient was found to be .90, .89 and .81 for the PMAT1, PMAT2, and PMAT3, respectively. Cronbach alpha value for the posttests was calculated .91, .90 and .88 for the MATP1, MATP2, and MATP3 respectively. Besides, the alpha reliability coefficient was also calculated as .92, .89 and .88 for the MATR1, MATR2, and MATR3, respectively.

Content validity evidence of the achievement tests were established by a specialist in mathematics education, class teachers, and an expert in Educational Sciences. Class teachers and an expert in mathematics teaching checked the tests items, and they modified and reworded them in the way that students would understand easily. Beside this, table of specifications (tests blueprints) were used during the achievement tests construction phase. In addition to this, an expert on measurement and evaluation reviewed all the items by considering the related course content and objectives.

The last form of achievement tests were shaped just after the completion of piloting, validity and reliability studies. The MAT1 originally consisted of 30 items, and it was reduced to 25 items; MAT2 and MAT3 consisted of 25 items and was reduced to 20. The results of the achievement tests were not presented to the students to avoid test-retests confound.

3.8.2 Attitude Scales

Likert scales are an extremely popular method for measuring attitude (Dwyer, 1993). In this study, two Likert scale namely Mathematics Attitude Scale (MAS) and

Computer Assisted Learning Attitude Scale (CALAS) were used to investigate students' attitude both towards mathematics and use of computer-assisted learning in mathematics lessons**.**

Students' attitude toward mathematics was investigated by conducting the Mathematics Attitude Scale (MAS) (see Appendix M). In this respect, using one of the already developed attitude scales would be convenient for the sake of this study. In order to find out the students' attitudes toward mathematics, an attitude scale, which was developed by Aşkar in 1986, was chosen. The MAS included items that were scored using a 5-point Likert type scale, ranging from strongly agree, agree, not certain, disagree, to strongly disagree. The reliability coefficient of the MAS was found to be as 0.96 by Aşkar when it was developed and administered to the 204 students in English Preparatory School at METU for the pilot test. The scale was in Turkish. MAS had one factor named "general attitude toward mathematics" and there were 20 items, with 10 negative and 10 positive. In scoring, negative items were calculated in the reverse format. Thus, the total score of MAS is between 20 and 100. The original MAS was ranked on a 5-point Likert, however the first pilot study showed that font size and the font style of the scale were slightly problematic. Therefore, the original MAS was modified and some slight changes were made in regards to the wording and the degree of legibility of the MAS was increased (Chandler, 2001).

In order to utilize the computers into mathematics teaching, students' current attitudes and beliefs towards computer assisted learning need to be considered. In order to measure the 4th grade students' attitudes toward computer supported learning, an attitude scale "Computer Assisted Learning Attitude Scale" which was developed by Aşkar, Yavuz, and Köksal (1991) was administrated (see Appendix N).

Aşkar, Yavuz and Köksal (1991) developed this scale in a study aimed at developing an attitude scale measuring attitudes of students, who received computer education at the stage of primary education, toward computer supported learning. The CALAS consisted of 10 items that were included in one factor, 8 positive and 2 negative. Thus, the total score of CALAS is between 10 and 30. Beside this, reliability coefficient was found as $\alpha = 0.81$ by Aşkar et al. that was high enough to be used in another computer supported learning study. The CALAS were scored using a 3-point Likert type scale, ranging from "Yes" to "Sometimes" and then to "No" (e.g., 3=Yes).

Both scales, MAS and CALAS, were piloted in the fall semester of 2005-2006 Academic Year by the researcher herself with the help of the class teachers. Three different primary schools were selected for the piloting of the attitude scales; two state primary schools and one private primary school. Since the original mathematics attitude scale was developed and piloted for the upper grades, it was necessary to pilot it for the 4^{th} grade level which was the same grade level of the actual study.

The piloting procedure took place as follows: first, MAS was piloted during October 2005 with 30 fourth grade students at "Şht. Zeki Salih" primary school in order to check the clarity and understandability of the scale items. On the basis of the piloting some items in the scale were revised and the format of the scale was redesigned on the basis of the feedback taken from both the students and class teachers. For instance, the visual layout of the mathematics attitude scale was modified and also item 7 "Matematik benim için angaryadır" was reworded to "Matematik benim için bıktırıcı bir iştir" in the scale. In order to assess the reliability of the modified scale, MAS was piloted for the second time with 63 fourth grade students in "Alasya" primary school. Simultaneously, a pilot study was carried out also for the computer assisted learning attitude scale (CALAS) with 85 fourth grade students, 41 of which were in "Doğu Akdeniz Private Primary School" and 44 of which were in "Alasya" primary school.

At the end of piloting of attitude scales, the reliability coefficient was calculated as .89 and .81 for MAS and CALAS, respectively. The reliability analysis was also carried out on the research sample ($N = 55$) at the beginning of the intervention and the reliability coefficient of the pre-MAS (PMAS) was found as .86 and the reliability coefficient of the post-MAS (MASP) was found as .90 when it was conducted at the end of the study. The result of the reliability analysis of the attitude scale was consistent with the result obtained by Aşkar (1986).

Similarly, the reliability coefficient of the pre CALAS (PCALAS) was found as .78 and the reliability coefficient of the post CALAS (CALASP) was found as .64 for the actual subjects of the study.

3.9 Data Collection Procedures

As explained earlier, in this study quantitative data collection methods were used. The data for the study was collected from the 4th grade students in "Sht. Osman Ahmet" primary school over a period from February 2006 to October 2006. Based on the pre tests scores, experimental and control groups were formed through selection with matching from the available "4 Red" and "4 Yellow" classes.

The consent for permissions to conduct the research and to use the computer laboratory during the treatment were received from the Ministry of Education and from the school administration (See Appendix O). For the treatment, the *Frizbi Mathematics 4* was loaded to all 15 computers in the computer laboratory. Since the program had some sounds effects and the students participated on the program individually, earflaps were provided and connected to each computer prior to the beginning of the study.

Since all tests and scales were piloted during the first semester, they were ready for actual administration with the tested reliability and validity. Thus, one week in advance the study, all the subjects in the assigned school were asked to respond to the pre-Mathematics Achievement Test 1 (PMAT1), Mathematics Attitudes Scale (MAS), and Computer Assisted Learning Attitude Scale (CALAS). Before the treatment, PMAT1, MAS, and CALAS, were administrated to each class in order to form the experimental and control groups. Pre-tests scores used to match the pairs of students. Afterwards, students in each matched pair were then randomly assigned to the experimental and control groups. After the matching was completed, it was checked if there were any significant differences among the groups, in terms of achievements in mathematics, attitude toward mathematics, and attitude toward computer assisted learning. All the pre-tests were administrated by the researcher herself before the treatment. The administration of the pre-tests was not done in one session but on different time periods. The duration of attitude scales completion was 35 minutes. However students spent 45-55 minutes to do the achievement tests.

During the intervention period, two groups were taught by using the same mathematics curriculum and books, which were taken from the 4^{th} grade primary school curriculum that was prepared by Directory of Talim-Terbiye, Ministry of Education of TRNC. Two teaching methods were used throughout the study, CAI and traditional methods. In CAI, students received computer aided activities by using *Frizbi Mathematics 4* software in addition to the actual teaching-learning activities that were suggested by the TRNC National Primary Mathematics Curriculum. Since the number of computers in the computer laboratory were limited to 15, the students in the experimental group did not attend the computer laboratory at the same time. Students were divided into two sections. They were studying with *Frizbi Mathematics 4* in different time periods such as first lesson period (40 minutes) was devoted to the experimental group of students who were from the class "Red" and the second lesson period was devoted to the experimental group of students who were from the class "Yellow" or vice versa. Experimental group received CAI with Frizbi Mathematics 4 as a supplementray teaching method. This group first received teacher-directed, traditional instruction for 4 lesson hours in the classroom and then CAI for two lesson hours in the computer laboratory. The researcher was present at all times during the lab sessions and provided assistance to individual students as needed. Students were required to follow the unit domains to do drill and practices with *Frizbi Mathematics 4* by solving the exercises related to the treatment units. For instance, if the class teacher was introduced the topic "Multiplication with Natural Numbers" then students in the experimental group were requires to complete the exercises related to multiplication with *Frizbi Mathematics 4* during the lab sessions. The students in the control group received the 4^{th} grade mathematics content through regular mathematics instruction (e.g. lecture, problem-solving, discussion, etc.) as suggested in the curriculum. Textbook, chalkboard, paper-pencil activities were used during the traditional teaching activities. The class teacher provided regular lecture instruction, assigned exercises from the text-book, reviewed previous classroom homework, and administrated teacher-made examination covering the instructional objectives of the 4^{th} grade mathematics course. Both groups received the identical exercises with respect to amount and level of difficulty. The students in the control group did not use computerized materials in mathematics lessons. Although the instruction was teacher oriented, examples based on daily life and immediate feedback were given after the question-answer practices. Although Class Red and Class Yellow had different teachers, since experimental groups were formed in each class (red and yellow) both control and experimental groups were taught by both of the class teachers. Consequently, they followed the same format based on the 4th Grade Mathematics Curriculum. That is to say, both experimental and control groups received the same content to reach exactly the same objectives.

This study was assumed that the teachers were not biased during the treatment. It also was assumed the intervention process and tests were administered under standard conditions. Furthermore, the study was assumed that all students' responses to the test items were honest and accurate. And finally, it was assumed that there was no interaction between the students in the experimental and control groups.

The role of the researcher was to guide and also to facilitate learning by organizing and supervising students' learning process during the software used sessions. However, before the treatment period, all teachers came together (two class teachers, computer teacher and the researcher) and prepared the semester plan; class hours, unit plans and the other regulations.

Among the units of 4th grade mathematics curriculum, "Multiplication of Natural Numbers", "Division of Natural Numbers", and "Fractions" were chosen as treatment units for this study. In other words, in order to assess the effectiveness of CAI over traditional instruction, data were collected only from these three units. With the aim of providing consistent and sufficient results for the research questions, it would be valuable for the study if the collected data covered three units. The topics "Multiplication of Natural Numbers" and "Division of Natural Numbers" play a significant role in the mathematics curriculum. These topics are the backbone of the mathematics curriculum and they are commonly used in daily life experiences. Although "Four Operations" have a central place in 4th grade mathematics curriculum, misconception and misunderstanding of these topics are frequently reported by the school teachers. Similarly with "Four Operations", teachers often experienced difficulties in teaching students the concept of "Fractions". The difficulties stem in part from the fact that the teaching methods and instructional materials used are inadequate and limited. Another reason for choosing these units was that they were the topics in the mathematics curriculum of the spring semester.

The duration of the study was 13 weeks including administration of pretests and posttests. The selection of subjects and forming the groups was completed at the beginning of the second semester of 2005-2006 academic year as presented earlier in this chapter. Throughout the semester both of the groups (control and experimental) received regular instruction with class teachers. Each week the control group had 6 class hours (each class hour was 40 minutes) of mathematics lecture in class however the experimental group had 4 class hours of mathematics lessons in class and 2 class hours of CAI with the help of *Frizbi Mathematics 4* in the computer laboratory. First the treatment units were presented by using the traditional classroom method by the class teachers, and then the experimental group of students had the laboratory sessions to complete the exercises and activities about the unit with the help of *Frizbi Mathematics 4*.

According to the mathematics curriculum, the first unit in the second semester was the "Multiplication of Natural Numbers". Whenever the unit was presented, students in the experimental group carried on with the exercises related with "Multiplication of Natural Numbers" by *Frizbi Mathematics 4* in the computer laboratory, meanwhile students in the control group carried on with the same unit by solving paper-and pencil based exercises in the classroom. This procedure was carried on 3 weeks until the classroom teachers presented the unit 2 which was "Division of Natural Numbers". But prior to the explanation of unit 2 post mathematics achievement test 1 (MATP1) and then pre mathematics achievement tests 2 (PMAT2) were administrated to both experimental and control groups. Just after 3 weeks when the unit 2 ("Division of Natural Numbers") was covered, the post mathematics achievement test 2 (MATP2) and pre mathematics achievement tests 3

(PMAT3) were administered to both groups. At the end of May when unit 3 was completed, it lasted 3 weeks as well; MATP3 was administrated to both groups.

After the treatment had been completed, MAS and CALAS were administrated as post-tests to both the experimental group and the control group to assess the effects due to treatment on attitudes towards mathematics and attitudes towards computer assisted learning.

Four months after the intervention (16 weeks), the mathematics retention tests (MATR1, MATR2, and MATR3) were given to all groups to measure the retention in the treatment units. The data collection procedure was tabulated in the following Table 3.2.

Table 3.2

Data collection procedure of the study

Units and Instrumentation	Dates	Groups	
		Class "4 Red"	**Class "4 Yellow"**
Pretest 1, Pre Mathematics Attitude Scale, Pre Computer Assisted Learning Attitude Scale	15 - 22 February 2006	PMAT1, PMAS, PCALAS	
Unit 1: Multiplication of Natural Numbers	28 February - 21 March 2006	Experimental CAI with *Frizbi Mathematics 4*	Control Traditional Instruction
Posttest 1, Pretest 2	21-29 March 2006	MATP1, PMAT2	
Unit 2: Division of Natural Numbers	4 - 25 April 2006	Experimental CAI with *Frizbi Mathematics 4*	Control Traditional Instruction
Posttest 2 , Pretest 3	25 April - 2 May 2006	MATP2, PMAT3	
Unit 3: Fractions	9 May - 23 May 2006	Experimental CAI with *Frizbi Mathematics 4*	Control Traditional Instruction
Posttest 3, Post Mathematics Attitude Scale, Post Computer Assisted Learning Attitude Scale	29 May - 9 June 2006	MATP3, MASP, CALASP	
Retention Tests	9 - 20 October 2006	MATR1, MATR2, MATR3	

3.10 Data Analysis

Data was collected from various sources based on the research questions stated at the beginning of this chapter. With the intention of answering research questions, data collected was analyzed by using descriptive and inferential statistical analysis methods. At the beginning of the study, reliability analysis was conducted to test the reliability of the achievement tests and attitude scales. First, the descriptive statistics was conducted to report the differences between the control group and the experimental group on mathematics achievement, retention, attitude toward mathematics and attitude toward computer assisted learning. Later, 3 X 2 Analysis of Variance (ANOVA) with repeated measures and independent sample *t*-tests were utilized to test the hypotheses at the level of significance p=.05. For the analysis of data, the SPSS 13.0 (Statistical Package for Social Sciences) was used.

3.11 Limitations

Before the results are discussed and recommendations made, it is useful to highlight some of the limitations the researcher faced in conducting this research. Briefly, these are:

This study is limited to 4^{th} grade students in a state primary school in TRNC, during the spring semester of the 2005-2006 academic year. Since the sample size is limited with 55 students, it might not reflect the general population so the results of the study cannot be generalized to other contexts.

Although the study continued one semester, the data was collected only from the treatment units: “Multiplication of Natural Numbers”, “Divisions of Natural Numbers” and “Fractions”.

Another limitation, since there was no earflaps in the computer laboratory in the first semester, the pilot study could not be conducted for the software *Frizbi Mathematics 4*. It could be useful for the actual study if there was a piloting study for the software in order to identify the possible problems that might occur during the intervention. However, there was no problematic situation faced throughout the laboratory sessions in the actual study.

Although matching design procedures were conducted in forming the experimental and control groups, some of the students might not have wanted to become a member of control group, instead they might have motivated to be member of experimental group. This might be considered as another limitation for this study.

The laboratory sessions were guided by the researcher and on the other hand, the control group was instructed by the class teachers. The teacher impact on the results of the study might be another limitation of this study.

CHAPTER IV

RESULTS

The purpose of this study was to examine the impact of educational software *Frizbi Mathematics 4* on 4th grade students' achievement, attitudes both towards mathematics and computer assisted learning in mathematics lesson and retention. By taking the research questions into consideration this chapter provides the results of the study. The first section of this chapter presents the findings both from descriptive and inferential statistics associated with the data collected from the administration of the mathematics achievement tests. The second section presents the descriptive and inferential statistical data yielded from testing null hypotheses outlined in the previous chapter for both mathematics attitude and computer assisted learning attitude scales. The chapter ends with a summary of the findings of the study.

4.1 The Results Concerning the Equality of Groups before the Treatment

As aforementioned in the method section, in order to ensure the equality of the experimental and the control groups, the matching-only pretest-posttest control group design method was used. In other terms, members of each group were attained based on the following matching variables: students' previous year mathematics achievement grades, pre-Mathematics Achievement Test 1 scores (PMAT1), Mathematics Attitude Scale (MAS) scores, and Computer Assisted Learning Attitude Scale (CALAS) scores. In order to select students to be in the groups (experimental and control) matching variables were combined and put into a formula (*matching score* = 0.4 × (previous year mathematics grade) + 0.3 × (PMAT1) + 0.2 × (MAS) + 0.1 × (CALAS)) to obtain a *matching score* for each student. Then students who have the same *matching score* were assigned either to the experimental or to the control group. After construction of the experimental and the control groups preliminary analysis were performed using independent *t*-test procedures to examine the equivalence of the groups on the dependent measures at pretests. Results of the independent *t*-test are presented in Table 4.1.

Table 4.1

Results of an independent t-test for matching variable.

					Levene's Test				
Variable	Groups	*N*	*M*	*SD*	*F*	Sig.	*t*	*df*	Sig.
Matching score	Control	26	71.65	17.10	0.01	.91	-0.30	53	.77
	Experimental	29	73.09	18.14					

First the tests of normality was conducted for the matching variable and the Kolmogorov-Smirnov test (K-S test) indicated that *matching scores* were normal for both groups; the K-S test for *matching score* for experimental group, *D* (29) = .12, *p* = .20 and for control group , *D* (26) = .14, *p* = .20 were both normal.

As seen from Table 4.1, the independent *t*-test results indicated that, there was no significant mean difference on matching scores between the experimental (*M* = 73.09, *SD* = 18.14) and the control group (*M*= 71.65, *SD* = 17.10). This finding indicates that the students' pre-test scores and attitudes both toward mathematics and computer assisted learning pre scale scores were similar in both the experimental group and the control group.

In addition, Levene's Test showed that variances were not significantly different (*p* = .91) therefore the test statistics equal variances were assumed and it was found that there was no statistically significant difference between the mean scores of the students in the control group and those in the experimental group on matching scores, *t* (53) = - 0.30 , *p* = .77.

4.2 The Results of Pre Achievement Tests

PMAT1 was used as a matching variable in order to equalize the groups of the study, it was controlled for two groups that there was no mean differences for PMAT1. In addition to this, an analysis was conducted to find out if there was any difference between two groups prior to each unit explanation. Hence findings based on the PMAT2 and PMAT3, for the unit 2 and unit 3 respectively, indicated that there was no statistically significant difference between the mean scores of the students in the control and those in the experimental group. The results of the *t*-test are presented in Table 4.2.

Table 4.2

The results of pre achievement tests (PMAT1, PMAT2, and PMAT3)

Variables	Traditional Instruction (*N* = 26)		Computer Assisted Instruction with *Frizbi Mathematics 4* (*N* = 29)		
	M	*SD*	*M*	*SD*	*p*
PMAT1	41.77	17.41	42.00	15.72	.63
PMAT2	34.42	19.25	34.65	19.64	.99
PMAT3	20.38	9.58	21.72	8.79	.98

As seen in Table 4.1 there was no significant mean difference in students' mathematics achievement scores between the experimental and control groups. Thus, both groups were considered as similar in their prior knowledge about treatment units; unit 1: "Multiplication of Natural Numbers", unit 2: "Division of Natural Numbers" and unit 3: "Fractions".

4.2.1 Results of Achievement Tests Concerning Unit 1: "Multiplication of Natural Numbers"

Descriptive statistics in the pretest1 (PMAT1), posttest1 (MATP1) and retention test 1 (MATR1) showed that the experimental group that was exposed to CAI had a higher level of achievement in unit 1 compared to the control group that was treated with TI (see Table 4.3). More detailed descriptive data analysis results obtained from the PMAT1, MATP1 and MATR1 are given in Table 4.4.

Table 4.3

PMAT1, MATP1, and MATR1 scores for TI and CAI groups

	PMAT1		MATP1		MATR1	
	M	*SD*	*M*	*SD*	*M*	*SD*
TI (*N* = 26)	41.77	17.41	60.46	22.42	57.23	22.85
CAI (N = 29)	42.00	15.72	72.69	16.35	68.97	18.04

As seen from Table 4.4, the scores of achievement tests for unit 1 change from 10 to 100 with 100 as the highest possible score. The mean of PMAT1 was 41.77, the mean of MATP1 was 60.46, and the mean of MATR1 was 57.23 for the control group. On the other hand, the mean scores of PMAT1, MATP1, and MATR1 for the experimental group were 42.00, 72.69, and 68.97 respectively. Although all Kurtosis and Skewness values of the PMAT1, MATP1, and MATR1 were in the limit of normality, it can be accepted as approximately normal since Kunnan (1998) indicated that Kurtosis and Skewness values between -2 and 2 can be assumed as approximately normal. Moreover the tests of normality was conducted for the achievement tests and the K-S test indicated that for PMAT1, MATP1, and MATR1 were normal such as the K-S test for PMAT1 for the experimental group , $D(29) = .10$, $p = .20$ and for the control group , $D(26) = .11$, $p = .20$ were both normal.

Table 4.4

Descriptive statistics of the PMAT1, MATP1, and MATR1

	Control			Experimental		
	PMAT1	MATP1	MATR1	PMAT1	MATP1	MATR1
N	26	26	26	29	29	29
Mean	41.77	60.46	57.23	42.00	72.69	68.97
Median	44.00	70.00	62.00	40.00	76.00	68.00
Standard Dev.	17.41	22.42	22.85	15.72	16.35	18.04
Min	10.00	20.00	16.00	12.00	28.00	40.00
Max	76.00	92.00	88.00	68.00	96.00	100.00
Range	66.00	72.00	72.00	56.00	68.00	60.00
Skewness	-0.26	-0.39	-0.43	-0.30	-0.90	-0.08
Kurtosis	-0.64	-1.16	-1.11	-0.70	0.68	-1.10

Boxplots graphically display measures of dispersion for a given variable--the range, median, and quartiles (Field, 2006). In order to compare the distribution and location of the achievement test scores visually, the clustered boxplot was constructed. The box shows the middle 50% of scores and each horizontal line (top and bottom) represents the upper and lower 25 percent of the cases. The maximum score of PMAT1 was about the median score of MATR1 in the experimental group. Besides, the mid 50 percent of PMAT1 in the experimental group was quite smaller than that of the control group. Thus, the MATP1 scores of the experimental group imply that the students took the scores close to each other. The boxplot of MATP1 was skewed to the left in the experimental group and also there was one outlier in MATP1. Figure 4.1 presents the clustered boxplot of the PMAT1, MATP1, and MATR1 for the experimental and control groups.

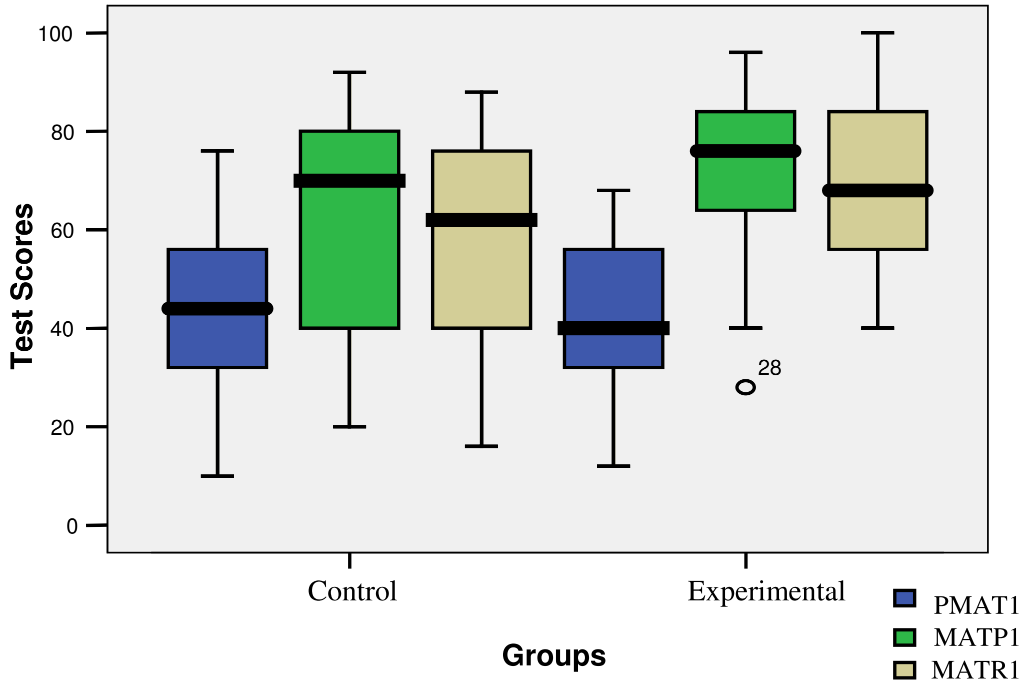


Figure 4.1. Boxplot of PMAT1, MATP1, and MATR1.

In this part, results of inferential analysis to test the hypothesis 1.1 and hypothesis 4.1 will be presented. The hypotheses were as follows:

Null Hypothesis 1.1: There is no significant difference between the achievement post test scores of the students exposed to computer assisted instruction with the *Frizbi Mathematics 4* and those who were exposed to traditional instruction with textbook on unit 1: "Multiplication of Natural Numbers".

Null Hypothesis 4.1: There is no significant difference between the retention test scores of the students exposed to computer assisted instruction with the *Frizbi Mathematics 4* and those who were exposed to traditional instruction with textbook on unit 1: "Multiplication of Natural Numbers".

In order to test the Null Hypothesis 1.1, a mixed design ANOVA with repeated measures was conducted with one independent variable (treatment) with two levels (CAI and TI) and dependent variable with 3 levels (PMAT1, MATP1, and MATR1). For the purpose of investigating the effect of the CAI with *Frizbi Mathematics 4*, a 3 (pre, post and retention) X 2 (groups) ANOVA with repeated measures was employed to the mathematics achievement tests scores of the experimental group and the control group students. The results of the ANOVA with repeated measures of the PMAT1, MATP1 and MATR1 scores are presented in Table 4.5.

Table 4.5

The results of the 3 X 2 ANOVA with repeated measures of PMAT1, MATP1 and MATR1 scores of the TI and CAI groups

Source	Sum of Square	*df*	Mean Square	*F*	*p*	η^2
			Between Subjects			
Groups	891.59	1	891.59	5.23	.03	.09
Error	9021.00	53	170.20			
			Within Subjects			
Time (PMAT1, MATP1 and MATR1)	19590.31	2	9795.16	35.02	.00	.40
Group* Time	1263.62	2	631.81	2.59	.11	.04
Error (Time)	29645.86	106	279.68			

A 3 (Time) x 2 (Group) mixed-model ANOVA revealed that the main effect for group was statistically significant F (1, 53) = 5.23 p = .03. Thus, there was a difference in achievement tests scores of students in the experimental group compared to the students in the control group.

The results of ANOVA with repeated measures indicated a significant time main effect of tests scores for the first unit, F (2, 106) = 35.02, p = .00, though this was a large effect η^2 = .63. This means that, mathematics achievement tests scores after the treatment were significantly higher than before the treatment (see Table 4.4). To break down this main effect, contrasts were performed comparing each achievement tests. The first contrast revealed that there was a significant time main effect between PMAT1 and MATP1, F (1, 53) = 63.06, η^2 = .54, but the second contrast was not significant (between MATP1 and MATR1), F (1, 53) = 1.119, η^2 =.02. This tells us that, both experimental and control groups' retention test scores decline with insignificant difference.

However, there was no significant interaction effect between the time and group, F (2,106) = 2.59, p = .11. This indicates that scores of students in different testing times (pre, post and retention) were not differed according to the groups (experimental and control).

Mean scores of the experimental group exposed to CAI with *Frizbi Mathematics 4* and control group exposed to TI across three different achievement scores of PMAT1, MATP1 and MATR1 are shown in Figure 4.2. As it is seen graphically from the figure, both the post test and retention test scores for experimental group was higher than the control group.

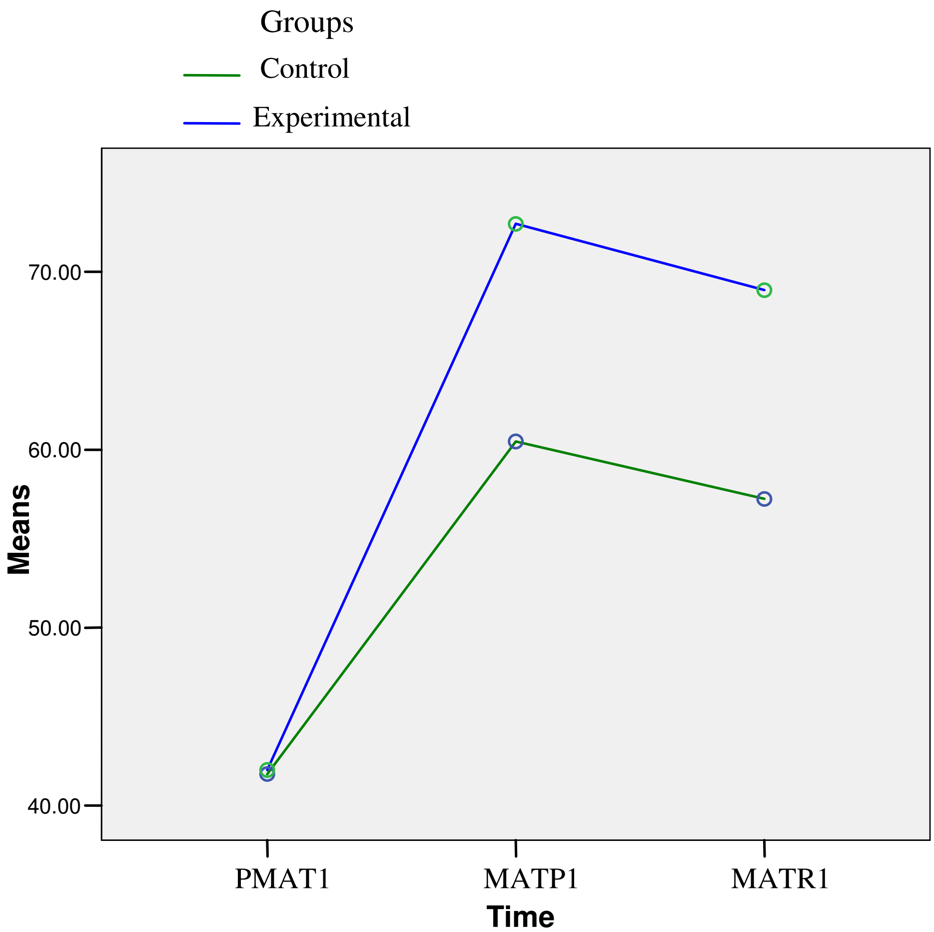


Figure 4.2. PMAT1, MATP1, and MATR1 Scores for Unit 1 in the Control and Experimental Groups' Students.

An independent samples *t*-test was also conducted to test the Null Hypothesis 4.1. The results of the *t*-test can been seen in the Table 4.6. As it is seen from the table, Levene's Test showed that variances were not significantly different (p = .13) therefore the test statistics equal variances assumed was used to test the hypothesis. It was found that there was a statistically significant difference between the retention test mean scores of the students exposed to traditional instruction and those exposed to CAI with *Frizbi Mathematics 4* in favor of the experimental group , t (53) = - 2.13, p = .04.

