EFFECTIVENESS OF CONCEPTUAL CHANGE INSTRUCTION ACCOMPANIED WITH DEMONSTRATIONS AND COMPUTER ASSISTED CONCEPT MAPPING ON STUDENTS' UNDERSTANDING OF MATTER CONCEPTS

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

AYSE YAVUZ

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY
IN
SECONDARY SCHOOL SCIENCE AND MATHEMATICS EDUCATION

JANUARY 2005

Approval of the Graduate School of Natural and Applied Sciences

Prof Dr. Canan Özgen
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Doctor of Philosophy.

Professor Dr. Ömer Geban
Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Doctor of Philosophy.

Prof. Dr. Ömer Geban
Supervisor

(Prof. Dr. Hamide Ertepinar)	METU, ELE	
(Prof. Dr. Ömer Geban)	METU,SSME	
(Assoc. Prof. Ceren Tekkaya)	METU, ELE	
(Assoc. Prof. Dr. Ayhan Yilmaz)	Hacettepe Univ.	
(Assist. Prof. Dr.Esen Uzuntiryaki)	METU, SSME	

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name : Yavuz Ayse

Signature :

ABSTRACT

EFFECTIVENESS OF CONCEPTUAL CHANGE INSTRUCTION ACCOMPANIED WITH DEMONSTRATIONS AND COMPUTER ASSISTED CONCEPT MAPPING ON STUDENTS' UNDERSTANDING OF MATTER CONCEPTS

Yavuz, Ayse

PhD., Department of Secondary Science and Mathematics Education

Supervisor: Prof. Dr. Ömer Geban

January 2005, 133 pages

The main purpose of this study was to investigate the effectiveness of conceptual change instruction accompanied with demonstration and computer assisted concept mapping on seventh grade students understanding matter concepts. In addition, the effect of instruction on students' attitudes toward science as a school subject and the effect of gender difference on understanding matter concepts were investigated.

Seventy five, seventh grade students from four classes of a General Science Course taught by the same teacher at Özel ENKA Middle School during fall semester of 2003–2004 was enrolled in this study.

The classes were randomly assigned as conrol group and experimental group. Students in the control group received traditional science instruction including traditional lecture method with discussions and traditionally designed labsheets. Students who were in the experimental group received conceptual change instruction accompanied with demonstration and computer assisted concept mapping. Both groups were administered Matter Concept Test as pre- and post-tests and Attitude Scale toward Science as a School Subject. In addition to these, Science Process Skill Test was used at the beginning of the study to determine students' science process skills.

T-test, univariate analysis of variance (ANOVA) and analysis of covariance (ANCOVA) were used for testing the hypotheses of the study. The results indicated that conceptual change instruction accompanied with demonstration and computer assisted concept mapping caused a better acquisition of scientific conceptions related to matter concepts and produced more positive attitudes toward science as a school subject than traditionally designed sicence instruction. In addition, science process skill was a strong predictor in understanding matter concepts. On the other hand, no significant effect of gender difference on students' understanding of matter concepts and their attitudes toward science as a school subject was found.

Keywords: Misconceptions, Alternative Conceptions, Conceptual Change Approach, Traditional Science Instuctin, Concept Map, Demonstration, Attitude Toward Science as a School Subject, Matter.

ÖZ

GÖSTERI VE BILGISAYAR DESTEKLI KAVRAM HARITALARIYLA DESTEKLENEN KAVRAMSAL DEGISIM METODUNUN ÖGRENCILERIN MADDE KONUSUNU KAVRAMALARINA ETKISI

Yavuz, Ayse

Doktora, Ortaögretim Fen ve Matematik Alanlari Egitimi Bölümü

Tez Yöneticisi: Prof. Dr. Ömer Geban

Ocak 2005, 133 sayfa

Bu çalismanin temel amaci gösteri ve bilgisayar destekli kavram haritalariyla desteklenen kavramsal degisim metodunun yedinci sinif ögrencilerinin madde konusunu anlamalarina etkisini geleneksel yöntem ile karsilastirmaktir. Ayni zamanda ögretim yönteminin ögrencilerin Fen Bilgisi dersine yönelik tutumlarina etkisi ve cinsiyet farkinin ögrencilerin madde ile ilgili kavramlari anlamalarina etkisi de arastirilmistir.

Bu çalisma Özel ENKA Ilkögretim Okulu'nda 2003-2004 Egitim Ögretim yili sonbahar döneminde ayni ögretmenin Fen Bilgisi alan dört sinifinda toplam seksen, yedinci sinif ögrencisiyle yapilmistir.

Siniflar rastgele olarak kontrol ve deney grubu olarak seçilmistir. Kontrol grubunda geleneksel yönteme dayali anlatim, tartisma ve geleneksel yöntemle hazirlanmis deneyler kullanilmistir. Deney grubunda ise kavramsal degisim yöntemi gösteri deneyleri ve bilgisayar destekli kavram haritalari ile pekistirilmistir. Iki gruba da Madde Kavram Testi öntest ve sontest olarak uygulanmistir. Ögrencilerin Fen Bilgisi dersine karsi tutumlarini belirlemek üzere Fen Bilgisi Tutum Ölçegi uygulanmistir. Bunlara ek olarak çalismaya baslamadan önce ögrencilerin islem becerilerini belirlemek üzere Bilimsel Islem Beceri Testi uygulanmistir.

Çalismanin hipotezleri t-testi, tek degiskenli varyans analizi (ANOVA) ve ortak degiskenli varyans analizi (ANCOVA) kullanilarak test edilmistir. Sonuçlar gösteri deneyleri ve bilgisayar destekli kavram haritalariyla pekistirilen kavramsal degisim metodunun ögrencilerin madde kavramlarini anlamalarinda daha etkili oldugunu ve Fen Bilgisi dersine karsi daha olumlu tutuma yol açtigini göstermistir. Ek olarak, Bilimsel islem becerisinin de ögrencilerin madde ile ilgili kavramlari anlamalarina istatistiksel olarak anlamli katkisi oldugunu belirlemistir. Diger taraftan, cinsiyet farki ögrencilerin madde kavramlarini anlamalarinda ve Fen Bilgisi dersine karsi tutumlarinda istatistiksel olarak herhangi bir etki yaratmadigi görülmüstür.

Anahtar Kelimeler: Kavram Yanilgilari, Alternatif Kavramlar, Kavramsal Degisim Yaklasimi, Geleneksel Yöntem, Kavram Haritasi, Gösteri Deneyi, Fen Bilgisine Karsi Tutum, Bilimsel Islem Becerisi, Madde

ACKNOWLEDGMENTS

I wish to express my deepest gratitude to my supervisor, Prof. Dr. Ömer Geban, for his guidance, advice, criticism and encouragement and insight throughout the research.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

CCIDS	: Conceptual Change Instructio Accompanied with Demosntrations and Concept Maps
TDSI	: Traditionally Designed Science Instruction
MCT	: Matter Concept Map
ASTS	: Attitude Scale Toward Science as a School Subject
SPST	: Science Process Skill Test
df	: Degrees of Freedom
SS	: Sum of the Squares
MS	: Mean Square
t	: T Statistic
p	: Significance Level or probability
n	: Sample Size
$\overline{X}$	: Mean of Sample
s	: Standard Deviation of the Sample

CHAPTERS

I. INTRODUCTION

Learning is a dynamic continuous process in which the new information interacts with the existing knowledge. To be successful in learning, students have to take possession of knowledge actively, by seeking explicit, conceptual linkages between new concepts and those they already possess. This process of elaborating personal, meaningful knowledge takes place by restructuring the already existing conceptual frameworks. Many of these studies have revealed the difficulties students have in making connections between various representations, basic concepts and principles, and real world phenomena (McDermott, Rosenquist, and Zee, 1987; Goldberg and Bendall, 1992). Many decisions students make about the behavior of physical systems seem to be driven by prior knowledge and beliefs. Ausubel (1968) stated that “If I had to reduce all of educational psychology to one principle, I would say this: The most important single factor influencing learning is what the learners already know. Ascertain this and teach accordingly”. Ausubel also emphasizes the importance of meaningful learning. Meaningful learning occurs when the learner’s appropriate existing knowledge interacts with the new learning in a non-arbitrary and substantive way. Osborne and Freyberg (1985) have revealed the knowledge claims employed by learners are not often well grounded by what they call “sound rules” or relevant associations of concepts. Research in students` misconceptions has found that students frequently have knowledge frameworks that, when taken together, are inconsistent within themselves. This conclusion implies that students' knowledge often consists of separate facts, formulas and equations poorly organized for retention and use (Heuvelen, 1991; Mestre, 1991).

There have been many studies of students' understanding and misunderstanding with regard to science in general and to chemistry specifically. Many of these studies have found that students have informal ideas which make sense of the world around them. In different studies these informal ideas have been described and named in different ways as preconceptions, alternative frameworks (Driver and Easley, 1978), spontaneous reasoning (Viennot, 1979), naive beliefs (Caramazza, McCloskey and Green, 1981), children's science (Osborne, Bell and Gilbert, 1983), alternative conceptions (Hewson and Hewson, 1989) and misconceptions (Griffiths and Preston, 1992). These alternative conceptions affect how the scientific knowledge is learned and have been found to hinder learning and meaningful understanding of scientific concepts taught in school (Hewson and Hewson, 1983; Shuell, 1987). Yavuz (1998) said that students usually pass their science courses without acquiring a proper understanding of the concepts, rather memorizing or solving related problems many times.

Literature on sources of incorrect conceptions shows that the sources of misconceptions can be various. Students' interaction with physical and social world

(Strauss, 1981), textbooks (Cho, Kahle and Nordland, 1985; Sanger and Greenbowe, 1999) and even interactions with teacher can lead to nonscientific conceptions.

This concern has increased research studies on student conceptual understanding in many subject areas as well as chemistry. Chemistry is a science that involves many abstract concepts that can be interpreted and learned incorrectly by the students. Many students exhibit misconceptions in several content areas in chemistry such as mole concept (Yalçinalp, Geban and Özkan, 1995), chemical equilibrium (Camacho and Good, 1989), matter (Mulford, 1997), electrochemistry (Garnett, 1992), acids and bases (Yavuz, 1998), chemical bonding (Uzuntiryaki, 2003), Gases (Azizoglu, 2004). Many studies focused on identifying the misconceptions related to the particulate nature of the matter (Novick and Nussbaum, 1981; Osborne and Crosgrove, 1983; Griffiths and Preston 1992). Since it is not possible to view the inside of matter it is perceived as abstract and therefore considered as difficult by many students. Understanding matter concepts requires understanding matter at molecular level. Understanding matter at molecular level is essential in order to understand the behavior of molecules through phase changes. Also to understand physical and chemical changes it is important to know that mass and quantity is conserved in all changes that matter undergoes.

Misconceptions held by students have many common features. One of the most important features of misconceptions is that they are highly resistant to traditional teaching (Chi, & Roscoe, 2002). Therefore researchers investigated how students change their alternative conceptions to scientific concepts. Since the main purpose of science education is the higher understanding of scientific conceptions, there should be effective instructional approaches eliciting meaningful acquisition of the scientific knowledge. There are various instructional methods used to overcome misconceptions for better understanding and meaningful learning. One of those methods is conceptual change model developed by Posner et al. (1982). This model proposed two types of conceptual change: Assimilation and Accommodation. Assimilation describes the process where students use existing concepts to deal with new phenomena and accommodation describes when students must replace or reorganize their concepts. They postulated four conditions necessary for conceptual change to occur:

a) there must be dissatisfaction with existing conceptions

b) a new conception must be intelligible

c) a new conception must appear initially plausible

d) a new conception should suggest the possibility of a fruitful research program

Many techniques based on the conceptual change approach help students to change their misconceptions. Using chemical demonstrations and concept mapping as supplements to conceptual change instruction are effective on correcting students' misconceptions.

An effective way to promote student understanding of abstract concepts is to perform demonstrations. Demonstrations provide teachers with a way to motivate students to learn and retain knowledge of chemistry. A chemical demonstration can focus a students' attention and arouse student interest and curiosity in the lesson being taught. Demonstrations can reflect the teachers' enthusiasm for the subject matter as well. Because chemical demonstrations can be used to demonstrate and/or imitate real-life phenomenon, students can see the importance of chemistry in their lives and learning experiences become more memorable.

Concept maps are very useful in curriculum planning. They present in a highly concise manner the key concepts and principles to be taught. The hierarchical organization of concept maps suggests more optimal sequencing of instructional material. Since the fundamental characteristic of meaningful learning is integration of new knowledge with the learners' previous concept and propositional frameworks, proceeding from the more general, more elusive concepts to the more specific information usually serves to encourage and enhance meaningful learning (Novak, 1984b).

Many research studies displayed that the type of instruction affected students' attitudes toward science as a school subject and that the students' attitudes had potential to affect students' motivation, interest and achievement in science (Rennie and Punch, 1991; Chambers and Andre, 1997; Greenfield 1996). In this study the effect of treatment on students' attitudes toward science was also investigated.

This study also investigated the contribution of science process skills to students' understanding of matter concepts. Science process skills were described as terminal skills for solving problems or doing experiments (Beaumont-Walter and

Soyibo, 2001). Science process skills involve identifying variables, identifying and stating hypotheses, operationally defining, designing investigations, graphing and interpreting data, explaining results and deducing conclusions. Low performance in using science process skills can be considered as important indicator of serious instructional problem (Mestre and Lochhead, 1990).

This present study was planned to identify the number and the type of alternative matter conceptions held by the seventh grade students before and after varying types of instruction. Also, the study compared the conceptual change instruction accompanied with demonstrations and computer assisted concept mapping interacting with traditionally designed science instruction. In essence, the main aim of conceptual change oriented instruction was to activate the secondary school students' misconceptions related to matter concepts and replace the misconceptions with cognitive science concepts. Also, the effects of gender difference and science process skills were investigated with respect to understanding of matter concepts.

This thesis comprises six chapters. In chapter 1 difficulty in chemistry teaching and why students struggle with chemistry concepts are summarized. Chapter 2 is devoted to a discussion on the comparison between understanding and knowledge, the meaning of misconception, and literature on misconceptions in chemistry teaching, conceptual change, demonstrations and concept mapping as teaching techniques. Chapter 3 is concerned with the main problem, sub-problems and associated hypotheses of the study. In chapter 4, the design of the study is summarized including the experimental design, variables, instruments used the treatment and the analysis of the data gathered. Chapter 5 includes the results and conclusion of the study. The last chapter of the study involves discussion of results and implications for further studies.

II. LITERATURE SURVEY

The main goal of science education is learning scientific concepts meaningfully. It is widely accepted that students come to class with their own ideas. These ideas are most of the time incorrect conceptions. In order for a meaningful learning, student conceptions should be identified prior to instruction.

Ausubel (1978) stated three conditions required for meaningful learning:

- The material to be learned must be conceptually clear and presented with language and examples relatable to the learner's prior knowledge. Concept maps can be helpful to meet this condition, both by identifying large general concepts prior to instruction in more specific concepts and by assisting in the sequencing of learning tasks tough progressively more explicit knowledge that can be anchored into developing conceptual frameworks

- The learner must possess relevant prior knowledge. For this condition it is necessary to be careful and explicit in building concept frameworks if one hopes to present detailed specific knowledge in any field in subsequent lessons. Therefore, conditions 1 and 2 are interrelated and both are important.

