EFFECT OF COMPUTER ASSISTED INSTRUCTION ON STUDENTS' CHEMISTRY ACHIEVEMENT, ATTITUDE TOWARD CAI AND CHEMISTRY AND THEIR PERCEPTIONS ABOUT THE CAI ENVIRONMENT AT THE SECONDARY SCHOOL LEVEL

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ABSTRACT

EFFECT OF COMPUTER ASSISTED INSTRUCTION ON STUDENTS CHEMISTRY ACHIEVEMENT, ATTITUDE TOWARD CAI AND CHEMISTRY AND THEIR PERCEPTION ABOUT THE CAI ENVIRONMENT AT THE SECONDARY SCHOOL LEVEL

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The main aim of this study was to explore the effects of CAI on students' chemistry achievement, attitude towards CAI and chemistry as a subject matter, and their perceptions about the difference between the CAI and regular classroom environments.

The second aim was to asses the effect of gender on the dependent variables of the study.

Another purpose of the study was to investigate the extent of correlation between the chemistry achievement of students and other three dependent variables such as students' attitudes towards CAI and chemistry as a subject matter and their perceptions about the CAI environment.

The subjects of the study were 101 students from the Ankara Gazi Anadolu High School at 8^{th} grade. The study was conducted in the fall semester in 1991.

In the study Pre-Post Test Control Group Design was used. Two classes were identified as experimental and control groups and they were instructed by the same teacher. These two classes have been judged as equalivant on the basis of their prior math and chemistry scores obtained from the first and second midterms that had been given by their teacher. Analysis of t-test run before the treatment indicated the equality of groups in terms of their chemistry achievement test, chemistry and CAI attitude scales, and perception about CAI environments scale. 51 students were exposed to CAI as a supplement to their traditional instruction. The software used in study was developed by the researchers at M.E.T.U, and was a tutorial pluss drill and practice type of instruction. The other group containing 50 students received supplementary problem solving hours (recitation).

The data were collected by the four measurement instruments employed in the study; 1) Chemistry Achievement Test 2) Chemistry Attitude Scale 3) CAI Attitude Scale and 4) Scale for the Perceptions of Students on CAI Environments.

Two-Way Analysis of Variance and Correlation Analysis statistical techniques were used for testing hypotheses of the study. The results of the present study indicated that students exposed to CAI inhabited significantly higher achievement in chemistry and showed greater attitudes toward chemistry and CAI. There was no

significant difference between the two groups in regard to perceptions of students about the difference between CAI and regular classroom environments. Gender had no significant effect on the dependent variables. The analysis of the test results indicated that there was no significant correlation between the chemistry achievement and attitude toward chemistry. There was a significant correlation between chemistry achievement and CAI attitudes, whereas the correlation between chemistry achievement and perceptions about the CAI environments was not significant. Moreover, there was a significant correlation between the CAI attitudes of students and their perceptions about the CAI environments.

In the light of the present study, we might conclude that CAI has significant and positive effects on the students outcomes. This study is expected to help other experimental investigations in related fields.

Keywords: Computer Assisted Instruction (CAI), Computer Aided Instruction (CAI), Computers in Education, Attitudes Toward Computer Aided Instruction, Perceptions on CAI Environments, Traditional Instruction Accompanied with CAI, Traditional Instruction Accompanied with Problem Solving Hours (Recitation).

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ÖZ

BİLGİSAYAR DESTEKLİ ÖĞRETİMİN ÖĞRENCİLERİN KİMYA BAŞARISI, KİMYA DERSİ VE BİLGİSAYAR DESTEKLİ ÖĞRETİME OLAN TUTUMLARI VE BDÖ ORTAMLARINI ALGILAMALARI ÜZERİNDEKİ ETKİSİ

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Bu araştırmanın başlıca amacı Bilgisayar Destekli Öğretim'in orta okul öğrencilerinin kimya başarısı, kimya dersi ve BDÖ'ye olan tutumları ve BDÖ ortamlarını algılayışlarını incelemektir. Ikinci amaç cinsiyet farklılığının bağımlı değişkenler üzerindeki etkisini görmektir. Çalışmanın diğer bir amacı ise kimya başarısı ile diğer üç bağımlı değişken olan kimya tutumu, BDÖ tutumu ve BDÖ ortamları anlayışı arasındaki ilişkiyi irdelemektir.

Araştırmanın örneklemini 1992 Güz döneminde Ankara Gazi Anadolu Lise'sinin 101 orta üçüncü sınıf öğrencisi oluşturmuştur. Bu araştırmada ön ve son test kontrol grup araştırma taslağı kullanılmıştır. 51 öğrenci deney, 50 öğrenci ise kontrol grubunda yer almış, her iki grup aynı öğretmen tarafından eğitilmiştir. Sınıflar öğrencilerin dönem başlarındaki kimya ve matematik derslerinden aldıkları notların eşitliği üzerine seçilmiş, ön test

sonuçlarında da gruplar arasında farklılık olmadığı gözlenmiştir.

Gruplara iki ayrı öğretim metodu uygulanmış; deneysel gruba geleneksel kimya öğrenimine destek olarak BDÖ verilirken kontrol grubuna ders süreleri dışında BDÖ grubunda görülen problemlere parelel problem çözme saatleri belirlenmiştir.

Deneysel grup için araştırmacılar tarafından O.D.T.Ü' de IBM firmasının Linkway yazarlık sistemi ile geliştirilmiş olan "CONCEPT" programı kullanılmıştır.

Araştırmada gerekli olan veriler başlıca 1) Kimya Başarı Testi 2) Kimya Tutum ölçeği, 3) BDÖ tutum ölçeği ve 4) BDÖ ortamlarını anlayış ölçeği olarak dört ölçek üzerinden toplanmıştır.

Araştırmanın hipotezlerini test edebilmek amacı ile F-test ve korrelasyon Analizleri uygulanmış, bu analizler sonucunda BDE grubundaki öğrencilerin kimya testinde diğer gruba göre anlamlı bir başarı gösterdiği, kimya ve BDÖ'ye karşı olan tutumlarında da diğer gruba göre olumlu ve anlamlı bir fark olduğu gözlenmiştir.

Analiz sonuçları cinsiyet farkının bağımlı değişkenler üzerinde bir etkisi olmadığını göstermiştir. Ayrıca korrelasyon analizi sonuçları kimya başarısı ve BDÖ tutumu arasında ve BDÖ tutumu ile BDÖ ortamının algılanışı arasında anlamlı bir ilişki olduğunu göstermiştir.

Bu araştırmanın ışığında Bilgisayar Destekli Öğretimin öğrencilerin kimya başarısı, BDÖ ve kimya

dersine olan tutumları üzerinde olumlu bir etkisi olduğu sonucuna varılabilir.

Anahtar Kelimeler: Bilgisayar Destekli Öğretim (BDÖ), Bilgisayar Destekli Eğitim (BDE), Eğitimde Bilgisayar kullanımı, BDÖ'e karşı tutum, kimyaya karşı tutum, BDÖ ortamlarını algılama.

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LIST OF SYMBOLS

CAI	:	Computer Aided Instruction
CAT	:	Chemistry Achievement Test
CAS	:	Chemistry Attitude Test
ASTCAI	:	Attitude Scale Toward Computer Assisted Instruction
CAIES	:	Computer Assisted Instruction Environment Scale
α;	:	Level of significance of a test
p	:	Probability
N	:	Sample Size
$\bar{x}$	:	Mean Score
d.f	:	Degrees of Freedom
s.d	:	Standart Deviation
t	:	Students' t value

CHAPTER I

INTRODUCTION

Presently, the world is rapidly changing from the industrial to information society. The computer is the tool we have designed to extend our limited human capacities, and information technology (IT) or informatics is the name given to the science or the art of processing information by machine. This change is also reflected in education by requiring it to change from top to bottom to become accompanied with the changes in IT and new methods of techniques of instruction.

Computers are engaged in almost all levels and areas of education especially during the last two decades. Educators like everyone else have a vision of using these machines for making their jobs easier and improving their product: educated children (Wiebe, 1983).

Not long ago, computers did not feature in the school curriculum, either as a topic of study or as an aid to learning. Their rapid introduction over recent years has been a piecemeal affair, and different schools, different school systems, different subject areas, and different teachers are at vastly different stages in their use of computers. One result of this is that computers have frequently been added to the existing curriculum in such a way that they seem to be an optional extra, or a departure from normal educational practice. Eventually, however, all schools and teachers will have to revise their curricula so as to integrate computer use as part of the educational activity (Woodhouse and Jones, 1988). On the other hand, the production of teaching programs must be put on to a formal and regular basis which will ensure that programs are available at the required time and are produced to agreed standards of quality and usability (Howes and Williams, 1986).

Although, microcomputer technology has been a part of our educational environment since the early 1980's, successful incorporation of this technology into the teaching process has been somewhat sporadic. A number of reasons to explain this, includes: lack of suitable hardware; lack of relevant and/or quality software; inadequate teacher training, and insufficient teacher time to design the changes in curriculum and modes of presentation required.

It appears to be a common idea that with appropriate courseware computers could widen the learning environment, extend the range of messages, provide immediate clues, feedback, and corrections necessary for learning. In the world of education, the computer appears not as a substitute for the teacher but instead as an assistant taking over routine chores expected of the teacher. Computers will never replace teachers, but they will certainly help teachers and learners take advantage of the many ways learning can take place. Use of computers frees learners to learn, trainers to train and teachers to teach. The act of using a computer as part of a teaching process encourages a certain distance and abstraction which can be most useful for all those involved in learning.

There are four roles played by microcomputers in schools: the computer as an object, the computer as a tool, the computer as a teacher, and the computer as a management aid. These roles are classified as models such as computer assisted instruction (CAI) and computer managed instruction (CMI).

1. Computer assisted Instruction (CAI) refers to the use of computers for instructional tasks. CAI is the use of computers to provide course content instruction in the form of drill and practice, tutorials, and simulations. These three categories-drill and practice, tutorials and simulations- make up what has become known in the United States as computer-assisted instruction (CAI), computer-based instruction (CBI), or computer based education. In Europe and elsewhere, these activities are usually referred to as computer-assisted learning (CAL).

2. Computer-managed instruction (CMI) refers to the use of computer as an educational management tool. CMI utilizes the computer to organize the learner's

progress through a variety of instructional methods: print materials, audio and video tape materials, lectures, tests and perhaps even CAL.

Other terms also appear such as computer-based training (CBT). Many users of this term work for large firms or various branches of the military. The learners in CBT environments tend to be paid employees and there is a far greater emphasis on efficient mastery of objectives and on comparisons of costs with traditional methods. (Chamber and Sprecher, 1983)

The CAI methods of instruction are:

- Drill and practice
- Tutorial (Dialogues)
- Simulation
- Games
- Testing
- Problem solving
- Discovery learning

DRILL AND PRACTICE

Drill and practice is a common CAI method in which a type of repetitive approach emphasizes rote memory. This strategy advances the acquisition of knowledge or skills through repetitive practice. Drill and practice exercises are designed to reinforce the regular classroom. Thus usually no new material is given. They are well suited for use with skill subjects such as math and spelling. The computer acts as a patient teacher that gives immediate feedback. Well-designed programs can free the teacher from preparing and correcting numerous drill exercises, allowing more time for other projects.

TUTORIALS

Tutorials use the computer in a high level of mode in which question and answer, dialogue type of learning is emphasized. Like drill and practice, it is used extensively at all educational levels. Unlike a drill program, new material (subjects not yet covered in the class) may also be present in a tutorial. This approach tries to emulate a dialogue between a teacher and a student. Therefore the computer holds the information that the student must learn through some type of interaction. A good tutorial can be an excellent teaching or reteaching device. A tutorial design can be linear or branched;

1. Linear design presents material the same way to all users.
2. Branched design directs the students to particular lessons based on responses to tests or questions embedded within the material.

An important advantage of tutorials is that since students respond to every query, a student can use a tutorial to catch up on missed material, and the teacher gains extra time for personal interaction. Skinner's (1988) illustration of how to develop a programmed learning sequence is directly applicable to the design of CAI tutorial modules, as follows:

1. Obtain a clear, detailed objective specification of what it means to know the given subject matter.
2. Write a series of information, question, and answer frames that expose students to the material in graded steps of increasing difficulty, and that frequently retest the same facts from many different angles.
3. Require the learner to be active, i.e., require a response for each frame.
4. Provide immediate feedback for each answer (response).
5. Try to arrange the material and questions in such a manner that the correct response is likely to occur so avoids the learning by punishing failures.
6. Provide students to proceed at their own pace.
7. Provide a variety of backup reinforcement.

SIMULATION

Simulations provide a model in which the student plays a role and interacts with the computer. Simulations have been used most often in higher education to model scientific processes. Computerized simulations present life-like situations and allow students to learn through experience without the risk of real life. Using simulations is also appropriate when the real experience is too costly or awkward. They are applicable to any field but are mainly helpful in illustrating concepts, in helping students to develop problem solving techniques, or in allowing students to explore complex interactions.

GAMES

A game is a goal oriented activity that can be completed successfully by the skillful application of a set of rules. Instructional games are those whose content and process closely relate to some instructional objective or benefit, such as word or vocabulary games. Computerized games are one of the most effective techniques if the teacher has an objective and the package evaluated carefully.

TESTING

Testing in a computer assisted system for evaluating the performance has the following cycle:

- test construction
- test delivery
- grading and analysis
- item analysis
- item storage for feedback in the next test

PROBLEM SOLVING

In many disciplines the main instructional objective is the development of student's ability to formulate and solve problems. Problem solving includes selective and sustained attention, cognitive style, memory and motivation. It has been suggested that computers may help overcome the misconceptions. It is important for teachers to recognize that the steps in information processing are complex and interrelated, and that difficulty at any step will influence the student's performance.

DISCOVERY LEARNING

The main strategy in discovery learning is to provide the student with tools for exploring, analyzing, and mastering new concepts and principles in a structured way.