Table 4.6

The Results of the independent t-test of MATR1 scores of the TI and CAI groups

					Levene's Test				
Variable	Groups	*N*	*M*	*SD*	*F*	Sig.	*t*	*df*	Sig.
MATR1	Control	26	57.23	22.85	2.36	.13	-2.13	53	.04*
	Experimental	29	68.97	18.04					

*$p < .05$

4.2.2 Results of Achievement Tests Concerning Unit 2: "Division of Natural Numbers"

Descriptive statistics in the pretest2 (PMAT2), posttest2 (MATP2) and retention test 2 (MATR2) showed that the experimental group that was exposed to CAI had a higher level of achievement in unit 2 compared to the control group that was treated with TI (see Table 4.7). More detailed descriptive data analysis results obtained from the PMAT2, MATP2 and MATR2 are presented in Table 4.8.

Table 4.7

PMAT2, MATP2, and MATR2 scores for TI and CAI groups

	PMAT2		MATP2		MATR2	
	M	*SD*	*M*	*SD*	*M*	*SD*
TI (*N* = 26)	34.43	19.25	60.00	19.49	56.54	21.90
CAI (*N* = 29)	34.66	19.64	77.41	14.80	67.76	19.21

As seen from Table 4.8, the scores of achievement tests for unit 2 change from 5 to 100 with 100 as the highest score. The mean of PMAT2 was 34.42, the mean of MATP2 was 60.00, and the mean of MATR2 was 56.54 for the control group. On the other hand, the mean scores of PMAT2, MATP2, and MATR2 for the experimental group were 34.66, 77.42, and 67.76 respectively.

Although all Kurtosis and Skewness values of the PMAT2, MATP2, and MATR2 were in the limit of normality, it can be accepted as approximately normal since Kunnan (1998) indicated that Kurtosis and Skewness values between -2 and 2 can be assumed as approximately normal. Moreover the tests of normality was conducted for the achievement tests and the K-S test indicated that for PMAT2, MATP2, and MATR2 were normal such as the K-S test for MATR2 for experimental group , $D(29) = .13$, $p = .20$ and for control group , $D(26) = .11$, $p = .20$ were both normal.

Table 4.8

Descriptive statistics of the PMAT2, MATP2, and MATR2

	Control			Experimental		
	PMAT2	MATP2	MATR2	PMAT2	MATP2	MATR2
N	26	26	26	29	29	29
Mean	34.42	60.00	56.54	34.66	77.41	67.76
Median	30.00	62.50	60.00	25.00	75.00	65.00
Standard Dev.	19.25	19.49	21.90	19.64	14.80	19.21
Min	5.00	30.00	15.00	5.00	45.00	30.00
Max	75.00	95.00	95.00	85.00	100.00	100.00
Range	70.00	65.00	80.00	80.00	55.00	70.00
Skewness	0.61	-0.05	-0.25	1.10	-0.32	-0.17
Kurtosis	-0.47	-0.97	-0.69	0.67	-0.77	-0.89

Figure 4.3 compares the clustered boxplots of the two groups (experimental and control) for the test scores of PMAT2, MATP2, and MATR2. The following figure shows that CAI had a significant effect on test scores of students in experimental group. PMAT2 was skewed to the right and the median and the lower quartile had almost equal value. MATP2 had the highest test scores (M = 77.41) in the experimental group. The maximum score of PMAT2 was about the median score of the MATP2 in the experimental group.

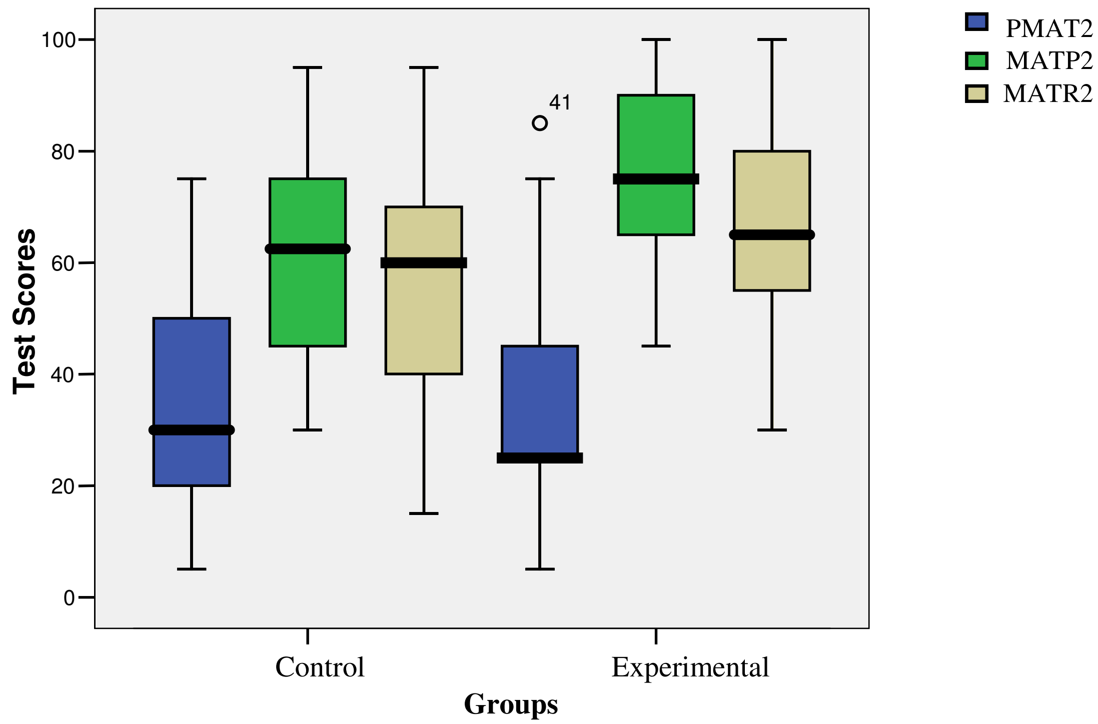


Figure 4.3. Boxplot of PMAT2, MATP2, and MATR2

In this part, results of inferential analysis to test the hypothesis 1.2 and hypothesis 4.2 will be presented. The hypotheses were as follows:

Null Hypothesis 1.2: There is no significant difference between the achievement post test scores of the students exposed to computer assisted instruction with the *Frizbi Mathematics 4* and those who were exposed to traditional instruction with textbook on unit 2: “Division of Natural Numbers”.

Null Hypothesis 4.2: There is no significant difference between the retention test scores of the students exposed to computer assisted instruction with the *Frizbi Mathematics 4* and those who were exposed to traditional instruction with textbook on unit 2: “Division of Natural Numbers”.

Similarly, in order to find out whether the difference is significant among the experimental group exposed to the CAI with *Frizbi Mathematics 4* and the control group exposed to TI at PMAT2, MATP2, and MATR2, a 3 (pre, post and retention)

X 2 (groups) ANOVA with repeated measures was employed to the mathematics achievement tests scores for unit 2 “Division of Natural Numbers”. The results of the ANOVA with repeated measures of the PMAT2, MATP2 and MATR2 scores are presented in Table 4.9.

Table 4.9

The results of the 3 X 2 ANOVA with repeated measures of PMAT2, MATP2 and MATR2 scores of the TI and CAI groups

Source	Sum of Square	*df*	Mean Square	*F*	*p*	η^2
			<u>*Between Subjects*</u>			
Groups	1269.23	1	1269.23	8.36	.01	.14
Error	8047.23	53	151.84			
			<u>*Within Subjects*</u>			
Time (PMAT2, MATP2 and MATR2)	36059.09	2	18029.54	56.43	.00	.52
Group* Time	2076.06	2	1038.03	3.25	.04	.06
Error (Time)	33870.01	106	319.53			

The results of ANOVA with repeated measures indicated that the main effect for group was also statistically significant F (1, 53) = 8. 36, p = .01. Thus, there was a difference in achievement tests scores of students in the experimental group compared to the students in control group concerning unit 2.

A significant time main effect of tests scores for the second unit was obtained, F (2, 106) = 56.43, p = .00, though this was a large effect (η^2 = .52). This means, achievement scores after the treatment were significantly higher than before the treatment (see Table 4.8). To break down this main effect, contrasts were performed comparing each achievement tests. Contrasts revealed that the time main effect between PMAT2 and MATP2 was higher, F (1, 53) = 97.23, η^2= .65 than the interaction between MATP2 and MATR2, F (1, 53) = 4.10, η^2 =.07.

Moreover for the unit 2, there was also significant interaction effect between the level of time and the groups of the students, F (2, 106) = 3.25, p = .04. This indicates that scores of students in different testing times (pre, post and retention) were differed in experimental and control groups. Examination of the cell means indicated that, there was a higher mean difference in achievement test scores for the experimental group students from PMAT2 to MATP2, than the students in control group.

The contrast between PMAT2 and MATR2 indicated that there was no significant difference between the experimental and control groups regarding achievement scores on Unit 2. This tells us that, both experimental and control groups' retention test scores decline with insignificant difference.

Mean scores of experimental group exposed to CAI with *Frizbi Mathematics 4* and control group exposed to TI across three different achievement scores of PMAT2, MATP2 and MATR2 are shown in Figure 4.2. As it is seen graphically from the figure, both the post test and retention test scores for experimental group was higher than the control group.

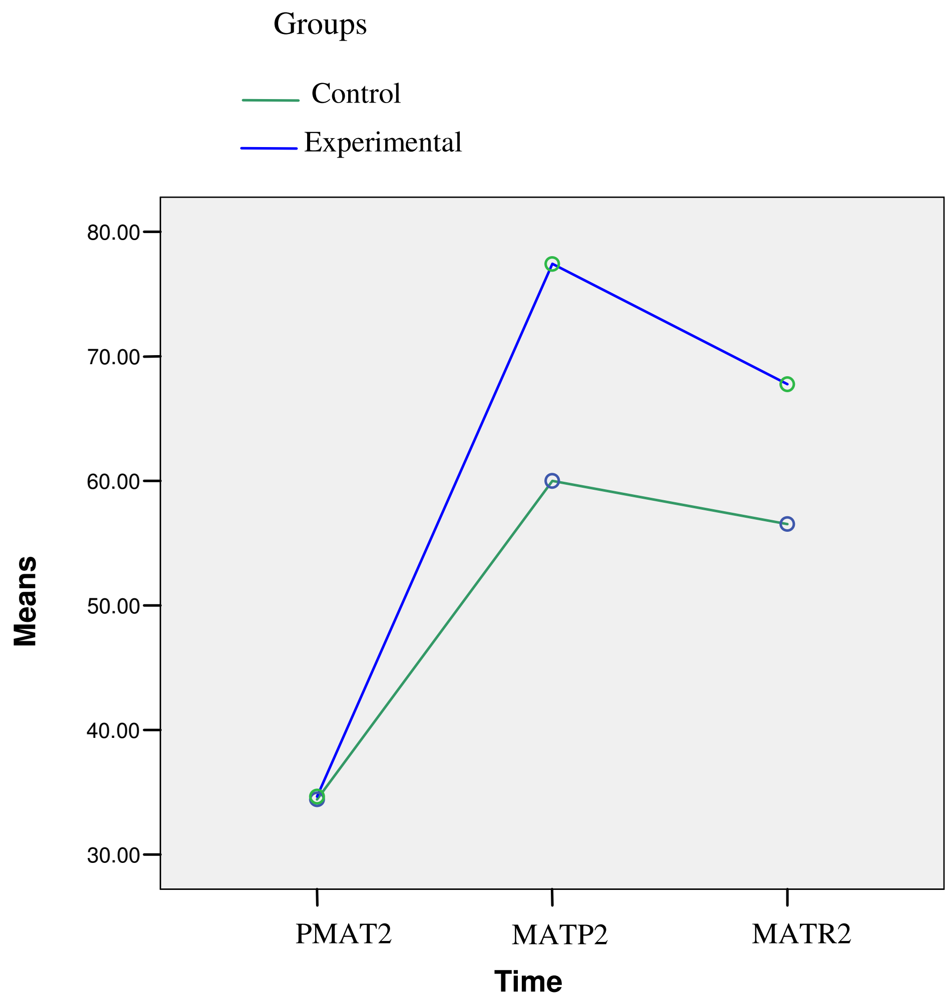


Figure 4.4. PMAT2, MATP2, and MATR2 Scores for Unit 2 in the Control and Experimental Groups' Students.

An independent samples *t*-test was also conducted to test the Null Hypothesis 4.2. The results of the *t*-test can been seen in the Table 4.10. As it is seen from the table, Levene's Test showed that variances were not significantly different (p = .57) therefore the test statistics equal variances assumed was used to test the hypothesis. It was found that there was a statistically significant difference between the retention mean scores of the students exposed to traditional instruction and those exposed to CAI with *Frizbi Mathematics 4* in favor of experimental group, $t(53) = -2.02$, p =.048.

Table 4.10

The results of the independent t-test of MATR2 scores of the TI and CAI groups

					Levene's Test				
Variable	Groups	*N*	*M*	*SD*	*F*	Sig.	*t*	*df*	Sig.
MATR2	Control	26	56.54	21.90	.32	.57	-2.02	53	.048*
	Experimental	29	67.76	19.21					

*$p < .05$

4.2.3 Results of Achievement Tests Concerning Unit 3: "Fractions"

Descriptive statistics in the pretest 3 (PMAT3), post test 3 (MATP3) and retention test 3 (MATR3) showed that the experimental group that was exposed to CAI had a higher level of achievement in unit 2 compared to the control group that was treated with TI (see Table 4.11). More detailed descriptive data analysis results obtained from the PMAT3, MATP3 and MATR3 are presented in Table 4.12.

Table 4.11

PMAT3, MATP3, and MATR3 scores for TI and CAI groups

	PMAT3		MATP3		MATR3	
	M	*SD*	*M*	*SD*	*M*	*SD*
TI (*N* = 26)	20.39	9.58	45.77	19.63	28.85	16.76
CAI (*N* = 29)	21.72	8.79	60.00	20.83	35.45	20.30

As seen from Table 4.12, the scores of achievement tests for unit 3 change from 5 to 100 with 100 as the highest score. The mean of PMAT3 was 20.39, the mean of MATP3 was 45.77, and the mean of MATR3 was 28.85 for the control group. On the other hand, the mean scores of PMAT3, MATP3, and MATR3 for the experimental group were 21.72, 60.00, and 35.45 respectively. Although all Kurtosis and Skewness values of the PMAT3, MATP3, and MATR3 were in the limit of normality, it can be accepted as approximately normal since Kunnan (1998) indicated that Kurtosis and Skewness values between -2 and 2 can be assumed as approximately normal. Moreover the tests of normality was conducted for the achievement tests and the K-S test indicated that for PMAT3, MATP3, and MATR3 were normal such as the K-S test for PMAT3 for the experimental group , D (29) = .11, p = .200 and for the control group , D (26) = .11, p = .20 were both normal.

Table 4.12

Descriptive statistics of the PMAT3, MATP3, and MATR3

	Control			Experimental		
	PMAT3	MATP3	MATR3	PMAT3	MATP3	MATR3
N	26	26	26	29	29	29
Mean	20.38	45.77	28.85	21.72	60.00	35.45
Median	20.00	45.00	26.00	20.00	60.00	32.00
Standard Dev.	9.58	19.63	16.77	8.79	20.83	20.31
Min	5.00	20	8.00	5.00	20.00	8.00
Max	45.00	90	74.00	40.00	100.00	80.00
Range	40.00	70	66.00	35.00	80.00	72.00
Skewness	0.55	0.45	1.11	0.15	0.07	0.74
Kurtosis	0.45	-0.22	1.00	-0.52	-0.66	-0.45

Figure 4.5 presents the clustered boxplots of the PMAT3, MATP3, and MATR3 for the experimental and control groups. The comparison of the achievement test scores for unit 3 for the control and the experimental groups clearly indicated that the scores of MATP3 was significantly higher than the PMAT3 scores; scores of MATR3 was

significantly lower than MATP3 scores. Thus, the minimum score of the MATP3 was about the median score of the PMAT3 in the experimental group. Moreover, the lower 75 percent (lower edge) of MATR3 scores were scattered in the lower 25 percent of MATP3 in the experimental group. In addition, the dispersion of the MATP3 was very high with respect to the MATR3 scores of the experimental group.

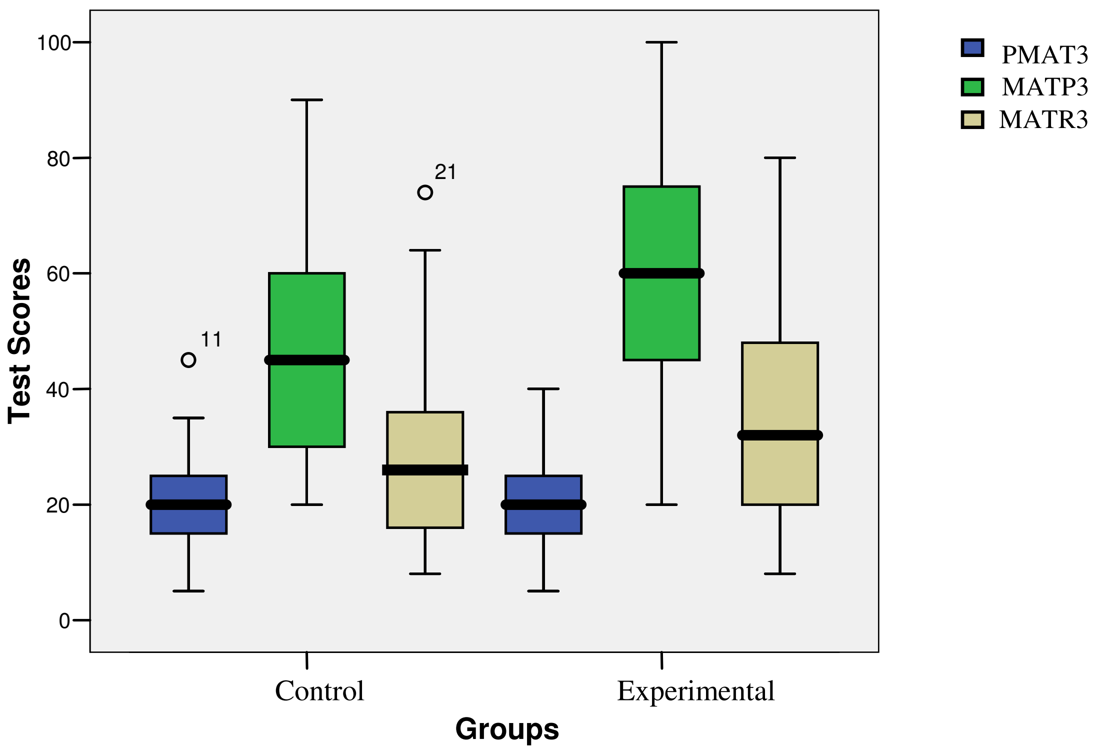


Figure 4.5. Boxplot of PMAT3, MATP3, and MATR3

The results of inferential analysis to test the last hypothesis for the first research question and the last hypothesis for the last research question will be presented. The hypotheses were as follows:

Null Hypothesis 1.3: There is no significant difference between the achievement post test scores of the students exposed to computer assisted instruction with the *Frizbi Mathematics 4* and those who were exposed to traditional instruction with textbook on unit 3: “Fractions”.

Null Hypothesis 4.3: There is no significant difference between the retention test scores of the students exposed to computer assisted instruction with the *Frizbi Mathematics 4* and those who were exposed to traditional instruction with textbook on unit 3: "Fractions".

Similarly with other two units, in order to find out whether the difference was significant among the experimental group exposed to the CAI with *Frizbi Mathematics 4* and the control group exposed to TI at PMAT3, MATP3, and MATR3, a 3 (pre, post and retention) X 2 (groups) ANOVA with repeated measures was employed to the mathematics achievement tests scores for unit 3: "Fractions". The results of the ANOVA with repeated measures of the PMAT3, MATP3 and MATR3 scores are presented in Table 4.13.

Table 4.13

The results of the 3 X 2 ANOVA with repeated measures of PMAT3, MATP3 and MATR3 scores of the TI and CAI groups

Source	Sum of Square	*df*	Mean Square	*F*	*p*	η^2
			Between Subjects			
Groups	748.85	1	748.85	7.16	.01	.12
Error	5544.68	53	104.62			
			Within Subjects			
Time (PMAT3, MATP3 and MATR3)	28629.24	2	14314.62	53.85	.00	.51
Group* Time	1151.91	2	575.95	2.17	.12	.04
Error (Time)	28179.07	106	265.84			

The results of ANOVA with repeated measures indicated that the main effect for group was also statistically significance F (1, 53) = 7.16, p = .01. Thus, there was a difference in achievement tests scores of students in the experimental group compared to the students in control group concerning unit 3.

A significant time main effect of tests scores for the third unit was obtained, F (2, 106) = 53.85, p = .00, though this was a large effect (η^2 = .71). This means, achievement scores after treatment were significantly higher than before the treatment (see Table 4.12). To break down this main effect, contrasts were performed comparing each achievement tests. Contrast revealed that the time main effect between PMAT3 and MATP3 is higher, F (1, 53) = 111.71, η^2 = .68, than the contrast between MATP3 and MATR3, F (1, 53) = 34.42, η^2 = .39.

There was no significant interaction effect between the time and group, F (2, 106) = 2.17, p = .12. This indicates that scores of students in different testing times (pre, post and retention) were not differed according to the groups (experimental and control). However, the first contrast revealed that there was a significant interactions when comparing experimental group scores to control group scores to PMAT3 and MATP3, F (1, 53) = 4.58, η^2 = .08), but the second contrast was not significant (between MATP3 and MATR3), F (1, 53) = 1.17, η^2 =.02.

The contrast between PMAT3 and MATR3 indicated that there was no significant difference between the experimental and control groups regarding achievement scores on Unit 3. This tells us that, both experimental and control groups' retention test scores decline with insignificant difference.

Mean scores of the experimental group exposed to CAI with *Frizbi Mathematics 4* and the control group exposed to TI across three different achievement scores of PMAT3, MATP3 and MATR3 are shown in Figure 4.6. As it is seen graphically from the figure the retention test scores for experimental group were approximately same with the control group.

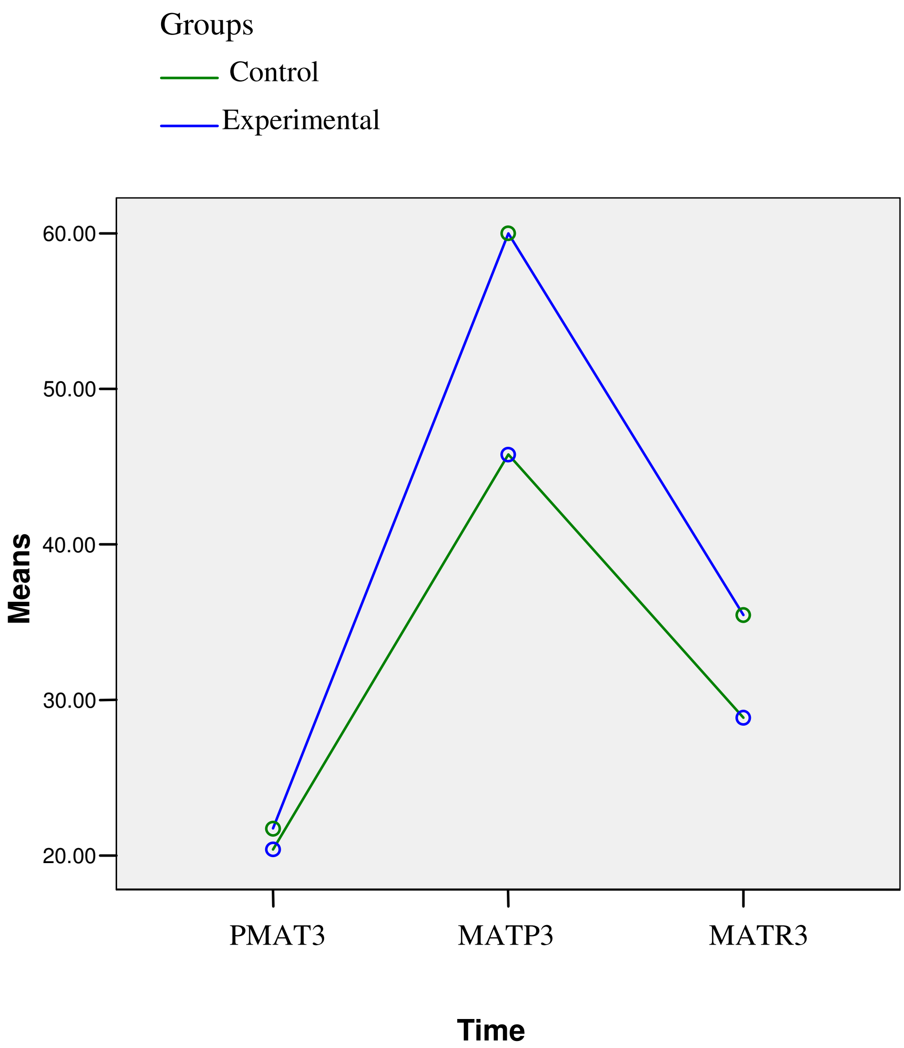


Figure 4.6. PMAT3, MATP3, and MATR3 Scores for Unit 3 in the Control and Experimental Groups' Students.

An independent samples *t*-test was also conducted to test the Null Hypothesis 4.3. The results of the *t*-test can been seen in the Table 4.14. As it is seen from the table, Levene's Test showed that variances were not significantly different (p = .31) therefore the test statistics equal variances assumed was used to test the hypothesis. It was found that there was no significant difference between the retention mean scores of the students exposed to traditional instruction and those exposed to CAI with *Frizbi Mathematics 4* , t (53) = - 1.31, p = .20.

Table 4.14

The results of the independent t-test of MATR3 scores of the TI and CAI Groups

					Levene's Test				
Variable	Groups	*N*	*M*	*SD*	*F*	Sig.	*t*	*df*	Sig.
MATR3	Control	26	28.85	16.76	1.06	.31	-1.31	53	.20
	Experimental	29	35.45	20.30					

4.3 Results of Attitude Scales

The Mathematics Attitude Scale (MAS) (Aşkar, 1986) and the Computer Assisted Learning Attitude Scale (CALAS) (Aşkar et al., 1991) were used in this study for measuring the students' attitude toward mathematics and attitude toward computer assisted learning. In this part both the descriptive and inferential analysis results will be provided for MAS and CALAS, respectively.

4.3.1 Results of Mathematics Attitude Scale (MAS)

The second research question aimed at finding whether there was a significant difference between the experimental (subjected to CAI with *Frizbi Mathematics 4*) and the control groups' (subjected to traditional instruction) attitude scores toward mathematics as measured through a mathematics attitude scale (MAS). Before the implementation, pretest results of the MAS showed that there was no significant difference in the mean scores of learners' attitude toward mathematics between the experimental (M = 80.97, SE = 1.53) and the control groups (M = 80.85, SE = 2.22). This finding indicates that the students' attitudes toward mathematics were similar in both the experimental group and the control group (see Table 4.15).

Table 4.15

PMAS and MASP scores for TI and CAI Groups

	PMAS	MASP
TI (*N* = 26)	80.85	78.19
CAI (*N* = 29)	80.97	86.90

More detailed descriptive data analysis results obtained from the PMAS and MASP are presented in Table 4.16. As seen from Table 4.16, the scores of mathematics attitude scales change from 47 to 100 with 100 as the highest score. The mean of PMAS was 80.846, and the mean of MASP was 78.19 for the control group. On the other hand, the mean scores of PMAS and MASP for the experimental group were 80.97 and 86.90 respectively. Although all Kurtosis and Skewness values of the PMAS and MASP were in the limit of normality, it can be accepted as approximately normal since Kunnan (1998) indicated that Kurtosis and Skewness values between -2 and 2 can be assumed as approximately normal. Moreover the tests of normality was conducted for the achievement tests and the K-S test indicated that for PMAS, and MASP were normal, such as the K-S test for PMAS for the experimental group , D (29) = .126, p = .20 and for the control group , D (26) = .09, p = .20 were both normal.

Table 4.16

Descriptive statistics of the PMAS and MASP

	Control		Experimental	
	PMAS	MASP	PMAS	MASP
N	26	26	29	29
Mean	80.85	78.19	80.85	86.90
Median	82.00	80.00	82.00	88.00
Standard Dev.	11.31	14.14	8.25	8.49
Min	54.00	47.00	64.00	69.00
Max	97.00	96.00	100.00	100.00
Range	43.00	49.00	36.00	31.00
Skewness	-0.62	-0.87	-0.20	-0.58
Kurtosis	-0.04	-0.31	0.74	-0.39

In order to compare the distribution and location of the mathematics attitudes scores visually, the clustered boxplot was constructed (see Figure 4.7). The comparison of the attitude scores for the control and the experimental groups clearly indicates that the scores of MASP of the experimental group was significantly higher than the MASP scores of the control group. Besides, the boxplot of PMAS was skewed to the right in the experimental group and also there was one outlier in PMAS. Moreover, the dispersion of the MASP was very high with respect to the PMAS scores of the experimental group.

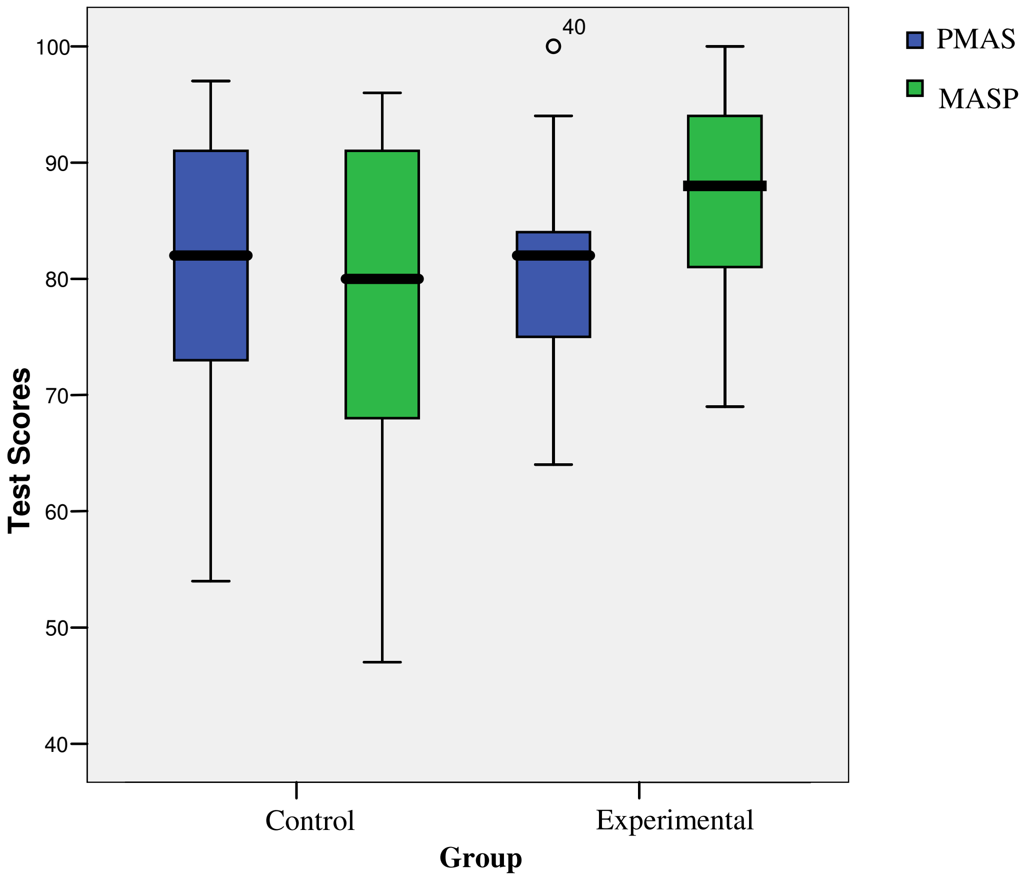


Figure 4.7. Boxplot of PMAS and MASP

In this part, results of inferential analysis to test the hypothesis 2 will be presented. The hypothesis was as follows:

Null Hypothesis 2: There is no significant difference between the mathematics attitude scale post scores of the students exposed to computer assisted instruction with *Frizbi Mathematics 4* and those who were exposed to traditional instruction with textbook.