The learner must choose to learn meaningfully. The one condition over which the teacher or the mentor has only indirect control is the motivation of the students to choose to learn by attempting to incorporate new meanings into their prior knowledge rather than simply memorizing concept definitions or propositional statements or computational procedures.

At this point a successful instruction would create learning environments providing students with opportunities to change their incorrect conceptions to scientific conceptions. To be successful in learning, students have to take possession of knowledge actively, by seeking explicit, conceptual linkages between new concepts and those they already possess. This process of elaborating personal, meaningful knowledge takes place by restructuring the already existing conceptual frameworks.

Chemistry particularly is a subject area where students' conceptions apart from the scientific facts. Discussions help teachers to recognize students' ideas about the concepts and also the help students to become aware of their thinking. Demonstrations embedded within the instructional sequence are useful tools for introducing the abstract concepts in a concrete form. Additionally, concept maps are useful instruction tools that help students to form relations between the key concepts within a topic. Instruction based on conceptual change helps teachers to affect the students' attitudes or interest toward science which in turn leads students construct scientific concepts using their existing conceptions. On this ground, the literature were examined with respect to students' conceptions, misconceptions in matter, conceptual change approach, demonstrations, concept mapping and students' attitudes and its relation with achievement.

2.1 Students' Conceptions in Science

In the literature there are vast amount of research studies carried out by many researchers to identify students' informal ideas (Driver and Easley, 1978; Osborne, Bell and Gilbert, 1983; Driver, 1992; Eylon and Linn, 1988; Wandersee, Mintzes and Novak, 1994). The common statement in these studies is that students develop some informal ideas making sense of the world around them. In different studies these informal ideas have been described and named in different ways as preconceptions, alternative frameworks (Driver and Easley, 1978), spontaneous reasoning (Viennot, 1979), naive beliefs (Caramazza, McCloskey and Green, 1981), children's science (Osborne, Bell and Gilbert, 1983), alternative conceptions (Hewson and Hewson, 1989) and misconceptions (Griffiths and Preston, 1992). At this point a common question arises: Do all these terms indicate different things or imply same things? It is well established that, during everyday life, children develop their own ideas from the world they live in and use them to make sense of the natural phenomena they experience (Anderson, 1989). Conception is an individual interpretation of the outside world and of the behavior within it. Preconceptions indicate the conceptions formed before formal instruction.

Children's science term also indicates children's idea formed prior to formal science teaching. Children have belief about how thins happen or have clear meanings for words which are used in everyday language and science (Gilbert, Osborne and Fensham, 1982). These views that they bring to classroom are logical and coherent for them but these views influence how and what they learn from the classroom experiences. Gilbert et al. (1982) delineated three ways of interactions of student ideas with classroom instruction. The first assumption is that students enter classroom with little or no knowledge relevant to the content of instruction. The second assumption supposes that the ideas held by the students can be easily displaced by effective instruction. The third assumption recognizes that the students' ideas are resistant to change. The interaction between these stable conceptions and instruction may yield several different outcomes: The students retain their idea intact; the students retrieve both their conceptions and school science knowledge or students may hold a form of synthesis between the two. Of course, the desired situation is students to gain a perspective that resembles that of school science.

Driver and Easley (1978) proposed the term alternative framework to indicate the interpretations that arise from students' personal experience of natural events and their attempt to make sense of them for themselves, prior to instruction. Schmidt (1997), described the term alternative frameworks as opposed to the alternative conceptions as a set of students' ideas that can be seen as a meaningful and logical coherent alternative to a science concept.

The term alternative conception (Hewson and Hewson, 1989) is used to describe a conception that in some aspects is contradictory to or inconsistent with the concept. Such inconsistencies usually appear in relations of the conception with other conceptions. Alternative conception often involves more than one concept.

The word "misconception" implies; Students' mistaken answers to particular situation, students' ideas which cause mistaken answers about a particular situation, students' beliefs about how the world works different than that of the scientists (Dykstra, Boyle and Monarch, 1992).

In order to dispel students' misconceptions, it is necessary to identify the sources of these misconceptions. During learning, the student tries to connect new knowledge into his cognitive structure. If he holds misconceptions, these misconceptions interfere with subsequent learning. Therefore, new knowledge can not be connected to his existing structure and misunderstanding of the concept occurs (Nakleh, 21992). So, students' ideas are important factor affecting the development of misconceptions.

Haidar and Abraham (1991) found that formal reasoning and pre-existing knowledge play an important role in the development of students' conceptions. Their study stated possible sources of misconceptions as:

i) Macroscopic reasoning: The students may have difficulty in translation of observable behavior of matter to the scale of atoms and molecules.

ii) Instruction: The students may misinterpret instructional devices. They suggested writing the chemistry curriculum materials in a way that promotes connections between students' macroscopic experiences and their scientific microscopic explanations. Students need instruction that will help them develop link between the macroscopic observations in the laboratory and the microscopic models that chemists use to explain them.

Smith and Metz (1996) also reported the same arguments about microscopic representations. They claimed that chemical concepts should be explained by microscopic representations before applying the mathematics. This must increase comprehension and retention by allowing students to picture the chemistry.

Another possible source of students' misconceptions is everyday knowledge. Prieto et al. (1989) suggested that students' ideas were the result of interaction between their social and school knowledge. Science teaching should address the issue of everyday language directly in the students' lessons. In the chemistry classroom, students' everyday ideas should be considered firstly, but in addition, the students should be encouraged to see chemists' ways of looking at the same phenomenon as a fruitful alternative in particular context. Better curriculum materials based on students' ways of learning and their prior knowledge to formal instruction should be developed (Longden, Black and Solomon, 1991; Ebenezer and Ericson, 1996).

Teachers themselves also may cause misconceptions. They may misunderstand the context. However, although instruction is accurate, students may misunderstand some concepts due to inadequate prerequisite knowledge (Taber, 1995).

Summary of the Misconception Literature:

Findings from the studies discussed above and from numerous other descriptive studies of misconceptions can be summarized as follows:

- Chemistry is a complex, abstract subject that lends itself to many misconceptions
- Misconceptions are deeply held (Griffiths & Preston, 1992) and persist, even after instruction (Gabel, 1999).
- Misconceptions are ubiquitous, occurring in all age and educational levels.
- Misconceptions are often internally consistent and coherent.
- The lack of particulate views of matter leads to common misconceptions about structure, bonding, and other chemical principles.
- Misconceptions arise from a variety of sources.
- Misconceptions are resistant to change (Chi, & Roscoe, 2002).

2.2 Students' Misconceptions in Matter Concepts

There are many researches done on the particulate nature of matter and all of these studies established that many of the students hold on to their childhood science concepts regardless of their age and level.

Bethge and Niedderer (1996) asked German students grade 13 (age 19) students to draw an atom. They found out that 25% of the students' drawings included conceptions close to those of quantum physics, another 25% used conceptions between quantum physics and classical physics such as "smeared orbits" and 50% drew the atom in terms of classical physics.

In another study of German secondary students' models of an atom, Fischler and Lichtfeldt (1992) taught a unit of 32 lessons concerning quantum physics to a test group of secondary students. They found out that 68% of the students in the test group oriented themselves toward conception of localization of energy whereas the control group students persisted in the conception of circle and shell.

Albanese and Vincentini (1995) point out that in teaching about atoms the focus is not on the existence of atoms, but on convincing students of the validity of an atomic model in order to explain the macroscopic properties of matter. Albanese and Vincentini (1995) concluded that "students seem to consider atoms not only as the elements of a model which tries to explain macroscopic properties as emergent properties of the collection of the elements but as the smallest part in which a microscopic object may be subdivided while retaining its characteristics.

Ünal and Zollman (1997) conducted a research study to investigate grade 9 through 12 students' ideas about an atom by asking them to describe an atom on a paper and pencil questionnaire. In their study they investigated students' understanding of the structure of an atom, its constituents and their approximate locations, the size of an atom and energy released by an atom. After their investigations they concluded that students fell into low hierarchical level of reasoning categories in terms of describing the atom. Forty-six percent of 9th graders fell into the combination of categories "constituents and models" or "units, constituents and models" whereas twenty-eight percent of 10th graders and twenty-six 11th graders fell in these combinations of categories. They also found out in their study that majority of the students did not include a model in their description of an atom. Students who included a model in their description used mechanical models in their descriptions whereas 3% of them mentioned some quantum mechanical concepts. The data they obtained showed that about 69% of all students except 9th graders indicated an atom could be seen with present technology. Ünal and Zollman (1997) concluded from most of the students' responses that they perceive atoms as something very small but still visible. They suggested that students are not clear about the size of the micro-world.

Mulford (1997) worked on first year college students' misconceptions in general chemistry topics. He grouped the misconceptions under different subtitles as: Phase Changes, conservation, macroscopic versus microscopic properties, solutions, ize of the atom,

1. Phase Changes:

- When water boils it breaks into its components hydrogen and oxygen molecules or atoms (Osborne and Cosgrove, 1983)
- The bubbles in the boiling water are composed of air (Osborne and Cosgrove, 1983)
- In the process of evaporation of water or alcohol the water or alcohol either disappears or is changed into something new (Lee, Eichinger, Anderson, Berkheimer and Blakeslee, 1993)
- Osborne and Cosgrove (1983) conducted a further study with 17-18 year olds to determine several misconceptions relating to the states of matter and changes

between those states. These misconceptions were: The bubbles in a jug of boiling water were made of air, heat, hydrogen and oxygen or steam.

Stavy (1990) concluded that, only 50% of the seventh grade students understood conservation of matter in the process of evaporation. Shepherd & Renner (1982) found that no tenth grade had a clear understanding of the states of matter and all had partial understanding and misunderstanding.

2. Conservation:

Osborne and Cosgrove, (1983) asked the question predict the weight or an iron nail after rusting to secondary students. Many predicated that an iron nail would weigh less after rusting and some said the weight would remain the same. Bodner (1991), found similar results among graduate students in chemistry, finding that 10% of the students predicted the iron bar to weigh less and 6 percent predicted that the weight would remain the same.

Similar to, Osborne and Cosgrove (1983), Bodner (1991) and Furio et al. (1996) found that 55% of the 12-13 year old students incorrectly predicted the results of the mass change for the oxidation of iron.

Basili and Sanford (1991) looked at different teaching strategies for encouraging conceptual change using conservation as one of their probes. By asking the questions “When a match burns, some of its matter is destroyed. Is this a true or a false statement? Explain your answer” they found out that 33% of the treatment group and 73% of the control group held misconceptions.

3. Macroscopic Versus Microscopic Properties:

Ben-Zvi, Eylon and Silberstein (1986) conducted a study with 10th grade students to differentiate macroscopic properties versus microscopic properties. Tenth grade students in Israel were presented a list of three properties of a metallic wire and three properties of the gas resulting from the evaporation the same wire. The students were asked to predict which six properties would remain the same for an individual atom obtained from the wire and which would remain the same for an individual atom from the gas. Forty six percent of the students did not make any distinction between the properties of an individual atom.

4. Solutions:

Lee et al. (1993) found that several middle school students held a destructive view of dissolving, using the term disappear synonymously with dissolve. Some students also held a transmutation view of dissolving, stating that “The sugar eventually becomes water”. Ebenezer and Gaskel (1995) asked a similar question as Lee et al. about sugar/water and asked grade 11 and grade 12 students’ conceptions of solutions. The results were similar to the results of Lee et al.

5. Size of an atom:

Griffith and Preston (1992) identified 52 misconceptions the twelve grade students have toward the fundamental characteristics of atoms and molecules. Of the 52, 19 were prevalent in over one third of the students, and six in over 50%. Also, macroscopic shapes reflect molecular shapes, matter is continuous and all matter is alive and sensitive.

Sometimes students who can successfully describe that matter consists of particles assign bulk properties to particles themselves. These kinds of misconceptions were revealed in a study carried out with 30 grade 12 Canadian students drawn from 10 high schools (Griffiths and Preston, 1992). Data were collected using interviews. The interview guide consisted of two parts, one related to molecules and the other to atoms. Questions in the first part were about the structure, composition, size, shape weight, bonding and energy of water molecules. The second part questions were about the structure, shape, size, weight and perceived animism of atoms. Subjects were grouped as Academic Science, Academic Non-science and Non-academic Non-science according to their academic average and science courses (chemistry, biology or physics) completed or on completing. Each group consisted of 10 students. As stated in the Mulford's classification of misconceptions Griffiths and Preston identified 52 misconceptions at the end of their research. Misconceptions related to the gaseous state of water were as follows: Water molecules from the gaseous phase (steam) are the smallest/largest, water molecules from gaseous state are the lightest, matter exists between atoms, collisions may result in a change of atomic size.

Sanger, Phelps and Fienhold (2000) developed an instructional approach to improve students' conceptual understanding of the molecular processes occurring when a can containing water is heated, sealed, and cooled. Two groups, control and experimental were taught by different kinds of instruction. The control group consisted of 70 students. They received instruction using static chalkboard drawings and overhead transparencies. The experimental group consisted of 86 students. They received the similar instruction including the use of a computer animation of this process at the molecular level. The can-crushing demonstration in which a soda can containing small amount of water was heated on a hot plate to boil the water, removed from the heat and sealed by inverting over a container of cold water was shown to all students. The students in the experimental group in addition, viewed the computer animation. The students were asked to predict what happen to the can and to explain what happen in the molecular level. The students in the experimental group were more likely to predict that, can collapse and were less likely to quote memorized mathematical relationships. The students in the control group quoted gas laws in their predictions. Some of the misconceptions identified among control group students are as follows: The gas molecules when heated are expanded and when they cool they shrink back not taking up as much space as before, the gas molecules take the shape and volume of the container they are in, the water vapor inside it would continue to press out against the can due to Charles Law and the can would possibly explode if the pressure was large enough

Lee et al. (1993) conducted a study to examine students' conceptual frameworks that students use to explain the nature of matter and molecules and to assess the effectiveness of two alternative curriculum units in promoting students' scientific understanding. The study involved 15 sixth grade science classes taught by 12 teachers. Data were collected through paper and pencil tests and clinical interviews for two consecutive years. The clinical interview included eight major tasks, each with several subtasks, concerning the nature of matter, three states of matter, expansion and compression of gases, thermal expansion, dissolving, melting and freezing, boiling and evaporation and condensation. The interviews were administered to 24 target students before and after instruction each year. The results revealed that students tended to attribute observable properties to molecules themselves. For example, students argue that the ice molecules would be cooler than the ones in the water. Also, students believe that air flows like water from one place to another and thus is unevenly distributed. Another misconception was as such "when a substance evaporates it no longer exists". About the second part of the study the results showed that the students taught by the revised unit in year 2 performed significantly better than the students taught by the original commercial curriculum in year 1.

As mentioned in the Mulford's classification of misconceptions Stavy (1990) carried out a study to examine Israeli children’s (ages 9-15) conceptions of changes in the state of matter from liquid or solid to gas, as well as their understanding of the reversibility of this process. Each student was interviewed while being shown the materials and the processes. First task was related to the evaporation of acetone. The subjects were presented with two identical closed test tubes, each containing one drop of acetone. The acetone in one tube was heated until it completely evaporated. The students were asked about the conservation of matter and conservation of properties of matter such as smell. Also, the conservation of weight and reversibility of the process were asked. The second task was related to sublimation of iodine. The subjects were presented with two identical closed test tubes, each containing an iodine crystal of identical size. The iodine in one tube was heated, upon which it turned completely to a purple gas filling the entire volume of the test tube. The students were asked about the conservation of matter and conservation of properties of matter such as smell. It was found that the students who recognize the conservation of mass in the first task did not necessarily recognize the conservation of mass in the second task.