Computer-assisted instruction (CAI) is a relatively new field in which the pioneer efforts occurred around 1960 following the introduction of computers into the higher education. A number of CAI projects have been conducted since then and their results have implications for the future use of CAI as a classroom tool.

CAI in TURKEY

Starting in 1984, Turkey has made considerable progress in introducing computers into Secondary Education. An estimate of 20000 microcomputers are now available in our schools, and the trend to get more computers is growing exponentionally. Unfortunately, during the acquisition of the hardware, the basic problem of integration of the new technology with the existing educational system has been overlooked. Of utmost importance are the issues of appropriate courseware to run on the computers, and teacher training. Almost no progress has been made on these problems. The available courseware, mostly prepared by the same companies who sold the hardware, have very little educational value. Presently, there is an overwhelming need for good-quality courseware, and an equally important need for the field-testing of the programs in their effectiveness on the learning process.

In this work, we have developed a Chemistry package conforming to the ongoing Secondary School curriculum. The computer program, prepared with IBM's Linkway authoring system, is a tutorial on the mole concept. It was intended to be supplementary to the traditional classroom instruction rather than replacing them. The courseware was tested on 51 eight grade students from Gazi Anadolu High School during the 1991-1992 school year. The major goals of the study were to asses the effect of CAI on:

a) students' chemistry achievement; b) their attitudes toward chemistry as a subject; c) their attitudes toward CAI; and d) their perceptions about the CAI environments.

In the design of the study, controlled and other variables are included in order to study the differences in the attributes of the treatment methods. The independent variables were gender and CAI, whereas chemistry achievement, chemistry attitude, CAI attitude, and perceptions of students on CAI constituted the dependent variables.

CHAPTER II

REVIEW OF LITERATURE

The widespread expectation that computers can be integrated to the educational system to help in improving the learning-teaching process has led to numerous research studies attempting to determine the effectiveness of the new environment.

Ronald (1987) emphasized the fact that extensive research and planning is required to plan and guide the educational system in its transitions to the new technology.

Computer assisted instruction has been more prevalent in higher education settings. It has been successfully used to teach a large variety of college courses. Examples include mathematics education (Grandgenett 1991), physics , (Boardman and Cooper, 1988) statistics (Benjamin, 1990), biomechanics (Boysen and Francis, 1982), hypothesis testing (Swartz, 1983), chemistry (Cavin, Cavin and Lagowski, 1981), physics education (Milkent and Roth, 1989), textiles (Kean and Laughlin, 1981), language arts (Penisten, 1981) and Language learning (Swann, 1992).

In the synthesis of their research findings, Norris & Poirot (1986) concluded that computer instruction has been demonstrated to be effective at all levels of education; elementary, secondary, university, and adult continuing education.

In the studies of Castleberry, Culp and Lagowski (1973), CAI is used in chemistry education, and shown to enhance the achievement. Summerline and Marjorie (1973), however, reported a study using randomized samples in which the control group (traditional instruction) scored significantly higher on both immediate and delayed posttests on chemistry achievement than did the CAI group.

Willet, Yamashita and Anderson (1983), found a gain on achievement score measures as a result of the use of CAI in science education. Wise and Okey (1983) found that the students using personal computers enjoyed significantly higher score averages, improved performance, and positive attitudes toward the use of computers in their coursework.

Several investigators suggested that computers may provide their greatest potential for the disadvantaged students those of low ability, and the concrete operational students (Kulik, Bangert and Williams, 1980; Cavin & Lagowski, 1978).

Cavin and Lagowski (1981) concluded that there was a significant interaction between treatment and gender on students attitudes toward computers. They also found that there was no significant difference between the mean scores of CAI and nonCAI groups on chemistry attitude test.

Canada and Brusca (1990) found that among middle school students, actual experience with computers interacted with gender to influence attitudes of student's toward the technology. They stated that experience with computers strengthened the beliefs of males in a technological gap whereas it weakened females' perceptions of such a gap.

Evidence from some sources indicates that female students are not getting as much computer experience as male students.

According to Canada and Brusca (1990), the 1977 National Assessment of Educational Progress found that girls in a national sample of 13-17 years old had less access to computers and lower levels of computer skills than the boys. They claimed that males tend to dominate computer rooms and computer resources compared to female students.

However, Badagliacco (1990) found that when the variance associated with actual computer experience was controlled, the gender gap in computer related attitudes and self-perceptions disappeared. Similarly, Arch and Cummins (1989) observed that when students were introduced to computers through structured in-class lessons and assignments, gender differences in students' computer-related attitudes and behaviors were not significant.

There is ample evidence from applications of CAI in higher education that the expense of CAI must be determined within the context of the educational setting in which it is to be used. Factors such as cost of the system hardware, software development, frequency of student use should all be included as part of any cost estimate (Kearsly, 1977; Spunk 1981). Considerations should also be given to variables such as the decreasing student learning time required under CAI conditions (Kulik et al., 1980); decreasing hardware and software costs (Hofstetter, 1983); frequency of use (Spunk 1981); subject matter durability (Spunk 1981), and student gains in computer literacy and familiarity (Kearsley,1977).

As stressed by Sidman (1980) and Johnston and Pennypacker (1980) behavior is a continuous phenomenon taking place through the time. The dynamic measures of the achievement taken over the course of the present project are sensitive to this dynamic nature of behavior.

Principles of the systematic design of instruction suggest that designers must clarify their instructional goals and requirements before considering the organization, strategy and delivery mechanisms for meeting these requirements and goals. Jonassen (1985) has proposed that " rather than creating problems to which we can apply our most popular interactive technology we need to develop design processes which identify the required components of interactive, adaptive instruction.

The characteristics of the software that will be implemented during the course in this project are mainly relied on such educational findings such as the one constructed by Ausebell (1960). Similarly, Kearsley and Frost (1985) list several factors which help produce a high level of student participation and involvement. These include the kind of the user control provided, and the instructional strategy used. The more control the learners feel the more involved they will be in the instruction.

On the base of Piaget's (1952) theories, Kinzie (1980) indicated that individuals want to feel personally effective in dealing with their environment. Researchers and theorists such as Merril (1980) also conclude that learners need to be given control over the instructional flow.

Results of two studies with high-school students and computer assisted science instruction indicate that students want to exercise more learner control over the program, and this exercise leads to more positive attitudes toward the instruction (Kinzie & Sullivan, 1989).

It should be noted, however, that complete learner control is beneficial for students of higher rather than lower ability as concluded by Snow, (1980).

Likewise, if the student is inexperienced in the use of learner control, its effects can be negatively influenced (Gray, 1987).

Weller (1988) has stressed that the quality of the interaction in a program can be assessed in terms of the type of input required from the learner during the interaction, the method of analyzing the response, and the action taken by the program after the input. Weller maintains that the quality of the interaction in the design of the program is the important determinant of the quality of the instructional program produced. He claimed that interactivity which enables learners to adjust the interaction to conform to their needs and capabilities includes some main aspects such as amount of interaction that occurs per unit time during the program, quality of the interactions, degree of learner control, evaluation of the learners response and the consequent feedback from the program.

Learning is an active process. Learners necessarily process information actively in order to comprehend and remember it (Ausebell, 1960).

From the software design point of view, all forms of interactivity are based upon branching (Kearsley and Frost, 1985). Branching to other parts of the program occurs when the student selects an option.

Motivation reflects an individuals willingness to learn (Maehr, 1976). Kinzie (1990) stated that students display continuing motivation when they return to a learning activity without an external pressure.

While many variables influence the success of CAI, it is safe to assume that the type of CAI used as well as the subject matter of investigation will affect the outcomes of CAI research (Bear, 1984, Dence, 1980).

Wainwright (1989) evaluated the attributes of a microcomputer courseware package that was used as a supplement to traditional instruction in general chemistry classes in a high school. The study was designed to answer questions such as; 1) In supplementing traditional instruction on selected chemistry topics, do the attributes of the microcomputer materials contribute to effective learning as measured by an achievement test?; and, 2) Among chemistry students of differing levels of cognitive development, is CAI an effective supplement to traditional instruction? Four general chemistry classes in a suburban high school were randomly assigned to experimental and control groups. In the study, the experimental group used the software, while the control group used traditional worksheets for a three- week of period on Chemical Formulas and Equations. Regular classroom routine was continued as much as possible since the study was designed to conduct research on instructional materials within the normal school environment. The Posttest-Only Group Design was selected to determine the effectiveness of the two different instructional techniques, and all students took a multiple-choice achievement test following the completion of the study. The two-way analysis of variance on Achievement test scores with the independent variables being treatment and time of study indicated that the use of microcomputer materials by the experimental group clearly did not contribute to more effective learning. Scores of the students in the control group was significantly higher on the achievement score. According to same analysis, the period of the day was also a significant factor. Wainwright's work is quite similar to the one undertaken in the present study. His discouraging results should be viewed with caution, however. As pointed out before, attributes of the courseware used in CAI are critical for its success.

Spain and Allen (1990) concluded that computerized instruction can offer an effective alternative to freshman chemistry recitation. He stated that the growing shortage of chemistry faculty and the existence of inexperienced graduate teaching assistants are making it difficult to maintain the quality of the freshman chemistry recitations. In this study at Clemson University, the use of computers was a required part of the chemistry course. The Chemistry center had 40 computers to handle over 100 students, and was open approximately 64 hours each week. During this time there were two assistants to answer questions and provide logistic support. In the study, it was discovered that there was a big difference between using CAI as an optional enrichment activity and making it a required component of the course. The results of student evaluations on the effectiveness of the Computer Assisted Instruction in freshman chemistry recitations showed a strong pattern of student support. Of the 370 questioners, over 94% stated that the center was providing a useful service, about 77% found the learning center helpful in answering their questions, about 95% thought that the programs were suitable to the material being covered in class and on exams, and 89% believed that the computer programs had significantly helped their understanding of chemistry. Also, Spain and Allen (1990) indicated a strong positive correlation between completing computer programs and the success in the course.

Geban (1990) concluded that investigative oriented chemistry laboratory accompanied with lecture (Instructional Treatment 1) and the computer simulated chemistry experiments accompanied with lecture (Instructional Treatment 2) produced significantly greater achievement in chemistry and science process skills than the conventional chemistry laboratory accompanied with lecture (Instructional Treatment 3). The subjects of his study included 200 Lycee-1 students. He stated that Instructional Treatment 2 produced significantly greater attitude toward chemistry than the other two methods. The results of analysis of his study also indicated that Instructional Treatment 1 produced significantly greater attitude toward chemistry than Instructional Treatment 3.

Milkent and Roth, (1989) investigated the effects of interactive computer-generated homework on student achievement. In the study, one section taking Physical Science I received homework via the computer, while another section received printed, equivalent homework assignments. Homework assignments were the requirements of the course, and they constituted 40% of the final course grade. Students in the computer group were allowed to study on a given homework as much as they wished, and their highest score was counted for a grade. The questions in the program were randomly generated to prevent the memorization by the students. The second section of the course was taught by the same instructor, and the students received printed homework sheets that were randomly generated by the computer program. The study was done using a pretest-posttest nonequivalent control group design with American College Test Composite Scores (ACT), grade-point averages (GPA), ACT combined science and mathematics scores (ACTSM) and pretest scores as available covariates. The results indicated that the use of computer-generated homework significantly reduced the effectiveness of ACT scores as predictor of course achievement. In the control group, ACTSM scores were a better predictor of the posttest scores than they were of pretest scores. Milkent and Roth also stated that the correlation coefficient between mathematics aptitude scores and posttest achievement scores was significantly lower for students in the experimental group than for the other group.

Skinner, (1988) conducted a study to determine the attitudes of college students toward working with CAI in a personalized instruction course. In the study, 36 undergraduate students participated in a behavior management course in education. During the course, application of behavioral principles and technologies to individuals, small classes and groups are focused on with emphasis on classroom management, increasing student opportunity to respond, providing feedback and evaluation of learning. In the study, three instructional conditions are used; TEXT-CAI-GUIDED, TEXT-CAI-SOLO and TEXT-ONLY on a total nine of units. TEXT-CAI-GUIDED units required students to 1) read the material in the text, 2) complete all objectives in the tutorial, 3) respond correctly to at least 70% of the questions contained in the unit tutorial, and 4) take a quiz over the unit material. The students successfully completing the unit tutorial could use the tutorial under SOLO conditions. In the TEXT-SOLO conditions, students were required to 1) read the material in the text, 2) complete CAI tutorials only for objectives on which they asked for additional assistance, and 3) take a quiz over the unit material. The TEXT-ONLY condition required students to read only the textual materials, and take a unit quiz. Two forms were developed for the evaluation of student attitudes toward CAI instruction. Student responses to these forms indicated overwhelmingly positive ratings of the instructional effectiveness and appropriateness of CAI.

Sasser (1990) conducted a study to investigate the differences between the mathematics achievement of students who received computer tutorials as homework assignments, and another group of students taking textbook exercises as homework assignments. In the study, the independent variable was the treatment which was computer tutorials as homework software in the experimental group, and textbook exercises in the control group. Subjects of the study were 92 students at Marshall University in two mathematics courses for elementary education majors. Homework assignments were given previously to both groups contained drill in materials that were previously covered in the class. The computer software that was used in the experimental group consisted of a series of nine algebra tutorial programs, and was chosen since it completely covered the specific algebra topics taught in the courses and found in the textbook. For the study, a pre-post test control group design was used. The instrument used to measure the students' achievements was the same for the pre- and post-tests, and was constructed by utilizing randomly generated questions from the computer programs. For the analysis of the results of the study, the t-test was employed. The results indicated that students receiving computer tutorials as homework assignments were more successful than those receiving the traditional textbook exercises as homework.

McCoy (1991) compared the geometry achievement of a class which used the computer software "Geometric Supposers" during one school year and another class which did not use the software. The program is a geometry tool that expected to promote problem solving skills in geometry by using inductive reasoning. Subjects of the study were two high school geometry classes from two similar high schools. The measurement tools of the study was Houghton-Miflin Modern Geometry Test (HMMGT). In order to measure higher level thinking skills, three subtest scores were obtained from the HMMGT by the classification according to Bloom's Taxonomy (Bloom,1979). Results of the analysis showed that the computer group's scores were significantly higher on the final achievement test (HMMGT) than the control group that did not receive the treatment. Further analyses indicated that a difference in post-test scores only at the application level and in higher-order questions. There was no difference in the scores of Knowledge and Comprehension questions.