After the implementation, an independent sample *t*-test was conducted to test the above hypothesis. Findings indicated that there was a difference between mean scores of the students exposed to traditional instruction with textbook (M = 78.19, SE = 2.77) and those exposed to computer assisted instruction with *Frizbi Mathematics 4* (M = 85.90, SE = 1.58) on MAS in favor of the experimental group. The results of *t*-test are presented in the Table 4.17.

Table 4.17

Results of an independent t-test for MASP

					Levene's Test				
Variable	Groups	*N*	*M*	*SD*	*F*	Sig.	*t*	*df*	Sig.
MASP	Control	26	78.19	14.14	5.70	.02*	-2.73	40.02	.01*
	Experimental	29	86.90	8.49					

*$p < .05$

As seen in Table 4.17 Levene's Test showed that variances were significantly different (p =.02) therefore the test statistics with unequal variances was used to test the hypothesis. Thus, it was found that there was a statistically significant difference between the mean scores of the students exposed to traditional instruction and those exposed to CAI with *Frizbi Mathematics 4* in favor of computer assisted instruction, t (40.02) = - 2.73, p = .01; however, it did represent a medium sized effect r =. 37 (Cohen, 1988).

In the light of these, it is deduced that there was a significant difference between the attitude toward mathematics of students who exposed to CAI with *Frizbi Mathematics 4* and those exposed to traditional instruction in the favor of CAI.

4.3.2 Results of Computer Assisted Learning Attitude Scale (CALAS)

The third research question aimed at finding whether there was a significant difference between experimental (subjected to CAI with *Frizbi Mathematics 4*) and control groups' (subjected to traditional instruction) attitude toward computer assisted learning as measured through an attitude scale. Before the implementation, pre scale results of the CALAS showed that there was no significant difference in the mean scores of learners' attitude toward mathematics between the experimental (*M* = 25.55, *SE* = .65) and the control groups (*M* = 25.85, *SE* = .74). This finding indicates that the students' attitudes toward computer assisted learning were similar in both the experimental group and the control group (see Table 4.18).

Table 4.18

PCALAS and CALASP scores for TI and CAI groups

	PCALAS	CALASP
TI (*N* = 26)	25.846	25.769
CAI (*N* = 29)	25.551	27.620

More detailed descriptive data analysis results obtained from the PCALAS and CALASP are presented in Table 4.19. As seen from Table 4.19, the scores of computer assisted learning attitude scale change from 47 to 100 with 100 as the highest score. The mean of PCALAS was 25.85 and the mean of CALASP was 25.77 for the control group. On the other hand, the mean scores of PCALAS and CALASP for the experimental group were 25.55 and 27.62 respectively. Although all Kurtosis and Skewness values of the PCALAS and CALASP were in the limit of normality, it can be accepted as approximately normal since Kunnan indicated that Kurtosis and Skewness values between -2 and 2 can be assumed as approximately normal. Moreover the tests of normality was conducted for the achievement tests and the K-S test indicated that for PCALAS, and CALASP were normal, such as the K-S test for PCALAS for experimental group , D (29) = .13, p = .20 and for control group , D (26) = .13, p = .20 were both normal.

Table 4.19

Descriptive statistics of the PCALAS and CALASP

	Control		Experimental	
	PCALAS	CALASP	PCALAS	CALASP
N	26	26	29	29
Mean	25.85	25.77	25.55	27.62
Median	27.00	26.00	26.00	28.00
Standard Dev.	3.76	3.10	3.51	2.27
Min	18.00	19.00	15.00	21.00
Max	30.00	30.00	30.00	30.00
Range	12.00	11.00	15.00	9.00
Skewness	-1.05	-0.73	-1.10	-0.88
Kurtosis	0.18	0.19	1.46	0.83

In order to compare the distribution and location of the computer assisted learning attitudes scores visually; the clustered boxplot was constructed (see Figure 4.8). The comparison of the attitude scores for the control and the experimental groups clearly indicated that the scores of CALASP of the experimental group were significantly higher than the CALASP scores of the control group. Besides, the boxplot of PCALAS was skewed to the left in the control group and also there was one outlier in CALASP. The upper quartile of PCALAS was about the same with the median score of the CALASP in the experimental group.

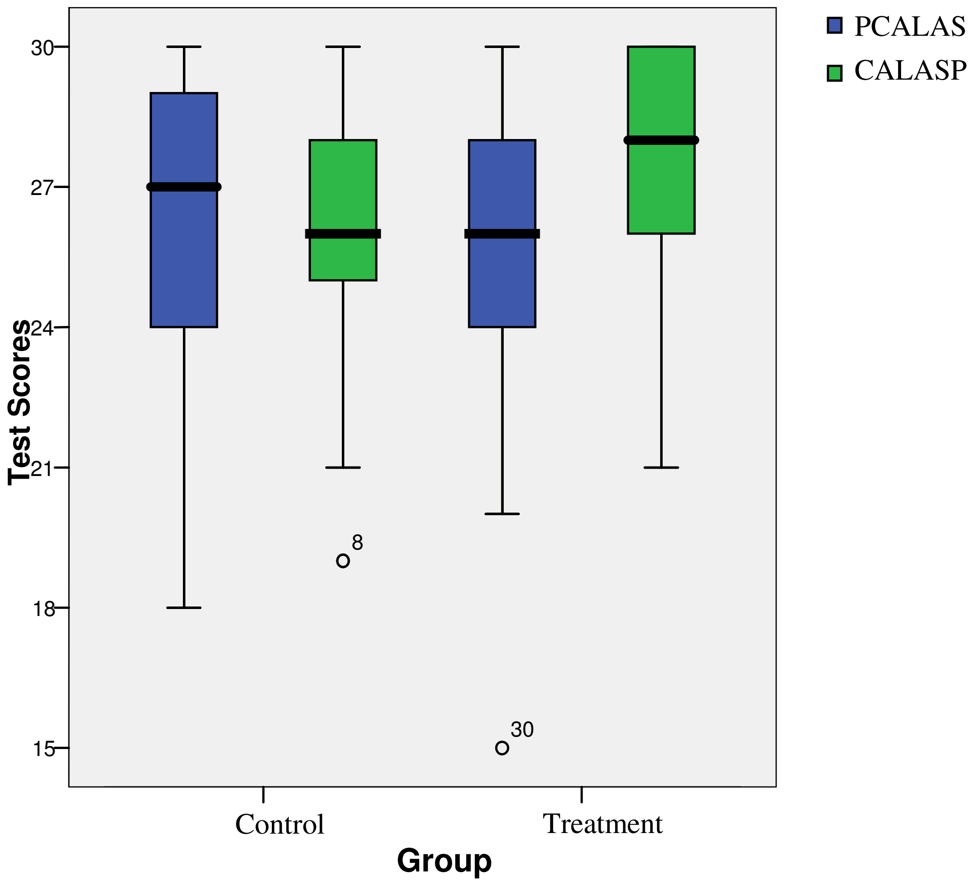


Figure 4.8. Boxplot of PCALAS and CALASP

The results of inferential analysis to test the hypothesis 3 will be presented after the descriptive statistics. The hypothesis was as follows:

Null Hypothesis 3: There is no significant difference between the computer assisted learning attitude scale post scores of the students exposed to computer assisted instruction with *Frizbi Mathematics 4* and those who were exposed to traditional instruction with textbook.

After the implementation, an independent *t*-test was conducted to test the above hypothesis. Findings indicated that there was a difference between mean scores of the students exposed to traditional instruction with textbook (M = 25.77, SE = .61) and those exposed to computer assisted instruction with *Frizbi Mathematics 4* (M = 27.62, SE = .42) in favor of experimental group. The results of *t*-test are presented in the Table 4.20.

Table 4.20

Results of an independent t-test for CALASP

					Levene's Test				
Variable	Groups	*N*	*M*	*SD*	*F*	Sig.	*t*	*df*	Sig.
CALASP	Control	26	25.77	3.10	1.06	.31	-2.54	53	.01*
	Experimental	29	27.62	2.27					

*p<.05

As seen in Table 4.20 Levene's Test showed that variances were not significantly different (p = .31) therefore the test statistics equal variances assumed was used to test the hypothesis. It was found that there was a statistically significant difference between the mean scores of the students exposed to traditional instruction and those exposed to CAI with *Frizbi Mathematics 4* in terms of CALAS in favor of computer assisted instruction, t (53) = - 2.54, p = .01; however, it did represent a medium size effect r =. 33 (Cohen, 1988).

In the light of these, it was deduced that there was a significant difference between the scale scores of students who exposed to CAI with *Frizbi Mathematics 4* and those exposed to traditional instruction concerning computer assisted learning attitude in the favor of CAI.

4.4 Summary of Results

In the light of the findings obtained by the statistical analyses, the results could be summarized as follows:

1. The results of pretest and posttest for unit 1: "Multiplication of Natural Numbers" revealed that the CAI with *Frizbi Mathematics 4* applied to the experimental group was demonstrated to be effective in increasing the

achievement scores of the students. That is to say, the results of pretest and posttest demonstrated that there were significant differences between achievement tests' mean scores of students in the experimental and control group on the first unit "Multiplication of Natural Numbers" in the favor of computer-assisted instruction with *Frizbi Mathematics 4*.

2. The results of pretest and posttest for unit 2: "Division of Natural Numbers" revealed that the CAI with *Frizbi Mathematics 4* applied to the experimental group was demonstrated to be effective in increasing the achievement scores of the students. That is to say, the results of inferential statistics demonstrated that there were significant differences between achievement tests' mean scores of students in the experimental and control group on the second unit "Division of Natural Numbers" in the favor of computer-assisted instruction with *Frizbi Mathematics 4*.

3. The results of pretest and posttest for unit 3: "Fractions" revealed that the CAI with *Frizbi Mathematics 4* applied to the experimental group was demonstrated to be effective in increasing the achievement scores of the students. That is to say, the results of inferential statistics demonstrated that there were significant differences between achievement tests' mean scores of students in the experimental and control group on the third unit "Fractions" in the favor of computer-assisted instruction with *Frizbi Mathematics 4*.

4. Although the unit 1 (Multiplication of Natural Numbers) retention test mean scores were lower than the post test mean scores in both groups and the "rate of retention decay" was not significantly different between the experimental and the control group, the results of independent *t*-test indicated that the experimental group's retention test mean score was significantly higher than the control group. Thus, the students in the experimental group which exposed to CAI with Frizbi Mathmematics 4 retained more of what they have learned on the unit 1: "Multiplication of Natural Numbers". That is to say, the results evidenced a significantly higher retention amount for the experimental group after four months.

5. Although the unit 2 (Division of Natural Numbers) retention test mean scores were lower than the post test mean scores in both groups and the “rate of retention decay” was not significantly different between the experimental and the control group, the results of independent *t*-test indicated that the experimental group’s retention test mean score was significantly higher than the control group. Thus, the students in the experimental group which exposed to CAI with Frizbi Mathmematics 4 retained more of what they have learned on the unit 2: “Division of Natural Numbers”. That is to say, the results evidenced a significantly higher retention amount for the experimental group after four months.

6. On the contrary there was no significant difference between the experimental group exposed to CAI with *Frizbi Mathematics 4* and the control group exposed to traditional instruction on the retention test scores of the unit 3: “Fractions of Natural Numbers”.

7. There was also a significant main effect of time on the three test scores for each of the treatment units. However, contrasts revealed that both the post-test and retention test scores were higher than the pre-test scores and the retention test scores were lower than the post tests scores.

8. Neither the unit 1: “Multiplication of Natural Numbers” nor the unit 3: “Fractions of Natural Numbers” analysis produced any interaction between group and time that approached significance but the unit 2: “Division of Natural Numbers” analysis produced a significant interaction between group and time (F (2, 106) = 3.25, p = .04).

9. Although it was not the purpose of the study, in order to show differences between three units, the comparisons of three effect sizes indicated that all the effect sizes were medium degree (Cohen, 1998). The effect size reported for the unit 2 (η^2 =. 14) is larger than the unit 1 (η^2 = .09) and the unit 3 (η^2 = .12).

10. There was a significant difference between the experimental and control groups' attitude towards mathematics. That is to say, CAI with *Frizbi Mathematics 4* was more effective in increasing the students' attitudes towards mathematics than the traditional way of teaching.

11. The similar results were obtained for the CALAS as well. There was a significant difference between the experimental and control groups' attitude towards computer assisted learning. That is to say, CAI with *Frizbi Mathematics 4* positively effected the students' attitudes towards computer assisted learning.

CHAPTER V

DISCUSSION

The purpose of the current study was to investigate the effects of CAI with *Frizbi Mathematics 4* on the 4th grade students' mathematics achievement, attitudes toward mathematics, attitude toward computer assisted learning and retention. First, the discussion of the results is given, and then the conclusion of the study is presented in the second section. Finally, the third section is devoted to the recommendations for practices and for the further studies.

5.1 Conclusions

In order to examine the impact of educational software *Frizbi Mathematics 4* on 4th grade students' achievement, attitudes and retention a quasi-experimental research design was conducted in TRNC. Throughout the spring semester of the 2005-2006 academic year, the experimental group was exposed to CAI with *Frizbi Mathematics 4* and the control group was exposed to traditional instruction. The study investigated how *Frizbi Mathematics 4* as a mode of CAI effects the students' achievement in multiplication, division and fractions when used as an instructional support. Data were collected by three achievement tests one for each unit; unit 1: "Multiplication of Natural Numbers", unit 2: "Division of Natural Numbers", and unit 3: "Fractions".

As a secondary purpose data were also collected by two attitude scales to investigate whether CAI has an effect on students' attitudes toward mathematics and toward computer assisted learning. Also, the retention tests were used to examine the students' retention on mathematics.

5.1.1 The Effect of Frizbi Mathematics 4 on Achievement

At the beginning of the treatment, there were no significant mean differences between the groups in any of the pre-test analyses. Hence, it could be suggested that the experimental and control groups were equivalent based on the *matching scores* prior the intervention.

The results that were presented in the previous chapter (Chapter 4) showed that both the experimental group and the control group experienced improvement in mathematics achievement from the beginning of the intervention to the end of it. On the other hand, results indicated that students who were exposed to CAI with *Frizbi Mathematics 4* significantly outperformed students who were exposed to TI on the mathematics achievement post tests of all the treatment units.

First, the main effect of groups on mathematics achievement on unit 1: "Multiplication of Natural Numbers", as measured by the MATP1 was found to be statistically significant at .05 level. That is to say, the mean MATP1 scores of the students exposed to CAI and the traditional instruction were significantly different. The comparison PMAT1 vs. MATP1 revealed there were no significant changes in the control group, however in the experimental group, the students statistically increased their scores (see Table 4.3). In addition to this, the comparisons of PMAT1, MATP1, and MATR1 revealed a significant time main effect of tests scores, that is students' test scores in both groups were changed based on the treatment. On the contrary there was no interaction main effect between the time and group.

Second, the main effect of groups on mathematics achievement on unit 2: "Division of Natural Numbers", as measured by the MATP2 was found to be statistically significant at .05 level. That is to say, the mean MATP2 scores of the students exposed to CAI and the traditional instruction were significantly different. The comparison PMAT2 vs. MATP2 revealed there were no significant changes in the control group, however in the experimental group, the students statistically increased their scores (see Table 4.7). In addition to this, the comparisons of PMAT2, MATP2, and MATR2 revealed a significant time main effect of tests scores, that was students' test scores in both groups were changed based on the treatment. Additionally, there was an interaction main effect between the time and group.

Third, the main effect of groups on mathematics achievement on unit 3: "Fractions", as measured by the MATP3 was found to be statistically significant at .05 level. That is to say, the mean MATP3 scores of the students exposed to CAI and the traditional instruction were significantly different. The comparison PMAT3 vs. MATP3 revealed there were no significant changes in the control group, however in the experimental group, the students statistically increased their scores (see Table 4.11). In addition to this, the comparisons of PMAT3, MATP3, and MATR3 revealed a significant time main effect of tests scores, that is students' test scores in both groups were changed based on the treatment. On the contrary there was no interaction main effect between the time and group.

Fourth, the main effect of groups on retained mathematics achievement as measured by three retention tests, one for each three treatment units, significant differences between the experimental and control group were found on the unit 1: multiplication of natural numbers and the unit 2: "Division of Natural Numbers", but not on the unit 3: "Fractions". Although the mean scores of the students exposed to CAI and those who were exposed to TI were significantly different to each other on the first retention mathematics achievement test and second retention mathematics achievement test in favor of CAI group, the retention test mean scores of students were not significantly different between two groups on the fraction unit. That is to say, the *Frizbi Mathematics 4* was an effective on mathematics achievement in a long-term period as well, except the fractions.

The results of the present study is congruent with the results of the studies concerning computer-assisted instruction which were reported by Akoğlu (2003), Ash (2005), Ball (1988), Budak (2000), Çoban (1998), Düzgün (2003), Genel (1998), Fankhouser (2003), Korkmaz (2000), Kılıç (2007), Önder (2001), Yavuz (1991), and Wilcox (1997).

The reviewed studies in which the CAI software used in the experimental group and not in the control group –the design used in this study- have compared the achievement of students. Research on the effectiveness of computers on student achievement began by Skinner's programmed instruction in 1969s (Lou, Abrami, & d,Appollonia, 2001, p. 450). In many of the studies computer had a significant positive effect on the achievement of the students' mathematics test scores. One of the earliest studies, Ball (1988) found similar results to the current study. Three intact fourth-grade classes worked with graphic fraction software as a supplement while they learned fractions during a period of three months, and two control classes served as controls followed the same lesson content by traditional instructional methods. Like the study by Ball (1988), results showed that the experimental group scored significantly higher on the fraction achievement posttest. Similarly with Ball's study, when the posttest achievement scores on fraction were examined in the current study, it is found that the students in the experimental group outperformed the control group. This implies that students gained better understanding of the concepts of fractions while participating with the *Frizbi Mathematics 4* software. The positive results obtained for using mathematics software in TRNC primary mathematics education are also consistent with the research findings of Wilcox (1997) who discovered that second grade students' performance improved when they provided animated instruction with fractions software in two public schools in Chatham Country, North Carolina.

In his study Düzgün (2003) conducted a research to investigate the effects of computer-assisted instruction on 5th grade students' mathematics achievement on fractions. Results of the study found significant mean differences between the students who exposed to CAI and the students who exposed to traditional instruction in the favor of the experimental group on the achievement test scores of the unit: Fractions. Additionally, Akoğlu's study revealed that programmed instruction with computer assisted instruction had an impact on fourth grade students' mathematics achievement on fractions (Akoğlu, 2003).

Another study was conducted to find out if Webquest assisted cooperative learning had any effects on the mathematics achievement and attitudes of 5th grade students. Kılıç (2007) included three groups in his study; "Webquest assisted cooperative learning group", "Cooperative learning group" and the control group. Results indicated that there was a significant difference in favor of webquest assisted cooperative learning method on the students' post-test scores. Beside this, students' attitude scale scores in the web quest assisted cooperative learning group were significantly higher than the cooperative learning and the control group.

Ash (2005) conducted a quasi-experimental study to investigate the effect of computer-assisted instruction software on the academic achievement of middle school students. Over a twelve-week period students in the treatment group used the computer-assisted instructional software package *Orchard* once per week in addition to traditional teaching methods, on the contrary students in control group received only traditional teaching methods throughout the study. The results indicated that the use of computer-assisted instruction with the software was more effective than traditional teaching methods alone.

Funkhouser (2003) investigated the effectiveness of educational geometry software on mathematics achievement and attitudes toward mathematics of secondary school students. A treatment group consisting of 22 students followed the geometry instruction with the *Geometric Supposer* (1993) software, while the students of a control group consisting of 22 students were involved in more traditional geometry instruction with traditional materials such as a compass, straightedge, and protector. After 36 weeks of instruction, students' achievement and attitudes were assessed by administration of geometry performance test and mathematics attitude scale. The experimental group who were exposed to computer- augmented instruction performed a significantly better achievement on the geometry test than the control group.

The results of Tabuk's study indicated that computer-assisted instruction had a positive significant effect on the achievement in mathematics lessons of the 7th grade students. Results of the study were indicated that CAI had positively effect students' attitudes towards mathematics (Tabuk, 2003).

Another study which was conducted by Genel (1998) aimed to analyze the effect of computer-assisted instruction on the second order functional graphics unit. The experimental group was exposed to two lesson hours of computer-assisted teaching with the educational software based on Visual Basic 5.0 and the control group was exposed to traditional instruction. Results showed that CAI had a positive effect on both successful and unsuccessful 9^{th} graders final test scores. Furthermore, study indicated that the achievement of the unsuccessful students was much higher than the successful students.

A similar research study also investigated the effectiveness of computer-supported education on the success and accomplishment of 7^{th} graders on the equation unit. Three school regions namely "Ağa Ceylan Primary School", "Çankaya Anadolu High School" and "Ankara Anadolu High School" were included in the study and the results pointed out that the experimental group students' post tests scores were higher than the control group students' post tests scores only in the "Ankara Anadolu High Scool" (Kirnik, 1998).

Korkmaz (2000) used the software "Bar Graphs and Coordinates" in order to investigate the effect of computer-assisted instruction on 6^{th} graders' performance on coordinate points and bar graphs. The significant gain of students' performance was observed for coordinates unit but not for the bar graphs unit.

In Gökcül's study a computer-based instructional tutorial method that was designed in parallel to the Keller' ARCS motivational model was used to analyze the effects on the academic achievement and retention in *sets* unit on the 6^{th} grade students. Throughout the first semester the experimental group followed the computer based instruction and the control group followed the traditional instruction. Results of Gökcül's study are similiar to the results of the current study. That is, post tests scores of the achievement test on the unit *sets* are significantly higher in the experimental group. However, a significant difference was obtained on retention test scores in favor of the control group (Gökcül, 2007).

Studies that were mentioned above present the general picture of the potential of computers in K-12 mathematics education. However, the benefits of technology integration are not limited with this, computers are an integral part of everyone's life, and learners need to be literate in not only basic skills but in computers too. One of the best ways to make students skillful in computers is empowering them to use computers and to communicate with computers. Incorporating technology with school subjects has many advantages; students gain new concepts for example mathematics in an enjoyable learning environment, and they may also develop computer usage skills. This way of integration can be obtained by employing educational software in teaching activities. Students in K-4 grade are excited when using computers, so turning this joy into effective learning outcomes causes the raise in the positive results. Today, there are many mathematics software for learning mathematical concepts in K-12 level. CAI is one of the application forms of computers, and there are different modes, such as drill and practice, tutorials, or simulations. Drill and practice mathematics software presents the exercises in interesting real-life based context in the form of computer games or activities (McCoy, 1996). The *Frizbi Mathematics 4* is in the form of drill and practice software as explained in method section, and also oriented around the general problem solving strategies, interactive exercises about mathematical problems and solutions based on adventure activities. In the current research study, researcher utilized the *Frizbi Mathematics 4* in the form of CAI application, and the results supported the literature that post-achievement test results were significant when CAI was used as a supplementary to traditional classroom instruction. Similarly the results of this study seem to be consistent with the findings of Suydam (1994, cited in Ndiforchu, 2003) that the drill and practice administration through a computer is less time-consuming than drill-and-practice through a paper-and-pencil.

Although there are lots of studies that discuss the effectiveness of computer- assisted instruction on fractions (Reimer & Mayer, 2005; Perez, 2007; Wilcox, 1997), there are a restricted number of studies which concentrate on multiplication and division.

Frizbi Mathematics 4 was developed in parallel to the 4th grade mathematics curriculum; therefore all the topics in the agenda were included in the software. Since the duration of this study was limited with the second semester, multiplications, divisions and fractions were included to the study. Algebra is one of the major topics in the mathematics curriculum. Moreover, it is the central to each student's understanding of mathematics. By introducing algebraic concepts at an early age, students will have a better chance of understanding the world around them and be prosperous in the job arena. Allowing students to relate four operations to real-life situations encourage them to enjoy and understand the basics of algebra. Also NCTM (1997) stated, "technological advancements are changing the way algebra is traditionally taught". Some computer software allow students to focus on problem-solving strategies and not only symbol manipulation (Fey, 1998).

The software *Rounding* was field-tested by Tabellion (2007) on twenty 3rd graders at an elementary school in Torrance, CA. Students spent one third of the time usually learning the concept of rounding, using CAI. When the intervention was completed students were tested once more and results indicated that students improved their scores significantly. Similarly, in California, Perez (2007) conducted research regarding twenty 2nd grade students' performance on mathematics by using *Equivalent Fractions* software. The researcher found a significant higher achievement in the computer-assisted group than the control group. In Taiwan, Chen and Liu (2007) found that Taiwanese 4th grade students' achievement on personalized computer-assisted instruction was higher than the nonpersonalized group. Another study (Ndiforchu, 2003) which supported the findings of the current study was conducted on elementary level and examined the effectiveness of computer-assisted instruction on the basic addition skills of second graders. Results of Ndiforchu's study showed a significant gain between the means of pretest and posttest scores, and concluded that the *Basic Math* software was effective in enhancing the addition skills of second graders. Unfortunately, there is no research study exploring the effectivness of computer-assisted instruction on mathematics in TRNC. In this respect, this study was conducted to fulfill this deficiency by exploring the applicability and effectivity of using a computer-assisted mathematics upon Cypriot students' performance in mathematics concepts.

The present study contradicts the result of Carter (2004) who reported that the web-based CAI and traditional lecture methods of instruction were equally as effective in teaching mathematics. Also Clinkscales (2002), Ortiz (1987), and Thayer (1992), reported no significant difference for the achievement result between computer-assisted instruction and traditional instruction.

The above results establishes the fact that no improvement in achievement for students exposed CAI may be related to some factors such as quality of instruction, quality of software, quality of teachers and duration of computer-assisted instruction (McCoy 1996; Mintz, 2000)

Kulik (2004) examined the 61 controlled evaluation studies' results published since 1990. Most of the studies in Kulik's review focused on the student learning as an instructional outcome of an achievement examination, and few of them were carried out for the retention, follow-up exams and attitudes. Contrary to an abundance of research studies, this research study examined also the students' achievement on long term, and the analysis of results showed that students who learned with *Frizbi Mathematics 4* outperformed the control group on the immediate posttests as well as on the retention tests, except the last retention test which was for the unit 3: Fractions. Effect of *Frizbi Mathematics 4* on retention is discussed in the next section.

5.1.2 The Effect of Frizbi Mathematics 4 on Retention

According to the results of this study *Frizbi Mathematics 4* was also effective on the students' retention scores in mathematics lesson specifically on the units: "Multiplication of Natural Numbers", "Division of Natural Numbers", but not on the unit "Fractions". This result was consistent with the findings on computer effect on retention. There have been several studies that were conducted to investigate the effectiveness of computers on long term achievement (Ortiz, 1987; Thomson, 1992; Wilcox, 1997).

There are many studies in literature which support the effectiveness of CAI on the students' retention in mathematical concepts. For instance, Ortiz (1987) indicated the significant differences between the computer and control groups' retention test scores, where significant differences favored the computer group.

The results of the current study contradict with Song's (1992) findings. In the Song's study students taught with the computer software *MYSTAT* achieved better than students in conventional lecture-type instruction group on the probability retention test. Furthermore, Song stated that these positive results are important findings since the major aim of instruction is retention.

Rivet (2001) examined changes in student achievement in middle school mathematics on operations involving Fractions based on the two instructional methods: computer-assisted instruction versus lecturing. After completion of 6-week study, difference scores were examined the use of computer-assisted instruction led to increased 6th grade students' achievement, attitudes, as well as retention when compared to traditional instruction.

A meta-analysis was conducted by Kuchler (1998) to integrate the findings contained in sixty-five studies; selected from published studies, ERIC documents, and dissertations, which investigated the use of computers to teach secondary school mathematics in the United States. Although the results indicated that the secondary level computer-assisted instruction has only an overall small positive effect on mathematics achievement, findings concerning retention of mathematics achievement had a possible medium positive effect (i.e. ES = 0.47) on mathematical concepts and skills of secondary school students.

The nonsignificant results that were obtained in the current study for the fractions unit consistent with the research findings of Wilcox (1997) who conducted an experiment with second grade students to examine whether the animated graphics were more effective than the static graphics in mathematic lessons when used as instructional support with fraction software. Wilcox's study contained five experimental groups and students in the experimental groups were tested three times; one before the intervention, one immediately after completing the study and also two weeks later as a retention test. The total retention test scores were analyzed by ANCOVA, and results indicated no differences between all experimental groups.

In Turkey, Gökcül (2007) examined the effectiveness of the computer-based instructional tutorial method that was designed in parallel to the Keller' ARCS motivational model on the students' academic achievement and retention in *sets*. Results indicated that the control group outperformed the experimental group on the retention test scores.

As mentioned in the literature review section, Breunlin (1999) designed a study to answer the following question: "Will anchored instruction augmented with hypermedia tutor provide the knowledge structures necessary for better long term retention of area concepts in high school geometry?" Although the answer of the question remained unclear in the study, all the groups decreased their retention scores and no significant mean differences between the groups were found on the retention test. However, Breunlin stated that students in the experimental group performed slightly higher retention amount and rate after three weeks.

Similarly, one of the earliest studies of CAI, Hawley (1984) studied the effectiveness of computers for instruction in terms of achievement, attitudes, and retention of content. Students in grade 6, 7, and 8 who were exposed to different amounts of computer-assisted instruction daily over a three week period of time were the participants of the study. The posttest results showed achievement was significantly related to time, and similar with the current study, Hawley indicated that the gains made by students were not sustained in a long-term period when the retention test was given after one month. In addition to this, contrary to current study, attitudes toward mathematics showed no positive significance.

The results of the 3 X 2 ANOVA with repeted measures for retention test scores indicated a decrease in retention tests scores in both of the groups. Further analysis using independent sample *t*-test revealed a significant difference ($p < .05$) between experimental and control groups in favor of experimental group on the first two units. Additionally, when an independent sample *t*-test, as a further analysis, was performed on the retention test scores of fractions unit, no differences between two groups were evident. There may be several reasons for this situation. One reason may be the "nature" of the fractions. "Fractions" is one of those concepts in mathematics that many students find difficult. Also, not the concept of "fractions" but the four operations with fractions is much more challenging for students. Since the 3^{th} grade mathematics curriculum does not contain the topic "four operations with fractions" then the topic is new for the 4^{th} grade students. Students may be more competent on multiplication and division since they learn them from first grade level. Since the "four operations with fractions" is new for the students, they can not grasp the meaning of the topic. Thus the retention test scores are lower than the other two units.

Secondly, the time between posttests and retention tests was four months summer holiday time and students were not exposed to any mathematical activities during the holiday time. That summer holiday may be a factor of the overall decreasing retention tests scores.

5.1.3 The Effect of Frizbi Mathematics 4 on Attitudes

The statistical analyses presented in Chapter 4 indicated that there was a significant mean differences between the students exposed to CAI and those who were exposed to traditional instruction with respect to attitude scale scores towards mathematics and computer assisted learning.

Like the diverse research results on academic achievement via CAI, the research findings were differed for attitude outcomes as well. There are studies in the literature that resulted with no attitude change towards mathematics when computer-assisted instruction was utilized (Carter (2004), Funkhouser (2003), Manuel (1987), Thayer (1992)), as well as studies that resulted positive attitude change towards mathematics in favor of computer-assisted utilization (Furner & Marinas (2006); Tabuk (2003)).