Students who perceived the conservation of matter and properties in their explanations focused on the facts that “the tube was closed” and “the material only changed its state or form”.

Paik et al. (2004) investigated students’ conceptions of state change and conditions of state changes. Subjects were selected among kindergarteners, second grade, fourth grade, sixth grade and eighth grade students. Five students from each level, total of 25 students were interviewed on tasks related to boiling, condensation, melting and solidification. Second grade students tended to explain that vapor changes to gas, air, steam or wind. The upper grade students had some conceptions of the invisible gas state but few of them could explain the conditions of state changes.

2.3 Conceptual Change Approach

Connection of new knowledge to the existing knowledge is important to promote meaningful learning. Therefore, teachers should take students’ prior knowledge into consideration because it is the most important factor affecting the meaningful acquisition of the concepts. Moreover, meaning learning in science requires more than just adding new concepts to the knowledge. It involves realigning, reorganizing or replacing existing conceptions to accommodate new ideas (Smith, Blakeslee & Anderson, 1993). This process has been called a process of conceptual change. Posner et al. (1982) proposed a conceptual change model of how students' conceptions change under the impact of new ideas and new evidence. Posner in his model of conceptual change describes learning as an active process in which conceptions of new experiences are built as a result of interaction with previous experiences. Learning in conceptual change model has been explained by two processes: If learner knows little about the learning task, the new information can be incorporated with the existing ideas; this process was referred to "assimilation" by Posner et al. (1982) and "conceptual capture" by Hewson and Thorley (1989). On the other hand, learners may have a well-developed conception about the learning task that may conflict with the new knowledge. In order to accept the new knowledge, learners restructure their existing ideas; this process was called "accommodation" by Posner et al. (1982) and "conceptual change" by Hewson and Thorley (1989). Posner et al. (1982) described four conditions that must be fulfilled before this type of change to occur:

1. There must be dissatisfaction with the existing conceptions. The individual must realize that the existing conceptions create difficulties or do not work without considering a new one. The major source of dissatisfaction is the anomaly. An anomaly exists when one is unable to assimilate something.

2. A new conception must be intelligible. The individual must be able to grasp how experience can be structured by a new concept scientifically to explore the

possibilities inherent in it. Finding theories intelligible requires more than just knowing what the words and symbols mean. Intelligibility also requires constructing or identifying a coherent representation of what a passage or theory is saying. Analogies and metaphors can make the new ideas intelligible.

3. A new conception must be plausible. That is, the learner should believe that the conception is true and consistent with other knowledge.

4. A new concept must be fruitful. The learner should be able to solve new problems by using the new conception.

These conditions are not the concrete conditions which used be used directly in the classroom by both teachers and students, but teachers should help students to meet each of the conditions to achieve conceptual change.

Stepans (1996) stated that conceptual change model creates an atmosphere where students confront their own preconceptions and those of their classmates, then work towards an answer and conceptual change. His model consisted of six strategies: 1. Students become aware of their own preconceptions about a concept by thinking about it and making predictions (committing to an outcome) before the activity begins, 2. Students expose their beliefs by sharing them, initially in small groups and then with the entire class, 3. Students confront their beliefs by testing and discussing them in small groups, 4. Students work toward resolving conflicts (if any) between their ideas (based on the revealed preconceptions and class discussion) and their observations, thereby accommodating the new concept, 5. Students extend the concept by trying to make connections between the concept learned in the classroom and other situations, including their daily lives.

Students are encouraged to go beyond, pursuing additional questions and problems of their choice related to the concept.

Hewson and Hewson (1983) suggested teachers to ensure that students find new content intelligible, plausible and fruitful by taking into account of prior knowledge. Because conception presented by the teacher can be plausible to one student but not to other another, based on this idea they proposed a new approach to conceptual change including new teaching strategies as integration, differentiation, and exchange and bringing. These teaching strategies were applied to 9th grade students to teach density, mass and volume concepts. The results of the study indicated that the instructional strategy used in the experimental group was responsible for the acquisition of a significantly greater number of scientific conceptions of density, mass and volume.

An important tool of conceptual change is discussions in the class. In science classes the talk with peers and the teacher is the heart of conceptual understanding. There can be student generated inquiry discussions, small group discussions and guided discussions. Small group discussions and guided discussions are similar to each other. In small group discussions the students construct knowledge by asking questions to each other without teacher presence. Guided discussions usually evolve from small group interactions. During a guided discussion, a teacher helps students to construct knowledge by asking questions to develop their understanding of a concept. In such discussions, the teacher is responsible for eliciting the students' thinking and facilitating the students expressing their own ideas, especially when these are different from the teacher's expectations. One of the most important properties of the guided discussions is that teacher asks conceptual questions to elicit student thinking.

Considering that discussions make students aware of their understanding, they are integrated in teaching strategies dealing with remedying misconceptions. In this study, guided discussions were used as part of conceptual change approach to initiate students' alternative conceptions, to clarify where their knowledge was not true and to develop their understanding of matter concepts.

2.4 Demonstrations

According to American Heritage Dictionary, a demonstration is an illustration or explanation as of a theory or product, by exemplification or practical application. This definition of demonstration has many applications in the chemistry classroom where educators teach chemical principles, theories and phenomena. Walton (2002) says that primary purpose of demonstrations is to entice students ask questions and create a classroom where questions are answered freely. Demonstrations can be used to introduce or reinforce a topic in lecture by illustrating a concept, principle or point. Demonstrations provide teachers with a way to motivate students to learn and retain knowledge of chemistry. A chemical demonstration can focus a student's attention and raise student interest ad curiosity in the lesson being taught. For example, when following a lecture on the properties of matter; the relationship between volume, mass and density of a substance, heating an ice cube until it evaporates and collecting the vapor in a balloon can illustrate the conservation of mass as the process continues but the space occupied by the water particles increases as the ice changes into water and then water vapor due to the increase in the energy of each particle. When the same demonstration is used as the introduction to a lecture on the relationship between mass, volume and density as the common properties of matter, the student inquiry and thought processes are initiated. Students may begin comparing the relationship between mass and volume and how that is related to the density of a substance until they form a hypothesis of why volume increases as the substance goes through phase changes or why substances in gas phase has less density than in solid phase.

Walton (2002) conducted a survey on a group of undergraduate students to understand how they felt about the demonstrations they received during the lectures on Acids and Bases. The results strongly support that demonstrations are popular teaching tools. More important, most of the students agreed that demonstrations helped them understand theories-an encouraging link between demonstrations and educational value. According to Walton there are three main hurdles confronting those contemplating demonstrations:

1. Worries about safety: Chemistry teachers should be aware that they are not only responsible for teaching chemistry accurately but also present a professional and careful attitude toward handling chemicals. Doing even very simple demonstrations with some chemicals can be very hazardous. To

avoid any unwanted results of a chemical demonstration they should present students what might happen if the safety is not in the first place in such demonstrations.

2. Lack of confidence on the part of teacher: Confidence part of the teacher is another hurdle to performing demonstrations. This has two impacts: One is the personality of the teacher; he/she may feel that demonstrations do not fit in his/her teaching style; second they may feel that doing demonstration would not add anything to subject matter. For both aspects one should have evidence that demonstrations could add to chemistry teaching. Abstract subjects such as structure of atoms, wave theory where it is not immediately apparent, it is important and helpful to use demonstrations if any available.

3. The time and effort needed to put together a successful demonstration: There is little doubt that setting up and performing a demonstration is both time consuming and needs considerable motivation on the part of the teacher. There are two golden rules for preparation Walton claims: Practice the demonstration in advance and make sure that the demonstration is relevant to the material being taught.

Demonstrations are useful tools in order to foster conceptual understanding but they must be carefully selected. If a series of demonstrations is to be used, then the demonstrations should deal with a single concept. Demonstrations should be performed in place that is visible for all children. The best demonstrations are simple and direct which means they do not involve a lot of time preparing or clean-up. A demonstration should not last more than 5 minutes to perform during lecturing. Demonstrations should be supported by additional activities in order to enable students to test their conceptual understanding they construct as a result of observing demonstration (Shepardson, Moje, and Kennard-McCelland, 1994).

Some educators feel that demonstrations are a waste of time, and time is better spent in lecture covering material or in laboratory where students can actively be involved in chemistry themselves. Demonstrations should never replace laboratory exercises where students can actively engage in scientific inquiry and discovery. However, demonstrations can be used if time and amount of resources do not permit a full student laboratory investigation. In any curriculum, in addition to chemical demonstrations, equal time and effort must be dedicated to cooperative learning and "hands-on" activities, incorporating modern and relevant content, writing across the curriculum and the use of modern media/technology and assessment techniques Swanson (1999).

Demonstration when combined with other techniques was also found to be effective (Swafford, 1989; Hynd, Alvermann and Qian, 1997). Hynd et al. (1997) investigated changes in pre-service elementary school teachers' conceptions about projectile motion. A study with a group of teachers (n=73) randomly assigned to groups of using combination of texts and demonstrations and only texts technique was carried out where the concepts were the lessons. Demo-text technique was found to be effective in short-term assessment while only text group found to be more successful in producing long-term change.

2.5 Computer Assisted Concept Mapping

Taylor (1996) states in his article that, concept map is a tool, based upon the cognitive psychologist theory of constructing meaning, developed by Novak and Gowin (1984b) as a convenient and concise representation of the learner's concept/propositional framework of a domain-specific knowledge. The concepts with their linking relationships would be visible in a concept map as concept labels and verbal connectives, illustrating the organization of the concepts in the learner's cognitive structure. The chemistry teacher should then partly follow the restructuring and evolution of the structure by comparing successive concept maps constructed by the student himself/herself at different stages of the teaching and the learning process of a given topic. The concepts could so reveal: a) The concepts already present in a students' mind (initial concepts), including misconceptions, b) the conceptual linkages between the concepts(context) c) the evolution that takes place as consequence of teaching/learning activities (conceptual change)

Regis, Albertazzi and Roletto (1996) reported on successful use of cognitive maps in teaching chemistry to overcome 16-18 year olds' chemical misconceptions, especially in the beginning of a course. Their focus at the beginning of the course was to use concept maps to overcome misconceptions in the particulate model of matter and the conceptions of the pure substances and chemical reactions.

Novak (1990) stated that, concept maps as tools for organizing and representing knowledge. He described concept maps as concepts usually enclosed in circles or boxes and relationships between concepts or propositions indicated by a connecting line between two concepts (nodes). He defined concept as a perceived regularity in events or objects, or records of events or objects designated by a label. The label for most cases was a word. He defined propositions as statements about some object or event in the universe, either naturally occurring or constructed. Propositions contain two or more concepts connected with other words to form meaningful statement.

According to Novak, another characteristic of concept maps was that the concepts were represented in a hierarchical fashion with the most inclusive, most general concepts at the top of the map and the more specific, less general concepts arranged hierarchically below. One other characteristic of concepts maps was the inclusion of “cross-links.” These were relationships (propositions) between concepts in different domains of the concept map. He believed that cross-links help us to see how some domains of knowledge represented on the map are related to each other.

White and Gunstone (1992) recommended a series of steps in concept mapping. For the teacher the steps are: 1.Select a set of concept terms, 2. Provide students with concept terms on index cards and a sheet of paper, 3. Give the following instruction to students: a) Sort through the cards and put the ones that you do not know pr you think the term is not related to one side, b) Put the remaining cards on the sheep of the paper and arrange them in a way that makes sense to you, c) When you are satisfied with your arrangement of the cards, stick them to the sheet, d) Draw lines between the terms you see to be related, d) Write on each line the relation between the terms.

White and Gunstone's recommendations can be helpful guidelines when working with the students who are not familiar with concept mapping, but today, concept mapping is considered as an important learning tool and used frequently in most of the classes. It is considered as evaluation tool as well. So, students are familiar with constructing concept maps or working with concept maps. Therefore, teachers need to find out other ways to use concept mapping in their classroom.

Another important aspect of education is the use of technology in the classrooms. There are many researches being done to integrate technology to our teaching environment. Computer programs are of important tools, which can help teachers to create a more effective learning medium for several reasons. First of all, most students are computer literate and find it easier and more fun to work with a computer. Second, computers provide a medium for students to use their creativity. When considered with concept maps students can create their own concept maps using their own creativity in the related topic. In this sense, Inspiration is a helpful program to construct concept maps and enhance learning through concept mapping.

Inspiration is a software program where students think and learn visually. Inspiration provides students with the tools that let them create a picture of their ideas or concepts in the form of a diagram. It also provides an integrated outlining environment for students to develop their ideas into organized written documents. When students work with visual representations of ideas, they easily can see how one idea relates to others. Learning and thinking become active rather than passive. They discover where their deepest knowledge lies, and where the gaps in their understanding are. When they create a visual map of ideas, they can recall the details better than if they had read a paragraph. That's because they can see it in their mind.

If they have an idea that they want to expand, whether it's an idea for a written document or the illustration of a key concept, Inspiration can help them organize their thoughts and save them time. Use the visual diagramming part of the program to play with their ideas, to arrange them and group in other words, to clarify their thinking.

In this study the students used Inspiration to make concept maps related to states of matter, classification of matter, classification of mixtures. They also used Inspiration to make visual representation of the structure of atoms. In the first activity the students obtained information by a guide sheet prepared by the researcher and they prepared their own work on the structure of particles in three different states; solid, liquid and gas. They had flexibility to draw the particles in a way they like and present them in their own taste. Similarly, in the second and third activities the students their own creativity and thinking into the work. That motivated students to produce a good work. Making concept maps using Inspiration is easier and more motivating than making concept maps using paper and pencil. Therefore, during these activities in the computer laboratory students showed high level of involvement which lead to better understanding.

As stated by Shuell and Farber (2001), modern teaching technologies provide opportunities that may enhance student learning, but the mere presence use of technology in a classroom does not guarantee that learning will be improved.

Since the fundamental characteristic of meaningful learning is the integration of new knowledge with the learner's previous concept and propositional frameworks, proceeding from the more general, more inclusive concepts to the more specific information that usually serves to encourage and enhance meaningful learning. Concept maps can be very useful, because they present a highly concise manner between the key concepts and the principles to be taught. Using concept maps in planning a curriculum or in instruction helps to make the instruction "conceptually transparent" to the students.

Concept mapping tasks vary widely along a number of dimensions, including whether or not: a) hierarchical map is to be produced, b) concepts are provided to the student for mapping, c) structure for the map is provided, d) students can physically move terms around before settling on a map, e) the student draws the map, f) more than a single line connects two concepts, g) Students use pre-selected labels for lines.

Novak and his colleagues (1984b) considering Ausubel's hierarchical memory (cognitive) theory claimed that concept maps must be hierarchical and the hierarchical structure arises because "new information often is relatable to and subsumable under more general, more inclusive concepts." Meaning increases for students as they recognize new links between sets of concepts or propositions at the same level in the hierarchy. Novak and Gowin (1984) argued that all concept maps should be: Hierarchical with super ordinate concepts at the apex, labeled with appropriate linking words, cross-linked such that relations between sub-branches of the hierarchy are identified.

One of the powerful uses of concept maps is not only a learning tool but also as an evaluation tool, thus encouraging students to use meaningful mode learning patterns (Novak, 1990, Mintzes, Wandersee and Novak, 2000). Concept maps are also effective in identifying both valid and invalid ideas held by students Edwards and Fraser, 1983)

Concept map measures can be characterized by:

a) a task that invites a student to provide evidence bearing on his or her knowledge structure in a domain

b) a format for the student's response

c) A scoring system by which the student's concept map can be substantively evaluated accurately and consistently.