Aşkar et.al. (1991) measured students' attitudes towards CAI and their perceptions of the difference between CAI environment and conventional classroom for a group of 137 fifth graders. They concluded that students showed positive attitudes towards learning from computers. Also they found that perceptions of the students were in favor of the computer assisted instruction. Results of their study indicated a high positive relationship between the perceptions of CAI environment and attitudes towards CAI. They found that gender had no significant effect on the attitudes of students towards CAI and their perceptions about CAI environment.

Köksal (1988) studied the effect of CAI on college students' mathematics achievement, attitude toward computers and mathematics as a subject matter. In his study two groups were exposed to two different treatments that were CAI and traditional instruction. The results of the analysis of t-test showed that students who were exposed to CAI achieved significantly higher mean scores on mathematics achievement test than the students who were exposed to traditional instruction. Also, there were no differences between the mean scores of students in terms of their attitudes towards computers and mathematics.

CHAPTER III

PROBLEMS AND HYPOTHESES

3.1 The Main Problem and Sub-Problems:

This chapter presents the problems and hypotheses of the study. The objective is to asses the effectiveness of CAI over problem-solving sessions (recitation hours), when both teaching methods are used as a supplement to the traditional chemistry instruction.

3.1.1 The Main Problem

The Main Problem of the study is:

What is the effect of computer assisted instruction used as a supplement to traditional classroom instruction on students' chemistry achievement, and attitudes toward chemistry, computer aided instruction and perceptions on computer aided instruction environments.

3.1.2 The Sub- Problems:

When used as a supplement to traditional chemistry instruction,

1. Is there any significant difference among the effects of CAI and traditional problem solving hours on the students' chemistry achievement?
2. Is there any significant difference among the

effects of CAI and traditional problem solving hours on students' chemistry attitudes ?

3. Is there any significant difference between the effects of CAI and traditional problem solving hours on students' attitudes toward computer assisted instruction?

4. Is there any significant difference between the effects of computer assisted instruction and additional problem solving hours on students' perception about the difference between CAI environments and regular classroom environments ?

5. What is the effect of gender on the chemistry achievement of students ?

6. What is the effect of gender on the attitudes of students toward chemistry ?

7. What is the effect of gender on the attitudes of students toward computer assisted instruction ?

8. What is the effect of gender on the perceptions of students toward CAI environments ?

9. Is there any significant effect of the interaction between treatment and gender on the chemistry achievement of students ?

10. Is there any significant effect of the interaction between treatment and gender on the attitudes of students toward chemistry ?

11. Is there any significant effect of the interaction between treatment and gender on the attitudes of

students toward computer assisted instructions?

12. Is there any significant effect of the interaction between treatment and gender on the perceptions of students toward computer assisted instruction environment?

13. Is there any significant relationship between achievement in chemistry and attitude toward chemistry after receiving computer assisted instruction ?

14. After taking the computer assisted instruction, is there any relationship between the students achievement in chemistry and their attitudes toward computer assisted instructions ?

15. After taking the computer assisted instruction, is there any relationship between the students achievement in chemistry and their perceptions toward computer assisted instruction?

16. After taking computer assisted instructions, is there any relationship between the students attitudes toward computer assisted instruction and their perceptions about the difference of computer assisted instruction environment from normal classroom environment?

3.2 Hypotheses

This study is an empirical design that was developed in order to investigate the following hypotheses which are stated in their null form at a significant level of 0.05:

1. With respect to chemistry achievement test scores, there will be no significant difference between the mean score of students taught by CAI and that of other students receiving additional problem solving hours (recitation).

2. With respect to chemistry attitude scale scores, there will be no significant difference between the mean score of students taught by CAI and that of other students receiving additional problem solving hours.

3. With respect to CAI attitude scale scores, there will be no significant difference between the mean score of students taught by CAI and that of the students taught by traditional instruction.

4. With respect to CAI environment (CAIES) scale scores, there will be no significant difference between the mean score of students taught by CAI and that of the students taught by traditional instruction.

5. There will be no statistically significant difference between the chemistry achievement mean scores of female and male students.

6. There will be no statistically significant difference between the chemistry attitude mean scores of female and male students.

7. There will be no statistically significant difference between the computer aided instruction

attitude mean scores of female and male students .

8. There will be no statistically significant difference between the computer aided instruction environment scale mean scores of female and male students with respect to CAIES test scores.

9. There will be no statistically significant interaction between the treatment (CAI) and gender with respect to chemistry achievement test scores.

10. There will be no statistically significant interaction between the treatment (CAI) and gender with respect to chemistry attitude scale scores.

11. There will be no statistically significant interaction between the treatment (CAI) and gender with respect to CAI attitude scale scores.

12. There will be no statistically significant interaction between the treatment (CAI) and gender with respect to computer assisted instruction environment scale scores.

13. There will be no significant correlation between chemistry achievement test scores and chemistry attitude scale scores of students that taught by CAI as a supplement to traditional chemistry instruction.

14. There will be no significant correlation between chemistry achievement test scores and computer aided instruction attitude scale scores of students taught by CAI as a supplement to traditional chemistry instruction.

15. There will be no significant correlation between chemistry achievement test scores and computer aided instruction environment scale test scores of students taught by CAI as a supplement to traditional chemistry instruction.

16. There will be no significant correlation between computer assisted instruction attitude scale scores and scores testing perceptions of students about the difference of CAI environment from normal classroom environments.

CHAPTER IV

DESIGN OF THE STUDY

This chapter presents the experimental design, subjects of the study, variables, selection and development of measuring tools, descriptions of the treatments and limitations and assumptions of the study.

4.1 The Experimental Design

As indicated earlier, the main aim of this study is to explore the effects of Computer Assisted Instruction on students' chemistry achievement, their attitudes toward chemistry and computer assisted instruction and perceptions about the difference between Computer Assisted Instruction and regular classroom environment.

For practical reasons, the CAI package which will be described below is planned to be used as a supplementary aid to the regular lectures, and not as a replacement for them. Thus students in the experimental group will use the courseware only after the school hours to reinforce what they learn in the lecture.This group may also continue studying at home from their textbooks, as well. The students in the traditional (control) group, on the other hand, have only their textbooks to study from. There appears to be a bias in favor of the experimental group because of the regularity of the CAI sessions received by this group. In order to balance the learning conditions of the two groups, it was decided to reinforce the traditional group by means of extra problem solving hours given after school and with equal duration as the CAI sessions. Effectively then, the present work investigates the utility of CAI methods over recitation hours in enhancing chemistry achievement.

In order to determine the effectiveness of the two different instructional methods, the Randomized Pre and Post-Test Design (Cambell and Stanley, 1973) was selected.

	Pre-Test	Treatment	Post-Test
EG	T_1, T_2, T_3, T_4	L+CAI	T_1, T_2, T_3, T_4
CG	T_1, T_2, T_3, T_4	L+PSH	T_1, T_2, T_3, T_4

Here EG represents the Experimental Group utilizing the specially prepared microcomputer courseware package as a supplement to lectures in traditional instruction (L+CAI), and CG denotes the Control Group taking the same lectures as the experimental group, and additionally supported with problem solving hours (L+PSH). T_1 is the Chemistry Achievement Test (CAT), T_2 is the Chemistry Attitude Scale (CAS), T_3 is the Attitude Scale Toward Computer Assisted Instruction (ASTCAI) and T_4 is the Computer Assisted Instruction Environment Scale (CAIES) Appendix B.

4.2 Description of the Courseware

A special computer program, called CONCEPT, was developed by Prof. İlker Özkan and the researcher to be used in the CAI part of this study. The topics included were all related to the mole concept, which is a regular part of eighth grade chemistry curriculum covered within the first two months of the school year. Since it was anticipated that the application would be carried out in a school with English as the medium of instruction, the courseware was prepared in English. The fundamental concept of mole, Avogadro's number, and related notions about chemical formulae, atomic weight, formula weight, and molecular weight were treated in detail. The program provided a learning environment to the students where they could study all possible mole/number/mass interrelations in reference to elements and compounds. The more then 40 subcategories of course material included in the program are summarized in the User's Guide given in Appendix C.

The courseware was prepared utilizing IBM's Linkway Authoring System. Several typical computer screens during the execution of the program are shown in Figs. 1-4 in Appendix A.1. During the design of the courseware, research findings about CAI were used as much as possible. Proper attention was paid to the issues of learner control, interactivity, and flexibility. Some of the important features of the program are:

- In order to allow learners with varying cognitive skills to "learn at their own rate", a very desirable feature of any CAI material, learner control and branching is provided. Nevertheless, a carefully designed linear route is also built into the program so that any student who prefers the instruction scheduled by the computer can proceed simply by pressing the NEXT and BACK buttons.

- Every effort is made to include into the program everything that a student might need during a CAI session. Context sensitive definitions and rules, data needed in solving exercises, problem specific hints, and a calculator can be accessed at any time by means of pop up windows.

- Interaction with the program makes use of both the keyboard and a mouse, thus making the use of the program extremely fast and easy.

- In any given subtopic included in the program, any number of examples, exercises and their solutions may be studied. Indeed, through the use of the random number generator, examples and questions are dynamically generated within the program. The probability of encountering the same example or question is thus made extremely small.

- A repertoire of feedback messages for both the correct and the incorrect answers is kept.

- Random numbers are also used in the construction of chemical compounds. Formulae of compounds (including both organic and inorganic) are created dynamically, thus presenting an enormous number of (realistic) chemical compounds for the student to study.

- Exercises can be printed on paper for later study at home.

4.3 The subjects of the Study

The subjects of the present study consisted of 101 students at eighth grade from two chemistry classes in an urban high school (Ankara Gazi Anadolu High School). The study was carried out during the fall semester in the 1991-1992 school year. The two classes were instructed by the same teacher to remove possible effects of differences in instruction on scores. Equality between the classes before the treatment is assured by selecting the two classes that were equal in terms of their prior scores on chemistry and mathematics. The experimental group consisted of 51 students (35 males + 16 females) while the population of the Control Group was 50, (32 males + 18 females) so the data analyzed for this study was taken from 101 students. Since there were 17 personal computers available for the study, and only one student could work efficiently with one computer, the experimental section was divided into three groups. Each group within the experimental section consisted of 17 students participating in the study.

In order to control the effects of treatment on the dependent variables such as achievement in chemistry, attitude toward chemistry and CAI, their perceptions on CAI environments, performance of students must be checked prior to the study. So, the four tests CAT, CAS, ASTCAI and CAIES were administered to both groups before the treatment. Table 1. displays the results of the t-test run before the treatment for comparison of both groups in terms of variables before the treatment.

Table 1. The Differences Between EG and CG Before the treatment

TESTS	GROUPS	N	x	S.D	d.f	t	P
CAT	EG	51	21.68	7.00	99	-1.27	p>.05
	GG	50	19.56	9.62			
CAS	EG	51	52.86	14.68	99	-1.62	p>.05
	CG	50	49.02	8.44			
ASTCAI	EG	51	25.68	3.79	99	- .08	p>.05
	CG	49	25.75	4.89			
CAIES	EG	51	41.51	5.39	99	.92	p>.05
	CG	50	42.48	5.19			

The behavioral abilities of the students in the two groups could thus be assumed similar before the treatment. As seen from Table 1., in all of the four tests given no significant differences were found between the two groups at the $\alpha=0.05$ level.

4.4 Variables

Independent Variables

The two independent variables included in this study were gender and treatment. Traditional instruction and Computer Aided Instruction were two different types of treatment that were taken as the independent variables for the main and subproblems.

Dependent Variables

Dependent variables were chemistry

achievement of the students' as measured by CAT, their attitudes toward CAI as measured by ASTCAI, their attitudes toward chemistry as measured by CAS and their attitudes toward Computer Aided Instruction environment as measured by CAIES.

4.5 Selection and Development of Measuring Tools

The hypotheses of the study were tested by the following four measuring tools:

Chemistry Achievement Test (CAT)

This test was developed by Özkan and Yalçınalp (1992). The items in the test were at three levels of Bloom's Taxonomy (knowledge, comprehension and application).

The topic in the test was the Mole Concept, and the items were constructed from a list of instructional objectives which were closely related to both the courseware and the recitation exercises.

The following steps were taken during the developmental stage of this original test:

The instructional objectives on the basis of the categories in the cognitive domain of Bloom's Taxonomy are listed. The content validity is assured by reviewing the course content and objectives. The test contained 53 multiple choice items at the beginning, of which 48 were selected after an examination by a group of experts in science education. The achievement test was then administered to a pilot study group of 93 students at ninth grade in Gazi Anadolu Lycee, Ankara to be certain that items have a reasonable degree of difficulty and appropriate distractors.

Using ITEMAN (Assessment Systems Corporation, 1986), the reliability coefficient for this instrument was determined to be 0.88 with 45 items that were selected by the first tryout. The final form of the test is presented in Appendix B.

Attitude Scale Toward Computer Aided Instruction (ASTCAI)

This scale was developed by Aşkar et. al. (1991) to assess student attitudes toward CAI. The scale consisted of 10 items and the alpha interval consistency reliability estimate of the total scores was determined to be 0.81 by the authors.

Chemistry Attitude Scale (CAS)

The chemistry Attitude Scale used in this study was originally developed by Berberoğlu, G. (1991) . The scale consisted of 16 items and the Cronbach reliability coefficient of the test was determined as 0.92.

Computer Assisted Instruction Environment Scale
(CAIES)

The CAI environment scale was used to assess the perceptions of students about the differences between CAI and regular classroom environments (Aşkar, et. al., 1991). The scale consisted of 17 items such as interest, comfort, attention, and self evaluation. The factors were identified by the authors as cognitive , emotional and interaction dimensions which had alpha reliability estimates of 0.75, 0.73, and 0.75, in order. Total reliability estimate was determined as 0.78.