Mathematics is perceived by students as a cold and complex lesson, and when it is asked which subject do you like most, definitely mathematics is not on the top of the list of “the best subjects”. Mathematics teachers, content of mathematics curriculum, achievement in K-12 mathematics courses, and teaching methods can be considered as factors that influence the student’ attitudes towards mathematics. According to Johnson (2000) students who had ever experienced with technology usage, cooperative learning practices, and manipulative in K-12 and/or college-level mathematics gained more positive attitudes towards mathematics. Generally, students who have experienced failure and negative attitude in mathematics lessons in primary grades may not change their attitudes towards mathematics in the further grades such as high school or college. Therefore, the positive attitude that was gained in the early years of education has a vital impact on student’ achievement in the high school or college education.

Most of the studies in the literature highlighted the importance of integration of computer technologies into mathematics lessons. With the use of such technologies, students can learn easily and meaningfully by participating real-life based learning environments. Integrating educational software into abstract topics in mathematics also renders learning more enjoyable, makes abstract concepts more concrete and catchy. We as educators need to make mathematics interesting for students to learn and enjoy while presenting mathematical concepts. Computers and educational software can be used to support the teaching and learning of mathematics. Learning mathematics with educational software such as *Frizbi Mathematics 4* may influence the students’ personal and emotional growth in positive ways. As this study indicated that, the mean change in attitude toward mathematics as measured by Mathematics Attitude Scale (Aşkar, 1986) was positive for all students for both of the groups, however attitude towards mathematics showed greatest increase in the experimental group who was exposed to CAI with *Frizbi Mathematics 4*.

Thus, carefully planned and structured software practices with clear mathematical objectives can play an important role in increasing students’ attitude towards mathematics. *Frizbi Mathematics 4* software is an excellent drill-and-practice tool that helps students to learn mathematical concepts in a constructivist environment. *Frizbi Mathematics 4* presents the real-life based examples and practices by animated colorful and sound supported screens and guides students as they form their own understanding of the topic. Furthermore practices with *Frizbi Mathematics 4* means students do not passively receive the instruction from the teachers, but instead actively construct their own new knowledge. These factors might have caused students in the experimental group to have more positive attitudes toward mathematics. Furner and Marinas (2006) point out, *Geometer's Sketchpad* serves as dynamic motivating tool to help students learn for understanding of elementary geometry concepts while increasing the level of the positive attitude towards mathematics scores.

The other major contribution of the current study was that the *Frizbi Mathematics 4* utilized also to assess the students' attitude towards computer-assisted learning. The findings of the current study revealed that students' attitudes toward computer-assisted learning were positively high in the experimental group.

When the issue is the incorporation of computers into primary education, students' attitudinal outcomes towards computer-assisted learning plays a crucial role. A student's having a positive attitude toward CAI is essential for that student's success with CAI. Since this is the first study which was focused on the computer-assisted mathematics instruction in TRNC, it is important for the sake of the study to put forward the 4th graders' attitudes towards computer-assisted learning. Positive and the same level of attitude towards computer- assisted learning were found at the beginning of the study for both of the groups, however at the end of the intervention post scale mean score of the students in the experimental group were significantly higher than the mean score of the students in the control group. That is to say, students exposed to practices with computers by *Frizbi Mathematics 4* gained more positive attitude towards computer assisted mathematics learning, whereas no significant change in student attitude towards computer assisted learning was found in the control group. Beside this, the researcher of this study observed that all the students in the experimental group were exited and willing to visit the computer laboratory on the days that computer assisted mathematics lessons were conducted with the *Frizbi Mathematics 4*.

The research findings of Aşkar (1992) provide similar results with the current study. Aşkar conducted a study on 137 Turkish 5th graders to find out the attitudes toward CAI, and results indicated a positive attitude towards CAI.

In his study Ruffin (2000) investigated the relationship between demographic variables and student attitudes toward computer-aided instruction. Results of the investigation revealed that attitude toward computers, average daily exposure to computer, race, and computer-related experiences are the predictors of attitude toward computer-assisted instruction. On the other hand, Teng (2001) stated that positive student attitudes towards computer-assisted learning were existed in well-organized and resourceful mathematics classes in Singapore. The findings from the current study indicated that the *Frizbi Mathematics 4* had a significant positive effect on the students' attitude towards computer-assisted learning, whereas students who received instruction from traditional instruction did not change and kept the same level of attitudes towards computer-assisted learning. Beside this, as Ruffin's study pointed out, because of the students in the experimental group spent more time on computers than students in control group, this was correlated with the experimental group of students' significantly better attitude towards computer-assisted learning. On the other hand, there may be some unknown effects that influence students' attitudes; a possible explanation may be the novelty effects of software. The increased attitudes both towards mathematics and computers-assisted learning by students in the experimental group may not be related to the actual improvement in attitude but in response to increased interest in *Frizbi mathematics 4*.

The contributions of computers and computer software into mathematics education has been discussed by researchers over 30 years, multiple research studies in an international arena has been documented in the literature. Similar to other studies, this study aimed to investigate whether computer-assisted instruction with *Frizbi Mathematics 4* had a significant effect on 4th graders' achievement on "Multiplication of Natural Numbers", "Division of Natural Numbers" and

“Fractions”, attitudes towards mathematics and computer assisted learning and retention in mathematics. Results revealed that the computer-assisted instruction with *Frizbi Mathematics 4* had a positive effect on the students’ achievement scores on the treatment units, also a significant change in attitudes towards mathematics and computer assisted learning in the favor of computer-assisted instruction with *Frizbi Mathematics 4*. Results indicated that CAI could be the supplementary teaching method to traditional instruction in the TRNC education system.

5.2 Discussion

In the developed countries a great amount of money and resources have been invested in the integration of computers and related educational technologies to classrooms, however in TRNC there is no such innovation regarding educational settings. There are some developments but when it is compared to other nations including South Cyprus, there is lack of improvement. This study offers promise and suggests that computer-assisted instruction would be good supplementary method of instruction for the conventional mathematics instruction in the mathematics courses in the TRNC case.

Computer-assisted instruction provides differentiated mathematics education for both teachers and students (Ash, 2005). Some forms of the CAI offer extensive opportunities for recitation of concepts in mathematics lessons. McCoy’s 1996 review article stated that, computer-based materials as prepared within the constructivism pedagogical provide active involvement. One of the effective ways of teaching mathematics is active participation. Hence students are not just passive learners, they do not watch the teacher’s demonstration of how to solve mathematical problems, but they understand the mathematical concepts by doing mathematics. The learner should be a part of concrete activities, real-life based scenarios. *Frizbi Mathematics 4* provides such an environment where mathematical concepts are presented in virtually concrete forms, activities are interesting and challenging. More so, the interactive feature of the software provides a user-friendly environment to the learner. Thus, *Frizbi Mathematics 4* could be successful in helping students gain concrete, real-life based and basic knowledge and also it lets them to construct their own understanding of multiplications, division and fractions.

Currently research studies world wide are not trying to answer the question whether or not to integrate computers in mathematics education, most of them are focused on the answer of how to utilize computers to maximize the students' learning. Unfortunately there is no research on the integration of technology in TRNC. TRNC can not be left out of these new developments and changes in educational technologies. A meta-analysis study of Quyang (1993) confirmed the conclusion that computer-assisted instruction was effective for the instruction of mathematics and the effect sizes were comparatively higher for the teaching of mathematics than to the teaching of language art. Additionally when Quyang compared the effect sizes among CAI types, higher effect sizes were produced for the CAI of drill and practice type (ES = .61). These studies which were consistent with the results of the current study indicate that computers are effective in facilitating mathematics achievement.

The main purpose of this research was to study the effectiveness of the use of computers for mathematics instruction in terms of achievement, attitudes and retention of mathematical content in TRNC case. The results of this study showed the positive outcomes on the 4^{th} grade students' immediate achievement in mathematics, attitudes towards mathematics and attitudes toward computer-assisted learning. Therefore, it can be concluded that computers could be integrated into TRNC education system. This study can be recognized as a kind of field testing of effectiveness of specifically the computer software *Frizbi Mathematics 4*, and in general the computer-assisted instruction in the TRNC mathematics lessons.

It is hoped that the findings of this study, the first in TRNC to focus on the effectiveness of computers on primary mathematics teaching, will prove useful to TRNC primary mathematics teachers and possible to TRNC educational system in general.

5.2 Recommendations

Based on the findings of the present study, several brief recommendations to the educators who wish to implement computer-assisted instruction at the primary mathematics lessons and to the researchers for future investigation on this topic are presented in the following sections.

5.2.1 Recommendation for Practice

Since the findings of this study revealed the positive outcomes of the effectiveness of CAI on the achievement and attitude scores of the 4th grade students in TRNC, the following recommendations for integration of computer-assisted instruction in mathematics lessons should be followed in order to get effective results in the TRNC education system.

1. *Frizbi Mathematics 4* was effective for increasing multiplication, division and fraction skills over the traditional instruction; therefore teachers in primary 4th grade can incorporate this software into mathematics lessons in TRNC.
2. Computers and educational software must be integrated into mathematics curriculum in TRNC education system.
3. *Frizbi Mathematics 4* was effective for increasing attitude toward mathematics; therefore it can be used in mathematics lesson to positively impact the 4th grade students' attitude toward mathematics.
4. *Frizbi Mathematics 4* produced a positive outcome in students' attitude toward computer assisted learning; therefore it can be concluded that students are ready for the integration of computer technologies into mathematics lessons.
5. Although teachers were not participating in the study, as McCoy (1996) indicated that teacher attitudes, abilities and skills plays a crucial role on the effectiveness of computer assisted instruction. Teacher training for successful integration of educational software should be put into Ministry of Education of TRNC budget.

6. All schools in TRNC should have a computer laboratory that can be used to support the conventional teaching methods for the subject matter presentation.
7. Teachers should consider the *Frizbi Mathematics 4* as a supplement rather than a substitute for traditional instruction.
8. During the laboratory environment mathematics teachers should always link their lessons to the actual classroom curriculum, beside this they should create learning environment that allows student interaction, creativity and participation.
9. New national mathematics curriculum and textbooks (MEB, 2005) should be revised based on the novelties in educational technologies and computer technologies.
10. Student teachers in the education faculties should be trained on computer-based education.

5.2.2 Recommendation for Further Research

Based on the results and findings revealed from the study, recommendations for future research on this topic are as following:

1. This study was limited with 4^{th} graders in the "Sht. Osman Ahmet" primary school in TRNC, and it can be replicated with a larger sample size for generalization to a bigger population.
2. Future studies should be carried out for different grade levels to investigate the effectiveness of CAI in mathematics education.
3. *Frizbi Mathematics 4* can be administrated to different topics in mathematics such as geometry.
4. Further research studies should be conducted for different subject matters in TRNC such as science and foreign languages.
5. The different kinds of educational software can be utilized in order to assess the attribution of a particular software type.

6. Researchers can carry out research studies to provide the effectiveness of CAI not only on attitudes but also on motivation. Stegemann (1986) studied the relation between the computer-assisted drill and practice and the motivation, and results indicated that students in CAI group were more motivated than the students in paper and pencil group.
7. Further research needs to be conducted which address the effectiveness of CAI among different periods of instructional time in terms of weeks. Quyang (1993) stated in his meta-analysis study that there were a significant difference in effect sizes among the different CAI instructional time for example for the duration of treatment of four weeks the effect size was calculated .53, whereas it was calculated .57 for eight weeks to fourteen weeks.
8. Since the random assignment was not possible for sampling, a quasi-experimental method was used for this research study. Further studies should be conducted with random assignment of subjects.
9. Follow-up studies should be conducted to assess the students' gains after the second and third years of CAI implementation.
10. Further studies should be conducted with the students with different levels of mathematics achievement and with different amounts of CAI activities. Results would indicate how the variance of students' achievement level interacts with different amounts of CAI.
11. Further research studies can be carried out to examine whether or not gender differences related the effectiveness of CAI.
12. Further research studies should be conducted to investigate the teacher's readiness, attitudes and knowledge about computer-assisted mathematics teachers in TRNC.
13. As a result, this study should be replicated in other school settings such as colleges, universities and private schools. This would provide the effectiveness of computer-assisted instruction in different population in TRNC.

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APPENDIX A

The General Description of the *Frizbi Mathematics 4*

The starting animation which gives information about the “task track” (görev sahası) shows Bike and her little dog who are sent to complete all the tasks in order to save their lives from the “Bad Professor”. When the starting animation is completed then next page asks student to type in their name, last name and student number. In this way, *Frizbi Mathematics 4* can recognize and keep the personal records of each student. As shown in Figure A.1, if the student clicks the “ok” button then the software is directed to the “task track” page which is shown in Figure A.2.

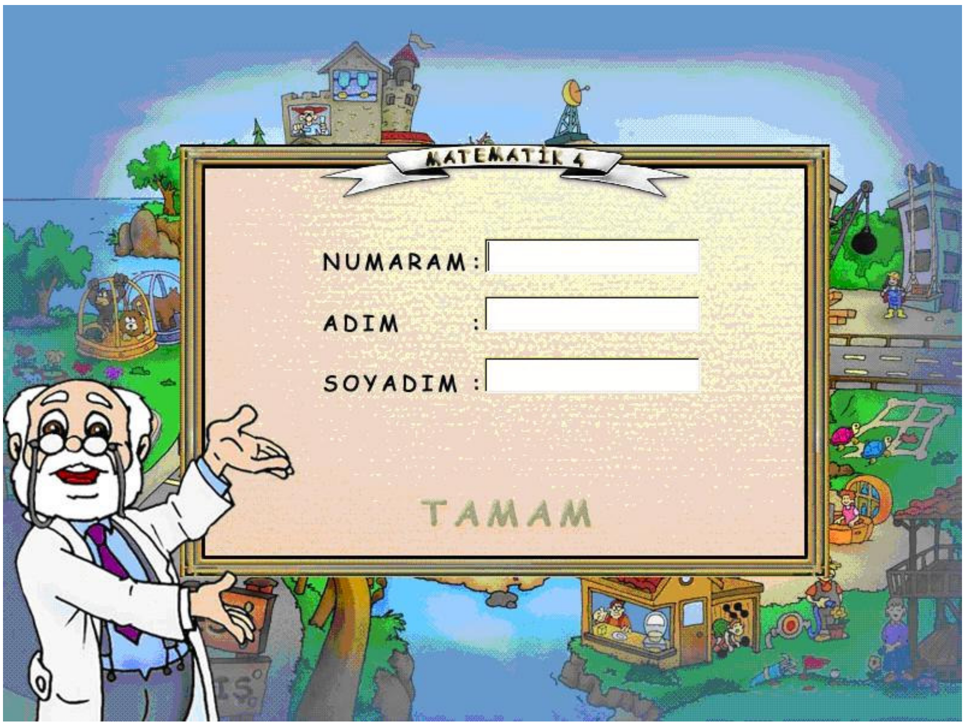


Figure A.1. The screen shot of an initial page that asks the number, name and last name of the student.

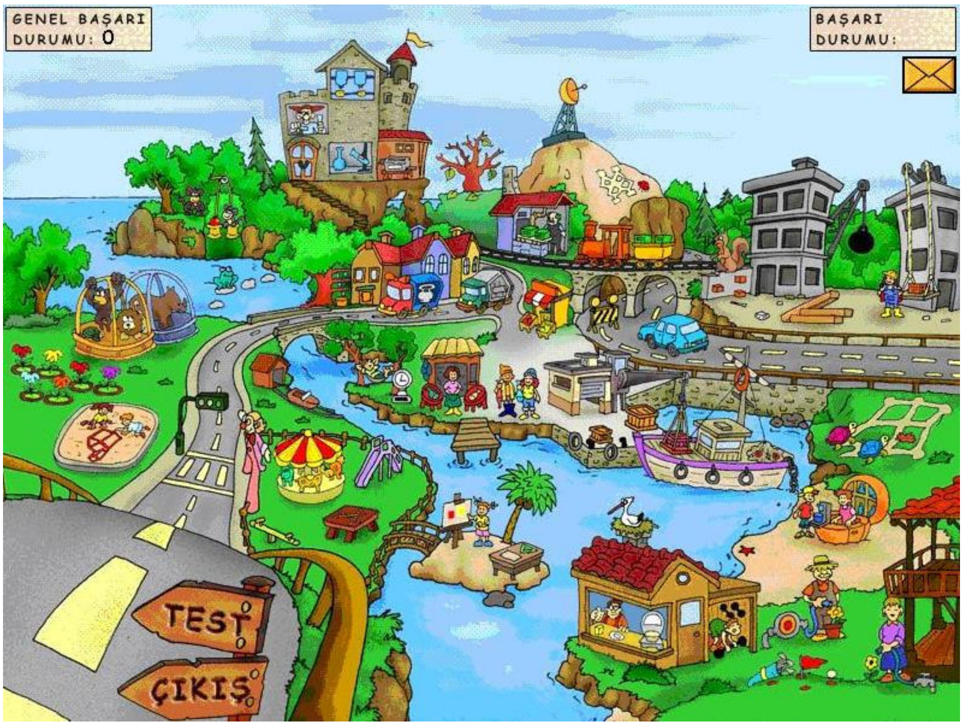


Figure A.2. The screen shot of the "task track".

All parts of this page are active; when the student moves the mouse cursor, then all the parts are activated. These parts are grouped based on the 4th grade mathematics curriculum. When the mouse cursor moves around the page then the name of the units are highlighted together with interactive exercise symbols, as shown in Figure A.3. For example, the new page is open when the cursor is on the "Fractions" unit and when it clicked on "the gardener" symbol.

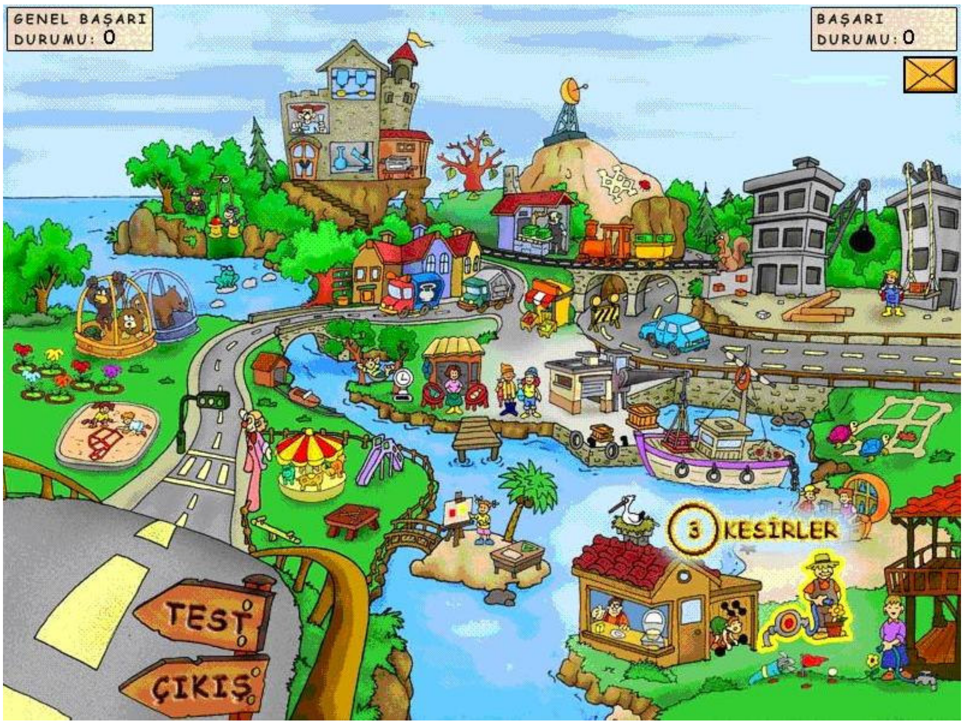


Figure A.3. The screen shot of the unit "Fractions" that is highlighted when the cursor is on it.

All instructions about the task such as, “what to do” and “how to do it” are given in a small information box as shown in Figure A.4.

Figure A.4. The screen shot of an “information box” that appears at the beginning of each interactive exercise.

Some of the tasks in the “task track” might be a bit difficult. If so, students can get help by clicking on the symbol “Good Professor” which is loacated at the bottom left side of the page. As shown the Figure A.5 a box appears and “Good Professor” gives important hints about the task.

Figure A.5. The screen shot of a "hint box" about the task.

If the student decides to study more about the unit while working on a specific task, then s/he should click on the "book" symbol on the left side of the page. When the mouse cursor moves around the units then sub units will become active automatically. Students can chose any subject by clicking on the unit names or sub unit names which are given in Figure A.6.

Figure A.6. The screen shot of all units that are included in the software.

The new page, as shown in Figure A.7, opens by clicking on one of the units and it explains the subject content. There are arrows which help to move up and down, "task track" symbol which brings the user to the "task track" page and small "book" symbol which contains exercises.

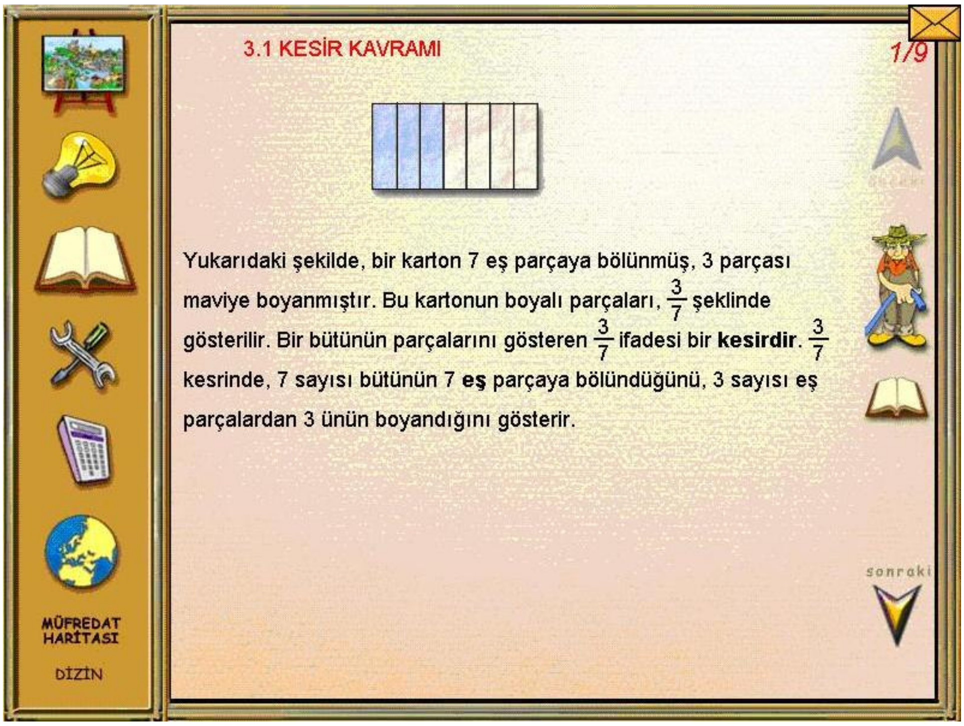


Figure A.7. The screen shot of a subject matter explanation.

The following page, as shown in Figure A.8, contains various exercises in the unit. There are numbers, operation symbols, and the other tools, which can be used for problem solving. These are located at the bottom of the page. To find out whether the answer is correct or wrong, the student should click on the "ok" button. Similarly, by clicking on the "solve" button, the program gives the correct solution of the problem.

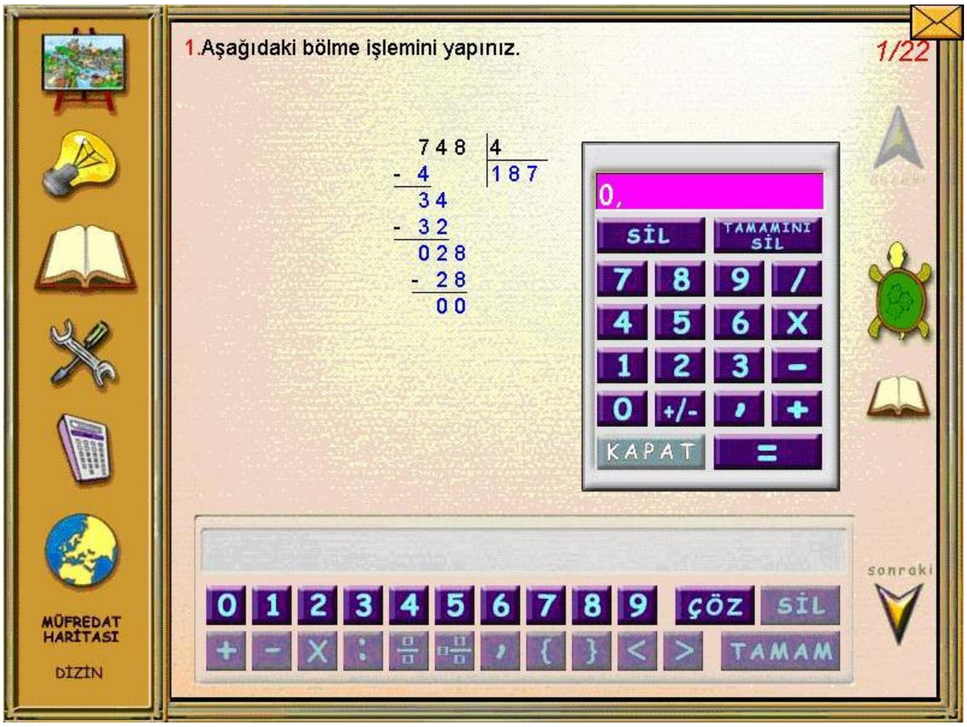


Figure A.8. The screen shot of the typical example page of *Frizbi Mathematics 4*.

Another aspect of the program, as shown in Figure A.9, is the "calculator" symbol. It can be used to check the calculations or sometimes it can be used for doing the long calculations.

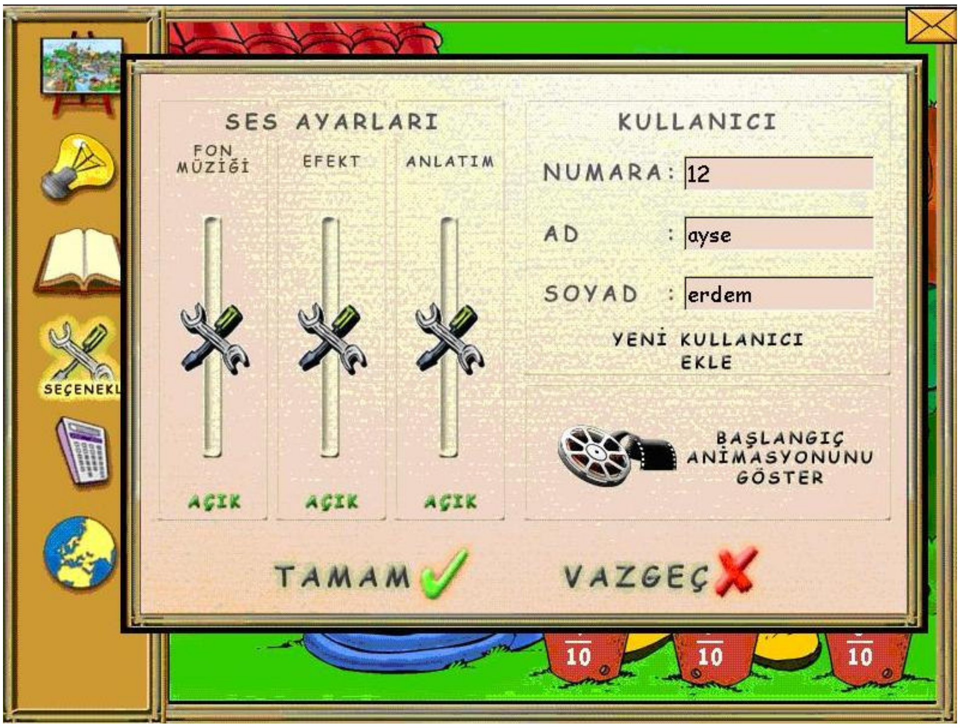


Figure A.9. The screen shot of a "calculator" box.

By clicking on the "choices" symbols, as shown in Figure A.10, the students can open or close the background music, sound effects or voiced explanations of the *Frizbi Mathematics 4*. In addition to this, students can connect to the internet by clicking on the "world" symbol which is located on the left side of the page. With the help of this explorer, they can reach additional knowledge about the subject.

Figure A.10. The screen shot of a "sound control" box.

In the "task track" page, as shown in Figure A.11, there is an option to take a test. The students are directed to the test page by the clicking the "test" signboard.

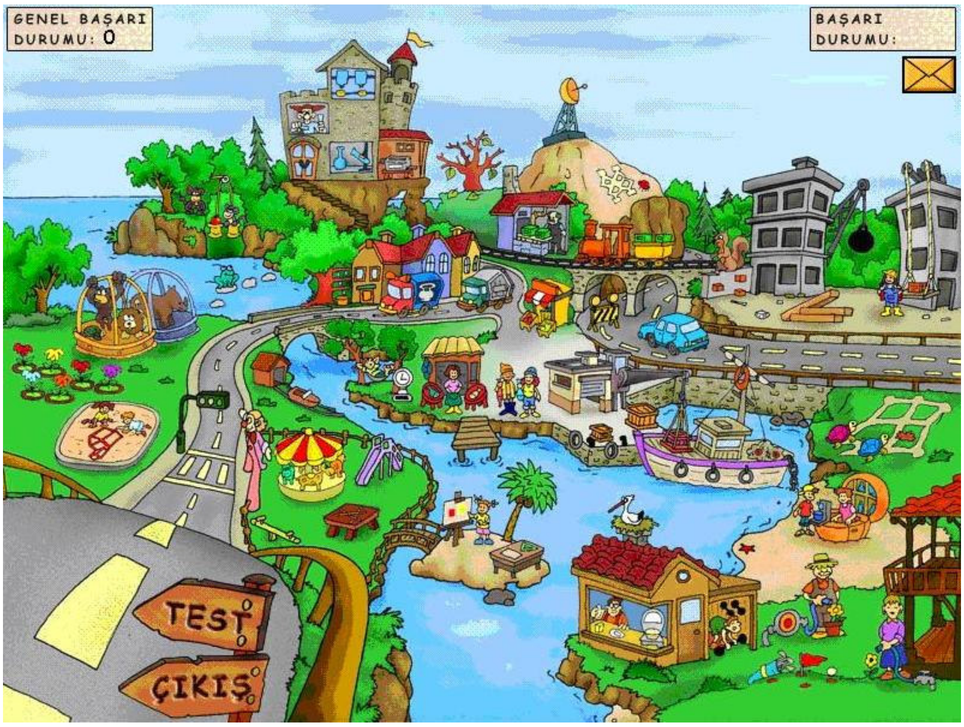


Figure A.11. The screen shot of a “task track”.

This test page contains ten general tests, besides, there are also one pre-test and one post-test as given in Figure A.12. The pre-test is designed for the utilization just after registration to software and the post-test is designed for the utilization after completing all the tests in the software. These tests can be taken at the beginning and at the end of the semester. The results of these two tests can be compared to check student progress at the end.