Concept map tasks varied in three ways:

a) Demands made on the students in generating concept maps (task demands)

b) constraints placed on the task (task constraints)

c) The intersection of task demands and constraints with the structure of the subject domain to be mapped (content structure).

Response format vary in three ways: Whether the student response is given with paper and pencil or on a computer (response mode)

a) The link between the task and format (response format)

b) Who draws the map (mapper) usually the students draw the maps however teachers or researchers can draw maps from students' interviews or essays.

To draw one's own map requires experience in mapping. As the student gets older the less experience needed to map. Some researchers such as Lomask, Baron, Greig and Harrison (1992) have trained teachers to draw concept maps from students' essays.

Three general scoring strategies have been used with maps: a) Score the components of the students' maps, b) Compare the students' map with a criterion map, c) A combination of both strategies.

Peuckert and Fischler (1999) used concept mapping in a research project about the long-term effectiveness of science education. In their study, they expected concept mapping by students to elicit conceptions about particle models. Concept maps constructed by researchers summarizing all data including students' maps were used as an assessment tool for intra-individual and inter-individual comparisons of groups. It turned out that students' concept maps mainly contained coherently used propositions. Concept maps from researchers identified central ideas concerning the topic and the development of these ideas. The researchers' maps were qualitative interpretations based on the following three aspects: Identification of known misconceptions, exploration of alternative conceptions, introducing into detailed analysis of verbal data or support of pictorial data.

The findings of their research met the following methodological aspects: a) Reliability of researchers' maps, b) validity of students' maps, c) a hierarchy of relations is the result of frequencies of codes, d) by means of difference maps more or less autonomous developments of conceptions could be identified, e) a descriptive overview of the topic, confirming, extending and connecting known misconceptions can be given by means of modal concept maps.

According to Gurdal and Kulaberoglu (1998) concept maps organize knowledge, increase student skills in establishing relations and comparisons between concepts. Concept maps are restricted by the knowledge of the mapper, the audience he is presenting and the time allowed.

2.6 Attitude and Achievement: Are they related?

Attitude toward science is another possible factor affecting the students' science achievement as well as students' alternative conceptions or misconceptions. Many research studies focused on the relationship among instruction, achievement and attitude. Results of many studies provided evidence that there is a relationship among instruction, achievement and attitude (Duit, 1991; Francis and Greer, 1999; Greenfield, 1996; George, 2000; Koballa and Crawley, 1985; Rennie and Punch, 1991).

Francis and Greer (1999) investigated secondary school pupils' attitudes toward science. Sample consisted of 2129 students in the third, fifth and lower sixth years of Protestant and Catholic grammar schools in Northern Ireland. Results demonstrated males have more positive attitude toward science than females and that younger pupils have more positive attitude toward science than older students.

George (2000) examined the change in the students' attitudes toward science over the middle and high school years using data from the Longitudinal Study of American Youth. The results of the study showed that students' attitudes toward science generally decreased over the middle and high school years. Teacher encouragement of science and peer attitudes were also found as significant predictors of students' attitudes, while the effects of parents were found to be quite small and statistically non-significant, with the exception of the seventh grade in the study.

Uzuntiryaki (2003) investigated the effect of constructivist teaching approach on students understanding of chemical bonding concepts and attitudes toward chemistry as a school subject. The results of the study indicated that the instruction based on constructivist approach had a positive effect on students' understanding of chemical bonding concepts and produced significantly higher positive attitudes toward chemistry as a school subject than the traditionally designed chemistry instruction.

Çetin (2003) examined the effect of conceptual change based on instruction on ninth grade students' achievement and understanding levels of ecology, attitudes toward biology, and attitudes towards environment. She found that the conceptual change texts oriented instruction accompanied by demonstrations in small groups had a significant effect on students' understandings of ecological concepts. Her study results also showed that the treatment had no significant effect on attitudes towards biology and attitudes towards environment.

However, there are some studies that did not support the positive relationship among instruction, achievement and attitude. Kesamang and Taiwo (2002) studied the relationship between Botswana Junior Secondary School students' attitudes toward science and their science achievement. They found that there was significant negative relationship between students' attitudes towards science and their science achievement.

The research on students' conceptions shows that students have misconceptions that influence their understanding of the science concepts during and even after instruction. Chemistry is one of the difficult science subjects. Especially, students have difficulties in understanding concepts, which cannot be visualized. Structures of matter including structure of atoms, phase changes, chemical and physical changes have abstract nature therefore are difficult to learn. Incorrect interpretations of matter concepts in daily life experiences add more incorrect conceptions to the students' minds. Conceptual change based teaching methods seem to be effective in remedying students' misconceptions. For this reason, in this study, we examined the effectiveness of conceptual change instruction accompanied with demonstration and computer assisted concept mapping on students' understanding of matter concepts and their attitudes toward science as a school subject when science process skills were controlled.

III. PROBLEMS AND HYPOTHESES

3.1 The Main Problem and Subproblems

3.1.1 The Main Problem

The purpose of this study is to investigate the effectiveness of conceptual change instruction accompanied with demonstration and computer assisted concept mapping over traditionally designed science instruction on 7th grade students' understanding of matter concepts and their attitudes toward science as a school subject.

3.1.2 The Subproblems

1. Is there a significant mean difference between the effects of conceptual change instruction accompanied with demonstration and computer assisted concept mapping and traditionally designed chemistry instruction on students' understanding of matter concepts when science process skill is controlled as a covariate?
2. Is there a significant difference between males and females in their understanding of matter concepts?
3. Is there a significant effect of interation between gender difference and treatment with respect to students' understanding of matter concepts?
4. What is the contribution of students' science process skills to their understanding of matter concepts?

5. Is there a significant difference between the effects of conceptual change instruction accompanied with demonstration and computer assisted concept mapping and traditionally designed sicence instruction with respect to attitudes toward science as a school subject?

6. Is there a significant difference between males and females with respect to their attitudes toward science as a school subject?

7. Is there a significant effect of interaction between gender and treatment with respect to students' attitudes towards science as a school subject?

3.2 Hypotheses

$H_0 1$: There is no significant difference between post-test mean scores of the students taught with conceptual change instruction accompanied with demonstration and computer assisted concept mapping and students taught with traditionally designed science instruction in terms of matter concepts when science process skill is controlled as a covariate.

$H_0 2$: There is no significant difference between the post-test mean scores of males and females on their understanding of matter concepts.

$H_0 3$: There is no significant effect of interaction between gender difference and treatment on students' understanding of matter concpets.

$H_0 4$: There is no significant contribution of students' science process skills to understanding of matter concepts.

$H_0 5$: There is no significant difference between post attitude mean scores of students taught with conceptual change instruction accompanied with demonstration and computer assisted concept mapping and traditionally designed science instruction with respect to attitudes toward science as a school subject.

$H_0$6 : There is no significant difference between attitude mean scores of males and females.

$H_0$7: There is no significant effect of interaction between gender and treatment with respect to students' attitudes towards science as a school subject.

IV. DESIGN OF THE STUDY

4.1 The Experimental Design

In this study, the Quasi Experimental Design was used (Gay 1987).

Table 4. 1 Research design of the study

Groups	Pre-test	Treatment	Post-test
Experimental Group	MCT ASTS SPST	CCIDC	MCT ASTS
Control Group	MCT ASTS SPST	TDSI	MCT ASTS

In the above table MCT represents Matter Concept Test. ASTS is the Attitude Scale toward Science as a School Subject. CCIDC represents conceptual change instruction accompanied with demonstration and computer assisted concept mapping and Traditional Designed Science Instruction. SPST refers to Science Process Skill test.

4.2. Subjects of the Study

This study consisted of 75 7th grade students (38 male and 37 female) from four classes of a Science Course from Enka Schools taught by the same teacher in the 2003 - 2004 fall semester. Two instruction methods used in the study were randomly assigned to groups. The data analyzed for this research were taken from 38 students participating in conceptual change instruction accompanied with demonstration and computer assisted concept mapping and 37 students participating in the traditionally designed science instruction.

4.3 Variables

4.3.1 Independent Variables:

The independent variables were two different types of treatment; conceptual change instruction accompanied with demonstration and computer assisted concept mapping and students taught with traditionally designed science instruction. Another independent variable was gender difference. Science process skills were taken as predictor for achievement.

4.3.2 Dependent variables:

The dependent variables were the students' understanding of matter concepts and their attitudes toward science as a school subject.

4.4 Instruments

There were three tools used to collect data in addressing the research questions of the present study. These were Matter Concept Test (MCT), Attitude Scale toward Science (ASTS), and Science Process Skills Test (SPST).

The conceptual change oriented instruction was introduced to the students in the experimental group was accompanied with demonstrations and computer assisted concept maps which were prepared as a result of detailed examination of literature and a variety of science textbooks.

4.4.1 Matter Concept Test (MCT):

This test was developed by the researcher. The content was determined by examining textbooks, instructional objectives of matter concept unit and related literature. During the developmental stage of the test, the instructional objectives of matter concepts unit were determined (see Appendix A) to find out whether the students achieved the behavioral objectives of the course and present study. The questions in the test were developed from the science books and from the literature (Milli Egitim Bakanligi, Fen Bilgisi 7, 2002; Chemical Concepts Inventory by Mulford, D.R., 1997; A Phenomenographic Analysis by Ünal R., Zollman D. 1997; The Effect of Conceptual Change Approach in Students' Understanding of Gas Concepts, Gurses, A., Dogan Ç., Yalçin M., Canpolat N., 2000), and a set of pilot interviews with some classroom teachers. During the interviews the teachers were asked questions about what kind of difficulties they have when they teach matter concepts in different grade levels; whether they face with students who bring their own conceptions to the class, what kind of reaction do the students give when they see that their conceptions can not be applied to all situations and do they cope with such problem? Then, the test was applied to the eight grade students (who were taught matter concepts in the seventh grade) to see how much of the misconceptions related to matter concepts they still carry. Only one essay question, which was related to the description of the structure of atom in either writing or drawing was omitted from the test, because most of the students did not understand this question properly. So, it was evaluated as a less clear question and thought that it could be a bit above the students' level the way it was designed. The rest of the items were used as they were. The final version of the test was applied to 7th grade students as a pretest that has not taken the course.

Students' misconceptions were summarized in Table 4.2.

Table 4. 2 Students' Misconceptions in Matter Concepts

A) Matter	Part Number	Item Number
Humans are not matter because they are alive	I	2
Matter is continous. There is no vacuum	I	3
Matter is a form of object but objects are not supposedly be matter	I	1
There is considerable space between molecules in a liquid	II	1B
The density of a gaseous matter has a larger density than a substance in liquid or solid state because it occupies more space	I	8

Table 4. 2 Continued

Water takes up more space than ice	I	8
	II	4B
B) Air as Matter		
Air is not matter because it doesn't take up any space	II	3A
Air is invisible, so it is not matter	I	10
Air doesn't have a mass or weight. It's like "wind"	I	1
There is no air in a closed container	I	9
Air does not have a shape, so we can't draw the shape of air	II	1B

C) States of Matter	Part Number	Item Number
Size of water molecule depends on which phase it is in	I	6
	II	3B
When water boils, it breaks into its components hydrogen and oxygen molecules	I	5
	II	6
	IV	2
The bubbles in a jug of boiling water were made of air, heat, hydrogen and oxygen or steam	I	5
In the process of evaporation of water or alcohol, the water or alcohol either dissappears or changes into something new. For example, alcohol changes into air	I	6
Gases do not mix with each other	I	10

Table 4. 2 Continued

In a closed container, if there are oxygen and nitrogen gases, oxygen gas stays at the bottom and nitrogen gas stays on the upper layer and they don't mix	I	10
In a closed container, there's gas but when the top is opened then, the gas would leave the container and there would be no more gas left in the container	I	9
When 2 or more gases are put in the same container, the one with the greater density or larger number of molecules would push the other one out from the container	I	10
Gases are lighter than the liquids or gases they are made from	I	6
	II	4A
Water vapor and ice are two different things. When ice changes into vapor, its structure changes	I	6
D) Size of an Atom – Molecule		
Atoms are large enough to be seen under a microscope	I	3
Atoms can not be seen, but it will be seen in the future with some invention	I	3
Seeing an atom is not a technological possibility	I	3
Atoms/molecules could change size; heating an atom/molecule would cause it to expand	II	3B

Table 4. 2 Continued

E) Elements and Compounds	Part Number	Item Number
Compounds are formed from atoms	IV	2
	IV	3
Compounds are broken into atoms as simpler forms	IV	2
	IV	3
Compounds can be found in atoms	III	1
	IV	2
	IV	3
Elements are formed as atoms in nature	III	1
	III	2
	III	3
Atoms of the same element can have different sizes	III	1
Same type of an atom found in different compounds can have	III	1
different sizes	IV	1
When a compound is broken into simpler forms it undergoes	I	6
physical changes	IV	1
F) Physical and Chemical Changes, Conservation of Mass		
When water evaporates, water changes into hydrogen an oxygen	I	6
	IV	2
Compounds can be formed by physical changes	I	6

Table 4. 2 Continued

Phase changes form new substances, so phase changes are chemical changes	IV	1
To dissolve is to dissappear,		
When sugar dissolves in water;		
a) it dissolves into nothing, it means it dissappears	II	2A
b) water molecules eat sugar molecules	II	2B
When iron rusts, the weight of the rusted iron would weigh less	I	7
or remain the same	II	5A
During a chemical change the total number of molecuels used in the reactants are conserved.	I	4

The test included four parts. First, third and fourth parts consisted of multiple-choice questions. Each question in these parts had one correct answer and three distracters. The distracters of each item reflected students' alternative conceptions or misconceptions found from the related literature and pilot interviews with science teachers. The interviews were done before implementation of the treatment. Second part of the test consisted of two-tier questions to examine students' knowledge of matter concepts. Each question had two parts: a response section in which students were asked to mark only one of the possible answers and a reason section in which students were asked to select the reason which explains the answer in the previous part of the question. Two-tier questions multiple-choice questions help teachers to improve students' learning of matter concepts. Özkan, Tekkaya and Geban (2004) reported that two-tier multiple choice tests can help teachers to address existing students' conceptions that are not compatible with scientific conceptions and to determine students' reasoning behind their choice. Students may give correct answers for wrong reasons. Once misconceptions are identified a teacher can help students acquire the scientifically acceptable conception by developing alternative teaching approaches, which address students' misconceptions. The items in the test were related to matter concepts. There were totally 21 items in the test. The test was prepared in Turkish because the language of instruction in Science Course, which included matter concepts unit, was in Turkish at Enka Schools. The conceptual questions required students to think a qualitative conceptual prediction about a situation in which there is a possibility to be directed towards a wrong answer caused by the misconceptions of students. For content validity, the test was examined by a group of expert teachers and by the course teacher for the appropriateness of the items as the extent to which the test measures a representative sample of the domain of tasks with respect to the matter unit of science education.

The reliability of the test was found to be .79. This test was given to students in both groups as a pre-test to control students' understanding of matter concepts at the beginning of the instruction. It was also given to both groups as a post-test to compare the effects of two instructions (CCIDC&TDSI) on understanding of matter concepts (see Appendix B).