4.6 Treatment

This study was conducted in a chemistry course on 8^{th} grade students of Gazi High School during the 1991-1992 fall semester. A total of 101 students in two classes were exposed to two different treatments. The two classes were chosen on the basis of equivalence of students in each class on their prior Mathematics and Chemistry scores. The two classes were instructed by the same teacher, and pretests were administered prior to the study in both groups to ascertain that they belong to the same population before the treatment.

Results of the t-test (See Table 1)

analyses indicated no significant difference between the two groups prior to the study in terms of their chemistry achievement, chemistry and computer attitudes and attitudes toward CAI environment. The students in each class were exposed to two different treatments explained below, to see whether there would be an effect of treatment on the dependent variables of the study.

4.6.1 The Experimental Group (CAI)

The experimental group consisted of 51 students of which 35 were males, and 16 were females. The students were exposed to the CAI treatment for a total of 8 hours during the four weeks in which elementary chemistry was taught as part of the Science course. They used their leisure times on weekends or at lunch times, for this purpose. The CAI activities took place in the computer laboratory of the school.

Since there were only 17 computers available in the laboratory, the experimental group was divided into three subgroups containing equal numbers of students, and each group studied chemistry using the software for two-hour periods at specified dates and times. Prior to the beginning of the treatment, 45 minutes were devoted to the introduction of the software and computers, and to providing a general literacy in computers. Students were also provided with manuals in which extended information was given about the usage of computers and running of the software.

The microcomputer courseware package that was used in this study is the tutorial kind of the CAI methods of instruction. The main purpose of the CAI instruction in this study was to allow the students to make revisions and to practice in solving problems in the unit of "Mole Concept" that was also mastered in the classroom by the method of lecturing and discussion.

The software program used in the study was menu driven and that composed of 11 menu options which were mainly RULES, HINT, EXAMPLES, QUESTION, SOLUTION, NEXT, BACK, MENU, PRINT, DATA and CALC (calculator). The program was constructed in branched design in which a dialogue type of learning was emphasized. In this design students were allowed to proceed at their own pace and stressed to follow a path that was at successively increased difficulty levels. Also, learner control was provided so that the students were free to begin from any point in the program regarding the topics of the unit and were also allowed to go back and forth within the sections of the unit in the program. The program required the students to be active by encouring them to answer each question. Immediate feedback was provided for each answer. When the students entered their answer to a question they were reinforced to find the correct answer. The questions were selected from the same topics mastered in both groups in the classroom, and included in the textbook. Students were free to see the solution of the problem whenever they wished. Also they were given an opportunity to see solutions in examples whenever they wanted. Print-outs of the questions that appeared on the screen were available for the students to provide them extra studies on-out-of treatment hours and at their home. Questions were prepared and they were randomly accessed in the program. Random generation was also used in the creation of molecular formulas. Hence rote memorization by the students was prevented. The software program also provided the students with useful information given in pop-up windows, such as data, hints and a calculator. The interaction with the program was easy and fast by the usage of a mouse and keyboard at the same time. The program was written in English since the subjects of the study were taught in that language in their chemistry courses.

4.6.2 The Control Group

Students in the control group were exposed to traditional instruction. They were instructed by the same teacher, and received 12 hours of instruction by lecturing and discussion as did the experimental group by using the same instructional materials. Students in the control group were exposed to problem solving hours for 8 hours of time period to equalize the time factor between the two groups. During these hours, problems that were parallel to those solved in the classroom, mastered in the textbook, and studied in experimental group via CAI were solved.

4.7 Assumptions and Limitations

The assumptions and limitations of in the present study are given below.

4.7.1 Assumptions

1. All subjects provided sincere responses to the items on the attitude scales.

2. The researcher was not biased during the treatment.

3. No outside event occurred during the treatment that influenced the responses to the items of the attitude scales and achievement test.

4. The scores in the respective populations were normally distributed.

5. The variance of the scores in the populations are equal ($\sigma_1^2 = \sigma_2^2$)

6. There was no interaction between the experimental and control group to change their attitudes and achievement scores.

4.7.2 Limitations

1. Subjects of this study were limited to eighth grade high school students in the Ankara Gazi

High School during the 1991-1992 fall semester.

2. The subjects were limited to 101 students.

3. Treatment time was limited to 8 hours.

CHAPTER V

RESULTS AND CONCLUSIONS

This chapter presents the methods of analysis used, the results and conclusions of this study.

5.1 Analysis of Data

In this study statistical techniques such as Two Way Analysis of Variance (Two-Way Anova) and Correlation are used to analyze the data that were collected from the measuring tools described above. Analysis of variance is used to predict the contributions of the independent variables to an explanation of the variance of each dependent variable.

5.1.1 Two-factor Analysis of Variance

In order to test the questions posed by the hypotheses 1 through 12, two-factor analysis of variance for independent measures technique was used. An experiment with two independent variables is called a two-factor experiment. Such an experiment can be diagrammed as a matrix by listing the levels of the first factor across the top, and the levels of the other factor down the side. Each cell in the matrix corresponds to a specific combination of the two factors. The two factors in this study were gender and treatment and can be shown as;

		A	
		CAI	nonCAI
B	Male	Ma. CAI	Ma. nonCAI
	Female	Fe. CAI	Fe. nonCAI

The purpose of analysis of variance is to determine whether there are any significant mean differences among the treatment conditions in the experimental matrix. These treatment effects are classified as follows:

a. The A-effect: Differential effects produced by the different levels of factor A.

b. The B-effect: Differential effects produced by the different levels of factor B.

c. The AxB interaction: Differences that are produced by unique combinations of A and B interaction. An interaction exists when the effect of one factor depends on the levels of the other factor.

The magnitude of the treatment effect is evaluated by an F-ratio having the basic structure of;

$$F= \frac{\text{variance between treatments}}{\text{variance within treatments}} = \frac{MS_{Bet}}{MS_{With}}$$

where the MS is actually a sample variance and computed by a sum of squares value (SS) and degrees of freedom value (df) as;

$$MS = \frac{SS}{df}$$

5.1.2 Correlation

In order to test the relation between variables asked by hypotheses 13 through 16 statistical technique of correlation was used. The Pearson correlation measures the degree and direction of linear relation between two variables. The Pearson correlation is identified by the letter "r" and is computed by ;

$$r = \frac{\text{degree to which X \& Y vary together}}{\text{degree to which X\& Y vary separately}}$$

$$= \frac{\text{covariability of X \& Y}}{\text{variability of X \& Y separately}}$$

where X and Y indicate the two dependent variables. Pearson correlation (r) measures the relationship between an individual's location in the X distribution and his location in the Y distribution (Gravetter, J.F., 1985). When r is calculated on the basis of sample data, a strong positive or negative value can be obtained by chance, even though there might actually be no relationship between the two variables. In this situation, the value that is obtained for r is only an estimate of a corresponding parameter, the population correlation coefficient (δ). It is common to base inferences about δ on the Fisher Z transformation, a change of scale from r to Z, which is given by;

$$Z = \frac{1}{2} \ln \frac{1+r}{1-r}$$

Under the assumptions of normal correlation analysis for any value of δ, the distribution of Z is approximately normal with;

$$\mu z = \frac{1}{2} \ln \frac{1+\delta}{1-\delta} \quad \text{and} \quad \sigma z = \frac{1}{\sqrt{n-3}}$$

Hence the z-score ;

$$z = \frac{Z-\mu z}{\sigma z} = (Z-\mu z)\sqrt{n-3}$$

has approximately the standart normal distribution where σ is the population standart deviation, μ is the population standart mean, Z is a random variable and n is the sample size (W.C. Guenther 1973).

5.2 Results

The hypotheses which are stated in Chapter III are tested at a significance level of α=.05. Effects of two independent variables, namely treatment group (experimental or control), and gender (male or female) will be considered simultaneously. There are, in fact, 4 subgroups in this study: males in the control group, females in the control group, males in the experimental group, and females in the experimental group. Two way Analysis of Variance (F- Test) and "Correlation" techniques were used to test the hypotheses. In this study, statistical analysis were carried out by the SPSS/PC-Statistical Package for Social Sciences for Personal Computers- (Neil, 1989).

Hypothesis 1

To answer the question posed by hypothesis 1 of this study, the significance level of the differences between the Chemistry Achievement Test scores of the students in the four subgroups are tested using Two-Way ANOVA. The results obtained are given in Table 2. As the table shows, the between-group F ratio (15.13) was significant at the 0.05 level.

The mean CAT scores of the experimental and the control groups were 30.39 and 24.82, respectively. It may thus be concluded that the treatment had a significant effect on the chemistry achievement of the students. Those receiving chemistry coursware in the CAI environment obtained significantly higher scores than the students in the control group who were supported by recitation hours.

Table 2. Two way Analyses of Data Obtained from CAT

Source of Variation	Sum of Squares	DF	Mean square	F	Sig. of F
BETWEEN GROUP	787.79	1	787.79	15.13	.000
BETWEEN GENDER	4.41	1	4.41	.09	.772
2-Way Interactions GENDER GROUP	130.99	1	130.99	2.52	.116
Explained	919.32	3	306.44	5.89	.001
Residual	5050.12	97	52.06		
Total	6969.446	100	59.69		

Hypothesis 2

To answer the question posed by hypothesis 2 of this study, the significance level of the differences between the Chemistry Attitude Scale scores of the students in the four subgroups are tested using Two-Way ANOVA. The results obtained are given in Table 3. As the table shows, the between-group F ratio (10.75) was significant at the 0.05 level

The mean CAS scores of the experimental and the control groups were 58.78 and 51.06, respectively. It can be said that CAI helped to improve the attitudes of the students in the experimental group toward chemistry. These students enjoyed studying chemistry more than the students in the control group.

Table 3. Two way Analyses of Data Obtained from CAS

Source of Variation	Sum of Squares	DF	Mean square	F	Sig. of F
BETWEEN GROUP	1457.80	1	1457.80	10.75	.001
BETWEEN GENDER	424.52	1	142.52	1.05	.308
2-Way Interactions GENDER GROUP	425.58	1	425.58	3.14	.080
Explained	2074.49	3	691.49	5.09	.003
Residual	13159.35	97	135.66		
Total	15233.84	100	152.338		

Hypothesis 3

To answer the question posed by hypothesis 3 of this study, the significance level of the differences between the Attitude Scale Toward Computer Assisted Instruction (ASTCAI) scores of the students in the four subgroups are tested using Two-Way ANOVA. The results obtained are given in Table 4. As the table shows, the between-group F ratio (11.05) was significant at the 0.05 level.

The mean ASTCAI scores of the experimental and the control groups were 27.58 and 24.72, respectively. We can conclude that after undergoing the CAI treatment, the students in the experimental group better appreciated the potential benefits of CAI, and they liked the CAI environment.

Table 4. Two way Analyses of Data Obtained from ASTCAI

Source of Variation	Sum of Squares	DF	Mean square	F	Sig. of F
BETWEEN GROUP	201.49	1	201.49	11.05	.001
BETWEEN GENDER	16.68	1	16.68	.91	.341
2-Way Interactions GENDER GROUP	8.61	1	8.61	.47	.494
Explained	232.99	3	77.67	4.26	.007
Residual	1769.14	97	18.23		
Total	2002.139	100	20.02		

Hypothesis 4

To answer the question posed by hypothesis 4 of this study, the significance level of the differences between the CAIES scores of the students in the four subgroups are tested using Two-Way ANOVA. The CAIES test was designed to determine student perceptions about differences between the CAI and regular classroom environments. The results obtained are given in Table 5. It is seen from the table that the observed between-group F value was not significant at the 0.05 level. Our findings indicate that CAI did not change students' perceptions of the differences between the two learning environment.

Table 5. Two way Analyses of Data Obtained from CAIES

Source of Variation	Sum of Squares	DF	Mean square	F	Sig. of F
BETWEEN GROUP	21.74	1	21.74	1.18	.443
BETWEEN GENDER	7.29	1	7.29	.39	.281
2-Way Interactions GROUP GENDER	37.32	1	37.32	2.02	.158
Explained	67.64	3	22.55	1.22	.306
Residual	1790.65	97	18.46		
Total	1858.29	00	18.58		

Hypothesis 5

In order to test hypothesis 5 which states that there is no statistically significant difference between the mean CAT scores of male and female students, F values of Table 2 were used. It is seen from the table that the between-gender F ratio was only 0.09, showing that gender had no significant effect on the chemistry achievement scores ($F_{crit.}$=3.94 at the 0.05 level). Indeed, the mean CAT score of the 34 females in both groups was 27.7, whereas that of the 67 males was 27.6.

Hypothesis 6

In order to test hypothesis 6 which states that there is no statistically significant difference between the mean CAS scores of male and female students, F values of Table 3 were used. It is seen from the table that the between-gender F ratio was 1.05, showing that gender had no significant effect on the attitudes of the students toward chemistry ($F_{crit.}$=3.94 at the 0.05 level). The mean CAS score of the 34 females in both groups was 53.0 whereas that of the 67 males was 55.9.

Hypothesis 7

In order to test hypothesis 7 which states that there is no statistically significant difference between the mean ASTCAI scores of male and female students, F values of Table 4 were used. It is seen from the table that the between-gender F ratio was 0.91, showing that gender had no significant effect on the attitudes of the students toward computer assisted instruction. The mean ASTCAI score of the females was 25.5 whereas that of the males was 26.5.

Hypothesis 8

In order to test hypothesis 8 which states that there is no statistically significant difference between the mean CAIES scores of male and female students, F values of Table 5 were used. It is seen from the table that the between-gender F ratio was 0.39, showing that gender had no significant effect on the perceptions of the students about the differences between CAI environment and the traditional classroom environment. The mean CASES score of the females and males were 43.3, and 44.0, respectively.