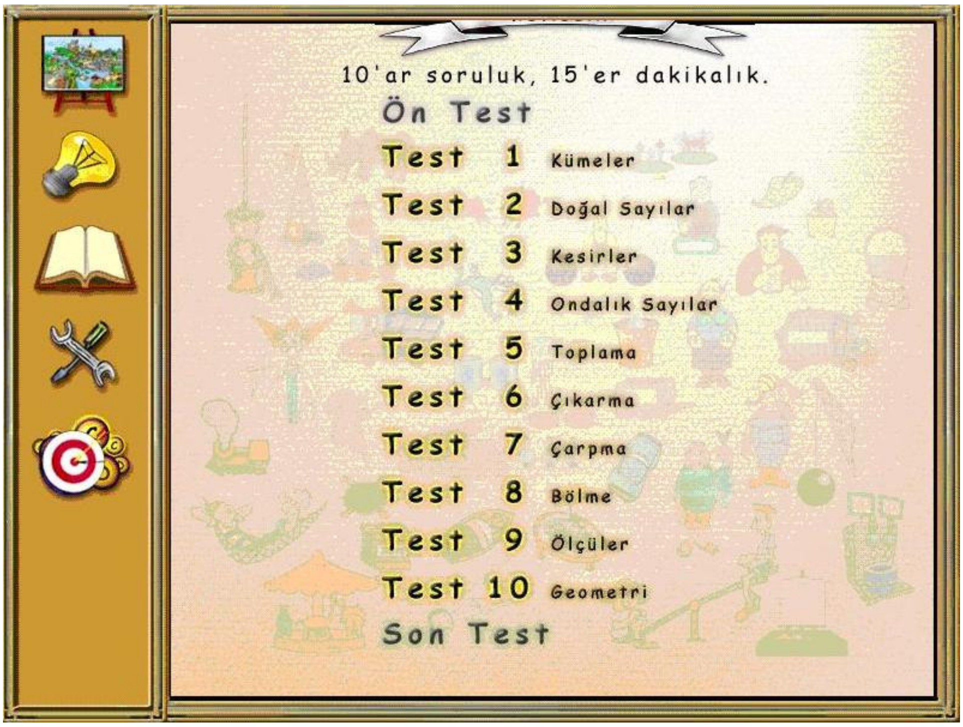


Figure A.12. The screen shot of a “test page”.

As shown in Figure A.13, the students can use the arrows to go forward and backward and the hourglass on the left shows the remaining time to complete the test.

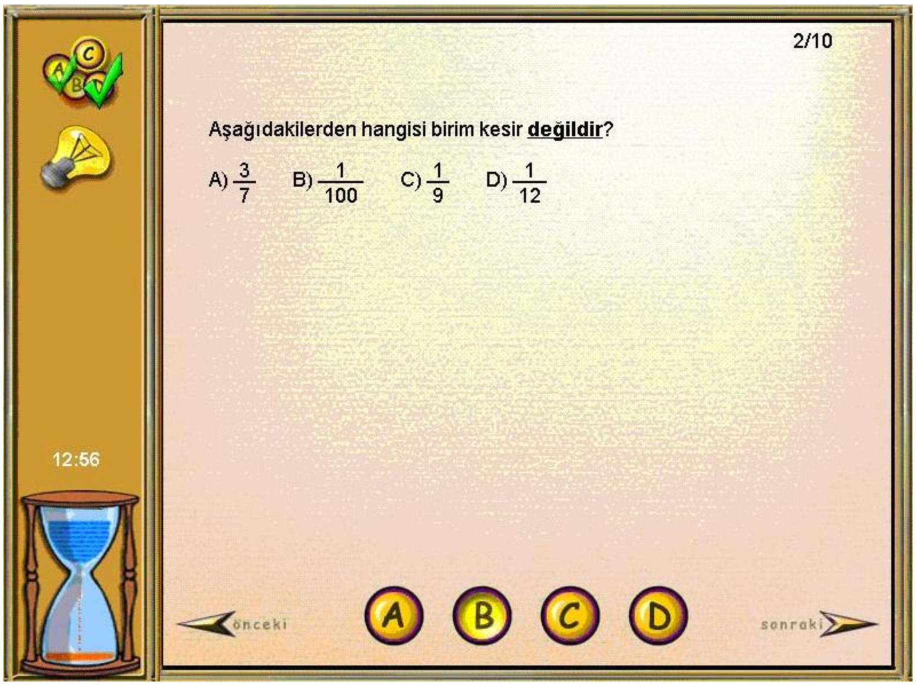


Figure A.13. This page represents the typical exercise page of the test on "Fractions".

The following Figure A.14 shows the test result table, the students can reach any question and re-examined the question. Beside this, *Frizbi Mathematics 4* provides total result table for all the tests that students were performed as shown in Figure A.15.

Figure A.14. The screen shot of a result page.

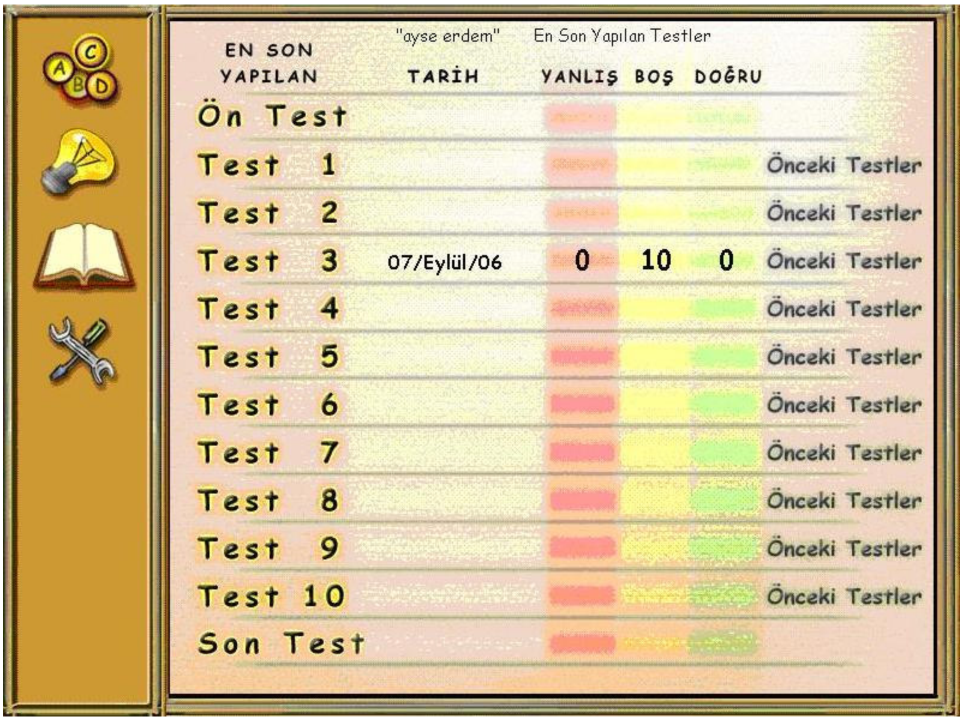


Figure A.15. The screen shot of total results page.

In *Frizbi Mathematics 4*, there is an "envelope" symbol that can be used as an interactive, two ways, and synchronize communication system for student-student, student-class and student-teacher interaction as shown in Figure A.16.

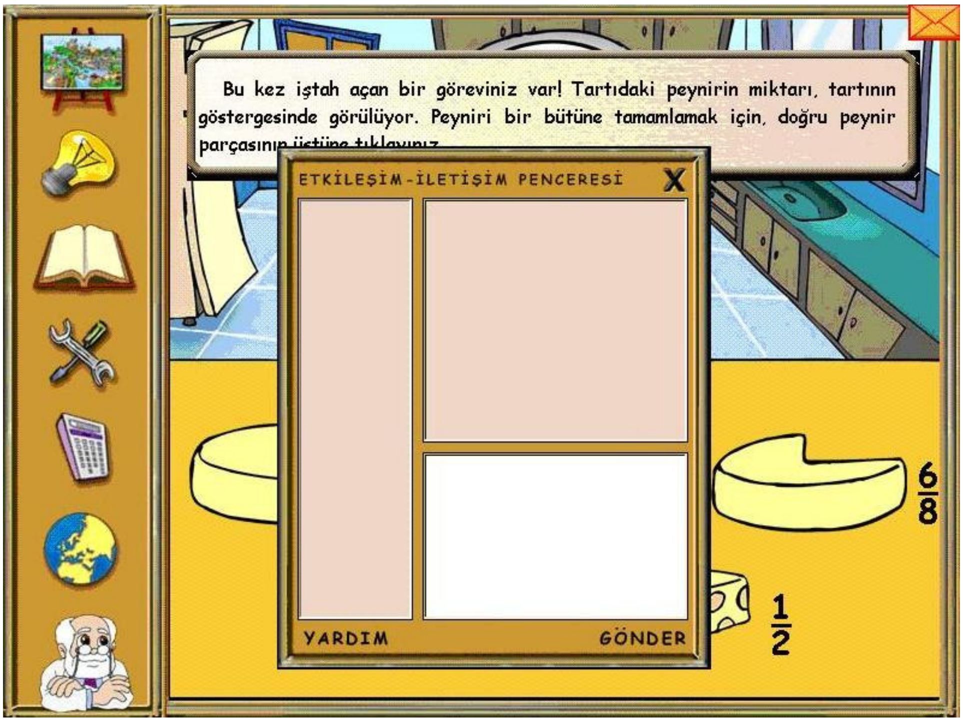


Figure A.16. The screen shot of a "chat" box.

In order to quit the *Frizbi Mathematics 4*, the students should go back to the "task track" page and click on the "exit" button (http://www.frizbi.com, 2006).

APPENDIX B

Software Evalaution Rubric

Educational Material Evaluation- Computer Software*

Title: ______

Series Title (If applicable): ______

Source (Publisher): ______

Date of Copyright: ______

Subject Area(s): ______

Intended Audience: Pre-K

Cost: ______

Brief Description & Objectives:

Format of Software	
☐	Tutorial
☐	Simulation
☐	Game
☐	Discovery
☐	Problem Solving
☐	Drill and Practice
☐	Application

Entry Capabilities Required:

Rating: 0 – 5 scale   0= Not included or component is far below standard   5= Exemplary

Criteria	Score	Criteria	Score
I. Content: Accuracy & Currency of Information	0	**III. Technical Aspects:** Loads quickly, error-free operation	0
Depth of Content (match to grade level)	0	Adaptability & Accessibility (platforms, export/import capabilities, works w/other programs)	0
Sources- Cited and Reliable	0	Graphics & Multimedia- Relevance & Quality	0
Alignment with Curriculum	0	**IV. Support Materials:** Teacher Guide, Printed Instructions	0
II. Format: Navigation, Menus, Tools	0	Instructions & Help Within Program- easily accessible & understandable	0
Interesting, Engaging, Motivating	0	Supplemental Resources	0
Interactivity & Feedback	0	**V. Assessment/Evaluation:** Embedded or Supplemental	0
Flexibility: Individual, Group, & Whole Class Implementation	0	Ability to Save Work/ Track Progress	0

TOTAL SCORE [ ]

Comments:

Recommended Action:
Reviewer:	Date Reviewed:

*http://www.glc.k12.ga.us/passwd/trc/ttools/attach/mediaspec/SoftwareEvalTemplate2.doc

APPENDIX C

Pre-test and retention-test form of Mathematics Achievement Test-1 (PMAT1-MATR1)

Başarı Testi 1
Doğal Sayılarda Çarpma

1. $\begin{array}{r} 367 \\ \times 12 \\ \hline \end{array}$ İşleminin sonucu aşağıdakilerden hangisidir?

   a) 3404 b) 4404 c) 4304 d) 4394

2. Aşağıda verilen çarpma işlemlerinden hangisi **yanlıştır**?

   A) $\begin{array}{r} 2453 \\ \times \quad 3 \\ \hline 7359 \end{array}$ b) $\begin{array}{r} 6871 \\ \times \quad 8 \\ \hline 54968 \end{array}$ c) $\begin{array}{r} 3594 \\ \times \quad 6 \\ \hline 21334 \end{array}$ d) $\begin{array}{r} 3408 \\ \times \quad 5 \\ \hline 17040 \end{array}$

3. $5 \times (14- 3) + 3 =$ işleminin sonucu kaçtır ?

   a) 58 b) 67 c) 70 d) 55

4. $4 \times (7 \times 5) = (\ \mathbf{?} \times 5\ ) \times 4$ eşitliğinde **?** yerine hangi sayı yazılmalıdır?

   a) 4 b) 5 c) 6 d) 7

5. Her birinde 34 adet balık konservesi bulunan 203 kasada toplam kaç balık konservesi vardır?

   a) 6892 b) 6902 c) 6802 d) 6992

6. 3041 – (47 x 36) = işleminin sonucu kaçtır?

   a) 1692 b) 1341 c) 1349 d) 1691

7. $\begin{array}{r} 3M8 \\ \times \quad 6 \\ \hline ..2. \end{array}$

   a) 3 b) 4 c) 5 d) 6

8. $6 \times 84 \times 29 \times 0 \times 5 =$ işleminin sonucu kaçtır?

a) 504 b) 2520 c) 0 d) 145

9. 2500 gramlık 60 paket küp şeker yağmurda unutulduğu için eridi. Eriyen şekerler toplam kaç gramdır?

a) 153 000 b) 15 000 c) 155 000 d) 150 000

10. Dört basamaklı **en büyük tek** sayı ile iki basamaklı **en küçük çift** sayının çarpımı kaçtır?

a) 109 989 b) 99 990 c) 109 978 d) 99 970

11. $5487 \times 84 =$ işleminin sonucu kaçtır?

a) 460 906 b) 461 906 c) 460 908 d) 461 907

12. Aşağıdaki çarpma işlemlerinden kaç tanesi **yanlıştır**?

I. $40 \times 200 = 8\,000$ **II. $105 \times 1000 = 10\,500$**

III. $225 \times 15 = 3\,325$ **IV. $100\,000 \times 100 = 1\,000\,000$**

a) 1 b) 2 c) 3 d) 4

13. Bir çiftlikte günde 18 450 lt süt veren inekler 1 haftada kaç lt süt vermektedir?

a) 129 150 b) 92 250 c) 129 850 d) 126 150

14. Sekiz katlı bir apartmanın her katında 4 daire vardır. Her dairede ise üç kişi yaşamaktadır. Bu apartmanda toplam kaç kişi yaşamaktadır?

a) 84 b) 72 c) 36 d) 96

15. Bir sayıyı 7 ile çarptığımızda 805 bulunur. Ayni sayıyı 11 ile çarptığımızda kaç bulunur?

a) 1264 b) 1265 c) 1255 d) 1260

16. Dakikada 28 adet kelime yazan bir kimse yarım saatte kaç kelime yazabilir?

a) 840 b) 1680 c) 640 d) 1620

17. Zeynep 14 yaşında, babası ise Zeynep'in yaşının 3 katındadır. Zeynep'in babası kaç yaşındadır?

a) 42 b) 32 c) 52 d) 44

18. Bir okuldaki kız öğrencilerin sayısı 208 dir. Erkek öğrenciler kızların 9 katı olduğuna göre, bu okuldaki erkek öğrenci sayısı kaçtır?

a) 1873 b) 1803 c) 1872 d) 1782

19. Bir kümeste bulunan 24 tavuk, 54 tavşan ve 64 güvercinin toplam ayak sayısı nedir?

a) 216 b) 398 c) 264 d) 392

20. 9 Mart caddesinde 14 adet sokak lambası vardır. İki lamba arası 8 metre olduğuna göre caddenin uzunluğu kaç metredir?

a) 124 b) 116 c) 112 d) 104

21. 44 sayısının 16 fazlasının 6 katı kaçtır?

a) 360 b) 704 c) 264 d) 280

22. $126 \times \square = 630$ ise $\square$ yerine hangi sayı yazılmalıdır?

a) 7 b) 6 c) 5 d) 4

23. Her birinde 32 kitap bulunan 12 koli kitap raflara dizilmek istenmektedir. Raflara dizilmesi gereken toplam kaç kitap vardır?

A) 381 A) 382 C) 383 D) 384

24. $(A \times 7) + 8 = 64$ matematiksel ifadesinin okunuşu aşağıdakilerden hangisidir?

A) Bir sayının 8 ile toplamının 7 katı 64' e eşittir.
B) Bir sayının 7 katının 8 fazlası 64 den küçüktür.
C) Bir sayının 7 katının 8 fazlası 64' e eşittir.
D) Bir sayının 8 katının 7 fazlası 64' e eşittir.

25. $520\ 000 \times 300 =$ çarpımında kaç sıfır vardır?

A) 3 B) 4 C) 5 D) 6

Test Bitti ..
Teşekkür Ederiz…

APPENDIX D

Pre-test and retention-test form of Mathematics Achievement Test-2 (PMAT2-MATR2)

Başarı Testi 2
Doğal Sayılarda Bölme

1) İşleminde kalan aşağıdakilerden hangisine eşittir ?   437 | 3

A) 0   B) 1   C) 2   D) 3

2) 1200 ÷ ☐ = 12   ise ☐ yerine hangi sayı yazılmalıdır?

A) 10   B) 100   C) 102   D) 120

3) Bir bölme işleminde bölen 8, bölüm 26 ve kalan 4 ise bölünen sayı kaçtır?

A) 112   B) 120   C) 212   D) 312

4) Aşağıdakilerden hangileri 5 ile tam bölünebilir?

I. 74 300   **II. 2643**

III. 1005   **IV. 52040**

A) I, II ve IV   B) I ve III   C) II ve IV   D) I,III ve IV

5) 54 ÷ ☐ = 9   ise ☐ yerine hangi sayı yazılmalıdır ?

A) 3   B) 4   C) 5   D) 6

6) Ayşegül bir kavanozdaki 48 kurabiyenin 6'sını yiyor. Geri kalan kurabiyeleri 7 arkadaşına eşit miktarda paylaştırmak istiyor. Her arkadaşına kaç kurabiye vermesi gerekiyor?

A) 5   B) 6   C) 7   D) 8

7) Aşağıdaki sayılardan hangisi hem 2 ile hem de 3 ile bölünebilir?

A) 6548   B) 7549   C) 8694   D) 9003

8) Kerem doğum günü partisinde 536 kişiye meyve suyu ikram etmeyi istiyor. Bir şişe meyve suyundan 4 bardak meyve suyu çıktığına göre Kerem kaç şişe meyve suyu almalıdır?

A) 134 B) 143 C) 144 D) 148

9) Mehmet, geçen hafta mantar toplamak için 8 km yürüdü. Bu hafta yürüdüğü yol ise geçen hafta yürüdüğü yolun yarısından 3 km daha fazla idi. Mehmet bu hafta kaç km yol yürüdü ?

A) 6 B) 7 C) 8 D) 9

10) Bir çiftçi, çevresi 656 metre olan tarlasının etrafını telle çevrelemek istemektedir. Çiftçinin elinde 82 adet direk olduğuna göre bu direkleri kaç metre arayla dikerse tüm tarlayı telle çevreleyebilecek?

A) 6 B) 8 C) 12 D) 14

11) 2548 litre sütü 4 litrelik bidonlara koymak isteyen Yahya Usta kaç bidon kullanmalıdır?

A) 367 B) 567 C) 634 D) 637

12) Bir koli 14 adet kitap almaktadır. 1218 adet kitabı kolilere yerleştirmek için kaç adet koli gerekir?

A) 86 B) 87 C) 88 D) 89

13) 1261 metre uzunluğundaki bir kurdele 5 metrelik parçalara ayrılmıştır. Artan parçanın uzunluğu kaç metredir?

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

14) Bir bölme işleminde bölen 7 ise kalan aşağıdaki sayılardan hangisi **olamaz** ?

A) 4 B) 5 C) 6 D) 7

15) "**Bir sayının 4 katının yarısı 38'dir**" ifadesinin matematiksel karşılığı aşağıdakilerden hangisidir?

A) $M + 4 \div 2 = 38$
C) $(M \times 4) \div 2 = 38$
B) $(M \div 4) \times 2 = 38$
D) $2 \div (M \times 4) = 3$

16) Bir konser salonunda 4 kişilik 216 koltuk kullanıldığında 1 yer boş kalmıştır. Bu konsere kaç kişi katılmıştır?

A) 863 B) 864 C) 865 D) 868

17) Aşağıdaki bölme işlemlerinden hangisi **yanlıştır**?

A) 4040 ÷ 5 = 808
B) 10 500 ÷ 50 = 215
C) 5555 ÷ 1 = 5555
D) 2488 ÷ 4 = 622

18) Aşağıdaki sayılardan kaç tanesi hem **3** ve hem de **9** ile tam olarak bölünebilmektedir?

I. 2232 **II. 1457**

III.6786 **IV. 1358**

A) I ve III B) I ve II C) III ve IV D) II ve III

19) Aşağıda verilen işlemlerden hangisinin yanıtı 73'tür?

A) 345 ÷ (14-9) =
B) (340 + 5) ÷ 10 =
C) (21 x 15) ÷ 315 =
D) (325 ÷ 5) + 8=

20) Bir çiçekçideki 1842 adet gülün 12 adeti solmuştur. Bu çiçekçi geriye kalanların yarısını 5'li buketler yapıp satmak istemektedir. Bu çiçekçi kaç buket çiçek yapabilir ?

A) 180 B) 183 C) 813 D) 915

Test Bitti ..
Teşekkür Ederiz…

APPENDIX E

Pre-test and retention-test form of Mathematics Achievement Test-3 (PMAT3-MATR3)

Başarı Testi 3
Kesirler

1) Aşağıda verilen sayılardan hangisi bileşik kesirdir ?

A) $\frac{7}{4}$ B) $\frac{10}{12}$ C) $\frac{14}{26}$ D) $\frac{30}{32}$

2) Yanda verilen işlemin sonucu kaçtır ? $\frac{3}{18} + \frac{1}{3} =$

A) $\frac{9}{18}$ B) $\frac{4}{21}$ C) $\frac{4}{18}$ D) $\frac{9}{21}$

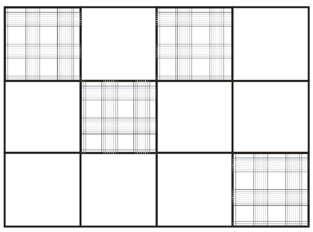
3) Yanda verilen işlemin sonucu kaçtır? $\frac{2}{5} + \frac{1}{3} - \frac{1}{4} =$

A) $1\frac{29}{60}$ B) $1\frac{11}{15}$ C) $\frac{11}{15}$ D) $\frac{29}{60}$

4) $\frac{\square}{8}$ kesirinin basit kesir olabilmesi için $\square$ yerine yazılabilecek en büyük doğal sayı kaçtır ?

A) 4 B) 8 C) 6 D) 7

5) Aşağıdaki şekildeki taralı bölgelerin kesir olarak ifadesi aşağıdakilerden hangisidir?



A) $\frac{4}{12}$ B) $\frac{8}{12}$ C) $\frac{9}{12}$ D) $\frac{12}{12}$

6) Aşağıdakilerden hangisi $\frac{5}{6}$ ‘ya denk olan bir kesirdir ?

A) $\frac{15}{20}$ B) $\frac{10}{18}$ C) $\frac{25}{24}$ D) $\frac{15}{18}$

7) Yandaki işlemin sonucu ne olur? $5\frac{4}{8} + 1\frac{3}{4} =$

A) $6\frac{10}{18}$ B) $6\frac{7}{8}$ C) $6\frac{10}{8}$ D) $6\frac{7}{9}$

8) $\frac{5}{6}$ $\frac{1}{4}$ $\frac{2}{5}$ kesirlerinin küçükten büyüğe doğru sıralanışı aşağıdakilerden hangisinde doğru olarak verilmiştir ?

A) $\frac{5}{6} > \frac{1}{4} > \frac{2}{5}$ B) $\frac{5}{6} < \frac{2}{5} < \frac{1}{4}$ C) $\frac{5}{6} > \frac{2}{5} > \frac{1}{4}$ D) $\frac{1}{4} > \frac{5}{6} > \frac{2}{5}$

9) Bir torba şeker 20 kilogramdır. Bunun $\frac{1}{4}$‘ü satıldı. Kaç kilogram şeker satıldı ?

A)5 B)10 C) 15 D) 16

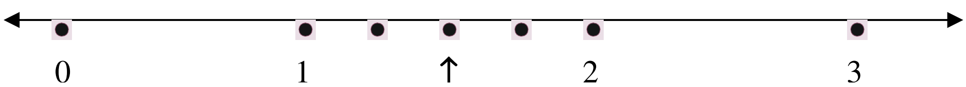
10) $\frac{6}{8}$ kesrine denk olan kesrin paydası 4 ise, payı nedir ?

A) 2 B) 3 C) 4 D) 5

11) Aşağıdakilerden hangisi yarımdan büyüktür ?

A) $\frac{2}{6}$ B) $\frac{5}{12}$ C) $\frac{2}{1}$ D) $\frac{8}{20}$

12) Aşağıda verilen sayı doğrusunda “↑” ile gösterilmiş yere hangi kesir yazılmalıdır ?



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

13) $5\frac{3}{a} = \frac{8}{a}$ eşitliğinde “a” yerine ne yazılmalıdır ?

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

14) Aşağıdaki kesirlerden hangisi $\frac{1}{3}$ ‘dan büyük $\frac{3}{5}$‘den küçüktür ?

A) $\frac{4}{15}$ B) $\frac{7}{15}$ C) $\frac{9}{15}$ D) $\frac{11}{15}$

15) Bir sınıftaki öğrencilerin, 3’te 2’si basketbol, 5 ‘de 3’ü de tiyatro etkinliklerine seçilmiştirler. Bu etkinlikler için sınıfın kaçta kaçı seçilmiş olur ?

A) $\frac{8}{5}$ B) $\frac{6}{15}$ C) $\frac{10}{15}$ D) $\frac{19}{15}$

16) Yandaki işlemin cevabı kaçtır ? $20+\frac{6}{7}=$

A) $20\frac{6}{7}$ B) $\frac{146}{7}$ C) $\frac{26}{7}$ D) $\frac{120}{7}$

17) $\frac{21}{49}$ kesrinin en sade şekli aşağıdakilerden hangisidir ?

A) $\frac{1}{7}$ B) $\frac{14}{7}$ C) $\frac{3}{7}$ D) $\frac{8}{7}$

18) Aşığıdakilerden hangileri denk kesirdir ?

I. $\frac{7}{11}$ ile $\frac{49}{77}$ II. $\frac{9}{14}$ ile $\frac{126}{196}$ III. $\frac{13}{20}$ ile $\frac{79}{120}$

A) I, II B) I, III C) II, III D) I, II, III

19) Bir pizzanın önce $\frac{4}{12}$‘si sonra da $\frac{5}{12}$ ‘si yenmiştir. Buna göre pizzadan geriye ne kadar kalmıştır ?

A) $\frac{10}{12}$ B) $\frac{9}{12}$ C) $\frac{8}{12}$ D) $\frac{3}{12}$

20) Aşağıdaki kesirlerden hangisi bütünden büyüktür ?

A) $\frac{2}{3}$ B) $\frac{4}{5}$ C) $\frac{6}{9}$ D) $\frac{5}{4}$

APPENDIX F

Post-test form of Mathematics Achievement Test-1 (MATP1)

Başarı Testi 1
Doğal Sayılarda Çarpma

1) $\begin{array}{r} 235 \\ \times\ 14 \\ \hline \end{array}$ İşleminin sonucu aşağıdakilerden hangisidir?

   A) 3270 B) 3290 C) 3295 D) 3920

2) Aşağıda verilen çarpma işlemlerinden hangisi **yanlıştır**?

   A) $\begin{array}{r} 1253 \\ \times\ 6 \\ \hline 7518 \end{array}$ b) $\begin{array}{r} 5476 \\ \times\ 3 \\ \hline 16228 \end{array}$ c) $\begin{array}{r} 3549 \\ \times\ 4 \\ \hline 14196 \end{array}$ d) $\begin{array}{r} 8406 \\ \times\ 5 \\ \hline 42030 \end{array}$

3) $4 \times (12 + 3) - 5 =$ işleminin sonucu kaçtır ?

   a) 40 b) 45 c) 50 d) 55

4) $(3 \times ?) \times 5 = 5 \times (3 \times 4)$ eşitliğinde **?** yerine hangi sayı yazılmalıdır?

   a) 2 b) 3 c) 4 d) 5

5) Her birinde 22 adet balık konservesi bulunan 106 kasada toplam kaç balık konservesi vardır?

   a) 2332 b) 2322 c) 2302 d) 2330

6) 4301 – (12 x 25) = işleminin sonucu kaçtır?

   a) 4000 b) 4001 c) 4300 d) 4303

7) $\begin{array}{r} 2K4 \\ \times\ 7 \\ \hline ..6. \end{array}$ Yandaki işlemde **K** harfi hangi rakam yerine yazılmıştır ?

   a) 5 b) 4 c) 3 d) 2

8) $4 \times 21 \times 0 \times 16 \times 5 =$ işleminin sonucu kaçtır?

a) 504 b) 2520 c) 0 d) 145

9) 1500 gramlık 75 paket küp şeker yağmurda unutulduğu için eridi. Eriyen şekerler toplam kaç gramdır?

a) 112 500 b) 112 000 c) 155 200 d) 115 000

10) Dört basamaklı **en büyük çift** sayı ile iki basamaklı **en küçük tek** sayının çarpımı kaçtır?

a) 109 989 b) 109 978 c) 99 970 d) 99 900

11) $3425 \times 28 =$ işleminin sonucu kaçtır?

a) 95 000 b) 95 500 c) 95 900 d) 95 905

12) Aşağıdaki çarpma işlemlerinden kaç tanesi **yanlıştır**?

I. 20 × 400 = 8 000 **II. 104 × 100 = 1 040**

IV. 215 × 15 = 3 125 **IV. 10 000 × 100 = 100 000**

a) 1 b) 2 c) 3 d) 4

13) Bir çiftlikte günde 15 250 lt süt veren inekler 1 haftada kaç lt süt vermektedir?

a) 106 750 b) 107 650 c) 156 250 d) 176 250

14) Üç katlı bir apartmanın her katında 7 adet sınıf vardır. Her sınıfta ise 12 öğrenci vardır. Bu okulda toplam kaç öğrenci bulunmaktadır ?

a) 84 b) 96 c) 252 d) 262

15) Bir sayıyı 6 ile çarptığımızda 450 bulunur. Ayni sayıyı 11 ile çarptığımızda kaç bulunur?

a) 800 b) 820 c) 825 d) 850

16) Dakikada 24 adet kelime yazan bir kimse bir çeyrekte kaç kelime yazabilir?

a) 340 b) 360 c) 530 d) 720

17) Nehir 16 yaşında, babası ise Nehir'in yaşının 4 katındadır. Nehir'in babası kaç yaşındadır?

a) 36 b) 44 c) 56 d) 64

18) Bir okuldaki kız öğrencilerin sayısı 104 dir. Erkek öğrenciler kızların 8 katı olduğuna göre, bu okuldaki erkek öğrenci sayısı kaçtır?

a) 832 b) 854 c) 882 d) 1040

19) Bir kümeste 6 köpek, 28 güvercin ve 12 tavuk bulunmkatadır. Bu kümeste bulunan toplam ayak sayısı nedir?

a) 46 b) 60 c) 92 d) 104

20) Ziya Gökalp caddesinde 12 adet ağaç bulunmaktadır. İki ağaç arası 5 metre olduğuna göre caddenin uzunluğu kaç metredir?

a) 45 b) 50 c) 55 d) 60

21) 32 sayısının 14 fazlasının 8 katı kaçtır?

a) 144 b) 368 c) 423 d) 560

22) $102 \times \square = 510$ ise $\square$ yerine hangi sayı yazılmalıdır?

a) 7 b) 6 c) 5 d) 4

23) Her birinde 24 kitap bulunan 8 koli kitap raflara dizilmek istenmektedir. Raflara dizilmesi gereken toplam kaç kitap vardır?

a) 192 b) 193 c) 194 d) 195

24) $(A \times 5) + 9 = 156$ matematiksel ifadesinin okunuşu aşağıdakilerden hangisidir?