4.4.2 Attitude Scale toward Science as a School Subject (ASTS)

This scale was developed by Geban, Ertepinar, Yilmaz, Altin, and Sahbaz, (1994) to measure students' attitudes toward science as a school subject. This instrument contains 15 items in a 5 point likert type scale (fully agree, agree, undecided, partially disagree and fully disagree). The reliability was found to be .83. This test was given to both groups(see Appendix D).

4.4.3 Science Process Skill Test (SPST)

This test is originally developed by Okey; Wise and Burns (1982). It consists of test exercised which require the application of some of the important abilities in science process skills. There are 36 items in the test. Contents for the items are taken from all science areas. It includes five subsets designed to measure the different aspects of science process skills. These are idendifying variables, identifying and stating hypotheses, operationally defining, designing investigations and graphing and interpreting data. There are 12 items for identifying variables, 8 items for identifying and stating hypotheses, 6 items for operationally defining, 3 items for designing investigations, and 6 items for graphing and interpreting data. Okey, Wise and Burns(1982), found the inernal consistency reliability (Kuder Richardson-21) as .82. This test was translated into Turkish and adapted by Geban, Özkan and Askar (1992). The reliability coefficient was found to be .81 (see Appendix E).

4.5 Treatment (CCIDC vs. TDSI)

This study was conducted over approximately 12 weeks during the 2003-2004 fall semester. Two of the classes were assigned as the experimental group instructed through conceptual change instruction accompanied with demonstration and computer assisted concept mapping and the other two groups were assigned as the control group instructed through traditional instruction. Both groups were instructed by the same teacher on the same content of the science course. During the treatment matter topics were covered as part of the regular classroom curriculum on the science course. The classroom instruction of the groups was four 40-minute sessions per week. The topics covered were the definition and properties of matter, states of matter, atoms and molecules, elements and molecules, physical and chemical properties of matter and conservation of mass.

At the beginning, both groups were administered MCT to determine whether there was any difference between the two groups with respect to understanding of matter concepts prior to instruction. Also, ASTS was distributed to measure students' attitudes toward science as a school subject. SPST was given to all students in the study to assess their science process skills.

In the control group, the teacher directed strategy represented the traditional approach used during the course. The students were instructed with traditionally designed science texts. During the classroom instruction, the teacher used lecture, discussion methods to teach concepts. Also, they were provided with paper-pencil coccept mapping on the board, traditionally designed worksheets and cookbok type lab.sheets. The worksheets consisted of questions which could be answered by recalling memorized information. Most of the time the labsheets were given as homework and they were corrected in the classroom in the following class period. The labsheets were prepared in a traditional way and had been used for a long time and all the directions were given in simple details and the students were asked only to follow the steps accurately and observe the results rather than inferring or deriving a conclusion themselves from their outcomes.

The experimental group received conceptual change instruction accompanied with demonstration and computer assisted concept mapping. See Appendix H for a sample lesson plan. Meaning learning in science involves realigning, reorganizing or replacing existing conceptions to accommodate new ideas (Smith, Blakeslee & Anderson, 1993). This process has been called a process of conceptual change. Stepans (1996) stated that conceptual change model creates an atmosphere where students confront their own preconceptions and those of their classmates, then, work towards an answer and conceptual change. His model consisted of six strategies. In this study these strategies are used. In accordance with the first strategy (awareness of their preconceptions), the teacher started the lessons by asking questions to activate prior knowledge of students and promote student-student interaction and agreement before presenting the concept. For example, the teacher began the instruction by asking what matter was, what could be considered as matter and what not. For the second strategy (exposing ideas in the class), students were provided sometime to think about the question and discuss it with their peers using their prior knowledge. During these discussions they realized that there was more than one idea and those ideas could be different from each other since each person defended his/her idea strongly. Moving to strategy three (providing atmosphere to test their preconceptions), the teacher provided demonstrations and asked questions related to their previous answers and required them to re-think about their former conceptions. For example, after students responses as matter was anything in the universe, the teacher showed them a few matter samples like paper, iron, toys, water and told them heat/electricity should also be considered as matter according to their responses but the last two examples hold different properties than the other samples. For strategy four (resolving conflicts), the teacher enabled time to resolve their conflicts between their ideas and derive scientific facts based on the discussions and observations. For strategy five (extend the concept), the teacher asked them to think about more matter samples from daily life and explain why they should be considered as matter. Finally, for the sixth strategy (to go beyond the concept and make connections with other concepts), the teacher asked why for instance water was liquid while iron was solid and air was gas although they were all considered as matter, why air was considered as matter while fire was not.

4.6 Demonstrations

Demonstrations used within conceptual change oriented instruction aimed to cause conceptual conflict and dissatisfaction with the existing but incorrect conceptions in the students' minds. The demonstrations were presented in such a way that students could see that they were wrong in their reasoning. Furthermore, demonstrations were designed to overcome misconceptions of students.

Demonstrations were presented in accordance with the sequence of the topics. Following demonstrations were performed in the experimental group:

1. Identifying difference between matter and object
2. Does air occupy space? Is air matter?
3. Properties of matter
4. States of matter
5. Matter consist of atoms
6. Identifying elements, compounds, atoms and molecule
7. Mixtures
8. Physical and Chemical Changes

In each of the above demonstrations the students were encouraged to tell their idea about what they would observe as the end. The teacher's aim was to hear the misconceptions of the students and then overcome these misconceptions by letting the students see that the results were not as they expected. See Appendix F for sample demonstrations.

4.7 Computer Assisted Concept Mapping

Usually at the end of each section the students were taken to the computer laboratory to prepare a concept map using inspiration program. Inspiration is a very helpful program for making concept maps because it provides students tools, which let them create a picture of their ideas or concepts in the form of a diagram. Concept maps varied according to the topic covered. The students received a concept map with blanks and were expected to fill it with correct concepts. Second and third concept map given below are examples of these types. In other cases the students received an information document about the concepts discussed in the class or during the demonstrations and they were asked to make a new concept map of the required conceptions. First and fourth concept map given below are examples of these kind. The concept maps and visual representations prepared by the experimental group were as follows: States of matter, classification of matter, mixtures, and structure of matter.

Concept maps were used both to make students' understanding meaningful, and understand whether or not the concepts achieved by the students. See Appendix C for sample concept maps.

At the end of treatment, all students were given MCT as post-test.

4.8 Analysis of Data

ANCOVA was used to determine and compare the effectiveness of two different instructional methods on students' understanding of matter concepts by controlling the effect of science process skills as a covariate. Independent t-test statistics was used to determine whether there was a significant mean difference between CCIDC and TDSI in terms of their understanding scince concepts at the beginning of the treatment. Univariate analysis of variance (ANOVA) was used to determine the difference between the post MCT mean scores of students who received CCIDC and those who received TDSI with respect to their attitudes toward science as a school subject.

4.9 Assumptions:

1. There was no interaction between the groups.
2. The teacher was not biased.
3. The tests were administered under Standard conditions.
4. The subjects answered the questions sincerely.

4.10 Limitations:

1. This study was limied to matter concepts.
2. This study was limited to 7th grade students of a private school.
3. This study was limited with 75 students in four classrooms.

V. RESULTS AND CONCLUSIONS

5.1 Results

This chapter presents the results of analyses of hypotheses stated earlier. The hypotheses were tested at a significance level of .05. Analysis of covariance (ANCOVA), univariate analysis of variance (ANOVA) and t-test were used to test the hypotheses. In this study, statistical analyses were carried out by using the SPSS/PC(Statistical Package for Social Sciences for Personal Computers) (Norusis, 1991).

The results showed that there was no significant difference at tthe beginning of the treatment between CCIDC group and the TDSI group in terms of students' understanding of matter concepts ($t = .575 > .05$).

Hypothesis I:

To answer the question posed by hypothesis 1 stating that there is no significant difference between the post-test mean scores of the students taught by CCIDC and those taught by TDSI with respect to understanding matter concepts when science process skill is controlled as a covariate, analysis of covariance (ANCOVA) was used. The measures obtained are presented in Table 5.1.

Table 5. 1 ANCOVA Summary (Understanding)

Source	Df	SS	MS	F	P
Covariate (Sicence Process Skill)	1	143.859	143.859	24.396	0.000
Treatment	1	74.973	74.973	12.714	0.001
Gender	1	1.692	1.692	0.287	0.594
Treatment * Gender	1	2.294	2.294	0.389	0.535
Error	70	412.773	5.897		

The result showed that there was a significant difference between the post-test mean scores of the students taught by CCIDC and those taught by TDSI with respect to understanding of matter concepts. The CCIDC group scored significantly higher than TDSI group ($\overline{X}_{(CCIDC)} = 13.027$, $\overline{X}_{(TDSI)} = 10.842$.

Figure 5.1 Shows the proportions of correct responses to the questions in the post-test for two groups.

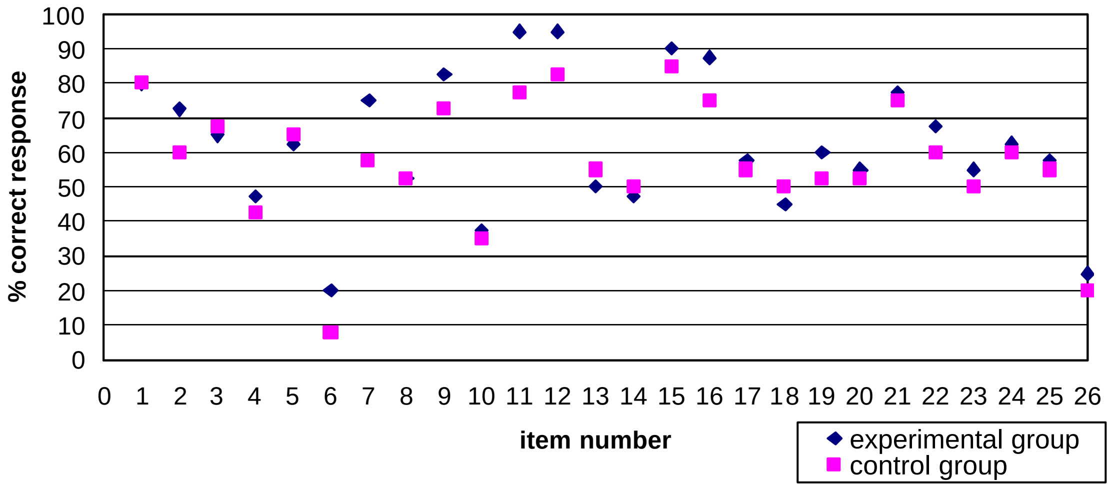


Figure 5.1 Comparison between post-test scores of CCIDC group and that of TDSI group.

As seen in the figure above, there were different responses between the two groups to the items of MCT. There were questions where both groups' correct response percentages were less than 50%. Those question 4, 6, 10 in part I and question 3 in part IV. Question 4 was related with the conservation of atoms and mass. In question 4 the students were asked to decide what would be remained the same before and after a chemical change. Around 22 % of the total students in both groups answered this question as "a" which said mass is conserved but they either didn't read the rest of the choices or chould not think that atoms were also conserved which was choice "c". The students in the experimental group answered this question correctly (47.5%) slightly higher than control group (42.5%). Question 6 was the poorest question in the overall test in terms of correct answer. Only 5% of the control group and 12.5% of the experimental group answered it correctly before treatment.

After treatment, only 7.5% of the students in the control group and 20% of the students in the experimental group answered this question correctly. The alternative conceptions held by the students were; compounds can be broken into simpler forms when they undergo physical changes 45% of the students in the experimental group and 57.5% of the students in the control group held this misconception even after the treatment. Another misconception held in this question was water changes into oxygen and hydrogen when it evaporates. 10% of the control group and 7.5% of the experimental group kept their alternative conception after the treatment. It seems that students could not grasp water vapor as the gaseous state of water molecule. The misconceptions that this item measured and the percentages of experimental and control group students' selection of alternatives in the posttest are given below:

Table 5. 2 Percentages of students' selection of alternatives for item 6 in Part I

Item 6: In the figure below on the left, you see the mangified form of the structure of a piece of ice cube. The container is heated and the ice cubes in the container are evaporated. What would the structure of water vapor look like? Choose the correct answer from the followings.

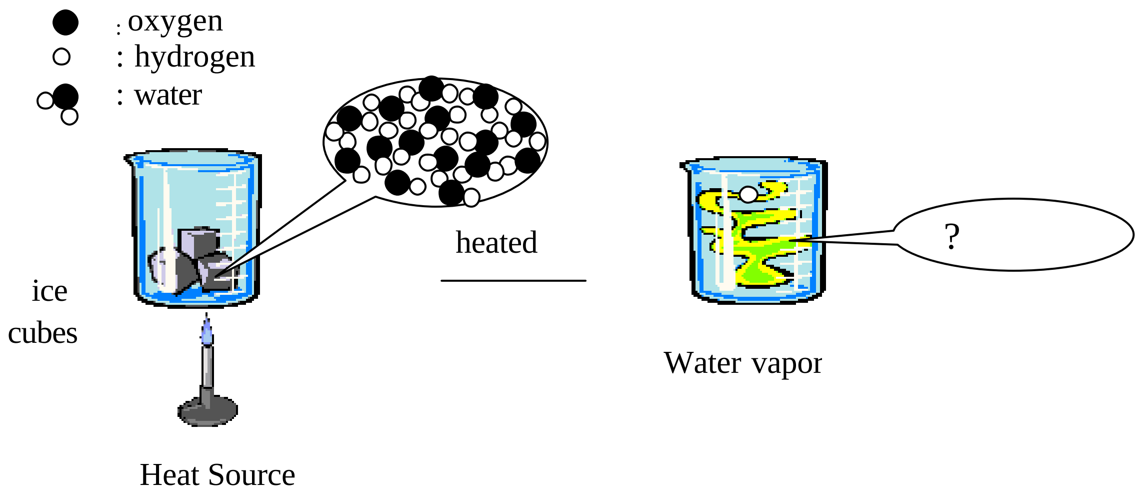
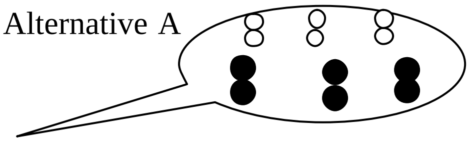
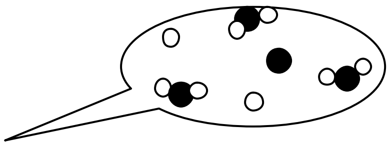
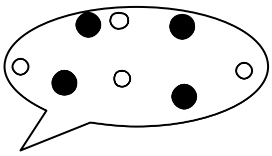
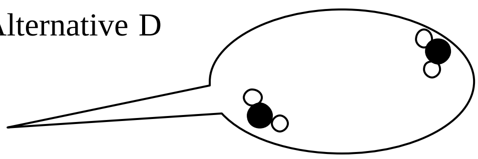


Table 5.2 Continued

	Percentage of students responses(%)	
	Experimental Group	Control Group
Alternative A  (this alternative corresponds to the misconceptions that when water boils, it breaks into its components hydrogen and oxygen molecules Water vapor and ice are two different things. When ice changes into vapor, its structure changes When water evaporates, water changes into hydrogen an oxygen)	7.5	10
Alternative B  (this alternative reflects the misconpcetions that in the process of evaporation of water or alcohol, the water or alcohol either dissappears or changes into something new, water vapor and ice are two different things. When ice changes into vapor, its structure changes)	27.5	25
Alternative C  (this alternative contains the misconceptions size of water molecule depends on which phase it is in, when water boils, it breaks into its components hydrogen and oxygen molecules, when a compound is broken into simpler forms it undergoes physical changes, when water evaporates, water changes into hydrogen an oxygen and Compounds can be formed by physical changes).	45	57.5
Alternative D  *Correct alternative	20	7.5

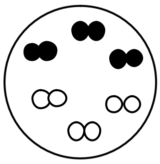
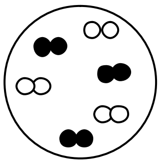
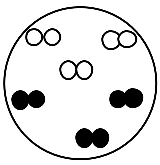
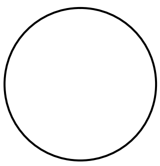
Another question which students did poorly was on the test was question 10. Before treatment only 20% of the control group answered this question correctly while the 32.5 % of the responses in the experimental group was correct. After the treatment the correct response percentage in the control group increased to 35% whereas it increased to 37.5% in the experimental group. The alternative conceptions held by students wereas follows: Air is invisible, so it is not matter, gases do not mix with each other in a closed container, if there are oxygen and nitrogen gases, oxygen gas stays at the bottom and nitrogen gas stays on the upper layer and they don't mix and when 2 or more gases are put in the same container, the one with the greater density or larger number of molecules would push the other one out from the container. The misconceptions that this item measured and the percentages of experimental and control group students’ selection of alternatives in the posttest are given below:

Table 5. 3 Percentages of students’ selection of alternatives for item 10 in Part I

Item 10: Air is mainly composed of nitrogen and oxygen. If you put some air in a balloon and examine the particles of air under an electron microscope which of the following structures would you expect to see?