Hypothesis 9

In order to test hypothesis 9 stating that the interaction between the treatment (CAI or Recitation) and gender (male or female) has no effect on the CAT scores of the students, the interaction F value of Table 2 was used. As seen from the table, $F_{obs.}=2.52$, indicating that the hypothesis should not be rejected at the 0.05 level. Thus gender differences had no significant effect on the success of the CAI method over the recitation method. The mean CAT scores of the females and males in the experimental group were 29.0 and 31.0, respectively, whereas those of the control group were 26.6 and 23.8.

Hypothesis 10

In order to test hypothesis 10 stating that the interaction between the treatment (CAI or Recitation) and gender (male or female) has no effect on the CAS scores of the students, the interaction F value of Table 3 was used. As seen from the table, $F_{obs.}=3.14$, indicating that hypothesis should not be rejected at the 0.05 level.The mean chemistry attitude scale scores were: 54.0 and 61.0 for the females and males,respectively, in the experimental group; and, 52.2 and 50.4 in the control group.

Hypothesis 11

In order to test hypothesis 11 stating that the interaction between the treatment (CAI or Recitation) and gender (male or female) has no effect on the ASTCAI scores of the students, the interaction F value of Table 4 was used. As seen from the table, $F_{obs.}=0.47$, indicating that gender differences had no significant effect on the attitudes of the students toward computer assisted instruction. The mean ASTCAI scores of the females and males in the experimental group were 26.6 and 28.1, respectively, whereas those of the control group were 24.6 and 24.8.

Hypothesis 12

In order to test hypothesis 12 stating that the interaction between the treatment (CAI or Recitation) and gender (male or female) has no effect on the CAIES scores of the students, the interaction F value of Table 5 was used. As seen from the table, $F_{obs.}=2.02$, indicating that gender differences had no significant effect on the perceptions of the students about the differences between CAI environment and the traditional classroom environment. The mean CAIES scores of the females and males in the experimental group were 44.7 and 44.0, respectively, whereas those of the control group were 42.1 and 43.9.

Hypothesis 13

The hypothesis which stated that there is no significant correlation between chemistry achievement and chemistry attitude test scores of students that taught by CAI at α=.05, was tested by using correlation analysis.

The results of this analysis are shown in Table 6. and are presented graphically in a scatterplot in Figure 5.

Table 6. Summary Table for the Analysis of Testing Significance of Correlation between CAT and CAS test scores of students Completing CAI.

N	(r)	z
51	0.0448	0.31

* r is significant at α=.05

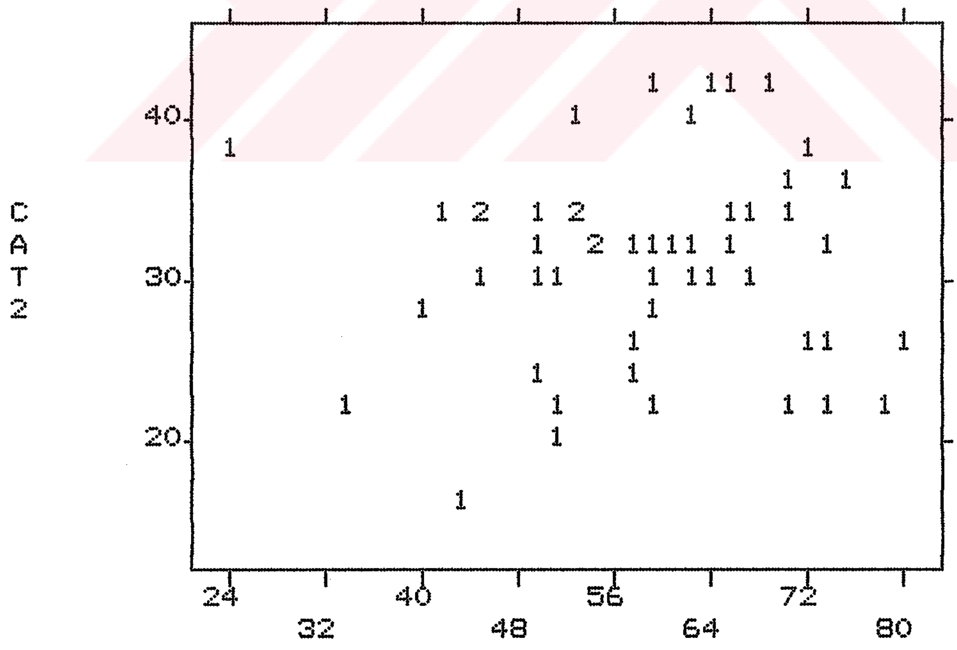

Figure 5. Scatter Diagram of Students' CAT and CAS Post Test Scores After the Treatment of CAI

As the table indicate $z(observed) = 0.31 < z(table) = 1.96$, there is no significant correlation between the students CAT and CAS test scores after completing the CAI instruction at $\alpha=0.05$ level of significance.

Hypothesis 14

The hypothesis which stated that there is no significant correlation between chemistry achievement and computer assisted instruction attitude test scores of students that taught by CAI at $\alpha=.05$, was tested by using correlation analysis.

The results of this analysis are shown in Table 7. and are presented graphically in a scatterplot in Figure 2.

Table 7. Summary Table for the Analysis of Testing Significance of Correlation between CAT and ASTCAI test scores of students Completing CAI.

N	(r)	z
51	0.3608	2.59

* r is significant at $\alpha=.05$

This result is also supported by the careful examination of the graphical presentation of scatterplot in figure 6.

As the table indicates $z(observed) = 2.59 > z(table) = 1.96$, there is a significant correlation between students chemistry achievement and computer assisted instruction attitude test scores following the completion of computer assisted instruction at 0.05 level of significance.

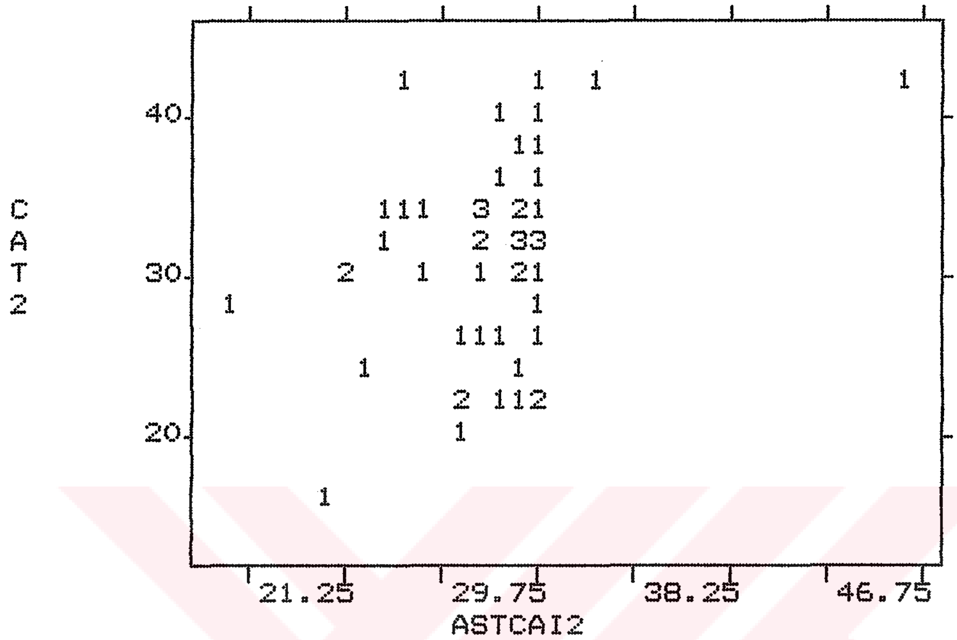

Figure 6. Scatter Diagram of Students' CAT and ASTCAI Post Test Scores After the Treatment of CAI

Hypothesis 15

The hypothesis which stated that there is no significant correlation between chemistry achievement and perceptions on computer assisted instruction environment scale scores of students that taught by CAI at $\alpha=.05$, was tested by using correlation analysis.

The results of this analysis are shown in Table 8. and are presented graphically in a scatterplot in Figure 7.

Table 8. Summary Table for the Analysis of Testing Significance of Correlation between CAT and CAIES test scores of students Completing CAI.

N	(r)	z
51	0.0469	0.32

* r is significant at α=.05

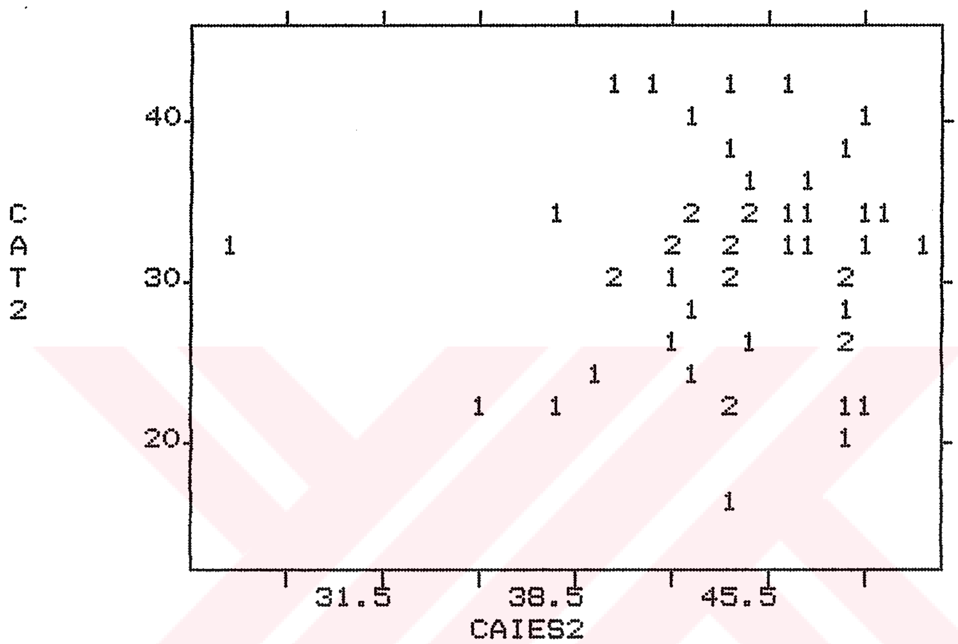

Figure 7. Scatter Diagram of Students CAT and CAIES Post Test Scores After the Treatment of CAI

As the Table 8. indicates z(observed)= 0.32 < z(table)= 1.96 there is no significant correlation between the students chemistry achievement mean scores and their perceptions about the difference between CAI and regular classroom environments scale mean scores after completing CAI at α=0.05 level of significance.

Hypothesis 16

The hypothesis which stated that there is no significant correlation between CAI attitude and perceptions on computer assisted instruction environment scale scores of students that taught by CAI at α=.05, was tested by using correlation analysis. The results of this analysis are shown in Table 9. and are presented graphically in a scatterplot in Figure 8.

Table 9. Summary Table for the Analysis of Testing Significance of Correlation between ASTCAI and CAIES test scores of students Completing CAI.

N	(r)	z
51	0.3374	2.41

r is significant at α=.05

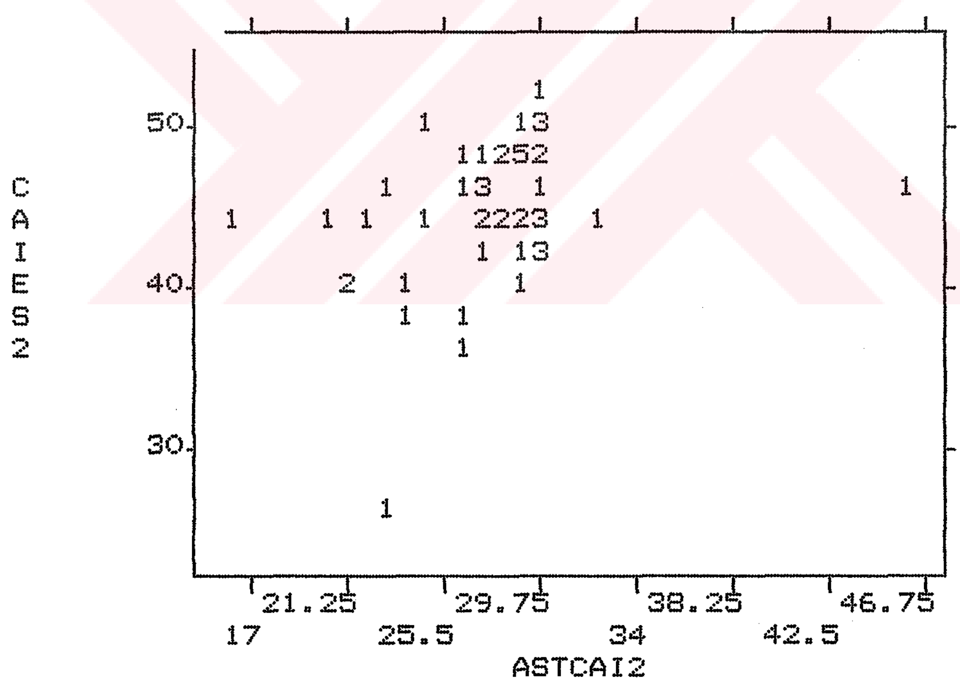

Figure 8. Scatter Diagram of Students ASTCAI and CAIES Post Test Scores After the Treatment of CAI

As the table indicates z(observed)= 2.41 < z(table)= 1.96, there is a significance correlation between students ASTCAI and CAIES test mean scores after computer assisted instruction at $\alpha=0.05$ level of significance.

5.3 Conclusions

In the light of the findings obtained by statistical testing of each hypothesis, the following results can be concluded.

1. Chemistry achievement of students who were exposed to CAI accompanied with lecture was significantly higher than the students that exposed to traditional instruction accompanied by additional problem solving hours for the unit of "Mole Concept".

2. The CAI produced significantly greater attitudes in students toward chemistry than the students in traditional group accompanied by problem solving hours.

3. The CAI produced significantly greater attitudes in students toward CAI than the students in traditional group accompanied by problem solving hours.

4. Although CAI has no significant effect on the perceptions of students about the difference between CAI and regular classroom environments, the CAIES gain scores of students in CAI group was significantly higher than the students in control group ($t(50)= 3.93$, $p < p=0.05$, two tailed).