C) Bir sayının 9 ile toplamının 5 katı 156' ya eşittir.
D) Bir sayının 5 katının 9 fazlası 156 den küçüktür.
E) Bir sayının 5 katının 9 fazlası 156' ya eşittir.
F) Bir sayının 9 katının 5 fazlası 156' ya eşittir.

25) $124\ 000 \times 200 =$ çarpımında kaç sıfır vardır?

a) 3 b) 4 c) 5 d) 6

Test Bitti ..
Teşekkür Ederiz…

APPENDIX G

Post-test form of Mathematics Achievement Test-2 (MATP2)

Başarı Testi 2
Doğal Sayılarda Bölme

1) Yandaki işlemde kalan aşağıdakilerden hangisine eşittir ? 349 | 3

A) 0 B) 1 C) 2 D) 3

8) 2300 ÷ ☐ = 23 ise ☐ yerine hangi sayı yazılmalıdır?

A) 10 B) 100 C) 102 D) 120

9) Bir bölme işleminde bölen 6, bölüm 37 ve kalan 2 ise bölünen sayı kaçtır?

A) 112 B) 120 C) 212 D) 224

10) Aşağıdakilerden hangileri 3 ile tam bölünebilir?

I. 306 **II. 4 251**

III. 1006 **IV. 2051**

A) I, II ve IV B) I ve II C) II ve IV D) I,III ve IV

11) 48 ÷ ☐ = 8 ise ☐ yerine hangi sayı yazılmalıdır ?

A) 3 B) 4 C) 5 D) 6

12) Ayşegül bir kavanozdaki 60 kurabiyenin 4'ünü yiyor. Geri kalan kurabiyeleri 8 arkadaşına eşit miktarda paylaştırmak istiyor. Her arkadaşına kaç kurabiye vermesi gerekiyor?

A) 5 B) 6 C) 7 D) 8

13) Aşağıdaki sayılardan hangisi hem 2 ile hem de 3 ile tam bölünebilir?

A) 6548 B) 7549 C) 8694 D) 9003

8) Deren ile Emre'nin düğün töreninde 720 kişiye meyve suyu ikram edilecektir. Bir şişe meyve suyundan 5 bardak meyve suyu çıktığına göre tören için kaç şişe meyve suyu alınmalıdır?

A) 134 B) 143 C) 144 D) 148

9) Mehmet, geçen hafta sahildeki çöpleri toplamak için 10 km yürüdü. Bu hafta yürüdüğü yol ise geçen hafta yürüdüğü yolun yarısından 2 km daha az idi. Mehmet bu hafta kaç km yol yürüdü ?

A) 6 B) 5 C) 4 D) 3

10) Çevresi 180 metre olan bir bahçenin etrafı tellenecektir. Bu amaçla 4 metre aralıkla direk dikilmiştir. Bahçenin etrafında kaç direk vardır?

A) 44 B) 45 C) 46 D) 47

11) 1 890 litre sütü 3 litrelik bidonlara koymak isteyen Yahya Usta kaç bidon kullanmalıdır?

A) 630 B) 635 C) 642 D) 645

12) Bir koli 12 adet kitap almaktadır. 1056 adet kitabı kolilere yerleştirmek için kaç adet koli gerekir?

A) 86 B) 87 C) 88 D) 89

13) 1881 metre uzunluğundaki bir kurdele 6 metrelik parçalara ayrılmıştır. Artan parçanın uzunluğu kaç metredir?

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

14) Bir bölme işleminde bölen 5 ise kalan aşağıdaki sayılardan hangisi **olabilir** ?

A) 4 B) 5 C) 6 D) 7

15) "**Bir sayının 3 katının yarısı 48'dir**" ifadesinin matematiksel karşılığı aşağıdakilerden hangisidir?

A) 4 030 ÷ 5 = 808
B)1 881 ÷ 9 = 209
C) 8888 ÷ 2 = 4 444
D) 4 260 ÷ 4 = 1 065

16) Bir konser salonunda 3 kişilik 324 koltuk kullanıldığında 1 yer boş kalmıştır. Bu konsere kaç kişi katılmıştır?

A) 971 B) 972 C) 973 D) 974

17) Aşağıdaki bölme işlemlerinden hangisi **yanlıştır**?

A) 4 030 ÷ 5 = 808
D) 1881 ÷ 9 = 209
C) 8888 ÷ 2 = 4 444
D) 4 260 ÷ 4 = 1 065

18) Aşağıdaki sayılardan kaç tanesi hem **3** ve hem de **9** ile tam olarak bölünebilmektedir?

I. 3222 **II. 7686**

III. 1457 **IV. 5318**

A) I ve III B) I ve II C) III ve IV D) II ve III

19) Aşağıda verilen işlemlerden hangisinin yanıtı 56'dır?

E) 255 ÷ (14-9) =
F) (340 + 5) ÷ 5 =
G) (27 x 6) ÷ 135 =
D) (750 ÷ 15) + 6 =

20) Bir çiçekçideki 1823 adet gülün 23 adeti solmuştur. Bu çiçekçi geriye kalanların yarısını 5'li buketler yapıp satmak istemektedir. Bu çiçekçi kaç buket çiçek yapabilir ?

A) 180 B) 183 C) 813 D) 138

Test Bitti ..
Teşekkür Ederiz…

APPENDIX H

Post-test form of Mathematics Achievement Test-3 (MATP3)

Başarı Testi 3
Kesirler

1) Aşağıda verilen sayılardan hangisi basit kesirdir ?

A) $\frac{7}{4}$ B) $\frac{10}{12}$ C) $\frac{27}{26}$ D) $\frac{34}{32}$

2) Yanda verilen işlemin sonucu kaçtır ? $\frac{4}{9} + \frac{5}{27} =$

A) $\frac{12}{27}$ B) $\frac{21}{27}$ C) $\frac{9}{27}$ D) $\frac{17}{27}$

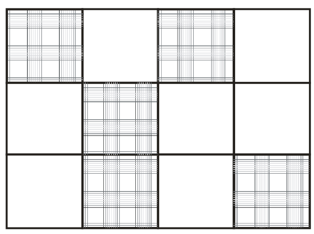
3) Yanda verilen işlemin sonucu kaçtır? $\frac{2}{3} + \frac{7}{8} - \frac{1}{4} =$

A) $1\frac{7}{24}$ B) $1\frac{11}{24}$ C) $\frac{36}{24}$ D) $\frac{31}{12}$

4) $\frac{\square}{8}$ kesirinin bileşik kesir olabilmesi için $\square$ yerine aşağıdaki doğal sayılardan hangisi yazılmalıdır ?

A) 4 B) 9 C) 6 D) 7

5) Aşağıdaki şekildeki taralı bölgelerin kesir olarak ifadesi aşağıdakilerden hangisidir?



A) $\frac{4}{12}$ B) $\frac{8}{12}$ C) $\frac{5}{12}$ D) $\frac{12}{12}$

6) Aşağıdakilerden hangisi $\frac{4}{9}$ 'a denk olan bir kesirdir ?

A) $\frac{12}{27}$ B) $\frac{12}{36}$ C) $\frac{16}{18}$ D) $\frac{16}{27}$

7) Yandaki işlemin sonucu ne olur? $2\frac{2}{7} + 4\frac{5}{14} =$

A) $6\frac{5}{7}$ B) $6\frac{7}{8}$ C) $6\frac{10}{14}$ D) $6\frac{9}{14}$

8) $\frac{5}{6}$ $\frac{1}{4}$ $\frac{2}{5}$ kesirlerinin büyükten küçüğe doğru sıralanışı aşağıdakilerden

hangisinde doğru olarak verilmiştir ?

A) $\frac{5}{6} > \frac{1}{4} > \frac{2}{5}$ B) $\frac{5}{6} < \frac{2}{5} < \frac{1}{4}$ C) $\frac{5}{6} > \frac{2}{5} > \frac{1}{4}$ D) $\frac{1}{4} > \frac{5}{6} > \frac{2}{5}$

9) Bir torba şeker 32 kilogramdır. Bunun $\frac{1}{4}$ 'ü satıldı. Kaç kilogram şeker satıldı ?

A)8 B)12 C) 24 D) 26

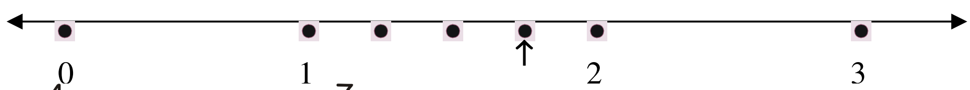
10) $\frac{5}{35}$ kesrine denk olan kesrin paydası 7 ise, payı nedir ?

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

11) Aşağıdakilerden hangisi yarımdan büyüktür ?

A) $\frac{2}{6}$ B) $\frac{5}{12}$ C) $\frac{2}{1}$ D) $\frac{8}{20}$

12) Aşağıda verilen sayı doğrusunda "↑" ile gösterilmiş yere hangi kesir yazılmalıdır ?



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

13) $5\frac{3}{a} = \frac{8}{a}$ eşitliğinde "a" yerine ne yazılmalıdır ?

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

14) Aşağıdaki kesirlerden hangisi $\frac{10}{12}$ 'den küçük $\frac{2}{3}$ 'den büyüktür ?

A) $\frac{9}{12}$ B) $\frac{8}{12}$ C) $\frac{9}{15}$ D) $\frac{12}{15}$

15) Bir sınıftaki öğrencilerin, 6'da 2'si basketbol, 5 'de 4'ü de tiyatro etkinliklerine seçilmiştirler. Bu etkinlikler için sınıfın kaçta kaçı seçilmiş olur ?

A) $\frac{6}{30}$ B) $\frac{6}{15}$ C) $\frac{34}{30}$ D) $\frac{5}{6}$

16) Yandaki işlemin cevabı kaçtır ? $15 + \frac{5}{6} =$

A) $\frac{20}{6}$ B) $\frac{95}{6}$ C) $\frac{26}{7}$ D) $\frac{90}{6}$

17) $\frac{42}{98}$ kesrinin en sade şekli aşağıdakilerden hangisidir ?

A) $\frac{1}{7}$ B) $\frac{21}{49}$ C) $\frac{3}{7}$ D) $\frac{8}{7}$

18) Aşığıdakilerden hangileri denk kesirdir ?

I. $\frac{7}{11}$ ile $\frac{49}{77}$ II. $\frac{9}{14}$ ile $\frac{126}{196}$ III. $\frac{13}{20}$ ile $\frac{79}{120}$

A) I, II B) I, III C) II, III D) I, II, III

19) Bir pizzanın önce $\frac{3}{14}$'si sonra da $\frac{5}{14}$ 'si yenmiştir. Buna göre pizzadan geriye ne kadar kalmıştır ?

A) $\frac{6}{14}$ B) $\frac{9}{14}$ C) $\frac{10}{14}$ D) $\frac{11}{14}$

20) Aşağıdaki kesirlerden hangisi bütünden büyüktür ?

A) $\frac{2}{3}$ B) $\frac{4}{5}$ C) $\frac{6}{9}$ D) $\frac{5}{4}$

APPENDIX J

Bluprint for Unit 1: "Multiplication of Natural Numbers

	Çarpımı en fazla altı basamaklı doğal sayı olacak şekilde iki doğal sayıyla çarpma işlemi yapar	Üç doğal sayı ile yapılan çarpma işleminde sayıların birbiriyle çarpılma sırasının değişmesinin, sonucu değiştirmediğini gösterir	En çok üç basamaklı doğal sayıları 10, 100, ve 1000'in en çok dokuz katı olan sayılarla kısa yoldan yapar	En çok üç basamaklı doğal sayıları 10, 100, ve 1000 ile zihinden çarpar	En çok iki basamaklı iki doğal sayının çarpımını tahmin eder ve tahmini işlem sonucu ile karşılaştırır	Doğal sayılarla çarpma gerektiren problemleri çözer ve kurar	**Toplam**
I. Çarpma kavramı ve çarpma işareti	2	1			2		**5**
II. En çok üç basamaklı doğal sayı ile en çok iki basamaklı bir doğal sayıyı çarpma	5				1		**6**
III. En çok dört basamaklı doğal sayı ile en çok iki basamaklı bir doğal sayıyı çarpma	1						**1**
IV. Çarpımları en çok altı basamak olacak şekilde iki doğal sayıyı kısa yoldan çarpma	1		1	1	1		**4**
V. Çarpma işlemi gerektiren problem çözme ve kurma	2					**7**	9
Toplam	11	**1**	**1**	**1**	**4**	7	25

APPENDIX K

Blueprint for Unit 2: "Division of Natural Numbers"

	En çok dört basamaklı doğal sayıları en çok iki basamaklı doğal sayılara böler	Son üç basamağı sıfır olan en çok beş basamaklı doğal sayıları 10,100,1000'e kısa yoldan böler	Bir bölme işleminin sonucunu tahmin eder ve tahmini işlem sonucu ile karşılaştırır	Çarpma ile bölme arasındaki ilişkiyi kavrar	Doğal sayıların 2,3,5 ve 9 ile bölünebilmesini kavrar	Doğal sayılarla bölme işlemi gerektiren problemleri çözer ve kurar	Toplam
I. Bölme ile ilgili temel kavramlar	1			1			2
II. Üç basamaklı doğal sayıları bir basamaklı doğal sayılara bölme							
III. Üç basamaklı doğal sayıları iki basamaklı doğal sayılara bölme			1				1
IV. Dört basamaklı doğal sayıları en çok iki basamaklı doğal sayılara bölme	1	1		2			4
V. Doğal sayıları 10, 100,1000'in katlarıyla bölme							
VI. Doğal sayıların 2,3,5 ve 9'a bölünebilmesi					3		3
VII. Doğal sayılarla bölme işlemi gerektiren problemler				2		8	10
Toplam	3	1		5	3	8	20

APPENDIX L

Blueprint for Unit 3: "Fractions"

	Payı ve paydası en çok iki basamaklı doğal sayı olan kesirleri, kesrin birimlerinden elde	Payı ve paydası en çok iki basamaklı olan kesirleri sayı doğrusunda gösterir	Paydası en çok iki basamaklı kesirleri karşılaştırır	Bir çokluğun belirtilen bir basit kesir kadarını belirler	Belirtilen basit kesir kadarı verilen bir çokluğun tamamını bulur	Paydaları en çok iki basamaklı kesirlerle toplama işlemi yapar	Paydaları en çok iki basamaklı kesirlerle çıkarma işlemi yapar	Kesirlerle toplama ve çıkarma işlemi gerektiren problemleri çözer	Toplam
I. Kesir kavramı (kesirlerin österimi ve kesirlerin okunuşu)	2	1	2						5
II. Kesir çeşitleri	5		2	1					8
III. Basit kesir kadarı verilen verilen bir bütünün tamamını bulma					1				1
IV. Kesir sayılarında toplama						4	1		5
V. Kesir sayılarında çıkarma								**1**	1
Toplam	7	1	**4**	1	1	4	1	1	20

APPENDIX M

Mathematics Attitude Scale (MAS)

Matematik Dersine Yönelik Tutum Ölçeği*

Aşağıdaki her ifadeyi okuduktan sonra, buna ne derecede katıldığınızı işaretleyiniz.

Örnek: "Matematik sevdiğim bir derstir" ifadesine ne ölçüde katıldığınızı gösteren sütuna "**X**" işareti koyunuz.

☺☺	☺	😐	☹	☹☹
Kesinlikle Katılıyorum	Katılıyorum	Emin değilim/ Kararsızım	Katılmıyorum	Kesinlikle Katılmıyoru m

	☺☺	☺	😐	☹	☹☹
1. Matematik sevdiğim bir derstir					
2. Matematik dersine girerken büyük bir sıkıntı duyarım					
3. Matematik dersi olmasa öğrencilik hayatı daha zevkli olur.					
4. Arkadaşlarımla matematik tartışmaktan zevk alırım.					
5. Matematiğe ayrılan ders saatlerinin fazla olmasını dilerim					
6. Matematik dersi çalışırken canım sıkılır.					
7. Matematik dersi benim için bir angaryadır.					
8. Matematikten hoşlanırım.					
9. Matematik dersinde zaman geçmek bilmez..					
10. Matematik dersi sınavından çekinirim.					
11. Matematik benim için ilgi çekicidir.					
12. Matematik tüm dersler içinde en korktuğum derstir.					
13. Yıllarca matematik okusam bıkmam.					
14. Diğer derslere göre matematiği daha çok severek çalışırım.					
15. Matematik beni huzursuz eder.					
16. Matematik beni ürkütür.					
17. Matematik dersi eğlenceli bir derstir.					
18. Matematik dersinde neşe duyarım.					
19. Derslerin içinde en sevimsiz matematiktir.					
20. Çalışma zamanımın çoğunu matematiğe ayırmak isterim.					

*Aşkar, Petek. (1986). Matematik dersine yönelik tutum ölçen likert-tipi bir ölçeğin geliştirilmesi. *Eğitim ve Bilim*, 11(62), 31-36

Anket bitti. Teşekkür ederiz. ☺

APPENDIX N

Computer Assisted Learning Attitude Scale (CALAS)

Bilgisayar Destekli Öğrenmeye Yönelik Tutum Ölçeği*

Aşağıdaki her ifadeyi okuduktan sonra, buna ne derecede katıldığınızı işaretleyiniz.

Örnek: "Bilgisayar başında çalışırken zamanım müthiş zevkli geçiyor" ifadesine ne ölçüde katıldığınızı gösteren sütuna "**X**"

☺	😐	☹
X		

☺	😐	☹
Evet	**Bazen**	**Hayır**

	☺	😐	☹
1. Bilgisayar başında çalışırken zamanım müthiş zevkli geçiyor			
. Bilgisayarla ders çalışırken çabuk öğreniyorum			
3. Bilgisayar ile öğrenmekten rahatsız oluyorum			
4. Bilgisayarla öğrenme kendime güvenimi artıyor			
5. Bilgisayar bende ders çalışma isteği yaratıyor			
6. Bilgisayarla ders öğrenmek baştan zevkliydi, fakat zaman geçtikçe bıkmaya başladım			
7. Bilgisayarla ders işlemek çok eğlenceli.			
8. Bilgisayarla ders öğrenmek başarımı artıyor.			
9.Bütün dersleri bilgisayarla öğrenmeyi isterim			
10.Dersi şekil ve hareketli resimlerle kolay öğreniyorum.			

*Aşkar, P.,Yavuz, H., & Köksal, M. (1991). Bilgisayar destekli örenmeye yönelik tutum ölçeği. *Eğitim ve Bilim*, 15, 29-33.

Anket bitti. Teşekkür ederiz. ☺

APPENDIX O

CONSENT LETTER OF THE INSTITUTION

KUZEY KIBRIS TÜRK CUMHURİYETİ
MİLLÎ EĞİTİM VE KÜLTÜR BAKANLIĞI
TALİM VE TERBİYE DAİRESİ MÜDÜRLÜĞl

Sayı: 3/2005 Tarih: 23/12/2005

İlköğretim Dairasi Müdürlüğü,
Lefkoşa.

İlgi; 3/2005 sayılı ve 19/12/2005 tarihli yazınız.

Konu: Olga Pilli'nin " Bilgisayar Destekli Matematik Öğretim " konulu uygulaması hk.

İlgi başvuruda, K. K. T. *C.* Milli Eğitim Ve Kültür Bakanlığı'na bağıı okullarca öğrenim gören ükokui 4. sınıf öğrencilerine bilgisayar destekli öğretim uygulanmasına yönelik anket soruları ve eğitsel yazılım incelenmiştir. Yapılan incelemede, bilgisayar destekli öğretim uygulanması müdürlüğümüzce uygun görülmüştür.

Ancak uygulamadan önce -anketlerin ve eğitsel yazılımın uygulanacağı okulların bağlı bulunduğu müdürlükle istişarede bulunulup, uygulamanın hangi okulda ne zaman yapılacağı birlikte saptanmalıdır.Uygulamadan sonra sonuçlarının Talim Ve Terbiye Dairesi Müdüriüğü'ne ulaştırılması gerekmektedir.

Bilgilerinize saygı ile rica ederim.

Dr. Hasan Alicik
Müdür

Teftiş Dairesi Müdürlüğü

M.S.K./ Lefkoşa-KIBRJS
Tel : (90) (392) 228 1791 -228 3136 Fax: (90)(392) 227 6073
E-mail : meb@mebnet.net

APPENDIX P

SUMMARY IN TURKISH

BİLGİSAYAR DESTEKLİ ÖĞRETİMİN 4.SINIF MATEMATİK DERSİNDEKİ BAŞARI, TUTUM VE KALICILIĞA ETKİSİ

Bu çalışma, bilgisayar destekli bir öğretim uygulaması olan *Frizbi Matematik 4* eğitsel yazılımının, ilköğretim 4. sınıf öğrencilerin matematik dersindeki akademik başarısına, bu başarının kalıcılığına ve matematik ve bilgisayar destekli öğrenmeye karşı tutumlarına etkisini incelemeyi amaçlamıştır.

Çalışmaya, Kuzey Kıbrıs Türk Cumhuriyeti, Gazimagusa bölgesinde, bir devlet okulunda bulunan 4.sınıf öğrencileri dahil edilmiştir. Kontrol grubundaki öğrenciler geleneksel yöntemle ders işlerken, deney grubunda *Frizbi Matematik 4* eğitsel yazılım kullanılmıştır. Kontrol grubu 26, deney grubu ise 29 öğrenciden oluşmaktadır. Çalışma 2006-2007 öğretim yılı bahar döneminde, doğal sayılarda çarpma, bölme ve kesirler üniteleri üzerinde yürütülmüştür.

Uygulama öncesi, sonrası, ve 4 ay sonrasında tüm gruplara her üniteyle ilgili çoktan seçmeli başarı testi uygulanmıştır. Matematiğe ilişkin ve bilgisayar destekli öğrenmeye ilişkin tutum olçekleri sadece uygulama öncesinde ve sonrasında uygulanmıstır. Başarı testlerinden elde edilen veriler 3 X 2 tekrarlı ölçümler varyans analizi (ANOVA) kullanılarak değerlendirilmiştir. Tutum ölçeklerinden elde edilen verilerin değerlendirlmesinde ise, t-test kullanılmıştır.

Araştırma sonunda deney grubu ile kontrol grubunun çarpma, bölme ve kesirler ünitelerindeki akademik başarı sontest puanları arasında deney grubu lehine anlamlı farklar bulunmuştur. Kalıcılık puanları açısından yalnızca çarpma ve bölme ünitelerinde deney grubu lehine anlamlı bir fark bulunmuştur. Bunun yanısıra, deney grubunda bulunan, Frizbi Matematik 4 ile bilgisayar destekli öğretim alan öğrencilerin matematiğe ve bilgisayar destekli öğrenmeye karşı tutumlarında, kontrol grubuna göre anlamlı farklar oluşmuştur. Elde edilen sonuçlar, Frizbi Matematik 4 eğitsel yazılımının Kuzey Kıbrıs Türk Eğitim Sisteminde ilköğretim matematik derslerinde geleneksel eğitime katkı koyacak şekilde uygulanmasının olumlu sonuçlar ortaya çıkaracağını destekler niteliktedir.

1. Giriş

Bu çalışma bir eğitsel yazılım olan Frizbi Matematik 4 programını geleneksel öğretim yöntemleriyle karşılaştırarak matematik derslerindeki etkililiğini ortaya koymayı amaçlamaktadır. Çalışmanın ilk bölümünde problem durumu ve calışmanın önemini, ikinci bölümde ise literatür taraması yer almaktadır. Üçüncü bölümde ise çalışmanın yöntem kısmına yer verilmiştir. Çalışma sonucu elde edilen verilerin yer aldığı dördüncü bölümde ayrıca bu verilerin açıklamalarından da söz edilmiştir. Son bölüm ise sonuç ve önerilere ayrılmıştır.

Matematik eğitiminin temelleri, genelde matematik bilim dalının gelişim sürecine bağlı olarak şekillenmiş ve toplumların gelişim sürecinde geçmişten günümüze değin etkili olmuştur. 1980'li yıllara kadar metematik izole edilmiş bir hedefler bütünü olarak görülmüş, bunun bir sonucu olarak da geleneksel matematik öğretim modelleri ile öğrenciler ezberci bir anlayışla yetiştirilerek, öğrendiklerini anlamlaştıramadan öğrenmeye teşvik edilmişlerdir.

Geleneksel öğretim yöntemleri ile yapılan öğretimde matematik kavramları genelde soyut örnekler kullanılarak öğretilmeye çalışılmaktadır. Bu şekilde yapılan öğretimde öğrencilerin üst seviye bilişsel becerilerini kullanmaları gerektirmektedir. Bunun sonucunda öğrenciler üzerinde ortaya çıkan yüksek baskı öğrencilerin güvenini ve matematiğe ilişkin tutumunu olumsuz yönde etkilemektedir. Kuzey Kıbrıs Türk Cumhuriyetin'de de durum yukarıda anlatılandan farlı bir eğilim göstermemektedir. Böylece pek çok öğrenci matamatiğin zor olduğunu ve matematik dersinden başarılı olamayacaklarını düşünerek kaygılanmakta ve çoğunlukla başarısız olmaktadırlar. Bu duruma bağlı olarak öğrencilerin matematiğe ilişkin olumsuz bir tutum geliştirdiği gözlemlenmiştir. Bu durum ilköğretimden başlamakta, okul yılları ilerledikçe de malesef artarak devam etmektedir. Yapılan araştırmalar bu konuda seçilen öğretim yöntemlerinin önemli bir rolü olduğunu göstermiştir. Ne yazık ki okullarda kullanılması gereken, öğrencileri yaparak yaşayarak öğrenmeye teşvik eden çağdaş yöntemler öğretim programlarına katılmamaktadır. Bu tür gereksinmlerin karşılanabileceği öğretim programları bilgisayar destekli öğretim yöntemlerinin yardımı ile yaratılması mumkün olarak görülmektedir. Dünyamızda, bilgisayar ve bilişim sektöründeki hızlı gelişim çerçevesinde eğitim alanında da çeşitli uygulamalar yapılmaya başlanmış.

Kuzey Kıbrıs Türk Eğitim sisteminde birçok okulda matematik eğitimi halen daha geleneksel yöntemlerin kullanılması ile, ezberci ve doğru cevap odaklı olarak sürüp gitmektedir. Oysa matematik eğitimin temel amacı sorun çözebilen, araştırmacı ve üretken bireyler yetişrmek olmalıdır. 2005 yılında K.K.T.C'nin eğitim sisteminde yeni bir eğitim programı uygulamaya geçirilmiştir. Yenilenen bu eğitim programında yenilikçi yaklaşımlara ve öğrenci merkezli uygulamalara yer verilmesine rağmen bilgisayar ve öğretim teknolejilerinin, özellikle matematik derslerinde yer almadığı göze çarpmaktadır. Tüm dünyada bilgisayar destekli eğitimin en etkin şekilde nasıl kullanılabileceği tartışılırken, ülkemizde hala daha bilgisayer destekli eğitimin öğretim programlarına katılıp katılmaması tartışılmaktadır.

Bilgisayar ve eğitsel yazılım programlarının etkili bir şekilde kullanılmasıyla matematik öğretiminde öğrencilerin matematiğe daha cok ilgi göstermeleri ve matematiği sevmeleri sağlanabilir. Bu bağlamda bilgisayarların K.K.T.C'de okutulan matematik derslerinde etkili öğrenme ortamları yaratacağı ve matematik becerilerini geliştireceği düşünülmektedir. Elde edilen bilgiler ışığında, bu araştırmanın amacı ilköğretim 2. sınıf seviyesinde Frizbi Matematik 4 programı ile yapılan bilgisayar destekli matematik öğretiminin başarıya, kalıcılığa, matematik ve bilgisayar destekli öğrenmeye ilişkin tutumuna olan etkisini belirlemektir.

1.2 Önem

Bilgisayar destekli öğretimin öğrenmeleri etkileşimli ortamlar oluşturarak daha etkili ve kalıcı hale getirdiği bir çok araştırmacı tarafından ortaya konmasına rağmen Kuzey Kıbrıs Türk Eğitim sisteminde bu alanda yapılmış hiçbir çalışma bulunmaması araştırma için bir önem teşkil etmektedir.

Günümüz okullarında yapılan eğitimin, öğretmen merkezli değil, öğrenci merkezli olması, yapılan uygulama ve etkinliklerin, ders kitabı ve yazı tahtalarının dışında, daha yenilikçi, görsel ağırlıklı öğretim materyallerinden yararlanırak yapılmaya başlaması gerkemektedir. Mevcut sistemde bulunan matematik eğitim ve öğretim programlarında yenilikçi yöntemlere yer verilmelidir. Bu bağlamda gösterip yapma, benzetim, problem çözme, alıştırma ve uygulama gibi uygulama alanları olan Bilgisayar Destekli Öğretim uygulamalarına yer verilmesi kaçınılmazdır. Bu çalışmada yöntem kısmında anlatılan Frizbi Matematik 4 adlı eğtisel yazılım programının KKTC deki matematik derslerinde kullanılması ile öğrencilerin matematik derslerindeki temel kavarmları görsel içerikli, ses ve animasyon efektli alıştırmalarla daha etkili ve kalıcı öğrenmeler gerçekleştirmesinde yardmıcı olacağı düşünülmesi yönüyle önemlidir.

Ayrıca, bu çalışma Kuzey Kıbrıs Türk Cumhuriyetinde şimdiye kadar matematik derslerinde ortaya çıkan sorunların önlenmesinde, daha kalıcı öğrenme ortamlarını sağlanmasına yönelik bilimsel çalışmaların yok denecek kadar az olması açısından da önem taşımaktadır.

Bu çalışma, Frizbi Matematik 4 kullanarak en çok zorlanan derslerden biri olan matematik dersinin ilköğretim 4.sınıf düzeyindeki öğrencilerin akademik başarısını yükseltilmesine, bu başarının kalıcığının artmasına ve buna ek olarak matematik ve bilgisayar destekli öğrenmeye ilişkin tutumlarının olumlu yönde gelişmesine katkıda bulunabilir.

2. Literatür Taraması

Bu bölümde bilgisyaraların eğitimdeki rollerine kısaca değinilmiş daha sonra ise bilgisayar destekli öğretimin matematik eğitimindeki yeri üzerinde durulmuştur. Bölümün son kısmında ise alanda yapılan çalışmalara yer verilmiştir.

2.1 Bilgisayarların Eğitimdeki Yeri ve Önemi

Günümüzde, bilgisayar ve buna bağlı teknolojiler dünayanın bir çok yerinde bulunan okullarda kullanılmaktadır. Hemen her alanda kullanılan bilgisayar teknolojisi, eğitime de girmiş ve yoğun biçimde kullanılmaktadır. Özellikle gelişimini tamamlamış, modern ülkelerde bilgisayarlar okullarda uzunca bir suredir eğitimi destekleyen bir araç olarak kullanılmakta, öğretmenler ise bu araçlardan öğretim yöntemlerini desteklemek amacı ile yararlanmaktadırlar. Birçok eğitimci bilgisayar teknolojilerini öğretim programlarında bulunan farklı derslerde kullanmaya çalışarak, öğrenim ve öğretim yöntemlerini değiştirmeyi amaçlamaktadırlar. Örneğin, matematik eğitiminde kullanılan yöntemler teknolojinin entegre olmasıyla değişikliye uğramış, bu ise hem öğrencinin hem de öğretmenin üstlendiği rolleri doğrudan etkilemiştir.

Hepimizin bildiği gibi, eğitimin amaçlarından biri, bireyleri toplumun gereksinmeleri doğrultusunda yetiştirmektir. Bu nedenle, eğitim sistemleri günümüzde bilgi çağına uygun, bilgi toplumu üyesinin özelliklerini taşıyan bireyler yetiştirmekle yükümlüdür. Bu da eğitim kurumlarının hem bireyleri yeni teknolojilerden haberli kılmalarını ve onları nasıl kullanacaklarını öğretmelerini hem de kendilerinin yeni teknolojileri kullanmalarını gerektirir.