Nitrogen: ●● Oxygen: ○○

Table 5.3 Continued

	Percentage of students responses(%)	
	Experimental Group	Control Group
Alternative A  (this alternative corresponds to the misconceptions that gases do not mix with each other in a closed container, if there are oxygen and nitrogen gases, oxygen gas stays at the bottom and nitrogen gas stays on the upper layer and they don't mix and when 2 or more gases are put in the same container, the one with the greater density or larger number of molecules would push the other one out from the container).	27.5	22.5
Alternative B  *Correct alternative	37.5	35
Alternative C 	32.5	22.5
Alternative D  (this alternative reflects to the misconceptions that air is invisible, so it is not matter).	5	20

Similar to the above two questions, both of the groups showed low achievement in the last question of the test. The experimental group students' correct response was 25% whereas the correct response percentage of control group was 20% after the treatment. In this question the students were asked to decide the products of the electrolysis of water. The alternative conceptions held by the students were; compounds are formed from atoms, compounds can be found in atoms and compounds are broken into atoms as simpler forms. Examining the correct response percentages of both groups it can be concluded that neither of the groups understood that water broke into hydrogen and oxygen molecules by using electrical energy. The misconceptions that this item measured and the percentages of experimental and control group students' selection of alternatives in the posttest are given below:

Table 5. 4 Percentages of students' selection of alternatives for item 3 in Part IV

Two students have an science assignment to present in the class related to chemical and physical changes. They decie to do an experiment for their project.

1st student put some water in a container and heat it until it evaporates.
2nd student does electrolysis of water by using electrical energy.

Item 3 (Part IV): Whic of the following substances does the second student observe as a result of his experiment?

	Percentage of students responses(%)	
	Experimental Group	Control Group
Alternative A Oxygen and hydrogen molecules in gas state *Correct response	25	20
Alternative B Atoms of water (this alternative included misconceptions as compounds are formed from atoms, compounds can be found in atoms and compounds are broken into atoms as simpler forms).	35	32.5

Table 5.4 Continued

Alternative C Water vapor molecules	10	20
Alternative D Oxygen and hydrogen atoms in gas state (this alternative corresponds to the misconception compounds are formed from atoms).	30	27.5

On the other hand, there were questions where both group students' correct response percentages were quite high. Item number 1 related with the identification of matter was achieved by most of the students after treatment. In this question the correct response percentage for experimental group was 47.5% and 40% for control group before treatment. After treatment both groups increased their understanding of matter. The correct response percentage for both groups increased to 80% after the treatment. The alternative conceptions held by the students were; humans are not matter because they are alive, matter is a form of object but objects are not supposedly be matter, air doesn't have a mass or weight. It's like "wind". The misconceptions that this item measured and the percentages of experimental and control group students' selection of alternatives in the posttest are given below:

Table 5. 5 Percentages of students' selection of alternatives for item 1 in Part I

Item 1: Which of the followings is not matter?

I. rays reaching earth from the sun
II. air in a bicycle tire
III. a new born baby
IV. burnt stick
V. air blown from a hair dryer

Table 5.5 Continued

	Percentage of students responses(%)	
	Experimental Group	Control Group
Alternative A Rays reaching earth from the sun *Correct response	80	80
Alternative B air in a bicycle tire (this alternative included misconceptions as matter is a form of object but objects are not supposedly be matter).	2.5	2.5
Alternative C a new born baby (this alternative included misconceptions as matter is a form of object but objects are not supposedly be matter).	10	10
Alternative D burnt stick (this alternative corresponds to the air doesn't have a mass or weight. It's like "wind"	7.5	7.5

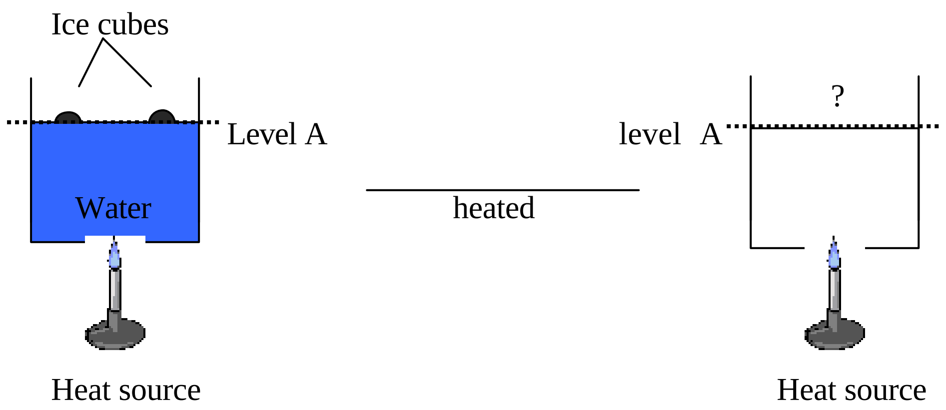
Both groups showed high achievement in question 9 after instruction. In this questions the students were asked to decide from which of the choices given there is no air. This question included misconception as there is no air ina closed container and when there is air in a closed container if the top is opened the air would leave and there would be no air left. The correct response percentage for experimental group was 82.5% and 72.5% for the control group. Only 15% of the experimental group held the alternative conception that there is no air in a closed container. The percentage of students who displayed this misconception in the control group was 12.5. In addition to this, 10% of the control group students held the misconception "In a closed container, there's gas but when the top is opened then, the gas would leave the container and there would be no more gas left in the container".

In the second part of the test there were two tier questions. The first item in the second part was related with choosing the items which are matter and second part of the question was related with reasoning their answer. Before treatment only 45% of the experimental group answered the first part correctly while 40% of the control group answered this part coorectly. The correct response percentage of the second (reasoning) part for both groups was 70% before treatment. After treatment both groups increased their correct response percentage but the increase in the experimental group was higher than the control group. 95% of the experimental group answered the first part correctly after the treatment whereas the control group increased their correct response percentage to 77.5%. A similar tendency was observed for the second part of the question. The experimental group answered the second part of the question correctly as 95%, on the other hand the in the control group the correct response ratio was 82.5%.

Part II question 3 was another question in which both groups had high achievement. In this question students were asked to decide how the volume of water changed when 2 ice cubes were melted by heating. Both groups increased their correct response percentage after treatment. The experimental group answered this question by 90% and control group answered it by 85% after the treatment. The alternative conceptions held by minority of the students were; size of water molecule depends on which phase it is in and atoms/molecules could change size; heating an atom/molecule would cause it to expand. The misconceptions that this item measured and the percentages of experimental and control group students' selection of alternatives in the posttest are given below:

Table 5. 6 Percentages of students' selection of alternatives for item 3 in Part II.

Item 3 (PartII): As seen in the below figure, two ice cubes are floating on top of water. What happens to the level of water in the container when it is heated untilthe ice cubes melt?



a) above level A
b) at level A
c) below level A

	Percentage of students responses(%)	
	Experimental Group	Control Group
Alternative A Ice molecules expand when they melt (this alternative included misconceptions as atoms/molecules could change size; heating an atom/molecule would cause it to expand).	12.5	12.5
Alternative B Melted ice changes the level of water (increases) *Correct alternative	87.5	75

Table 5.6 Continued

Alternative C Density of water is greated than the density of ice	0	10
Alternative D Water molecules take up more space than ice molecules (this alternative contains misconceptions size of water molecule depends on which phase it is in, atoms/molecules could change size; heating an atom/molecule would cause it to expand).	0	2.5

Table 5.7 shows the correct response percentages of pre-test and post-test for some questions for both experimental and control groups. The striking thing about these questions was that students in both groups understood the conceptions very clearly. These questions were related with identifying and stating the properties of matter and volume changes during phase changes.

Table 5. 7 Percentages of students' correct responses in the pre-test and post-test for selected items

		Experimental Group		Control Group	
Part	Item	Pre-test (%)	Post-test (%)	Pre-test (%)	Post-test (%)
I	1	47.5	80	40	80
I	9	72.5	82.5	65	72.5
II	1	57.5	95	55	80
II	3	73.5	88.5	75	80

When the above table is examined it is clearly seen that both groups increased their understanding of matter concepts but the students in the experimental group increased their understanding in related concepts more than the students in the control group.

Table 5.8 shows the questions where students in both groups did not change their conceptions very much. The correct response percentages of both groups' students are lower than 50% for the selected questions below.

Table 5. 8 Percentages of students' correct responses in the pre-test and post-test for selected items

		Experimental Group		Control Group	
Part	Item	Pre-test (%)p	Post-test (%)	Pre-test (%)	Post-test (%)
I	4	37.5	47.5	45	42.5
I	6	12.5	20	5	7.5
II	10	32.5	37.5	20	35
IV	3	15	25	25	20

The items selected in table 5.8 has distinguishing characteristics compared to other questions in the test. All four of these questions had low correct response percentages in both groups. These questions were related with particle model of matter. The students did not graps the conception that, when water evaporates the structure of water remains the same. They held the misconception that water breaks into hydrogen and oxygen atoms/molecules because phase change is a chemical change. Another important result observed in this table is that the students in the experimental group increased their understanding after instruction but this is not correct for students in the control group. For the sixth question in part I and the third question in part IV the students' correct response percentages are lower after the instruction. The reason for such a result may be because the students did not get a chance to test their conceptions and see that their conceptions are not scientfic. Since the teacher in the control group did not consider student misconceptions while teaching the students held onto their own conceptions and kept them even after treatment.

The experimental and control group students' correct response percentages of each question in MCT is presented in Appendix G.

Hypothesis 2:

To answer the question posed by hypothesis 2 which states there is no significant difference between the posttest mean scores of males and females in their understanding og matter concepts, analysis of covariance (ANCOVA) was run. Table 5.1 also gives the effect of gender difference on the understanding of matter concepts. The findings revealed that there was no significant mean difference between male and female students in terms of understanding matter concepts. The mean post-test scores were 11.46 for females and 12.33 for males.

Hypothesis 3:

To test hypothesis 3 which states that there is no significant effect of interaction between gender and treatment with respect to students' understanding of matter concepts, analysis of covariance (ANCOVA) was used. Table 5.1 also gives the interaction effect on understanding of matter concepts. The findings revealed that there was no significant interaction effect between gender difference and treatment on students' understanding of matter concepts.

Hypothesis 4:

To analyze hypothesis 4 which states that there is no significant contribution of students' science process skills to understanding of matter concepts, analysis of covariance (ANCOVA) was used. Table 5.1 also represents the contribution of science process skill to understanding of matter concepts. F value indicated that there was a significant contribution of science process skills on students' understanding of matter concepts.

Hypothesis 5:

To answer the question posed by hypothesis 5 which states that there is no significant mean difference between the students taught with instruction based on conceptual change approach and traditionally designed science instruction with respect to their attitudes toward science as a school subject, two-way analysis of variance (ANOVA) was used. Table 5.9 summarizes the result of this analysis.

Table 5. 9 ANOVA Summary (Attitude)

Source	Df	SS	MS	F	P
Treatment	1	262.64	262.64	4.77	.032
Gender	1	10.86	10.86	.197	.66
Treatment * Gender	1	.18	.18	.003	.96
Error	71	3908.39	55.05		

The results showed that, there was a signifiicant mean difference between students taught with conceptual change instruction accompanied with demonstration and computer assisted concept mapping and traditionally designed science instruction with respect to their attitudes toward science as a school subject in favor of the experimental group. The mean score of the experimental group was 54.4 and that of control group was 50.65.

Hypothesis 6:

To test hypothesis 6 which claims that there is no significant difference between post-attitude mean scores of males and females with respect to their attitudes toward science, two-way analysis of variance (ANOVA) was run. Table 5.9 also shows the effect of gender difference on students’ attitudes. It was found that there was no significant mean difference between male and female students with respect to their attitudes toward science as a school subject.

Hypothesis 7:

To test hypothesis 7 which claims that there is no significant effect of interaction between gender and treatment with respect to students' attitudes toward science as a school subject, analysis of variance (ANOVA) was used. Table 5.9 also shows the interaction effect on students' attitudes toward science as a school subject. The findings revealed that there was no significant interaction effect between gender difference and treatment on students' attitudes toward science as a school subject.

5.2 Conclusions

The following conclusions can be deducted from the results:

1. The conceptual change instruction accompanied with demonstration and computer assisted concept mapping caused a significantly beter acquisition of scientific conceptions related to matter concepts and elimination of misconceptions than traditionally designed science instruction.
2. The conceptual change instruction accompanied with demonstration and computer assisted concept mapping produced positive attitudes towards science as a school subject than traditionally designed science instruction.
3. Science process skill had a contribution to the students' understanding of matter concepts.
4. There was no significant effect of gender difference on the students' understanding of matter concepts and their attitudes toward science as a school subject.

VI. DISCUSSION, IMPLICATIONS AND RECOMMENDATIONS

6.1 Discussion

The main purpose of this study was to compare the effectiveness of conceptual change instruction accompanied with demonstration and computer assisted concept mapping and traditionally designed science instruction on 7th grade students' understanding of matter concepts.

Based on the statistical analyses results given in chapter V, it can be concluded that the conceptual change instruction accompanied with demonstration and computer assisted concept mapping caused a significantly beter acquisition of scientific conceptions related to matter concepts and elimination of misconceptions than traditionally desgined science instruction.