5. Gender has no significant effect on the chemistry achievement of students at $\alpha=0.05$.

6. Although gender has no significant effect on the chemistry attitude of students , the mean scores of the male students was significantly higher than the mean scores of female students in the computer assisted group ($t(49)=2.34$, $p<.05$, two tailed)

7. Gender has no significant effect on the computer assisted instruction attitude of students at $\alpha=0.05$ level.

8. Gender has no significant effect on perceptions of students about the difference between the CAI and regular classroom environments at $\alpha=0.05$.

9. There is no interaction between the treatment (CAI) and gender on the chemistry achievement of students at $\alpha=0.05$.

10. There is no interaction between the treatment of computer assisted instruction and gender on the chemistry attitude of students at $\alpha=0.05$.

11. There is no interaction between the treatment and gender on the CAI attitudes of students at $p=0.05$.

12. There is no interaction between treatment and gender on the perceptions of students on the difference between the CAI and regular classroom environments at $\alpha=0.05$.

13. There is no significant correlation between the chemistry achievement and chemistry attitudes of students that have been exposed to CAI, at $\alpha=0.05$.

14. There is significant correlation between

chemistry achievement and CAI attitudes of students that have been exposed to CAI, at $\alpha=0.05$.

15. There is no significant correlation between the chemistry achievement and perceptions about the difference between the CAI and regular classroom environments of students that have been taken CAI, at $\alpha=0.05$.

16. There is a significant correlation between the computer assisted instruction attitudes and perceptions about the difference between CAI and regular classroom environment of students that have been exposed to CAI, at $\alpha=0.05$.

CHAPTER VI

DISCUSSION, IMPLICATION AND RECOMMENDATIONS

This chapter presents the interpretation and discussion of the results obtained from the statistical testing of the hypotheses, and the implications and recommendations for further research.

6.1 Discussion of the Results

As stressed before, the main aim of this study was to investigate the effects of CAI on students' chemistry achievement, computer assisted instruction and chemistry attitudes, and their perceptions about the difference between CAI and regular classroom environments. The other purpose of the study was to asses the effect of gender on the four variables that are chemistry achievement, CAI and chemistry attitudes and perceptions about the CAI environment.

The study was also designed to investigate the correlation between the chemistry achievement of students and their attitudes toward chemistry, toward CAI and perceptions about the CAI environments.

6.1.1 Chemistry Achievement

As indicated previously, the chemistry achievement test was administered to all subjects of the study prior to the treatment (CAI), and it was found that there was no significant difference between the pre-test mean scores of the experimental and control groups. These results proved the equality between the two groups prior to study.

Although the findings of the Wainwright (1989) was to the contrary, following the completion of the treatment, results of the Two-Way Anova indicated that the treatment had a significant effect on the chemistry achievement of the students in which the chemistry achievement of students in the experimental group was significantly higher than the mean scores of students in the control group. This result supported the findings of the researchers (Willet, 1983; Sasser, 1990; Wise and Okey, 1983; McCoy,1991) in which each concluded that the mean scores of the CAI group were significantly higher than those of control group.

It is worthwhile to note that control group's chemistry achievement test scores indicated a gain between the pre and post tests. So, traditional lecturing method was also resulted in enforcement of students' learning, but it was not as effective as the one in CAI group.

The interaction between the treatment and gender on the chemistry achievement of students was not significant at $\alpha=0.05$ ($F=2.52$). This indicates that there is no interaction between treatment and gender on the chemistry achievement of students. Similarly, the difference between chemistry achievement mean scores of male and female students was not significant at $\alpha=0.05$

(F=2.52).

The correlation between the chemistry achievement of students and their chemistry attitudes was not significant at $\alpha=.05$ (z=2.71). We concluded that there is no relation between the students chemistry achievement and their chemistry attitudes in the experimental group. According to this result we can not expect individuals who scored high on chemistry achievement test to tend to score high on chemistry attitude test.

The correlation between the students' chemistry achievement and their computer assisted instruction attitudes was significant in the experimental group at $\alpha=.05$. So the students who scored high on the ASTCAI scale can be expected to get high scores on the chemistry achievement test for the CAI group.

The correlation between the students chemistry achievement and their perceptions about the difference of CAI and regular classroom environments was not significant in experimental group at $\alpha=.05$. So, the students who scored high in the CAIES are not expected to have high scores on the CAT test. This can be explained on the basis of limited period of the study.

6.1.2 Chemistry Attitude

As stated in the previous chapter, the chemistry attitude test was administered to all subjects of the study prior to the treatment, and it was found that there was no significant difference between the pre and post test mean scores of the experimental and control groups on the chemistry attitude.

Results of the F-test showed that CAI has a significant effect on the chemistry attitude of students. This result is not in agreement with the findings of Cavin and Lagowski (1981) in which they concluded that there was no significant difference between the mean scores of CAI and nonCAI groups on chemistry attitude.

6.1.3 Computer Assisted Instruction Attitude

Prior to the study all subjects were given pre-ASTCAI and results of the t-test indicated no difference between the mean scores of students on ASTCAI in control and experimental groups. After the completion of the treatment, it has been determined that CAI has a significant effect on the computer assisted instruction attitudes of students in the experimental group.

The subjects at the beginning of the study have shown high attitudes toward CAI. Pre mean scores of experimental and control groups on ASTCAI prior to the study were 25.74 and 25.68 respectively.

Although there was a significant improvement in the post-test scores of students on ASTCAI in experimental group, (x_{pre} =25.74 to x_{post} = 27.58 there was no such a significant difference between the pre and post test mean scores of students in control group.

There was no significant effect of gender on the CAI attitudes of students as indicated by the Two Way Analysis of Variance at α=.05.

From the findings of the same F-test, it has been concluded that there is no interaction between gender and treatment on the CAI attitudes of students. This finding is in agreement with the conclusion of Cavin and Lagowski (1981) who stated that there is no interaction between gender and treatment on the students attitudes towards computers.

Results of this study are also supported by the findings of Badagliacco, (1990) and Arch and Cummins (1989) who concluded that when the variance with actual computer experience was controlled and when students were introduced to computers thorough structured in-class lessons and assignments, gender differences in students computer related attitudes were disappeared.

Canada (1990) claimed that males tend to dominate computer rooms compared to female students and indicated that female students are not getting as much computer experience as male students. The results of the present study need to be reconsidered in the light of above findings on the effect of times spent on computers by males and females before the treatment to investigate the influence of time on male and female students' attitudes toward chemistry. So a careful observation is required on this factor. In this study, the male and female students were assumed to spend equal times on computers since they had not taken any courses related to computers or CAI prior to study with the exception of two students having computers at home.

The correlation between computer assisted instruction attitudes and perceptions of students about the difference between CAI and regular classroom environments was significant at α=.05 in agreement with the findings of Askar et.al. (1991).

6.1.4 Perceptions of CAI Environments

Results of the pre-CAIES given to all subjects indicated no significant difference between the CAIES mean scores of the experimental and control groups. This might be a result of by the limited period of time for the treatment received by the experimental group. It is expected that improvement of perceptions about CAI environment requires more time and more involvement with computers in related courses.

There was no significant difference between the CAIES mean scores of male and female students at α=.05. So, gender was not a significant effect on students perceptions about the CAI environments.

Furthermore, the results of the F-test indicated that there was not a significant interaction between gender and treatment on the students' perceptions about CAI environments.

6.2 Implications

The results of the present study have implications for the classroom teachers, school administrators, computer teachers, teacher trainers (coordinator teachers), and the people who deal with the educational system in Turkey. The findings of the study have following implications;

1. The study suggests that students chemistry achievement will be improved by supplementing the traditional lecture with CAI.
2. This study suggests that traditional problem solving hours (recitations) can be replaced by the supplementary CAI.
3. The supplementary CAI is useful when appropriate programs are used.
4. This study suggests that CAI has a positive effect on the students' attitudes toward computer assisted instruction and toward chemistry.
5. This study suggests that attitudes of students toward CAI can be used in predicting students' achievement in chemistry in CAI groups.
6. This study suggests students' perceptions about the difference between the CAI and regular classroom environments can be used in predicting students' attitude to computer assisted instruction in CAI group.
7. This study suggests that Chemistry Achievement Test

(CAT) can be used to asses the students' achievement in "Mole Concept" in further research.

8. This study suggests that CAI reduces the teachers' and students' time on the given topic and assures the efficient use of time.

6.3 Recommendations

1. Similar research studies are needed to evaluate the effect of CAI on other student outcomes than the ones employed in this work.

2. Similar research studies should be conducted for different subject matters and different grade levels.

3. Similar research studies should be conducted in the absence of the course teacher to asses the effectiveness of CAI as compared with the teacher. The findings of such studies will be of great value especially in those schools with a shortage of teachers.

4. Similar research studies must be conducted to see the effect of student's cognitive and affective entry characteristics and CAI instruction on students' achievement.

5. Similar research studies can be designed in which Turkish is used as opposed to English used in this study, to compare the effect of foreign language in such studies.

6. Similar studies can be conducted to see the

effect of treatment time on the students' outcomes (dependent variables).

7. Further research studies must be conducted to see the effect of different types of CAI on students' outcomes.

8. The sample size must be increased in further studies.

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APPENDICES

APPENDIX A

Screens from the "Concept", The Instructional Objectives for Chemistry Achievement Test, The Content Outline for the Treatment, and Table of Specification for the Chemistry Achievement Test

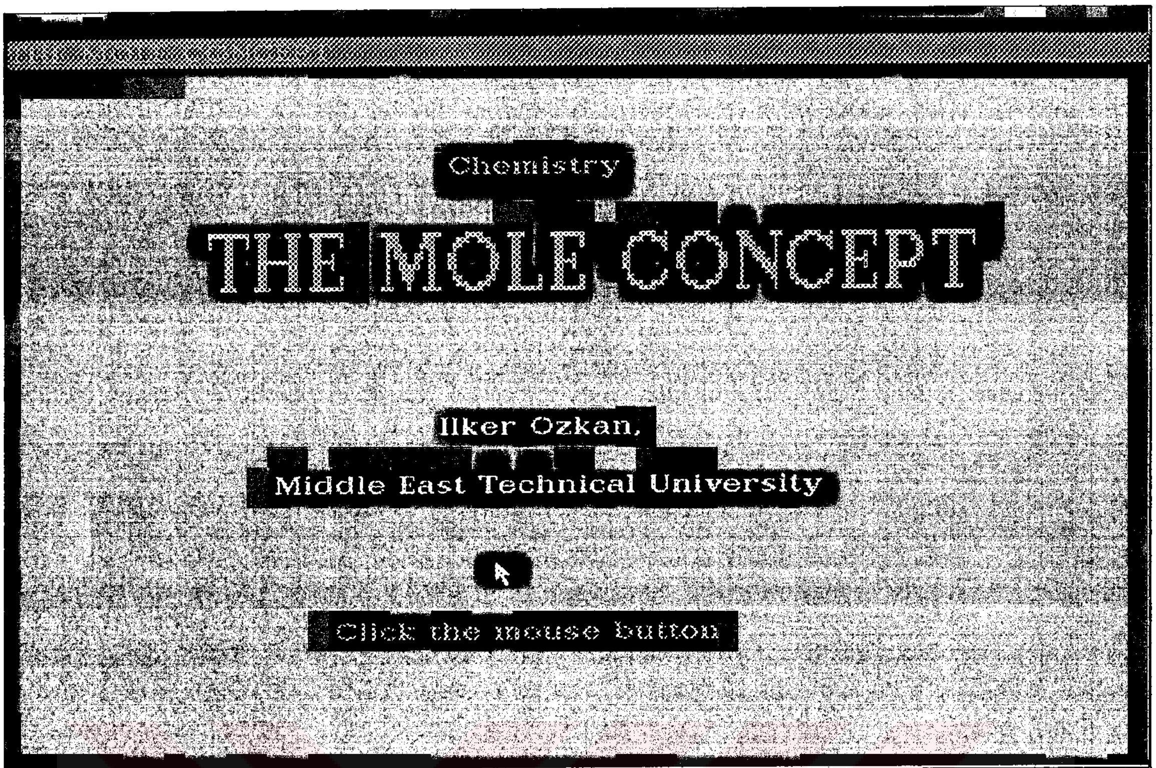

Figure 1. The Computer Assisted Instruction program "CONCEPT"

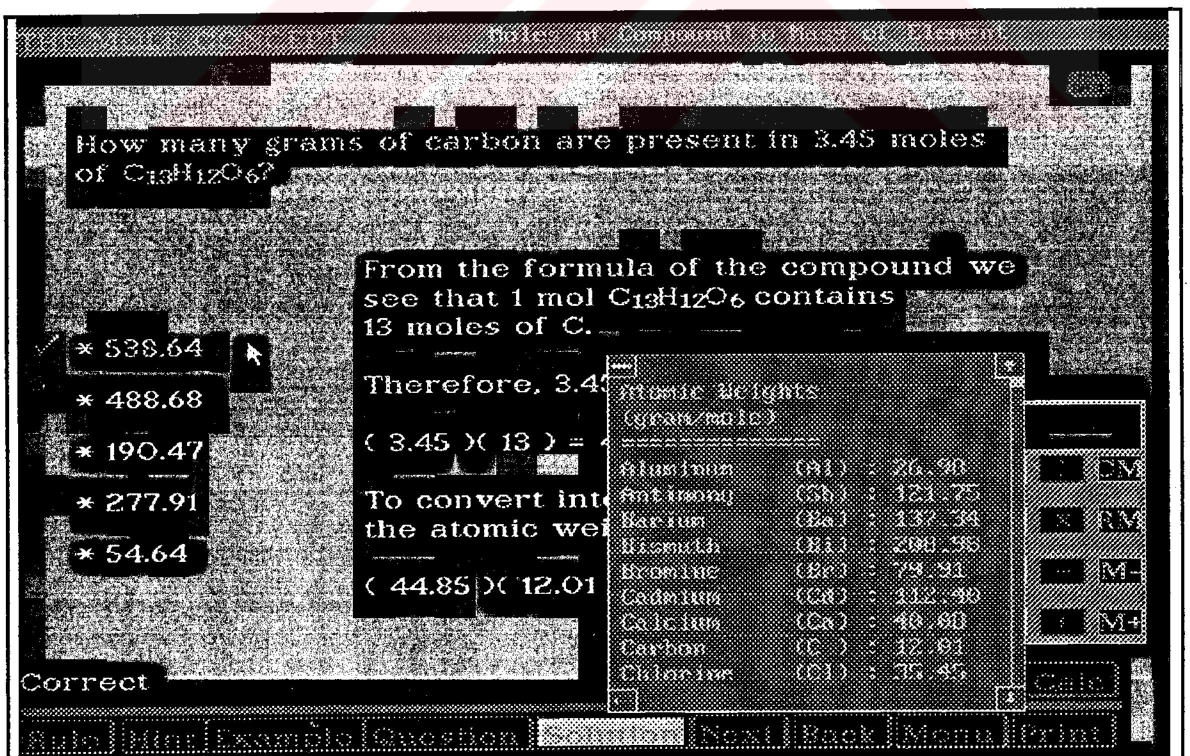

Figure 2. A typical screen in the courseware.