Bilgisayar, 1960'larda okullarda sınırlı sayıda öğretmen ve seçilmiş öğrencilerlerle kullanılmaya başlanmıştır. Ancak, o yıllarda donanıma ağırlık verilmiş, yazılım ise arka planda kalmıştır. Bu ise, programlama dillerinin öğretimini öne çıkarmıştır. Zaman içerisinde bu görüş değişmiş, bilgisayar uygulamalarına ağırlık verilmiştir. "Bilgisayar farkındalığı", "bilgisayar okuryazarlığı" önem kazanmıştır. Daha sonra da, bilgisayar teknolojisinde elde edilen bilgilerin iletişim teknolojisine uygulanmasıyla, yeni teknolojiler bireyleri iletişim teknolojisi içerisinde etkin kılmıştır. Bütün bu değişmelerin sonucu olarak, bilgi toplumunun gerektirdiği insan tipini yetiştirmek zorunlu duruma gelmiştir. Bilgi çağının insan tipini belirlemek, eğitim sisteminin yönlendirilmesi açısından önemlidir. Bilgi toplumunun insan tipini yetiştirmede ise, teknoloji kullanımı önemlidir.

Bilgisayar, son yıllarda eğitim alanında en hızlı gelişen ve kullanılan araç olmuştur. Bilgisayarların eğitim ortamlarında kullanılması 1950'li yillara kadar uzanmış olsada genel anlamda ve işlevsel olarak kullanılması 1980'li yılların başlarına denk gelmektedir. Donald Bitier'in 1959 yılında uygulamış olduğu PLATO adlı bilgisayarların eğitimde kullanılması bu alanda yapılan ilk çalışmalardan sayılmaktadır. Nitekim 1980'den sonra eğitimle ilgili donanım ve yazılımlar hızla artmıştır. Bu durum, öğretme-öğrenme sürecinde önemli değişikliklere ve sonuçlara yol açmıştır.

2.2 Bilgisayar Destekli Öğretim

Bilgisayarın eğitimde kullanılmasıyla ilgili önemli bir konu da bilgisayar desketli öğretimdir. Bilgisayar destekli öğretim, bilgisayarın hem sınıf içinde çeşitli derslerin öğretimi için hem de okul yönetiminin çeşitli işleri için kullanılmasına verilen addır.

Öğrencinin karşılıklı etkilişim yoluyla eksiklerini ve performansını tanıması, dönütler alarak kendi öğrenmesini kontrol altına almasını; grafik, ses, animasyon ve şekiller yoluyla derse karşı daha ilgili olmasını sağlamak amacıyla eğitim ve öğretim sürecinde, bilgisayardan yararlanma yöntemine Bilgisayar Destekli Öğretim denir (Baki, 2000; Rushby, 1989; Uşun, 2000).

Bilgisayarın öğretme-öğrenme sürecinde bir araç olarak kullanılmasına bilgisayar destekli öğretim diyebiliriz. Bilgisayar destekli öğretimde, herhangi bir derste bir konu, önceden hazırlanmış olan yazılımlarla öğretilir. Örneğin, matematik dersinde "kümeler" konusunu öğretmen bu konuyla ilgili bilgisayar yazılımını öğrencilere kullandırtarak öğretebilir. Öğrenciler, bilgisayarda bu yazılımın kapsadığı metni okuyup, şekilleri inceleyip alıştırmaları yapabilirler. Sonra da yaptıklarının doğru olup olmadığını yine bu yazılımdaki doğru yanıtlarla karşılaştırıp öğrenip öğrenmediklerini denetleyebilirler.

Bilgisayar destekli öğretimde öğretmen derslerinde bilgisayardan yardımcı bir araç olarak başlıca şu tür etkinliklerde yararlanabilir:

• Öğretim konularını tekrar ettirme ve alıştırma yaptırtma.
• Kavram, yöntem, ilke ve yasaları öğretme.
• Problem çözme yollarını öğretme.
• Gözlem ve deney yaptırtma.

Bilgisayar destekli öğretimde bilgisayardan etkili biçimde yararlanılabilmesi için yeterli sayıda ve nitelikli yazılımlara gerek vardır. Bu sağlanamadan okullarda bilgisayar destekli öğretimin başarılı olması beklenemez. Bilgisayar, okullarda öğretim ya da ders dışı etkinliklerde de kullanılabilir.

2.2 Bilgisayar Destekli Öğretimin Yararları

Aşağıda bilgisayarların eğitim-öğretim ortamlarına getirdiği yararlar kısaca belirtilmiştir.

- Öğrenci kendine ait kişisel bir ögrenme ortamında rahatlıkla çalışır. Bunun yanısıra, bilgisayar hoşgörülü, anlayışlı ve tekrar tekrar ögretebilen bir arkadaş ya da öğretmen gibi davrandığı için kendisini yalnız hissetmez.
- Öğretim adımları daha önceden planlandığı için her bir üniteden sonraki adım ögrencinin bilinçli bir eylemini gerektirmeden kendiliğinden oluşur.
- Çizimler,şekiller ve sorular sırası geldikçe öğrenciye sunulur. Bu sayede ögrenilenleri görselleştirme, hareketlendirme olanaği yaratır.
- Öğrencinin kendi hızında bir öğrenim sağlanır.
- Öğretmenden öğretmene değişen ögretim niteliği yüksek bir düzeye çıkarılır.
- Öğrenim küçük birimlere indirildiğinden, başarı bu birimler üzerinde sürekli sınanarak adım adım gerçekleştirilir.
- Öğrenciyle ilgili kişisel ve istatiksel bilgiler aynı ortamda saklanır.
- Öğrenme olanaklari yer ve zaman kısıtlamalarından bağımsız kılınır.Ama

hızlı öğrenme sayesinde de zamandan tasarruf edilmektedir.

- Öğrenci kendi başına çalışmasına rağmen eğitmen tarafından sürekli denetlenir ve gerektiğinde müdahale edilir.

2.3 Bilgisayar Destekli Öğretimin Sınırlılıkları

Günümüzde bilgisayar destekli öğretim her geçen gün daha da önem kazanmasına ve yukarda belirtilen bilgisayarın eğitim ortamlarına getirdiği yararlara rağmen, bilgisayarların egitim alanında daha aktif ve üretken bir şekilde kulanılmadığına şahit olmaktayiz. Bunun başlıca sebebleri arasında eğitimcilerin bilgisayar kullanmada yeterli tecrübeye sahip olmamalarını ve bilgisayarlara ulaşma imkanlarının kısıtlı olmasını ileri sürebiliriz. Ayrıca**,** BDÖ konusnun henüz yeni olması ve sonuçlarının yeni alınmaya başlanması dolayısıyla bunun yarattığı korku, ayrıca hazırlanmış birtakım yazılımların iyi dökümente edilmemiş olması; bunun yanısıra bu tür yazılımların ve gerekli donanımların fiyati da BDÖ sistemlerinin dezavantajlarıdır.

2.4 İlgli Araştırmalar

Günümüzde bilgisayarın eğitimde kullanılması ile ilgili birçok araştırma yapılmaktadır. Bunlar öğretmenlerin sahip olması gereken niteliklerden, uygulama yaklaşımına kadar geniş bir yelpazeye yayılan araştırma konularıdır. Bugüne dek yapılan araştırmalar, bilgisayarın öğrenciyi öğrenmede etkin kıldığını, öğrencinin hızlı ve sistemli dönüt sağlayabildiğini, her öğrencinin kendi öğrenme düzeyine ve hızına göre ilerlemesine olanak verdiğini ve öğretmenin öğrencileriyle daha çok ilgilenmesini sağladığını ortaya koymuştur.

Öğretimde bilgisayar kullanımı konusunda gerçekleştirilen uluslar arası bazı araştırmalarda aşağıdaki bulgular elde edilmiştir;

1. Bilgisayar öğrencilerin öğretim hedeflerine ulaşmasına yardımcı olmaktadır.
2. Geleneksel öğretimle karşılaştırıldığında; bilgisayar programları, öğrenme zamanında %20 ile %40 arasında tasarruf sağlamaktadır.
3. Bilgisayarın öğretim alanında kullanılması, geleneksel öğretime oranla,

öğrenci başarısını olumlu yönde etkilemekte ve motivasyonu arttırmaktadır.

4. Bilgisayar destekli öğretimin başarısında eğitsel (ders) yazılımların etkililiği önemli rol oynamakladır.

Burns ve Buzmen (1981) gelenksel öğretim ile bilgisayar destekli öğretimi karşılaştırmak için 40 araştırma çalışması üzerinde bir meta-analiz gerçkleştirmiştir. Çalışmada bilgisayar destekli öğretim ve bilgisayar destekli öğretimin geleneksel öğretimle destekli kullanımının öğrencilerin matematik başarısı üzerindeki etkileri kıyaslanmıştır. Sonuçlar, bilgisayar destekli öğretimin geleneksel yöntemleri desteklenerk kullanılmasının öğrencilerin matematik başarıları üzerinde etkili olduğu ortaya konmuştur.

Hasselbring (1984) yaptığı araştırmada bilgisayar destekli matematik öğretiminin öğrencilerin başarı ve matematiğe ilşkin tutumlarında gelenksel öğretim yöntemlerine göre daha etkili olduğunu bulmuştur. Benzer bir çalışmada Cotton (1991) bilgisayar destekli öğretimin geleneksel yönetmeleri destekler nitelikte kullanılması sonucunda öğrencilerin matematik dersindeki başarılarında etkili olduğunu belirtmiş ve bunun değişik yaş grublarında farklılık göstermediğini belirtmiştir.

Glikman (2000) calışmasında bilgisayar destekli öğretim alan öğrencilerin matematiğe ilşkin tutumlarını araştırmış ve çalışmasının sonucunda öğrencilerin kendilerine olan güvenlerinde artış ve matematiğe ilişkin kaygılarında ise bir düşüş olduğunu gözlemlemiştir. Buna karşın, kontrol grubunda bulunan öğrencilerde ise istatistiksel anlamda bir farka rastlamamıştır.

Akinsola ve Animasahun (2007) deneysel çalışmasında bilgisayar detekli öğretim uygulaması ile matematik derslerini takip eden öğrenciler ile geleneksel yöntemlerle öğrenim gören öğrencileri karşılaştırmıştır. Sonuçlar, matematik derslerini simulasyon-oyun uygulamalı BDÖ takip eden öğrencilerin başarı ve tutumlarında belirgin bir artış olduğunu göstermiştir.

Bu çalışmaya benzer bir çalışmada, Vale (2001) matematik derslerinde bilgisayar ile etkileşim süresi öğrencilerin bilgisayar destekli öğretime ilişkin tutumlarını doğru oranda etkilediğini ortaya koymuştur. Sonuçlar ayrıca, bilgisayar destekli matematik öğretimin öğrencilerin bilgisayar destekli öğrenime ilişkin tutumlarını olumlu yönde etkilediğini destekler niteliktedir.

Türkiye'de birçok araştırmacı bilgisayar destekli öğretimin genelde eğitime, özelde matematik eğitimine olan olumlu katkılarını ortaya koyan çalışmalar yürütmüşlerdir. Bunlardan bazıları aşağıda verilmiştir.

Sezer (1989) yaptığı deneysel çalışmada, bilgisayar destekli öğretimin 5. sınıf öğrencilerinin matematik başarısına olan etkisini incelemiştir. Çalışmanın sonucunda, bilgisayar destekli matematik öğretimi yapılan grubun başaraısının ayni öğretimin geleneksel yöntemle yapıldığı gruba göre anlamlı düzeyde yüksek olduğu belirtilmiştir.

Tanaçan (1994) yaptığı çalışmada, bilgisayar destekli öğretimin geleneksel öğretim yöntemine göre öğrenci başarısı üzerindeki etkisini belirlemeye çalışmış ve araştırma sonucunda bilgisayar destekli öğretimin kullanıldığı deney grubunun geleneksel öğretimin uygulandığı kontrol grubuna oranla daha başarılı olduğu sonucuna ulaşmıştır.

Budak (2000) araştırmasında bilgisayar destekli öğretimin öğrenci üzerindeki etkisini gözleme ve ortaya çıkacak öğrenme ürünlerini değerlendirme amacı ile sayılar konusu ile ilgili BDMÖ materyali geliştirmiştir. Çalışmanın sonucunda geliştirilen materyalin, öğrencilerin keşfederek, kendi bilgilerini kurarak ve neden niçin sorgulamasını yaparak öğrenme ortama oluşturduğu saptanmıştır.

Akoğlu (2003) benzer bir çalışmada, ilköğretim 4. sınıflarda, kesirler konusunun, bilgisayara destekli öğretim yöntemi ve geleneksel öğretim yöntemiyle işlenmesinin öğrenci başarısı üzerine etkileri incelenmiştir. Her iki grup öğrencilerine çalışma öncesinde ön-test ve sonrasında ise son-test uygulanmıştır. Araştırmanın sonucunda elde edilen bulgular, bilgisayar destekli öğretim uygulanan gruptaki öğrencilerin matematik son-test puanları, geleneksel öğretim grubunda bulunan öğrencilere göre daha yüksek olduğunu işaret etmektedir.

Yukarda belirtildiği gibi, ilgili araştırmalar bilgisayar destekli öğretimin öğrenci başarısını artırdığını, matematiğe ve bilgisayarlı öğrenmeye ilişkin tutumlarını olmlu yönde değiştirdiğini göstermiştir. Bu çalışmada amaçlanan yukarda belirtilen çalışmalarla benzerlik göstermektedir. Bu çalışmanın amacı; bilgisayar destekli öğretimin 4.sınıf öğrencilerinin matematik derslerindeki başarısına, matematiğe ve bilgisayar destekli öğrenmeye ilişkin tutumlarına olan etkisini incelemektir.

3. Yöntem

Bu bölümde araştırmanın yöntemi, araştırma soruları, araştırmanın yürütüldüğü grup, araştırmanın değişkenleri ve veri toplama araçları açıklanmıştır. Bölümün sonunda verilerin analizinde kullanılan statistiksel yöntemler açıklanmış ve çaılşamın sınırlılıkları sıralanmıştır.

3.1 Araştırmanın Modeli

Bu araştırmayla 4. sınıf matematik derslerinde kullanılan bilgisayar destekli öğretim ile geleneksel yöntemin öğrencilerin başarı, tutum ve kalıcılık üzerine etkisi sınanmıştır. Bu çalışmada yarı-deneysel araştırma modeli kullanılmıştır.

Alan yazında yapılmış bulunan birçok çalışma gibi bu çalışmada da bilgisayar destekli öğretimin etkisini araştırmak için yarı- deneysel bir çalışma yürütülmüş olup, araştırmacı bağımsız değişkenin (BDÖ) bir veya birden çok bağımlı değişken üzerindeki etkisini analiz etmiştir (Frankel and Wallen, 2000). BDÖ yöntemin öğrenci başarısına, tutumuna ve kalıcılığa olan etkisini sınamak için bir deney bir kontrol grubu oluşturulmuştur. Bağımsız değişken; Frizbi Matematik 4 eğitsel yazılım ile Bilgisayar Destekli Öğretim, bağımlı değişkenler ise; başarı, matematiğe ilişkin tutum, bilgisayar destekli öğrenmeye ilişkin tutum ve kalıcılık olarak saptanmıştır.

Çalışma boyunca deney grubuna Frizbi Matematik 4 adlı eğitsel yazılım eşliğinde bilgisayar destekli öğretim uygulanmış, ayni zamanda kontrol grubundaki öğrenciler ise geleneksel yöntemlerle öğretim görmüşlerdir.

Çalışma Kuzey Kıbrıs Türk Cumhuriyetinde bulunan Şht. Osman Ahmet İlkokulu isimli bir devlet oklunda yürütülmüştür. Çalışmanın yürütüldüğü okul 47 adet ilköğretim okulu arasında bilgisayar laboratuar olması nedeniyle amaçlı olarak seçilmiştir. Okulda bulunan tüm (N = 55) 4. sınıf öğrencileri çalışmaya katılımcı olmuşlardır. Okul yönetimi akademik dönem başında öğrencileri 4 Sarı ve 4 Kırmızı diye iki gruba yerleştirmiştir. 4 Sarı sınıfı 28 öğrenciden, 4 Kırmızı ise 27 öğrenciden oluşmaktaydı. Dersler her iki sınıfın sınıf öğretmenleri tarafından yürütülmekteydi.

Çalışmanın başlangıcında 4. sınıf öğrencileri araştırmacı tarafından eşleştirme yöntemi kullanılark kontrol ve deney grubu şeklinde ikiye ayrılmışlardır. Eşleştirme yöntemi öğrencilerin öntest sonuçları ve bir önceki dönem matematik dersi notları göz önüne alınarak gerçekleştirilmiştir. Kontrol ve deney grubundaki öğrencilerin denkliğini sağlamak için öğrencilerin Matematik Başarı Testi 1 (MBT1), Matematiğe ilişkin Tutum Ölçeği (MTÖ), Bilgisayar Destekli Öğrenmeye ilişkin Tutum Ölçeği (BDÖTÖ) sonuçları ve bir önceki dönem matematik dersi notları bir formülle (*eşleştirme puanı* = 0.4 x (bir önceki dönem matematik ders puanı) + 0.3 x (Matematik Başarı Testi 1) + 0.2 x (Matematiğe ilişkin Tutum Ölçeği) + 0.1 x (Bilgisayar Destekli Öğrenmeye ilişkin Tutum Ölçeği) birleştirilmiş ve her öğrenciye ait bir eşleştirme puanı saptanmıştır. Daha sonra elde edilen puanlar yardımı ile, denk puan alan öğrenciler eşleştirlmiş ve denk puan alan öğrencilerden biri kontrol grubuna bir diğeri ise deney grubuna atanmıştır. Sonuç olarak öğrencilerin ön test puanları baz alınarak bir birine denk iki grup elde edilmiştir. Böylece, 4 Sarı ve 4 Kırmızı sınıflarındaki öğrencilerin bir kısmı kontrol grubunda diğer bir kısmı ise deney grubunda çalışmaya katılmışlardır. Kontrol ve deney grubundaki öğrencilerin eşleştirme puanları ortalamsı ise t = .05 de anlamlı bir farklılık göstermemektedir.

Bu deneysel çalışma 2005-2006 bahar döneminde yürütülmüştür. Bahar dönemi akademik takvime göre Şubat ayı ortasında başlamakta ve Hazşran ayı ortasında ise son bulmaktadir. 4.sınıf öğretim programında matematik dersleri haftada 6 saat yapılmakta ve bahar dönemi ise 15 hafta sürmektedir. Çalışma boyunca 6 saatlik matematik derslerinin 4 saatinde her iki sınıf öğretmenleri ile birlikte konu anlatımı yapmakta, geriye kalan 2 saatlik ders diliminde deney grubu bilgisayar laboratuarında Frizbi Matematik 4 eğitsel yazılımını kullanarak anlatılan konuya yönelik alıştırma problemlerini Frizbi Matematik 4 bilgisayar yazılımı kullanarak BDÖ görmüşlerdir. Diğer taraftan kontrol grubundaki öğrenciler ise 4.sınıf ders kitabına bağlı olarak aynı içerikteki konularla ilgili geleneksel yöntemleri (soru-cevap, kalem ve kağit kullanarak problem çözme) kullanarak alıştırma yapmışlardır. Her hafta deney grubu araştırmacının eşliğinde ve gözetiminde bilgisayar laboratuarında, kontrol grubu ise öğretmenleri ile birlikte sınıflarında 2 saatlik uygulama sürecini tamamlamışlardır. Çalışma sonlandığı zaman kontrol grubundaki öğrencilerin Frizbi Matematik 4 eğitsel yazılımının kullanılması sağlanmıştır.

Bu çalışma ikinci dönem konularından olan "Doğal Sayılarda Çarpma" , " Doğal Sayılarda Bölme" ve "Kesirler" üzerinde yürütülmüştür. Her ünitenin başında, matematik başarı testi öntest (MBÖT1, MBÖT2, MBÖT3) olarak öğrencilere uygulanmıştır. Ünite sonlarında ise matematik başarı testi sontest (MBST1, MBST2, MBST3) olarak öğrencilere tekrardan uygulanmıştır. Başarı testlerine ek olarak, çalışmanın bir başında bir de sonunda hem kontrol grubuna ve hem de deney grubuna matematik tutum ölçeği ve bilgisayar destekli öğrenme tutum ölçekleri verilmiştir. Buna ek olarak son testlerin uygulanmasından 4 ay sonra öğrencilerin matematik dersindeki başarılarının kalıcılıkları ölçmek için matematik kalıcılık testleri (MBKT1, MBKT2, MBKT3) öğrenciler tarafindan yanıtlanmıştır.

3.2 Araştırma Soruları

Bu çalışma aşağıdaki araştırma sorularını cevaplamayı amaçlamıştır.

Araştırma Sorusu 1: Frizbi Matematik 4 ile Bilgisayar Destekli Öğretim yapan öğrencilerin ve geleneksel yöntemlerle öğretim yapan öğrencilerin sontest puanları arasında anlamlı bir farklılık var mıdır?

Araştırma Sorusu 1: Frizbi Matematik 4 ile Bilgisayar Destekli Öğretim yapan öğrencilerin ve geleneksel yöntemlerle öğretim yapan öğrencilerin matematiğe ilişkin tutum ölçeği puanları arasında anlamlı bir farklılık var mıdır?

Araştırma Sorusu 1: Frizbi Matematik 4 ile Bilgisayar Destekli Öğretim yapan öğrencilerin ve geleneksel yöntemlerle öğretim yapan öğrencilerin bilgisayar destekli öğrenmeye ilişkin tutum ölçeği puanları arasında anlamlı bir farklılık var mıdır?

Araştırma Sorusu 1: Frizbi Matematik 4 ile Bilgisayar Destekli Öğretim yapan öğrencilerin ve geleneksel yöntemlerle öğretim yapan öğrencilerin kalıcılık testi puanları arasında anlamlı bir farklılık var mıdır?

3.3 Çalışmanın Değişkenleri

Bu çalışmada 5 adet değişken vardır. Bunlardan bir tanesi bagımsız değişken, diğerleri ise bağımlı değişkenlerdir. Bu değişkenler aşağıdaki gibidir.

Bağımsız değişken: Öğretim yöntemi; Frizbi Matematik 4 ile Bilgisayar Destekli Öğretim
Bağımlı değişkenler: (a) Matematik başarısı, (b) matematiğe ilişkin tutum, (c) bilgisayar destekli öğrenmeye ilişkin tutum ve (d) kalıcılık.

3.4 Eğitsel yazılım: Frizbi Matematik 4

Frizbi Matematik 4 Milli Eğitim Bakanlığı 4. sınıf ilköğretim programı ile bire bir uyumlu olarak hazırlanmış, bireysel ve web kullanımlarını destekleyen bir ders destek yazılımıdır. Eğlenceli bir animasyon-öykü ile başlayan yazılım, tüm ekranlarında öğrencinin matematik bilgisini geliştirebileceği ayrıntılı konu anlatımı sayfalarını, etkileşimli alıştırmaları ve bilgisini değerlendirebileceği testleri kapsamaktadır. Bu yönüyle bireysel kullanımlarda ders destek aracı olarak kullanılabileceği gibi WEB tabanlı uygulaması edinildiğinde öğretmen, öğrenci, veli ve okul yöneticilerinin de eğitim sürecine aktif olarak katılacakları bir eğitim ve iletişim platformu olarak da kullanılabilmektedir.

Frizbi Matematik 4, okullarda öğretilen matematik dersinin daha etkili, daha kalıcı ve daha eğlenceli bir öğrenme atmosferi içinde gerçekleşmesini sağlamak üzere geliştirilmiş ders-destek yazılımıdır. Ağırlıklı olarak "çizgi film çizimleri" (cartoon) ve iki boyutlu animasyon teknolojileri kullanılarak geliştirilen bu ürünlerin her birinde, eğitim bilimsel literatürde sıkça vurgulanan çağdaş öğretim stratejilerinden bir ya da bir kaçı izlenmektedir; bu özellikleriyle Frizbi ürünleri akademik açıdan bilinçli planlanmış, kullanıcı ilgilerini dikkate alan ve Milli Eğitim Bakanlığı gerekleriyle uyumlu yazılımlardır. Matematik konularının didaktik bir tek düzeliğe düşmeksizin, belli bir öykü kurgusu ve gerçekçi bağlamlar içinde çalışılmasına olanak verecek bir tasarıma sahiptir. Frizbi Matematik 4, önce öğreten sonra test eden geleneksel yaklaşımlar yerine, ders konusunun, gündelik yaşamdan seçilmiş "sorun durumları" ile ilişkisinden ve bu durumlarla gerçekçi bir olay akışı sırasında karşılaşılması fikrinden hareket ederek, konunun dikkat merkezine alınmasını sağlayarak ve ancak öğrenci gereksinim duyduğunda, gereksindiği kadar bilgi sunmaya göre programlanmıştır. Frizbi Matematik 4 de, ayrıca, geleneksel konu anlatımları, alıştırma ve testler de bulunmakta, öğrenciler okulda-laboratuar ortamında birbirleriyle ve öğretmenle "sanal sohbet" de (chat) yapma şansına da sahiptirler. Frizbi eğitim yazılımları, Bakanlık öğretim programlarıyla birebir uyumlu ancak bu programlarla sınırlı değildir.

Frizbi Matematik 4 eğitsel yazılımında, gerçek yaşam durumlarının temsil edildiği görsel bir bağlam içinde dolaşan öğrencinin, karşılaştığı problemleri aşabilmesi için önce bilgiye gereksinim duyması, onu araması ve gerektiğinde yeteri kadar bir ders desteği ile yoluna devam edebilmesi amaçlanmıştır. Bu tasarım doğası gereği kavram, kural ve prosedür öğretimini bütün bir yazılım tabanına yaymış, bir anlamda, "ders" ile "tenefüs" saatini birleştirmiştir.

3.5 Veri toplama araçları

Bu çalışmada aşağıdaki veri toplama araçları kullanılmıştır.

- Matematik başarı testleri: öntestler (MBÖT1, MBÖT2, MBÖT3), son testler (MBST1, MBST2, MBST3) ve kalıcılık testleri (MBKT1, MBKT2, MBKT3)
- Matematik tutum ölçeği (MTÖ)
- Bilgisayar destekli öğrenme tutum ölçeği (BDÖTÖ)

3.5.1 Matematik Başarı Testleri

Öğrencilerin matematik dersindeki başarılarını ölçmek için her unite için bir başarı testi araştırmacı tarafından geliştirilmiştir. Matematik başarı ön testi 1, birinci üniteyle ilgili konuların tümünü kapsamaktadır. Matematik başarı ön testi 2, ve Matematik başarı ön testi 3 sırası ile ünite 2 : "Doğal sayılarda bölme" ve ünite 3: "Kesirler" ünitesindeki tüm konuları içermektedir. Ön testlere paralel olarak hazırlanan son testler çalışma bittikten hemen sonra ve kalıcılık testleri ise son testlerin uygulanmasından dört ay sonra öğrenciler tarafından cevaplandırılmıştır. Ön test, son test ve kalıcılık testleri ayni problemlerin farklı sözel anlatımı ve sayı değerlerini kullanılarak hazırlanmıştır. Testlerin hazırlanmasında her ünite ile ilgili belirtke tabloları hazırlanmış ve belirtke tablosunda yer alan her davranışa denk gelen bir test maddesi eklenerek içerik güvenilirliği sağlanmıştır. Bunun yanısıra testler matematik öğretmenleri, çalışmaya katılan sınıf öğretmenleri ve test geliştirme uzmanları tarafından kontrol edilerek testlerin güvenilirliği artırılmıştır.

3.5.2 Tutum Ölçekleri

Bu çalışmada öğrencilerin matematiğe ilişkin tutumları Aşkar (1986) tarafından geliştirilmiş olan Matematik Tutum Ölçeği (MTÖ) kullanılarak saptanmıştır. Matematik Tutum Ölçeği 5'li Likert tipi bir ölçek olup 20 maddeden oluşmaktadır. Matematik tutum ölçeğinin güvenlirlik katsayısı ön test için .86 ve son test için .90 olarak hesaplanmıştır. Bunun yanısıra öğrencilerin bilgisayar destekli öğrenmeye ilişkin tutumlarını ölçmek için Aşkar, Yavuz ve Köksal (1991) tarafından geliştirilmiş Bilgisayar Destekli Öğrenmeye ilişkin Tutum Ölçeği (BDÖTÖ) kullanılmıştır. Matematik tutum ölçeği 3'li Likert tipi bir ölçek olup 10 maddeden oluşmaktadır. Maddelerin 2'si olumsuz, 8'i ise olumlu yöndedir ve "evet", "bazen" ve "hayır" şeklinde hazırlanmıştır. Bilgisayar destekli öğrenmeye ilişkin tutum ölçeğinin güvenlirlik katsayısı ön test için .78 ve son test için .64 olarak hesaplanmıştır.

3.6 Verilerin Çözümlenmesi

Araştırmanın sorularının yanıtlanması için istatistiksel çözümleme yolları kullanılmıştır. Çalışmanın başında, tüm başarı testlerine ve tutum ölçeklerine güvenirlilik analizi uygulunmaştır. Her iki grubun test puanlarının karşılaştırlmasında ise 3 x 2 tekrarlı ölçümler ANOVA ve bağımsız gruplar T-testi kullanılmıştır. Verilerin analizinde SPSS 13.0 istatistik programından yardım alınmıştır.

3.7 Sınırlılıklar

Bu kısımda,verilerin analizinden önce, çalışma ile ilgili karşılaşılan bazı sınırlılıklardan söz edilecektir.

1. Araştırma, Kuzey Kıbrıs Türk Cumhuriyeti, Gazimagusa ilçesi, Şht. Osman Ahmet İlkokulu, 4.sınıf öğrencileri ile sınırlandırılmıştır.
2. Araştırma, 2005-2006 bahar dönemi ile sınırlıdır.
3. Araştırma 4. sınıf matematik dersi konularından, "Doğal Sayılarda Çarpma" , " Doğal Sayılarda Bölme" ve " Kesirler" üniteleri ile sınırlıdır.

4. Bulgular

Bu bölümde, çalışmanın başında saptanan araştırma sorularının doğrultusunda yapılan istatistiksel çözümlemlerde elde edilen sonuçlar veilecektir. Öncelikle bilgisayar destekli öğretim öncesinde grupların eşitliği ile ilgi yapılan analiz sonuçlarına yer verilecek, daha sonra ise her ünite ile ilgili elde edilen sonuçlar açıklanacaktır. Bu bölüm tutum ölçeklerinden elde edilen sonuçların verilmesiyle son bulacaktır.

4.1 Bilgisayar Destekli Öğretim öncesi grupların denkliği ile ilgili sonuçlar

Yöntem bölümünde de belirtildiği gibi grupların eşitlenmesi amaçlı her öğrenci için bir eşleştirme puanı hesaplanmış ve öğrenciler bu eşleştirme puanlarına göre, denk puanda olan iki öğrenciden biri deney diğeri ise kontrol gruplarına yansız olarak atanmışlardır. Deney grubu ve kontrol grubu oluşturulduktan sonra bağımsız gruplar T-testi analizi eşleştirme puanları üzerinde kullanılmış ve sonuçlar her iki grubun eşleştirme ortalama puanları arasında anlamlı bir farklılık bulunmamıştır. Deney grubunun eşleştirme puanları aritmetik ortalamsı 73.09, kontrol grubunun ise eşleştirme puanları aritmetik ortalamsı ise 71. 65 olarak elde edilmiştir.