In this research, matter concepts in which students have difficulties understanding were studied. It is easier for students to understand the concepts that they see the applications in the laboratory via hands on activities but it is not possible to observe the inside of atoms in a regular laboratory with light microscopes. Therefore, it makes it difficult for the students to picture the structure of atoms. Since the particles of atoms or molecules are not visible it is also difficult to study the changes of particles when matter undergoes phase changes. For example, students tend to believe that matter is only the visible and touchable inorganic objects and therefore air is not considered as matter and some others hold the misconception that live things can not be matter so they don't include cats, babies or trees as matter. On the contrary, students believe that atoms are the smallest living form of life. Atoms are alive. Students also hold the misconception that atoms/molecules could change size; heating an atom/molecule would cause it to expand. Therefore, when teaching matter concepts the teacher should focus on these misconceptions and make the scientific concepts as concrete as possible. It is not enough for students to become aware of their existing ideas but also they should change their incorrect views by interacting with their teachers and peers. For this purpose, the present study used Stepan's (1996) conceptual change model in the experimental group. This model consisted of six strategies. According to the first strategy (awareness of their preconceptions), the teacher asked questions to activate prior knowledge (misconceptions) of students and promote student-student interaction and agreement before presenting the concept. For example, the teacher began the instruction by asking what matter was, what could be considered as matter and what not. As the second strategy (exposing ideas within the group and to entire class), students were provided sometime to think about the question and discuss it with their peers in the classroom. By this way, the teacher created a learning environment where students could use their prior knowledge and become aware of their already existing conceptions. During these discussions they realized there is more than one idea and those ideas could be different from each other since each person defended his/his idea strongly. Moving to strategy three (providing atmosphere to test their preconceptions), the teacher provided demonstrations and asked questions related to their previous answers and required them to re-think about their former conceptions. For example, after students responses as matter was anything in the universe, the teacher showed them a few matter samples like paper, iron, toys, water and told them heat/electricity should also be considered as matter according to their responses but the last two examples hold different properties than the other samples. And as strategy four (resolving conflicts), the teacher enabled time to resolve their conflicts between their ideas and derive scientific facts based on the discussions and observations. For strategy five (extend the concept), the teacher asked them to think about more matter samples from daily life and explain why they should be considered as matter. Finally, for the sixth strategy (to go beyond the concept and make connections with other concepts), the teacher asked why for instance water was liquid while iron is solid and air is gas although they were considered as matter, why air is considered as matter while fire is not. On the other hand, in the control group where traditionally designed science instruction was used, the teacher transmitted the facts to students who were passive listeners. Generally, she used a lecture method in instruction. She wrote important notes on the board and distributed worksheets to the students without considering students' prior knowledge or did not make any effort to correct their misconceptions. The teacher acted as a provider (authority) who transfers the facts actively to the students. She presented the "right" way to solve problems. However, students were not given opportunity to activate their prior knowledge and misconceptions. These reasons may have caused a better acquisition of scientific knowledge for the experimental group

In the experimental group social interaction was emphasized for learning. The teacher provided opportunity for class discussions and encouraged the students to work together, to explain what they are doing and thinking during the learning process. They used their current ideas and became ready to change them with the scientifically correct explanations after seeing their conceptions not being able to explain certain situations. Moreover, these discussions provided the development of reflective thinking and metacognitive awareness. However, students in the control group were not able to be aware of their conceptions. In the control group, there was a slight interaction between the teacher and the students. The students listened to their teacher, studied their textbooks, did experiments using cookbook type labsheets and completed the worksheets. The reason why the students in this group were not as successful as the students in the experimental group might be due to the fact that they were not given the opportunity to think about situations and continued to hold wrong conceptions in their cognitive framework. These findings are parallel with the findings of Azizoglu (2004) who worked on the misconceptions of gases in high school level. She stated that more meaningful learning occurs if students are asked to think about appropriate questions for a given situation and explain the relationships involved.

Traditionally designed science instruction was based on declerative knowledge, which is factual knowledge. Students were supposed to capture the scientific facts from teachers' explanations and recall these facts in the future lectures. However, instruction based on conceptual change approach favored a procedural knowledge which means knowledge about knowing how to do certain activities. In the experimental group, through discussions, students applied their knowledge about properties of matter to structure of matter and were able to criticize their thinking. This might have caused the difference in the concept test scores of students in the control group and experimental group. Although students in the control group could explain matter and give examples from daily life when the objects are easy to observe they had difficulties to explain the relationship between matter and atoms since they relied on theri declerative knowledge. On the other hand, the students in the experimental group used their procedural knowledge by applying their knowledge on matter consisted of particles and these particles making up the mass of that matter and the space occupied by these particles making up the volume. Azizoglu (2004) from her study of gases using conceptual change approach stated that better acquisiton of concepts can be because of continuous process of exchange and differentiation of the the existing concepts and integration of these concepts with the new concepts. On the contrary the students who received the traditionally designed instruction added scientific conceptions to their concetual framework which was full of alternativeconceptions.

In this study the demonstration used was based on conceptual change approach. Before doing a demonstration the teacher asked questions to the students about what they would expect to see during the demonstration to allow students to express their existing knowledge and discuss these ideas in the classroom with their peers. Usually there were conflicting ideas between the students. Allowing the students to express their ideas before the demonstration created a disequilibration in the classroom. Then, the teacher asked further questions to make students understand how their ideas would not reach to the same result if applied to other cases. At this point the students sought for a conception, which would work for all cases (scientific concepts). The teacher performed demonstrations to help students visually see what had been discussed. This study has also parallel findings with Walton (2002) who conducted a survey on a group of undergraduate students to understand how they felt about the demonstrations they received during the lectures on acids and bases. The results strongly support that demonstrations are popular teaching tools. More important, most of the students agreed that demonstrations helped them understand theories and formed an encouraging link between demonstrations and educational value. Demonstrations provide teachers with a way to motivate students to learn and retain knowledge of chemistry. A chemical demonstration can focus a student's attention, cause student interest and add curiosity in the lesson being taught.

Also in the experimental group computer assisted concept mapping based on conceptual change approach was used as supplementary material. Concept maps were usually used after conceptual change based demonstrations. There were several advantages of making concept maps on the computer. First of all, making the concept maps in a computer laboratory gave students more freedom to use their creativity and produce their own creative work. In the concept map activities, the students were expected to identify the relationship between the connections matter concepts. For example, after teaching the behaviour of particles in solid, liquid and gas states, a demonstration related to this was performed. Then, the teacher took the students to the computer laboratory to make a concept map about how particles are arranged in these three states of matter. Students' concept maps were evaluated to understand which conceptions were achieved by the students and which conceptions were not. Concept maps were used in other studies as teaching tools or assessment tools. An important difference of concept map usage in this study was that, students prepared their own concept maps on the computer.

The present study has similar findings with other research studies using concept maps (Peuckert and Fischler (1999)) who searcherd the long term effectiveness of concept mapping in science education. They studied concept mapping by students to elicit conceptions about particle models.

Concept maps from researchers identified central ideas concerning the topic and the development of these ideas. Concept maps are not only powerful learning tools used as evaluation tools, thus encouraging students to use meaningful mode learning patterns (Novak, 1990, Mintzes, Wandersee and Novak, 2000). Concept maps are also effective in identifying both valid and invalid ideas held by students Edwards and Fraser (1983). They stated that, an important point in that drawing one’s own map requires experience in mapping. As the student gets older the less experience needed to map. Teacher should also be trained to evaluate student maps. Some researchers such as Lomask et al. (1992) have trained teachers on how to evaluate student maps and to draw concept maps from students’ essays.

This study also investigated the effect of treatment (conceptual change instruction accompanied with demonstrations and computer assisted concept mapping) on students attitudes towards science as a school subject. It could be concluded that students instructed through conceptual change instruction accompanied wih demonstration and computer assisted concept mapping had more positive attitudes toward science than students taught by traditionally designed science instruction. Generally most students see science as a difficult subject to learn and believe that they can’t be successful in science so they do not want to study it. Conceptual change instruction accompanied with demonstration and computer assisted concept mapping focused on students’ ideas, encouraged students to think about situations and share their ideas. Demonstrations helped to establish curiosity in the students and grasp their attention in the classroom. Concept mapping on the computer was perceived very positively by most of the students since young people of this century are very fond of computers and can produce very creative work of their own on the computer when computer use is integrated with instruction. These factors might have caused students in the experimental group to have more positive attitudes.

The findings indicated that there was no significant mean difference between male and female students with respect to understanding matter concepts and their attitudes toward science. Similar results were reported by Ünlü (2000). She investigated the effectiveness of conceptual change approach on students’ achievement of atom, molecule and matter concepts. While the treatment was effective alone in increasing students’ achievement, gender difference found as not effective in changing students’ attitudes toward science significantly. Tis result is also supported by Yavuz (1998) who reported that conceptual change oriented instruction accompanied with laboratory activities was effective in increasing students’ understanding but not effective in increasing students’ attitudes toward science. Also, no significant interaction between gender difference and treatment in terms of understanding matter concepts was found. The reason why no significant difference was found in this study might be due to the fact that the school was a private school and students had similar backgrounds or experience. This situation might have also affected their attitudes toward science where there was no significant difference found between males and females in terms of their understanding and attitudes toward science.

In this study, students' science process skills accounted for a significant portion of variance in achievement related to matter concepts.

To sum up, this study showed that students had sifficulty in understanding matter concepts and held misconceptions. By using conceptual change instruction , demonstrations and concept mapping better acquisition of scientific concepts could be observed. Advance questioning activates relevant prior knowledge and promotes meaningful learning. This also causes students to have more positive attitudes toward science as school subject.

6.2 Implications

In the light of findings of the present study the following implications could be offerred:

1. If the goal of instruction is meaningful learning, one of the poweful strategies to use would be conceptual change approach. This approach facilitates the integration of the existing and new knowledge. The integration would result in meaningful learning if the cognitive structure

of the learner's pre-existing knowledge is relevant. If there is no relevant ideas students would try to make new conception meaningful by interpreting their own point of view. This would lead to formation of alternative conceptions and misconceptions. Changing the old and useless conceptions to new and plausible conceptions would be achieved by well-designed conceptual based instruction.

2. The results of MCT showed that, the students possess the same misconceptions with thoose previously found in different research studies. Students have misconceptions no matter where they live on earth or what they are taught. Students should be aware of their existing knowledge. Conceptual based instructions enables them to be aware of these conceptions. Class discussions are important in conceptual change based instruction. Because, by thse discussions teachers can identify the conceptions that students have difficulties understanding and can desgin the instruction to deal with those problems. Teacher guided discussions are importand for students reach to the scientific conceptions from their naive conceptions. These may be time consuming but important for a long term meaningful understanding in science education.

3. Science teaching should favor prcedural knowledge. Although declerative knowledge is important and necessary, it is not enough. If students learn how to use their existing knowledge, they can solve real life problems and develop complex skills. Conceptual change based instruction creates

environment for students use their knowledge for solving real life problems.

4. Curriculum programs should be based on conceptual change perspective and textbooks and teaching materials should be improved so that students' misconceptions can be minimized.
5. Teacher education should place emphasize on conceptual change.
6. Teachers should be trained to develop and assess effective concept maps. Effective concept maps are considered as important tools of instruction or assessment but it also needs experience to make an effective concept map.
7. Teachers should also be trained how demonstrations can be used during instruction. Effective demonstrations have basic criteria. For instance demonstrations should never be replaced by hands-on activies, they should not be longer than 5 minutes in a class period. So, it is important for teacher to know the idea behind using demonstrations and how to intergrate them with their teaching.
8. Teachers should be aware of students' attitudes towards science as a school subjec, because it is important for students to have a postive attitude to be successful in a subject area. Therefore teachers should seek ways to make students have positive attitudes.

6.3 Recommendations

Based on the results, the researcher recommends the following:

1. This study can be replicated with a larger sample size for a generalization to a bigger population.

2. Studies can be carried out for different grade levels to investigate the effectiveness of conceptual change instruction accompanied with demonstration and computer assisted concept mapping.
3. The conceptual change instruction accompanied with demonstration and computer assisted concept mapping can be used to teach different science topics.
4. Studies can be carried out for different grade levels and different science courses to investigate the effectiveness of computer assisted concept mapping.
5. Further studies can be conducted in different schools to provide a generalization for Turkey.

REFERENCES

Albanese, A. and Vicentini, M. (1995). Why do we believe that an atom is colorless? Reflections about the teaching of the particle. Unpublished manuscript.

Anderson, L. M. (1989). Implementing instructional programs to promote meaningful, self regulated leaning. In J. Brophy (Ed.), Advances in Research on Teaching. 1, 311-343.

Ausubel, D. P. (1968). Educational Psychology: A cognitive view. New York: Holt, Rinehart and Winston, Inc.

Ausubel, D. P. (1978) Educational Psychology: A cognitive view 2nd edition. New York: Holt, Rinehart and Winston, Inc.

Azizoglu, N. (2004). An analysis of undergraduate students' misconceptions related to phase equilibrium in chemistry. Unpublished Ph.D. Thesis, Middle East Technical University, Ankara, Turkey.

Basili, and Sanford, J. P. (1991). Basili, P. A., & Sanford, J. P. (1991). Conceptual change strategies and cooperative group work in chemistry. Journal of Research in Science Teaching, 28, 293-304.

Beaumont-Walters, Y. And Soyibo, K. (2001). An analysis of high school students' performance on five integrated science process skills. Research in Science and Technological Education, 19(2), 133-145

Ben-Zvi, Eylon and Silberstein, (1986). Is an atom of copper malleable? Journal of Chemical Education, 63, 64-66.

Bodner, (1991). I have found you an argument: The conceptual knowledge of beginning chemistry graduate students. Journal of Chemical Education, 68, 385-388.

Camacho, M. and Good, R. (1989). Problem solving and chemical equilibrium: successful versus unsuccessful performance. Journal of Research in Science Teaching, 26, 251-272.

Caramazza, A., McCloskey, M., and Green, B., (1981). Naive beliefs in "sophisticated" subjects: Misconceptions about trajectories of objects. Cognition, 9, 117-123.

Chambers, S. K. and Andre, T. (1997). Gender, prior knowledge, interest and experience in elctricity and conceptual change text manipulations in learning about direct current. Journal of Research in Science Teaching, 34, 107-123

Chi, M.T.H., and Roscoe, R.D. (2002). The process and challenges of conceptual change. Reconsidering conceptual change: Issues in Theory and Practice, 3-27.

Cho, H., Kahle, J. H., and Nordland, E. H., (1985). An investigation of high school biology textbooks as sources of misconceptions and difficulties in genetics and some suggestions for teaching genetics, Science Education, 69, 707-719.

Çetin, G. (2003). The effect of conceptual change instruction on understanding of ecological concepts. Unpublished Doctoral Thesis, The Middle East Technical University, Ankara.

Driver, R., (1992). Pupils Alternative Frameworks in Science, European Journal of Science Education, 18,365-392.

Driver, R., and Easley, J., (1978). Pupils and paradigms: a review of literature related to concept development in adolescent science students. Studies in Science Education, 5, 61-84.

Duit, R.(1991). Bibliography: Research on students' alternative frameworks in science-topics, theoretical frameworks, consequences for science teaching. Kiel, Germany, IPN.

Dykstra, D. I. Jr., Boyle, C. F., Monorch, I. A. (1992). Studying conceptual change in learning physics. Science Education, 76(6), 615-652.

Ebenezer, J. V. and Ericson, G. L. (1996). Chemistry students' conceptions of solubility: A phennomenography. Science Education, 80(2), 181-201.

Ebenezer, J. V., and Gaskel, P. J. (1995). Relational conceptual change in solution chemistry. Science Education, 79, 1-17.

Edwards, J. and Fraser, K.)1983). Concept maps as reflectors of conceptual understanding. Research in Science Education, 13, 19-26.

Eylon, B. and Linn, C. (1988). Learning and instruction:An examination of four research perspectives in science education. Review of Educational Research, 58(3), 251-301.

Fischer, H. and Lichfeldt, M. (1992). Modern physics and students' conceptions. International Journal of Science Education, 14, 181-190.