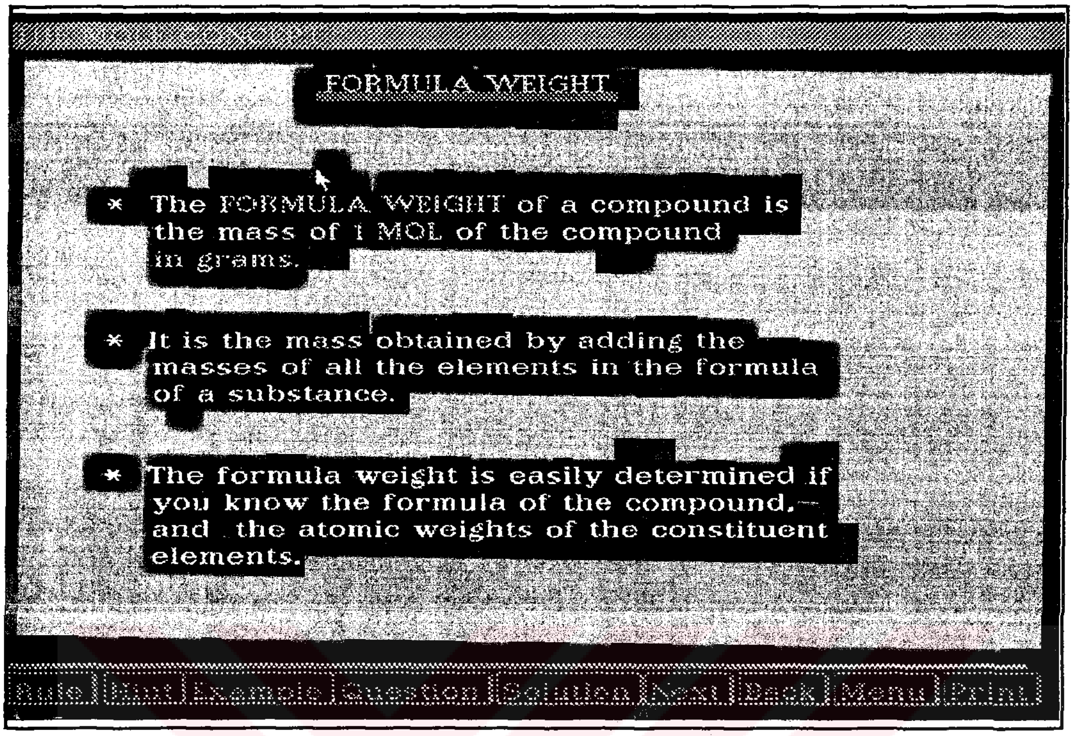

Figure 3. Students may see the underlying rules at any time they wish.

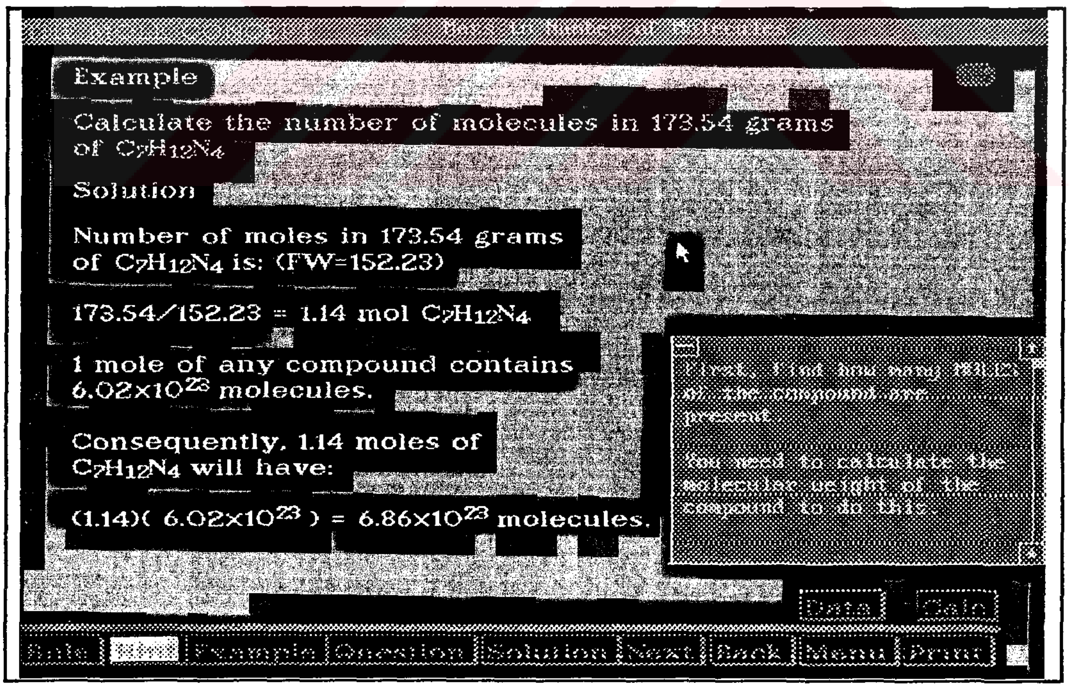

Figure 4. Examples or Hints are available at all times.

APPENDIX A.2

CONTENT OUTLINE

(For the treatment)

1. The Mole

   1.1 Mole to Particle conversion

   1.2 Avogadro's Number

   1.3 Mole to No. of Atoms

   1.4 Mole to No. of Molecules

   1.5 Moles of Molecules to Moles of Atoms

   1.6 Mole of Molecules to No. of Atoms

2. Mole to Mass Conversion

   2.1 Atomic Weight

   2.2 Mass to Moles of Atom

   2.3 Mass to No. of Atoms

   2.4 Molecular Weight Determination

   2.5 Mass to Mole of Molecule

   2.6 Mass of Molecules to Mass of Atoms

   2.7 Mass to No. of Molecule

   2.8 Mass of Molecule to No. of Molecules

   2.9 Mass of Atom to Mass of Other Atom in a Given Compound

   2.10 Mass of Molecule to Moles of Element

   2.11 Mass of Molecule to No. of Atoms

   2.12 Mass of an Element in a Molecule to No. of Atoms

   2.13 No. of Atoms of an element to No. of Molecules

APPENDIX A.3

Instructional Objectives for the Chemistry Achievement Test

Mole to Particle Conversion

* To choose the definition of mole concept.
* To define the Avogadro's number
* To find the no. of particles in a given no. of moles of any substance
* To find the no. of atoms in a given moles of an element.
* To find the no. of molecules in given moles of molecules.
* To distinguish between the moles of molecules and moles of elements.
* To find the no. of moles of an element in given no. of moles of a compound.
* To use the no. of moles to find the no. of total moles of a given substance.
* To find the no. of atoms of an element in given no. of moles of a compound
* To find the no. of atoms of an element from given no. of atoms of an element in the compound.
* To distinguish between the no. of moles and no. of molecules of substances.

Mole to Mass Conversion

* To find the mass of an element from its given no. of moles.
* To distinguish between the mass of an atom and mass of an element.

* To find the mass of given no. of atoms of an element.
* To find the no. of moles of a compound from its given mass.
* To analyze the molecular weight of a substance from the given data for it's elements.
* To find the mass of a compound from its given no. of moles.
* To find the mass of a molecule from its given no. of molecules.
* To calculate the mass of an element from the given mass of a compound.
* To calculate the mass of a compound from its given mass of an element.
* To calculate the no. of atoms of an element from the given mass of a compound.
* To find the no. of moles of a compound from the given mass of an element in the compound.
* To calculate the mass of an element from given no. of molecules of a compound.

APPENDIX A.4

Table of Specification for the Chemistry Achievement Test

Objectives / Content	Knowledge	Comprehension	Application
1.1 **	1,2*		
1.2	3		
1.3		5	4
1.4		6,7,8	
1.5		9,11,12	13
1.6		10,15,16, 17,18	
2.2		19,20	21,22
2.3		23	
2.4		24	
2.5		25,27	
2.6		31,32	26,33
2.7		28,30	29
2.8			39
2.9		34	
2.10		35,36,40, 41,42,43	
2.11		37	
2.12		38,44	
2.13		45	

* Test Item Number   ** Content

APPENDIX B

Chemistry Achievement Test, Chemistry Attitude Scale, CAI Attitude Scale, CAI Environment Scale.

APPENDIX B.1

CHEMISTRY ACHIVEMENT TEST

Dec.12, 1991

NAME and SURNAME :
STUDENT NUMBER :
SEX :
CLASS :

TIME : 90 min.
NUMBER OF PAGES : 9
NUMBER OF QUESTIONS : 46

DIRECTIONS :

- Use the **ANSWER SHEET** to mark the correct answers !
- Count the number of pages !
- Calculators are allowed !

ATOMIC WEIGHTS OF ELEMENTS

P Phosphorus 31	H Hydrogen 1.00	O Oxygen 15.99	C Carbon 12.01	Cl Chlorine 35.4
Br Bromine 79.9	Ca Calcium 40.08	Ba Barium 137.33	S Sulfur 32.06	Al Aluminum 26.98
Cr Chromium 51.99	N Nitrogen 14.00	Na Sodium 22.98	Zn Zinc 65.38	K Potassium 39.09
Mn Manganese 54.9	Fe Iron 55.85			

GOOD LUCK

1) The amount of a substance that contains 6.02×10^{23} units of that substance is called ________________.

a) Mole b) Molecule c) Weight d) Mass e) Element

2) Which one of the following is the definition of mole ?

a) The number of molecules or atoms in certain amounts of substances.

b) The amount of a substance represented by Avegadro's number of formula units of that particular substance.

c) The number of chemical units as the number of atoms in one gram a substance.

d) One gram of substance that contains Avegadro's number of atoms.

e) The amount of a substance that contains the chemical unit of that substance

3) The number of objects in one mole is equal to __________.

a) Molecule b) Mole c) Avegadro's Number d) Mass Number

e) Molecular Weight

4) One mole of books has _________ books.

a) 6.02×10^{23} b) 60.2×10^{23} c) 6.02×10^{24} d) 1 e) 4

5) How many atoms are there in 0.25 mol P ?

a) 1.505×10^{24} b) 2.408×10^{24} c) 24.08×10^{22} d) 1.505×10^{23}

e) 2.408×10^{24}

6) If you had 3.01×10^{23} molecules of water (H_2O), how many moles of water would you have ?

a) 2 b) 5 c) 0.2 d) 0.5 e) 1

7) How many molecules are there in 4 moles of CO_2 ?

a) 2.408×10^{24} b) 6.65×10^{-24} c) 1.505×10^{23}

d) 6.65×10^{-24} e) 1.505×10^{24}

8) How many moles of HCl contain 6.02×10^{24} molecules ?

a) 20 b) 30 c) 10 d) 1 e) 2

9) How many moles of Br_2 have 0.4 mol Br ?

a) 0.4 b) 0.8 c) 0.2 d) 0.1 e) 2

10) How many moles of O atoms are there in 0.05 mol $Ca_3(PO_4)_2$?

a) 4 b) 0.2 c) 8 d) 0.4 e) 2

11) What is the number of moles of Ba in a compound of $Ba_3(PO_4)_2$ that contains 8 moles of P ?

a) 24 b) 4 c) 12 d) 3 e) 6

12) What is the total number of moles of atoms in 0.8 mol H_2O ?

a) 0.8 b) 1.6 c) 16.8 d) 0.9 e) 2.4

13) Which one of the following substances has the greatest number of moles of oxygen ?

a) 0.2 mol H_2O
b) 6.02×10^{23} SO_2 molecules
c) 1 mol H_2SO_4
d) 0.5 mol O_3
e) 3.01×10^{23} CO_2 molecules

14) How many moles of $Al_2(SO_4)_3$ contain 1.5 moles of S atoms ?

a) 0.45 b) 0.5 c) 0.2 d) 4.5 e) 2

15) How many atoms of Cr are there in 0.5 mol of $Al_2(Cr_2O_7)_3$?

a) 3.61×10^{24} b) 3.01×10^{23} c) 1.806×10^{24}

d) 1.204×10^{22} e) 6.02×10^{23}

16) What is the number of atoms of C in $C_6H_{12}O_6$ that contains 1.204×10^{24} H atoms ?

a) 6.02×10^{23} b) 1.505×10^{24} c) 3.612×10^{24}

d) 1.505×10^{23} e) 1.806×10^{24}

17) How many moles of $(NH_4)_3PO_4$ contain 1.806×10^{23} atoms of N ?

a) 0.1 b) 0.3 c) 0.25 d) 3 e) 10

18) What is the number of moles of Na in a compound of $Na_2(CrO_4)$ which contains 1.806×10^{24} atoms of Cr ?

a) 2 b) 0.66 c) 3 d) 4 e) 6

19) What is the mass of 0.25 mol Ca in grams ?

a) 10 b) 160 c) 100 d) 16 e) 40

20) How many moles of nitrogen (N) weigh 112 g ?

a) 14 b) 80 c) 2.8 d) 8 e)1.4

21) Which one(s) of the following statements is true for 0.1 mole of SO_2 and 6.4 g of O_2 gases ?