Deney ve kontrol grubundaki eşleştirme puanlarının normal dağılım gösterdigi Kolmogorov-Simirnov Testi kullanılarak gösterilmiştir. Bu veriler doğrıltusunda, deney ve kontrol grupları arasında eşleştirme puanları arasında anlamlı bir farklılık olup olmadığını independent t-test kullanılarak ortaya çıkarmak amaçlanmıştır. T-test sonuçları gruplar arasında anlamlı bir farklılık olmadığını işaret etmektedir ($t(53) = -.301$, $p = .77$).

Bunun yanısıra, matematik başarı öntestleri (MBÖT1, MBÖT2, MBÖT3) de independent t-test kullanılarak uygulama öncesi kontrol ve deney grubu test puanları arasında anlamlı bir farklılık olmadığı ortaya konulmuştur. Aşağıdaki Tablo 1' de ise deney ve kontrol grubu öğrencilerinin öntest puanlarına ait t-test sonuçlarına yer verilmiştir.

Tablo 1

Deney ve kontrol grubu öğrencilerinin öntest (MBÖT1, MBÖT2, MBÖT3) puanlarına ait bağımsız gruplar t-testi sonuçları

Değişkenler	Geleneksel Yöntem (*N* = 26)		Bilgisayar Destekli Öğretim (*Frizbi Mathematics 4)* (*N* = 29)		
	Arit.Ort.	*SD*	*Arit. Ort.*	*SD*	*p*
MBÖT1	41.77	17.41	42.00	15.72	.63
MBÖT2	34.42	19.25	34.65	19.64	.99
MBÖT3	20.38	9.58	21.72	8.79	.98

Tablo 1, deney ve kontrol grubu öğrencilerinin her üniteye ait ön test aritmetik ortalamalarını, standart sapmalarını ve p anlamlılık değerini göstermektedir. Her ünite için hesaplanan öntest p değeri .05 değerinden büyük olduğundan dolayı, deney ve kontrol grubunda bulunan öğrenciler arasında çalışma öncesinde anlamlı bir farklılık olmadığını işaret etmektedir.

4.2 Unite 1 : " Doğal Sayılarda Çarpma" ile ilgili sonuçlar

Deney ve kontrol grubundaki öğrencilerin ünite 1 öntest, sontest ve kalıcılık testlerinden aldığı puanların aritmetik ortlaması aşağıdaki tabloda verilmiştir.

Tablo 2

Deney ve kontrol grubu öğrencilerinin MBÖT1, MBST1 ve MBKT1 aldığı puanlar

	MBÖT1		MBST1		MBKT1	
	Arit.Ort	*SD*	*Arit.Ort*	*SD*	*Art. Ort.*	*SD*
GÖ (*N* = 26)	41.77	17.41	60.46	22.42	57.23	22.85
BDÖ(N = 29)	42.00	15.72	72.69	16.35	68.97	18.04

Tablo 2’den de anlaşılacağı gibi deney grubundaki öğrencilerin sontest puanlarının artitmetik ortalaması kontrol grubundaki öğrencilerin son test aritmetik ortalamasından daha fazladır. Tablo 2’den görüldüğü gibi öğrencilerin başarı testlerinden aldığı puanlar 10 ile 100 arasında değişklik göstemektedir. Kontrol grubunun MBÖT1, MBST1 ve MBKT1 aritmetik ortalamaları sırasıyla 41.77, 60.46 ve 57.23 olarak elde edilmiştir. Diğer bir taraftan deney grubundaki öğrencilerin MBÖT1, MBST1 ve MBKT1 aritmetik ortalamaları sırasıyla 42.00, 72.69 ve 68.97 olarak elde edilmiştir.

Grupların başarı test verilerine ANOVA ve bağımsız gruplar t-test uygulanabilmesi için bu verilerin normal dağılım sergilemesi gerekmektedir. Ayrıca çalışmaya katılan deneklerin verilerinin, normal dağılım gösterip göstermediğinin tespiti, araştırma sorularının hangi istatistiksel formülle test edileceğinin belirlenmesi açısndan da önemlidir. Bu amaçla, önce araştırmaya katılan deney ve kontrol grubuları kendi içlerinde normal dağılım gösterip göstermediği kontrol edildi. Bunu istatistik olarak ortaya koymak için Kolomogrov-Smirnov Testi kullanıldı. Test sonuçları tüm grubların unite 1 için başarı testlerinin normal dağılım sergilediğini göstermektedir. Şöyleki BMÖT1 sonuçları deney grubu öğrencileri için K-S testi D (29) = .10, p = .20 ve kontrol groubu öğrencileri için , D (26) = .11, p = .20 sonuçlarnı vermiştir. P anlamlılık değeri .05 den büyük olduğu için her iki grup da normal dağılım göstermektedir.

Deney ve kontrol grubu öğrencileri arasında sontest ve kalıcılık testleri aritmetik ortalama puanları arasında anlamlı bir farklılık olup olmadığını anlamak için, 3 (öntest, sontest, kalıcılık testi) x 2 (deney grubu ve kontrol grubu) tekrarlı ölçümler ANOVA kullanılmıştır. 3 x 2 tekrarlı ölçümler ANOVA sonuçlarına göre, kontrol ve deney gruplarının sontest ve kalıcılık testi puan ortalamaları arasında manidar bir farklılık saptanmıştır, F (1,53) = 5.23 p = .03.

Deney ve kontrol grubu öğrencileri kalıcılık testi puanları arasındaki fark bir de bağımsız gruplar t-Test kullanılarak desteklenmiştir. Aşağıdaki Tablo 3’de kalıcılık testi için ibağımsız gruplar T-test sonuçları verilmiştir.

Tablo 3

Deney ve control grubları kalıcılık testi puanları için bağımsız gruplar T-test

					Levene's Test				
Değişken	Gruplar	*N*	*Arit.Ort*	*SD*	*F*	Sig.	*t*	*df*	Sig.
MBKT1	Kontrol	26	57.23	22.85	2.36	.13	-2.13	53	.04*
	Deney	29	68.97	18.04					

*$p < .05$

Tablo 3 incelendiğinde deney grubu öğrencilerinin kalıcılık testi aritmetik ortalaması kontrol grubu öğrencilerinin aritmetik ortalamasından daha fazla olduğu görülmektedir. Uygulanan independent t-test sonucunda ise bu farklılığın istatistiksel olarak anlamlı olduğu ortaya konmuştur, t (53) = - 2.13, p = .04.

Yukarda elde edilen bulgular deney grubunun kontrol grubundan daha iyi öğrendiği şeklinde yorumlanabilir. Bunun yanı sıra, deney grubundaki öğrenciler öğrendiklerini daha fazla hatırlıyorlar.

4.3 Ünite 2: " Doğal Sayılarda Bölme" ile ilgili sonuçlar

Deney ve kontrol grubundaki öğrencilerin ünite 2 öntest, sontest ve kalıcılık testlerinden aldığı puanların aritmetik ortlaması aşağıdaki tabloda verilmiştir.

Tablo 4

Deney ve kontrol grubu öğrencilerinin MBÖT2, MBST2 ve MBKT2 aldığı puanlar

	MBÖT2		MBST2		MBKT2	
	Arit.Ort	*SD*	*Arit.Ort*	*SD*	*Art. Ort.*	*SD*
GÖ (*N* = 26)	34.43	19.25	60.00	19.50	56.54	21.90
BDÖ(N = 29)	34.66	19.64	77.42	14.80	67.76	19.21

Tablo 4' den anlaşılacağı gibi deney grubundaki öğrencilerin sontest puanlarının artitmetik ortalaması kontrol grubundaki öğrencilerin sontest aritmetik ortalamasından daha fazladır. Öğrencilerin başarı testlerinden aldığı puanlar 0 ile 100 arasında değişklik göstemektedir. Kontrol grubun MBÖT2, MBST2 ve MBKT2 aritmetik ortalamalrı sırasıyla 34.43, 60.00 ve 56.54 olarak elde edilmiştir. Diğer bir taraftan deney grubundaki öğrencilerin MBÖT2, MBST2 ve MBKT2 aritmetik ortalamaları sırasıyla 34.66, 77.42 ve 67.76 olarak elde edilmiştir.

Grupların başarı test verilerine ANOVA ve bağımsız gruplar T-test uygulanabilmesi için bu verilerin normal dağılım sergilemesi gerekmektedir. Ayrıca çalışmaya katılan deneklerin verilerinin, normal dağılım gösterip göstermediğinin tespiti, araştırma sorularının hangi istatistiksel formülle test edileceğinin belirlenmesi açısndan da önemlidir. Bu amaçla, önce araştırmaya katılan deney ve kontrol grubuları kendi içlerinde normal dağılım gösterip göstermediği kontrol edildi. Bunu istatistik olarak ortaya koymak için Kolomogrov-Smirnov Testi kullanıldı. Test sonuçları tüm grubların unite 2 için başarı testlerinin normal dağılım sergilediğini göstermektedir. Şöyleki BMÖT2 sonuçları deney grubu öğrencileri için K-S testi D (29) = .13, p = .20 ve kontrol groubu öğrencileri için , D (26) = .11, p = .20 sonuçlarnı vermiştir. P anlamlılık değeri .05 den büyük olduğu için her iki grup da normal dağılım göstermektedir.

Deney ve kontrol grubu öğrencileri arasında unite 2 sontest ve kalıcılık testleri aritmetik ortalama puanları arasında anlamlı bir farklılık olup olmadığını anlamak için, 3 (öntest, sontest, kalıcılık testi) x 2 (deney grubu ve kontrol grubu) tekrarlı ölçümler ANOVA kullanılmıştır. 3 x 2 tekrarlı ölçümler ANOVA sonuçlarına göre, kontrol ve deney gruplarının sontest ve kalıcılık testi puan ortalamaları arasında manidar bir farklılık saptanmıştır, F (1,53) = 8.40 p = .00.

Deney ve kontrol grubu öğrencileri kalıcılık testi puanları arasındaki fark bir de independent t-test kullanılarak desteklenmiştir. Aşağıdaki Tablo 5 de kalıcılık testi için independent t-test sonuçları verilmiştir.

Tablo 5

Deney ve control grubları kalıcılık testi (MBKT2) puanları için independent t-test

					Levene's Test				
Değişken	Gruplar	*N*	*Arit.Ort*	*SD*	*F*	Sig.	*t*	*df*	Sig.
MBKT2	Kontrol	26	56.54	21.90	.32	.58	-2.02	53	.048*
	Deney	29	67.76	19.21					

*$p < .05$

Tablo 5 incelendiğinde deney grubu öğrencilerinin kalıcılık testi aritmetik ortalaması kontrol grubu öğrencilerinin aritmetik ortalamasından daha fazla olduğu görülmektedir. Uygulanan independent t-test sonucunda ise bu farklılığın istatistiksel olarak anlamlı olduğu ortaya konmuştur, t (53) = - 2.05, p = .048.

Yukarda elde edilen bulgular deney grubunun kontrol grubundan daha iyi öğrendiği şeklinde yorumlanabilir. Bunun yanı sıra, deney grubundaki öğrenciler öğrendiklerini daha fazla hatırlıyorlar.

4.4 Ünite 3: " Kesirler" ile ilgili sonuçlar

Deney ve kontrol grubundaki öğrencilerin ünite 3 öntest, sontest ve kalıcılık testlerinden aldığı puanların aritmetik ortlaması aşağıdaki tabloda verilmiştir.

Tablo 6

Deney ve kontrol grubu öğrencilerinin MBÖT3, MBST3 ve MBKT3 aldığı puanlar

	MBÖT3		MBST3		MBKT3	
	Arit.Ort	*SD*	Arit.Ort	*SD*	*Art. Ort.*	*SD*
GÖ (*N* = 26)	20.39	9.58	45.77	19.63	28.85	16.76
BDÖ(N = 29)	21.72	8.79	60.00	20.83	35.45	20.30

Tablo 6'dan anlaşılacağı gibi deney grubundaki öğrencilerin sontest puanlarının artitmetik ortalamsı kontrol grubundaki öğrencilerin sontetst aritmetik ortalamasından daha fazladır. Tablo 6 den görüldüğü gibi öğrencilerin başarı testlerinden aldığı puanlar 10 ile 100 arasında değişklik göstemektedir. Kontrol grubunun MBÖT1, MBST1 ve MBKT1 aritmetik ortalamaları sırasıyla 20.39, 45.77 ve 28.85 olarak elde edilmiştir. Diğer bir taraftan deney grubundaki öğrencilerin MBÖT1, MBST1 ve MBKT1 aritmetik ortalamaları sırasıyla 21.72, 60.00 ve 35.45 olarak elde edilmiştir.

Grupların başarı test verilerine ANOVA ve bağımsız gruplar T-testİ uygulanabilmesi için bu verilerin normal dağılım sergilemesi gerekmektedir. Ayrıca çalışmaya katılan deneklerin verilerinin, normal dağılım gösterip göstermediğinin tespiti, araştırma sorularının hangi istatistiksel formülle test edileceğinin belirlenmesi açısndan da önemlidir. Bu amaçla, önce araştırmaya katılan deney ve kontrol grubuları kendi içlerinde normal dağılım gösterip göstermediği kontrol edildi. Bunu istatistik olarak ortaya koymak için Kolomogrov-Smirnov Testi kullanıldı. Test sonuçları tüm grubların unite 3 için başarı testlerinin normal dağılım sergilediğini göstermektedir. Şöyleki BMÖT1 sonuçları deney grubu öğrencileri için K-S testi D (29) = .11, p = .20 ve kontrol groubu öğrencileri için , D (26) = .11, p = .20 sonuçlarnı vermiştir. P anlamlılık değeri .05 den büyük olduğu için her iki grup da normal dağılım göstermektedir.

Deney ve kontrol grubu öğrencileri arasında sontest ve kalıcılık testleri aritmetik ortalama puanları arasında anlamlı bir farklılık olup olmadığını anlamak için, 3 (öntest, sontest, kalıcılık testi) x 2 (deney grubu ve kontrol grubu) tekrarlı ölçümler ANOVA kullanılmıştır. 3 x 2 tekrarlı ölçümler ANOVA sonuçlarına göre, kontrol ve deney gruplarının sontest ve kalıcılık testi puan ortalamaları arasında manidar bir farklılık saptanmıştır, F (1,53) = 7.16 p = .12.

Deney ve kontrol grubu öğrencileri kalıcılık testi puanları arasındaki fark bir de independent t-test kullanılarak desteklenmiştir. Aşağıdaki Tablo 7 de kalıcılık testi için independent t-test sonuçları verilmiştir.

Tablo 7

Deney ve control grubları kalıcılık testi (MBKT3) puanlarına ilişkin t-Testi sonuçları

					Levene's Test				
Değişken	Gruplar	*N*	*Arit.Ort*	*SD*	*F*	Sig.	*t*	*df*	Sig.
MBKT3	Kontrol	26	28.85	16.76	1.06	.31	-1.30	53	.20
	Deney	29	35.45	20.30					

Tablo 3 incelendiğinde deney grubu öğrencilerinin kalıcılık testi aritmetik ortalaması kontrol grubu öğrencilerinin aritmetik ortalamasından daha fazla olduğu görülmektedir. Ancak uygulanan independent t-test sonucunda ise bu farklılığın istatistiksel olarak anlamlı olmadığı ortaya konmuştur, t (53) = - 1.30, p = .20.

Yukarda elde edilen bulgular deney grubunun kontrol grubundan daha iyi öğrendiği şeklinde yorumlanabilir. Buna karşı, deney grubundaki öğrenciler ile kontrol grubu öğrencileri arasında kalıcılık testi puan ortalamaları bir farklılık göstermemiştir.

4.5 Matematik Tutum Ölçeği ile ilgili sonuçlar

Araştırmanın ikinci problem cümlesi, Frizbi Matematik 4 ile Bilgisayar Destekli Öğretim uygulaması alan deney grubu ile geleneksel yöntemlerle öğretim uygulamasını takip eden deney grubu öğrencilerinin matematiğe ilişkin tutumları arasında anlamlı bir farklılık olup olmadığını araştırmaktadır. Uygulama önesinde deney ve kontrol grupları arasında anlamlı bir farklılık olmadığı bağımsız gruplar T-testi ile ortaya konmuştur. Öğrencilerin matematik tutum ölçeğinden aldığı öntest ve sontest puan ortalamaları Tablo 8 de verilmiştir.

Tablo 8

Deney ve Kontrol grup öğrencilerinin ön-MTÖ ve son-MTÖ puanları

	ön-MTÖ	son- MTÖ
GÖ (*N* = 26)	80.85	78.19
BDÖ (*N* = 29)	80.97	86.90

Matematik Tutum Ölçeği, deney ve kontrol gruplarına çalışma öncesinde ön uygulama ve çalışma sonrasında son uygulama şeklinde olmak üzere iki kez verilmiştir. Daha sonra deney ve kontrol grubu öğrencilerinin son uygulama puanları arasında anlalı bir farklılık olup olmadığının ortaya konması için ise bağımsız gruplar T-test kullanılmıştır. Tablo 9 da son-MTÖ ne uygulanan bağımsız gruplar t-test sonuçları verilmektedir.

Tablo 9

Deney ve Kontrol gruplarındaki öğrencilerin son-MTÖ puanlarına ilişkin bağımsız gruplar t-Testi sonuçları

					Levene's Test				
Değişken	Gruplar	*N*	*M*	*SD*	*F*	Sig.	*t*	*df*	Sig.
Son-MTÖ	Kontrol	26	78.19	14.14	5.70	.02*	-2.73	40.02	.01*
	Deney	29	86.90	8.49					

Tablo 9' dan anlaşılacağı üzere tutum ölçeği son uygulama sonuçları istatistiksel anlamda deney grubu lehine bir farklılık göstermektedir, t (40.02) = - 2.73, p = .01. Öğrencilerin matematiğe ilişkin tutumları uygulanan öğretim yönteminden etkilendiği ve bu etkinin BDÖ yönünde olumlu olarak artmış olduğu söylenebilir.

4.6 Bilgisayar Destekli Öğrenme Tutum Ölçeği ile ilgili sonuçlar

Araştırmanın üçüncü problem cümlesi, Frizbi Matematik 4 ile Bilgisayar Destekli Öğretim uygulaması alan deney grubu ile geleneksel yöntemlerle öğretim uygulamasını takip eden kontrol grubu öğrencilerinin bilgisayar destekli öğrenmeye karşı tutumları arasında anlamlı bir farklılık olup olmadığını araştırmaktadır. Uygulama önesinde deney ve kontrol grupları arasında anlamlı bir farklılık olmadığı t-testi ile ortaya konmuştur. Öğrencilerin Bilgisayar Destekli Öğrenme Tutum Ölçeğinden aldığı ötest ve sontest puan ortalamaları Tablo 10 da verilmiştir.

Tablo 10

Deney ve Kontrol grup öğrencilerinin ön-BDÖTÖ ve son-BDÖTÖ puanları

	ön-BDÖTÖ	son-BDÖTÖ
GÖ (*N* = 26)	25.85	25.77
BDÖ (*N* = 29)	25.55	27.62

Bilgisayar Destekli Öğrenme Tutum Ölçeği, deney ve kontrol gruplarına calışma öncesinde ön uygulama ve çalışma sonrasında son uygulama şeklinde olmak üzere iki kez verilmiştir. Daha sonra deney ve kontrol grubu öğrencilerinin son uygulama puanları arasında anlamlı bir farklılık olup olmadığının ortaya konması için ise bağımsız gruplar t-test kullanılmıştır. Tablo 11 da son-BDÖTÖ ilişkin bağımsız gruplar t-Testi sonuçları verilmiştir.

Tablo 11

Deney ve Kontrol gruplarındaki öğrencilerin son-BDÖTÖ puanlarına ilişkin bağımsız gruplar t-Testi sonuçları

					Levene's Test				
Değişken	Gruplar	*N*	*M*	*SD*	*F*	Sig.	*t*	*df*	Sig.
son-BDÖTÖ	Kontrol	26	25.77	3.10	1.06	.31	-2.54	53	.01*
	Deney	29	27.62	2.27					

Tablo 11 den anlaşılacağı gibi tutum ölçeği son uygulama sonuçları istatistiksel anlamda deney grubu lehine bir farklılık göstermektedir, t (53) = - 2.54, p = .01. Öğrencilerin bilgisayar destekli öğrenmeye karşı tutumları uygulanan öğretim yönteminden etkilendiği ve bu etkinin BDÖ yönünde olumlu olarak arttığı söylenebilir.

5. Sonuç ve Öneriler

5.1 Sonuçlar

Bu çalışmayla 4. sınıf matematik derslerinde kullanılan Bilgisayar Destekli Öğretim ile geleneksel yöntemin öğrencilerin başarı, tutum ve kalıcılık üzerine etkisi sınanmıştır. Bu bölümde bulgulardan elde edilen sonuçlara ve bu sonuçların yorumlarına yer verilmiştir.

İlköğretim 4.sınıf matematik dersi "Doğal Sayılarda Çarpma" , " Doğal Sayılarda Bölme" ve " Kesirler" ünitelerinin öğretilmesinden öncesinde deney ve kontrol gruplarındaki öğrencilerin başarı testleri ön-test puan ortlamaları arasında manidar bir fark bulunmamıştır.

İlköğretim 4.sınıf matematik dersi "Doğal Sayılarda Çarpma" , " Doğal Sayılarda Bölme" ve " Kesirler" ünitelerinin öğretilmesinden öncesinde deney ve kontrol gruplarındaki öğrencilerin matematiğe ve bilgisayar destekli öğrenmeye karşı tutum puan ortlamaları arasında manidar bir fark bulunmamıştır.

İlköğretim 4.sınıf matematik dersi "Doğal Sayılarda Çarpma" , " Doğal Sayılarda Bölme" ve " Kesirler" ünitelerinin öğretilmesinde Frizbi Matematik 4'ü kullanarak BDÖ takip eden öğrenciler ile geleneksel öğretimi takip öğrencilerin, başarı testi son-test puan ortlamaları arasında Frizbi Matematik 4'ü kullanan öğrenciler lehine manidar fark bulunmuştur.

İlköğretim 4.sınıf matematik dersi "Doğal Sayılarda Çarpma" ve " Doğal Sayılarda Bölme" ünitelerinin öğretilmesinde Frizbi Matematik 4'ü kullanarak BDÖ takip eden öğrenciler ile geleneksel öğretimi takip eden öğrencilerin, başarı testi kalıcılık puan ortlamaları arasında Frizbi Matematik 4'ü kullanan öğrenciler lehine manidar fark bulunmuştur.

Ancak ilköğretim 4.sınıf matematik dersi "Kesirler" ünitelerinin öğretilmesinden Frizbi Matematik 4'ü kullanarak BDÖ takip eden öğrenciler ile geleneksel öğretimi kullanan öğrencilerin başarı testi kalıcılık puan ortlamaları arasında istatistiksel anlamda bir fark bulunamamıştır.

İlköğretim 4.sınıf matematik derslerinde Frizbi Matematik 4'ü kullanarak BDÖ takip eden öğrenciler ile geleneksel öğretimi kullanan öğrencilerin, matematiğe karşı tutum puan ortalamaları arasında Frizbi Matematik 4'ü kullanan öğrenciler lehine manidar fark bulunmuştur. Bu ise bilgisayar destekli matematik öğretimin, öğrencilerin matematiğe ilişkin tutumlarını olumlu yönde etkilediği şeklinde yorumlanmıştır.

İlköğretim 4.sınıf matematik derslerinde Frizbi Matematik 4'ü kullanarak BDÖ takip eden öğrenciler ile geleneksel öğretimi kullanan öğrencilerin, bilgisayar destekli öğrenmeye ilişkin tutum puan ortlamaları arasında Frizbi Matematik 4'ü kullanan öğrenciler lehine manidar fark bulunmuştur. Bu ise bilgisayar destekli öğretimin, öğrencilerin bilgisayar destekli öğrenmeye ilişkin tutumlarını olumlu olarak etkilediği şeklinde yorumlanmıştır.

Alan yazında birçok çalışma bu çalışmanın sonuçlarını destekler niteliktedir. Örneğin, Bayraktar (1988) yaptığı araştırmada, matematik öğretiminde BDÖ yönteminin uygulandığı deney grubunun, kontrol grubundan daha başarılı olduğunu göstermiştir. Sezer (1989) yaptığı araştırmada, İlkokul 5.sınıfta bilgisayarlı öğretim yapılan grubun matematik erişisi ile geleneksel öğretim yapılan grubun matematik erişisi arasında anlamlı bir fark olduğunu saptamıştır. Buna ek olarak, Kirnik (1998) yürüttüğü tez çalışmasında, BDÖ yönteminin geleneksel yönteme göre 7.sınıf matematik dersi denklemler ünitesinde daha etkili olduğunu bulmuştur. Budak (2000) yaptığı araştırmada, ön ve son test sonuçlarının Bilgisayar Destekli Matematik Öğretim materyalinin başarıyı olumlu yönde etkilediğini yorumlamıştır. Buna benzer başka bir çalışmada, Akoğlu (2003) tez araştırmasında, ön-son-test puanları, deney ve kontrol grubu öğrencilerinin son test puanları arasında anlamlı farklar bulmuştur. Ash (2005) yürüttüğü deneysel çalışma sonucunda, bilgisayar destekli eğitsel yazılımın (Orchard) ilköğretim sınıflarındaki matematik derslerinde kullanılmasının geleneksel yöneteme göre daha etkili olduğunu bulmuştur.

Bilgisayar destekli öğretimin kalıcılığa olan etkisin araştran birçok çalışma da bu çalışmaya benzer sonuçlar ortaya koymuştur. Örneğin, Ortiz (1987) yaptığı çalışmada, bilgisayar destekli öğretim gören grup ile kontrol grubunun kalıcılık test puan ortalamaları BDÖ ders işleyen grubun lehine anlamlı farklılıklar olduğunu bulmuştur. Rivet (2001) yaptığı çalışmada, ilköğretim öğrencilerinin kesirler ünitesini bilgisayar destekli matematik öğretim yöntemiyle ve geleneksel yöntemle yürütülmesini incelemiştir. Sonuçlar, deney grubundaki öğrencilerin akademik başarı, kalıcılık ve tutumlarının geleneksel yöntem kullanan öğrencilerin başarı, tutum ve kalıcılıklarına göre daha olumlu ve yüksek olduğu göstermiştir.

Furner ve Marinas (2006) yaptığı çalışmada, Geometer's Sketchpad adlı eğitsel yazılımın öğrencilerin temel geomtri becerilerinin gelişmesine yardımcı olduğu ve öğrencilerim matematiğe karşı tutumlarını olumlu yönde etkilediğini ortaya koymuşlardır.

Bilgisayarların eğitim sistemlerine katılması yıllarca tartışlan bir konu olmuştur. Bu konuda gerek Türkiye de gerkese dünyada birçok çalışmayla desteklenmiştir. İlgili alan yazında bulunan birçok çalışmada olduğu gibi bu çalışmanın sonucu da, Frizbi Matematik 4 ile Bilgisayar Destekli Öğretim yönteminin 4.sınıf matematik dersinde "Doğal Sayılarda Çarpma" , " Doğal Sayılarda Bölme" ve " Kesirler" ünitelerinin öğretilmesinde kullanılmasının öğrencilerin, akademik başarısına, bu başarının kalıcığına, ve matematiğe ve bilgisayar destekli öğrenmeye yönelik tutumuna olumlu yönde etkisi olduğu ortaya konmuştur. Bu bağlamda, Bilgisayar Destekli Öğretimin Kuzey Kıbrıs Türk Cumhuriyet'indeki matematik derslerinde geleneksel öğretimi destekleycek nitelikte kullanılması, özelde öğrencilerin başarısana, genelde ise KKTC eğitim sistemine katkı sağlayacağı düşünülmektedir.

5.2 Öneriler

Araştırmanın ortaya koyduğu veriler ve elde edilen sonuçlara göre aşağıdaki önerilerden söz edilebilir.

5.2.1 Uygulama ile ilgili öneriler

- Kuzey Kıbrıs Türk Cumhuriyeti ilköğretim okullarında matematik derslerinde Frizbi Matematik 4 gibi eğitsel yazılım programlarından faydalanılmalıdır.
- BDÖ konusunda, ilköğretim okullarında görev yapan öğretmenler hizmet içi eğitim kurslarıyla yetiştirilmelidir.
- Kuzey Kıbrıs Türk Eğitim sistemine bağlı okullarda bilgisayar ve matematik laboratuarları kurulmalıdır. Bu laboratuarlar bilgisayar yazılım ve görsel araç-gereçlerle takviye edilmelidir.
- Öğretmen yetiştiren fakülteler ile KKTC Milli Eğitim Bakanlığı işbirliği yaparak, bilgisayar destekli öğretim uygulamalarında kullanılan yazılım ve donanım takviyesi ilköğretim okullarına yapılmalıdır.
- KKTC deki ilköğretim matematik programları yeniden gözden gecirilmeli ve öğretim teknolojilerinin kullanımına imkan sağlaycak hale getirilmelidir.

5.2.1 Yapılacak Araştırmalarla ilgili öneriler

- Araştırmada, ilköğretim 4.sınıf matematik dersi “Doğal Sayılarda Çarpma” , “ Doğal Sayılarda Bölme” ve “Kesirler” ünitelerinde BDÖ’nün etkis incelenmiştir. Ayni tarz araştırmalar, KKTC eğitim sisteminde bulunan farklı sınıf düzeyleinde ve farklı dersler üzerinde yapılmalıdır.
- Bu araştırma, bir eğitim ve öğretim yılının ikinci dönemi ile sınırlı tutulmuştur. Başka ve daha uzun süreli deneysel çalışmalar yapılmalı ve sonuçlar karşılaştırılmalıdır.

- Bu araştırmada Frizbi Matematik 4 adlı eğitsel yazılım programı ile sınırlı tutulmuştur. Farklı eğitsel yazılımlar kullanılarak deneysel çalışmlara yapılmalıdır.
- Bu çalışmada öğrencilerin tutumları değişken olarak kullanılmıştır. BDÖ uygulamalarının öğrencilerin motivasyon gibi farklı değişkenlere olan etkisi incelenmelidir.
- BDÖ uygulamaları ile ilgili öğretmenlerin tutum, hazır olma durumu ve görüşlerine yönelik araştırmalar yapılmalıdır.

APPENDIX Q

CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name: Pilli, Olga
Nationality: Turkish Cypriot (KKTC)
Date and Place of Birth: 16 June 1976 , Lefkoşa, Kıbrıs
Marital Status: Married
Phone: +90 392 366 92 22
email: olga.pilli@emu.edu.tr

EDUCATION

Degree	**Institution**	**Year of Graduation**
MS	EMU Applied Mathematics and Computer Science	2000
BS	EMU Applied Mathematics and Computer Science	1998
High School	Canbulat High School, Gazimagusa	1993

WORK EXPERIENCE

Year	**Place**	**Enrollment**
2004- Present	EMU	Part-time Senior Instructor
2006-2007	NEU	Part-time Senior Instructor
2000 July	Levent Primary School	Mathematics and Computer Teacher
1998 September	EMU	Research Assistant

FOREIGN LANGUAGES

English

PUBLICATIONS

1. 7th Grade Mathematics Text Book (2006). Member of the Mathematics Commission, Turkish Republic of Northern Cyprus Ministry of National Education and Culture.
2. 6th Grade Mathematics Text Book (2005). Member of the Mathematics Commission,
Turkish Republic of Northern Cyprus Ministry of National Education and Culture.
3. What are the Major Curriculum Issues?: The Use of Mindmapping as a Brainstorming Exercise" presented in First Int. Conference on Concept Mapping A. J. Cañas, J. D. Novak, F. M. González, Eds. Pamplona, Spain 2004

HOBBIES

Cultivation of flowering plants or flowers, Dancing: Tango, Salsa, Swimming, Movies, Salon Sports