I) Masses are equal
II) Total number of atoms are equal
III) Number of moles are equal
IV) Number of oxygen atoms are equal

a) I-II b) only I c) only IV d) I-III e) III-IV

22) What is the mass of one C atom in grams ?

a) 1.99×10^{-23} b) 5.02×10^{22} c) 12 d) 1.99×10^{22}

e) 5.02×10^{-22}

23) What is the mass of 2.04×10^{23} atoms of Zn ?

a) 130 g b) 782×10^{23} g c) 22 g d) 78.2×10^{23} g

e) 7.82×10^{22}

24) Which one of the following is the molar mass of Al_2O_3 in grams ?

a) 75 b) 43 c) 92 d) 102 e) 86

25) What is the number of moles of 930 g of $Ca_3(PO_4)_2$?

a) 0.3 b) 4 c) 7 d) 3 e) 0.4

26) 3.1 g of the compound X_2O has 2.3 g of X. What is the molecular weight of X_2O ?

a) 3.9 g b) 62 g c) 20.6 g d) 6.2 g e) 39 g

27) What is the mass of 0.25 mol $Al_2(CO_3)_3$?

a) 114 g b) 55 g c) 58.50 g d) 13.75 g e) 234 g

28) What is the mass of 18.06×10^{23} molecules of SO_2 ?

a) 144 g b) 192 g c) 21,3 g d) 19.2 g e) 14.4 g

29) What is the value of "n" if 1.204×10^{24} molecules of $C_nH_{2n}O$ weighs 92 g ?

a) 2 b) 4 c) 3 d) 1 e) 5

30) What is the number of molecules in 88 g of CO_2 ?

a) 6.02×10^{24} b) 6.02×10^{23} c) 12.04×10^{23}

d) 12.04×10^{24} e) 1.806×10^{23}

31) What is the mass of P atoms in 21.2 g of $K_3(PO_4)$?

a) 3.1 g b) 6.2 g c) 62 g d) 310 g e) 6.4 g

32) Which one of the following is the mass of $(NH4)_2CO_3$ containing 22.4 g of N ?

a) 153.6 b) 96 c) 76.8 d) 11.2 e) 90.4

33) What is the molecular weight of the compound X_2Y, if mass of 12.04×10^{23} atoms of X is 2 g and 2.408×10^{23} atoms of Y is 12.8 g ?

a) 5.2 g b) 8.4 g c) 10.4 g d) 34 g e)16.8 g

34) What is the mass of K in a compound of K_2MnO_4 that contains 6.4 g of O ?

a) 15.6 g b) 62 g c) 3.9 g d) 7.8 g e) 6.2 g

35) What is the mass of H_2SO_4 which contains 0.2 mol S ?

a) 19.6 g b) 98 g c) 196 g d) 9.8 g e) 6.4 g

36) Determine the number of K atoms in 29.8 g KCl ?

a) 24.08×10^{22} b) 6.02×10^{23} c) 1.505×10^{24}

d) 2.408×10^{24} e) 15.05×10^{22}

37) What is the mass of H_2CO_3 that contains 9.03×10^{23} atoms of O ?

a) 31.5 g b) 41.3 g c) 31 g d) 186 g e) 93 g

38) What is the number of atoms of C in a compound of $(NH_4)_2CO_3$ which contains 28 g of N ?

a) 1.204×10^{24} b) 6.02×10^{23} c) 2.408×10^{24}

d) 1.204×10^{23} e) 2.408×10^{23}

39) One molecule of compound XY has a mass of 3×10^{-23} grams. What is the molecular weight of XY ?

a) 5 g b) 18.06 g c) 44 d) 0.5 g e) 1.806 g

40) What is the number of moles of O atom in 186 g of H_2CO_3 ?

a) 2 b) 3 c) 1 d) 4 e) 9

41) What is the number of moles of Na_2SO_4 that contains 115 g Na ?

a) 2.5 b) 0.2 c) 0.1 d) 1.25 e) 5

42) What is the mass of oxygen in 0.5 mol of $Ca(Cr_2O_7)$?

a) 112 g b) 8 g c) 56 g d) 16 g e) 32 g

43) What is the mass of Fe in a compound of $Fe_3(PO_4)_2$ which contains 4 moles of O ?

a) 33 g b) 168 g c) 33.6 g d) 336 g e) 84 g

44) What is the number of molecules of NO_2 if it contains 35 g of N ?

a) $1.505x10^{23}$ b) $2.408x10^{23}$ c) $6.02x10^{23}$

d) $2.408x10^{24}$ e) $1.505x10^{24}$

45) How many atoms of C are there in $6.02x10^{24}$ formula units of $Al_2(CO_3)_3$?

a) $1.806x10^{23}$ b) $6.02x10^{24}$ c) $6.02x10^{22}$

d) $1.806x10^{25}$ e) $6.02x10^{23}$

APPENDIX B.2

ANKET

Aşağıda Kimya dersi ve konuları ile ilgili tutumlara yönelik cümleler vardır. Cümleleri okuyarak size uygun gelen seçeneğe X işareti koyunuz. Işaretsiz cümle bırakmayınız.

Yardımlarınız için teşekkür ederiz.

	Kesinlikle Katılıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle katılmıyorum
1- Kimya çok sevdiğim bir alandır.					
2- Kimya konuları ile ilgili kitapları okumaktan hoşlanırım.					
3- Kimya dersleri genellikle çok sıkıcı geçer.					
4- Kimya ile ilgili daha çok şey öğrenmek isterim.					
5- Fenle ilgili bir alanda çalışacak olsaydım kimyayı seçerdim.					
6- Kimya derslerine çok istekli girerim					

	Kesinlikle katılıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle katılmıyorum
7- Fen bilimleri öğrenmem					
8- Kimya çalışması zevkli bir alandır.					
9- Kimya konuları ile ilgili bir tartışmaya katılmak bana cazip gelmez.					
10- Zorunlu olmasa da kimya dersi almak isterim.					
11- Kimya dersinde duyduğum mutluluğu başka hiç bir derste hissetmem.					

	Kesinlikle katılıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle katılmıyorum
12-"Kimya" beni huzursuz eden bir kelimedir.					
13- Kimya dersini hiç sevmem.					
14- Kimya derslerinde başka şeyler düşünürüm.					
15-Kimya konularına harcadığım zamana acımam.					
16- Kimya ile ilgili bir problemle uğraşmak bana zevk verir.					

APPENDIX B.3

ADINIZ , SOYADINIZ :

CİNSİYETİNİZ :

BİLGİSAYAR DESTEKLİ ÖĞRENMEYE YÖNELİK TUTUM ÖLÇEĞİ

Açıklama: Aşağıda Bilgisayar Destekli öğrenmeye yönelik tutum cümleleri ile her cümlenin karşısında "EVET", "BAZEN", "HAYIR" olmak üzere üç seçenek verilmiştir. Lütfen cümleleri dikkatli okuduktan sonra her cümle için size uygun olan ***seçeneklerden birini*** işaretleyiniz.

	EVET	BAZEN	HAYIR
1. Bilgisayar başında çalışırken zamanım müthiş zevkli geçiyor.	0	0	0
2. Bilgisayarla ders çalışırken çabuk öğreniyorum.	0	0	0
3. Bilgisayarla öğrenmekten rahatsız oluyorum.	0	0	0
4. Bilgisayardan öğrenme kendime güvenimi arttırıyor.	0	0	0
5. Bilgisayar bende ders çalışma isteği yaratıyor.	0	0	0
6. Bilgisayarla ders öğrenmek baştan zevkliydi, fakat zaman geçtikçe bıkmaya başladım.	0	0	0
7. Bilgisayarla ders öğrenmek başarımı arttırıyor.	0	0	0
8. Bilgisayarla ders işlemek çok eğlenceli.	0	0	0
9. Bütün dersleri bilgisayarla öğrenmeyi isterim.	0	0	0
10. Dersi renkli şekil ve hareketli resimlerle kolay öğreniyorum.	0	0	0

APPENDIX B.4

ADINIZ , SOYADINIZ :

CİNSİYETİNİZ :

BİLGİSAYAR İLE YAPILAN ÖĞRETİMİN NORMAL SINIF ORTAMINDA YAPILAN ÖĞRETİMDEN FARKLILIĞI ÖLÇEĞİ

Sevgili Öğrenci,

Bilgisayar ile yapılan öğretimin bildiğimiz sınıf ortamında yapılan öğretimden farklılığını ortaya çıkarmak için bir ölçek hazırladık.

Aşağıda bazı durum veya özellikler verilmiştir. Örneğin, bilgisayar destekli eğitimde derse ilginiz, diğer öğretime göre arttı ise arttı kutucuğunu, azaldı ise azaldı kutucuğunu, değişmedi ise değişmedi kutucuğunu işaretleyiniz.

Bilgisayar destekli eğitimde;	*ARTTI*	*AZALDI*	*DEĞİŞMEDİ*
1. Derse ilgi	0	0	0
2. Dersi anlama	0	0	0
3. Derse dikkat süresi	0	0	0
4. Öğretmenden yardım	0	0	0
5. Korku	0	0	0
6. Utanma	0	0	0
7. Gürültü	0	0	0
8. Kendini değerlendirme	0	0	0
9. Rahatlık	0	0	0
10. Öğretmen-öğrenci etkileşimi	0	0	0
11. Öğrenci-öğrenci etkileşimi	0	0	0
12. Ödül alma	0	0	0
13. Güven	0	0	0
14. Çalışma isteği	0	0	0
15. Başarı	0	0	0
16. Okulu sevme	0	0	0
17. Endişe / Kaygı	0	0	0

APPENDICES C

Manual Of "CONCEPT"

Used in Experimental Group

INTRODUCTION TO PROGRAM

Starting and Quitting program:

STARTING:

To start the program, follow these steps:

1- Insert the program diskette in the diskette drive.
2- Start your computer.

NOTE: If your mouse is not attached, the following display appears.

No mouse installed. Press + to use keyboard.

In such a case, press shift and + at the same time to start the program.

3- Press any key to continue.

QUITTING:

To exit the program,

1- Click on EXIT TUTOR at the upper right box.

2- Take the disk out and then turn the computer off.

GENERAL

Using the Menu:

This program is menu driven. The current menu appears at the bottom of the screen as shown:

							Data	Calc
RULES	HINT	Example	Question	Solution	Next	Back	Menu	Print

RULES:

If you click on rules box, principles that related to the current topic appears.

HINT:

This gives the necessary hints (help) to solve the problem if you have any difficulty.

EXAMPLE:

If you click on this box, then the questions with their solutions appears.

QUESTION:

If you click on questions box, questions from the selected menu appears.

NEXT:

If you click on next box, questions of the next topic appears on the screen.

BACK:

Back menu allows you to access to the questions of previous topic.

DATA:

When you click on this box, the data containing atomic weights of elements appears.

CALC:

This box allows you to perform the required calculations. (multiplication, division, addition and substraction)

PRINT:

This box allows you to printout the desired questions.

MENU

You may choose the topic you want to study simply by clicking on the MENU box of the menu items. After clicking the following line appears on the bottom of your screen.

1-Mole(E) 2-Mole(C) 3-Mass(E) 4-Mass(C) 5-Number(E) 6-Number(C)

Select your choice and type it.

In there 1-Mole(E) means mole of an element
2-Mole(C) means mole of a compound
3-Mass(E) means mass of an element
4-Mass(C) means mass of a compound
5-Number(E) means number of atoms of an element
6-Number(C) means number of molecules of a compound

As an example if you want to study on the topic " Moles of compound to mass of compound" you must simply type 24 .

MORE ABOUT MENU

In the following section details of menu selection are given.

digits: 11

. Moles of element1 in a compound to moles of element2 in the same compound

digits: 12

. Moles of Element in Moles of compound

. Moles of an Element to Moles of Compound

digits: 13

. Moles to Atomic Weight in grams

. Moles of Atoms to Mass in grams

. Moles of Element1 to Mass of Element2

. Mass of Element1 to Moles of Element2

digits: 14

. Mass of Compound to Number of Molecules

. Number of Molecules to Mass of compound

digits: 15

. Moles to Mass of a Compound

. Mass to Mole of a Compound

. Moles of Element1 to Number of Element2 Atoms

. No. of Atoms of Element1 to Moles of Element2

digits: 16

. Moles of Element to No. of Molecules

. No. of Molecules to Moles of Element

digits: 22

. Moles of Atoms to Mass in grams

. Mass in grams to Moles of Atoms

digits: 23

. Moles of Compound to Mass of Element

. Mass of Element to Moles of Compound

digits: 24

. Mass to Number of Molecules

. Number of molecules to Mass

digits: 25

. Moles of Molecules to No. of Atoms

. No. of Atoms to Moles of Molecules

digits: 26

. Moles to Atomic Weight of an Element

. Moles of Atoms to Mass in grams

digits: 33

. Mass of Element1 to Mass of Element2 in a compound

digits: 34

. Molecular Weight- Formula Weight

. Mass of Compound to Mass of element

. Mass of Element to mass of Compound

digits: 35

. No. of Atoms to Mass

. Mass in grams to No. of Atoms

. Mass of Element1 to No. of Atoms of Element2

. No. of Atoms of Element1 to Mass of Element2

digits: 36

. Mass of Element to No. of Molecules

. No. of Molecules to Mass of Element

digits: 44

. Molecular Wt. - Formula Wt.

digits: 45

. No. of Atoms of Element to Mass of Compound

. Mass of Compound to No. of Atoms of Element

digits: 46

. Mass of Compound to No. of Molecules

. No. of Molecules to Mass of Compound

digits: 55

. No. of Atoms of El1 to No. of Atoms of El2

digits: 56

. No. of Molecules to No. of Atoms of Element

. No. of Atoms of Element to No. of Molecules

digits: 66

. Moles to Number of molecules