Fischler, H. and Peuckert, J.(1999). Concept Mapping as a tool for research in science, Report on Workshop at the Theory, Methodology and Results in Science Education - Fourth European Science Education Summer School http://www.summerschool.dk/esera/summerschool/sumsc98/4these/workshops.htm, last date accessed Feb. 2005.

Francis, L. J. And Greer, J.E. (1999). Measuring attitude toward sicence among secondary school students: The affective domain. Research in Science and Technonological Education, 17(2), 219-226.

Furió, C.; Calatayud, M.L. (1996) Difficulties with the geometry and polarity of molecules. Journal of Chemical Education, 73, 36-41.

Gabel, D.L. (1999). Improving teaching and learning through chemistry education research: A look to the future. Journal of Chemical Education, 76, 548-554.

Garnett, P. J. (1992). Conceptual difficulties experienced by senior high school students of electrochemistry: Electric circuits and oxidation-reduction equations. Journal of Research in Science Teaching, 29(2), 121-42.

Gay, L. R. (1987). Educational Research: Competencies for Analysis and Application. Charles E. Merril Publishing Co.

Geban Ö., Askar P, and Özkan I., (1992). Effects of Computer Simulated Experiments and Problem Solving Approaches On High School Students, Journal Educational Research, Vol 86, pg: 5-10

Geban, Ö., Ertepinar, H., Yilmaz G., Altin, A. and Sahbaz, F. (1994). Bilgisayar destekli egitimin ögrencilerin fen bilgisi basarilarina ve fen bilgisi ilgilerine etkisi. I. Ulusal Fen Bilimleri Egitimi Sempozyumu: Bizldiri Özetleri Kitabi, s:1-2, 9 Eylül Üniversitesi, Izmir.

George, R. (2000). Measuring change in students' attitudes toward science over time: An applicaiton of latent variable growth modeling. Journal of Science Education and Technology, 9(3), 213-225.

Goldberg, F. M., Bendall, S. (1992). Computer-video-based tutorials in geometrical optics. Research in physics learning: Theoretical issues and empirical studies, 356-379.

Greenfield, T. A. (1996). Gender, ethnicity, science achievement and attitudes. Journal of Research in Science Teaching, 22(5), 421-436.

Griffiths, A. K and Preston, K. R. (1992). Grade-12 students' misconceptions relating to fundamental characteristics of atoms and molecules, Journal of Research in Science Teaching, 29(6), 611-628.

Gilbert, J.K., Osborne, R.J. and Fensham, P.J. (1982). Children's science and its consequences for teaching. Science Education, 66, 623-633.

Gürdal, A. Kulaberoglu, N. (1998). Fen Ögretiminde kavram haritalari, Milli Egitim Dergisi, 140, 47-54.

Gürses, A., Dogan, Ç., Yalçin, M., and Canpolat, N. (2000). Kavramsal degisim yaklasiminin ögrencilerin gazlar konusunu anlamalarina etkisi. Atatürk Üniversitesi.K.K. Egitim Fakültesi, Kimya Ögretmenligi, Erzurum, Atatürk Üniversitesi, Erzincan Egitim Fakültesi, Fen Ögretmenligi, Erzincan.

Haidar, A. H. and Abraham, M. R. (1991). A comparison of applied and theoretical knowledge of concepts based on the particulate nature of matter. Journal of Research in Science Teaching, 28(10), 919-938.

Van Heuvelen A. (1991). Learning to think as a physicist: a review of research - based instructional strategies; Overview, case study physics. American Journal of Physics, 59, (10)

Hewson, M. G. and Hewson, P. W. (1983). Effect of instruction using prior knowledge and conceptual change strategies on science learning. Journal of Research in Sicence Teaching, 20(8), 731-743.

Hewson, P. W. and Hewson, M. G. (1989). Analysis and use of a task for identifying conceptions of teaching science. Journal of Education for Teaching, 15(3), 191-209.

Hewson, P. W. and Thorley, (1989). Hewson, P.W.; Thorley, N.R. (1989) The conditions of conceptual change in the classroom. International Journal of Science Education, 11, 541-553.

Hynd, C., Alvermann, D. and Qian, G. (1997). Preservice elementary school teachers' conceptual change about motion: Refutation text, demonstration, affective factors, and relevance. Science Education, 81,1-27.

Kesamang, M., E., E, and Taiwo, A., A. (2002) Socio-Cultural Background of Botswana Junior Secondary School students with their attitudes towards and achievements in science International Journal of Science Education, 24(9), 919-940.

Koballa, T. R. Jr. And Crawley, F. E. (1985). The influence of attitude on science teaching and learning. School Science and Mathematics, 85(3), 222-232.

Lee, O., Einchinger, D. C., Anderson, C. W., Berkheimer, G. D. and Blakeslee, T. D. (1993). Changing middle school students' conceptions of matter and molecules. Journal of Research in Science Teaching, 30(3), 249-270.

Lomask, M., Baron, J. B. and Harrison, C. (1992). Concept map: Connecticut's use of concept mapping to assess the structure of students' knowledge of science. A symposium presented at the annual meeting of the National Association of Research in Teaching, Cambridge, MA.

Longden, K., Black, P., Solomon, J. (1991). Children's interpretation of dissolving. International Journal of Science Education, 13(1), 59-68.

McDermott, L. C., Rosenquist, M. L. and Van Zee, E. H. (1987). Student Difficulties in Connecting Graphs and Physics: Examples from Kinematics. American Journal of Physics 55(6), 503 –13

Mestre, J. P. And Lochhead, J. (1990). Academic preparation in science: Teaching for transition from high school to college. New York, NY: College Entrance Examination Board.

Mestre, J. P. (1991). Learning and Instruction in Pre-College Physical Science, Physics Today, September.

Minztes, J. Wandersee, J. and Novak, J. (2000). Assessing science undertanding. San Diego, Academic Press.

Mulford, D.R. (1997). An Inventory for measuring college students' level on misconceptions in first semester chemistry., Masters of Science Thesis submitted to Purdue University, 12/97.

Nakleh, M. B. (1992). Why some students don't learn chemistry: Chemical misconceptions. Journal of Chemical Education, 69, 191-196.

Niedderer, H., Bethge, T., Cassens, H., Petri, J. (1996). Teaching quantum atomic physics in college and research results about a learning pathway. Proceedings of the International Conference on Undergraduate Physics Education (ICUPE). University of Maryland, College Park, USA, July 31 - August 3.

Norusis, M. J. (1991). The SPSS guide to data analysis for SPSS/PC+, Chicago, IL, SPSS Inc.

Novak, J. D. (1990). Concept maps and Vee diagrams: Two metacognitive tools to facilitate meaningful learning. Instructional Science, 19, 29-52.

Novak, J. D. and Gowin, D. R. (1984b). Learning how to learn. New York Cmabridge University Press.

Novick, S. and Nussbaum, J., (1981). Pupils' understanding of the particulate nature of matter: A cross age study. Science Education, 65(2), 187-196.

Okey, J. R., Wise, K. C. and Burns, J. C. (1982). Integrated Process Skill Test-2. Department of Science Education, University of Geprgia, Athens, GA, 30602).

Osborne, R. J. And Cosgrove, M. M. (1983). Children's conceptions of the changes of state of water. Journal of Research in Science Teaching, 20(9), 825-838.

Osborne, R. J., Bell, B. F., & Gilbert, Y. K. (1983). Science teaching and children's view of the world. European Journal of Science Education, 5, 1-14.

Osborne, R., and Freyberg, P. (1985) Learning in science: The implications of children's science. Hong Kong: Heinemann.

Özkan, Ö. Tekkaya, C. and Geban Ö. (2004). Facilitating conceptual change in students' understanding of ecological concepts. Journal of Research Education and Technology. 13(1), 91-101.

Paik, S.–H., Kim, H.–N., Cho, B.-K., and Park, J.-W.(2004). K-8th grade Korean students' conceptions of "changes of state" and "conditions for changes of state". International Journal of Science Education, 26(2), 207-224.

Posner, G. J., Strike, K. A., Hewson, P. W. And Gertzog, W. A. (1982). Accomodation of a scientific: Toward theory of conceptual change. Science Education, 66(2), 211-227.

Prieto, T., Blanco, A. and Rodrigues, A. (1989). The ideas of 11 to 14 year-old students about the nature of solutions. International Journal of Science Education, 11(4), 451-463.

Regis, A., Albertazzi, P.G., & Roletto, E. (1996). Concept maps in chemistry education. Journal of Chemistry Education, 73(11), 1084-1088.

Rennie, J. J. and Punch, K. F. (1991). The relationship between affect and achivement in science. Journal of Research in Science Teaching, 28(2), 193-209.

Sanger, M. J. and Greenbowe, T. J. (1999). An analysis of college chemistry textbooks as source of misconceptions and errors in electrochemistry. Journal of Chemical Education, 76(6), 853-879.

Sanger, M. J., Phelps, and Fienhold, (2000). Sanger, M.J., Phelphs, A.J., Fienhold, J., (2000). Using A Computer Animation To Improve Student's Conceptual Understanding Of A Can-Crushing Demonstration, Journal Of Chemical Education, 77, 11, 1517-1520.

Schmidt, H.-J. (1997). Students' misconceptions-looking for a pattern. Science Education, 81, 123-135.

Shepperd, D. and Renner, J. (1982). Student understanding and misunderstandings of a states of matter and density changes. School Science and Maths, 82(8), 650-665.

Shepherd, D. L., Renner, J. W. (1982). "Student understandings and misunderstandings of states of matter and density changes."School Science and Mathematics 82(8), 650-665.

Shepardson, D. P., Moje, E. B., and Kennard-McClelland, A. M. (1994). The impact of a science demosntration on children's understanding of air pressure. Journal of Research in Science Teaching, 31(3), 243-258.

Shuell, T. (1987). Congitive psyhology and conceptual change: Implicaitons for teaching science. Science Education, 71- 239-250.

Shuell, T. and Faber, (2001). Students' perceptions of technology use in college courses. Educational Computing Research. 24(2), 119-138.

Smith, E. L., Blakeslee, T. D., & Anderson, C. W. (1993). Teaching strategies associated with conceptual change learning in science. Journal of Research in Science Teaching, 30(2), 111-126.

Smith, K. J., Metz, P. A. (1996). Evaluating student understanding of solution chemistry through macroscopic representations. Journal of Chemical Education, 73(3), 233-235.

Stavy, R. (1988). Children's conceptions of gas. International Journal of Science Education,10(5), 553-560.

Stavy, R. (1990). Children's conceptions of changes in the state of matter: From liquid (or solid) to gas. Journal of Resaerch in Science Teaching, 27(3), 247-266.

Stepans, J. (1996). Targeting Students' Science Misconceptions. Review, FL: The Idea Factory.

Strauss, S. (1981). Cognitive development in school and out. Cognition, 10, 295-300.

Swafford, J. (1989). The effects of a science text and demonstration on conceptual change of high school students. (Ph.D. Thesis, University of Georgia). Dissertation Abstracts International, 50, 3040A.

Swanson, E. (1999). Chemical Demonstrations in the classroom, Independent paper in Chemistry Department, Bradley University.

Taber, K.S. (1995). Prior Learning as an Epistemological Block: The Octet Rule. An example from Science Education Paper Presented at the European Conference On Educational Research (University of Bath, September)

Taylor, P.C. (1996). Mythmaking and myth breaking in the mathematics classroom. Educational Studies in Mathematics, 31, 151-173.

Ünal, R., Zollman, D. (1997). Students' description of an atom: A phenomenographic analysis. Department of Physics, Kansas State University.

Uzuntiryaki, E. (2003). Effectiveness of constructivist approach on students' understanding of chemical bonding concepts. Unpublished Ph.D. Thesis, Middle East Technical University, Ankara, Turkey.

Ünlü, S. (2000). The effect of conceptual change texts in students' achievement of atom, molecule, matter concepts. Unpublished Master Thesis, Middle East Technical University, Ankara, Turkey.

Van Heuvelen, A. (1991). Learning to think as a physicist: a review of research - based instructional strategies; Overview, case study physics, American Journal of Physics 59(10), 888-897.

Viennot, L. (1979). Spontaneous reasoning in elementary dynamics. European Journal of Science Education, 1, 202-221.

Walton, P. H. (2002). On the use of chemical demonstrations in lectures. University Chemistry Education, 6, 22-27.

Wandersee, J. H., Mintzes, J. J., and Novak, J. D. (1994). Research on alternative conceptions in science. In D. L. Gabel (Ed.), Handbook of Research on science teaching and learning. New York: Macmillan, 177-210.

White, R., & Gunstone, R. (1992). Probing understanding. New York, NY: The Falmer Press.

Yalçinalp, S., Geban, Ö., and Özkan, I., (1995). Effectiveness of Using Computer Assisted Supplementary Instruction For Teaching the Mole Concept, Journal of Research in Science Teaching, 32, 1083-1095

Yavuz, A. (1998). Effect of conceptual change texts accompanied with laboratory activities based on constructivist approach on understanding of acid-base concepts. Unpublished Master Thesis, Middle East Technical University, Ankara, Turkey.

APPENDIX A

INSTRUCTIONAL OBJECTIVES

1. To identify matter and non-matter using common properties
2. To give examples for matter and non-matter in the universe
3. To distinguish between matter and-nonmatter
4. To explain that mass is conserved before and after a chemical reaction
5. To explain that number of atoms are conserved
6. To state the relationship between mass, volume and density
7. To state that the volume of a liquid water increases when someice melts in it
8. To explain that the mass of a product is the sum of the masses of reactants
9. To teach that the structure of water molecule in the solid and the gas form is the same
10. To state that matter is not destroyed after a chemical reaction
11. To explain that elements are made up of same type of atoms
12. To explain that compounds are made up of different types of atoms
13. To explain that water is separated into hydrogen and oxygen molecules by electrolysis
14. To distinguish the properties of chemical and physical processes
15. To describe why density of a gas is smaller than the density of a liquid
16. To describe why density of a liquid is smaller than the density of a solid
17. To clarify that ice, liquid water and water vapor have the same structure
18. To explain atoms as the smallest units of matter
19. To interpret that molecules are formed by joining of atoms
20. To state that compounds are formed by chemical changes

APPENDIX B

MADDE KAVRAM TESTI

BÖLÜM I) ASAGIDAKI SORULARDA DOGRU SEÇENEKLERI YUVARLAK IÇINE ALINIZ.

1) Asagidaki varliklardan hangileri madde degildir?
I. günesten dünyamiza ulasan isinlar
II. bisiklet tekerlegindeki hava
III. yeni dogmus bebek
IV. yanmis kibrit çöpü
V. fön makinesinden çikan sicak hava
a) yalniz I b) yalniz II c) yalniz III d) Yalniz V

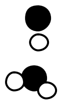
2) Asagidaki varliklardan hangileri atomlardan yapilmistir?
I. günesten dünyamiza ulasan isinlar
II. musluktan akan su
III. çürümüs yaprak
IV. fön makinesinden çikan sicak hava
V. yeni dogmus bebek
a) yalniz II b) yalniz III c) I,II ve III d) II,III,IV ve V

3) Bir atomu asagidaki yollardan hangisi(hangileri) ile görebiliriz?
I. nesneleri elimizde inceleyerek
II. normal bir mikroskop ile (isik)
III. elektron mikroskobu ile
IV. atomlar henüz görülemiyor, ancak gelecekte bazi buluslar yapilarak görülebilecek
V. insanoglu atomu hiçbir zaman göremeyecek
a) yalniz II b) yalniz III c) IV ve V d) I,II ve III

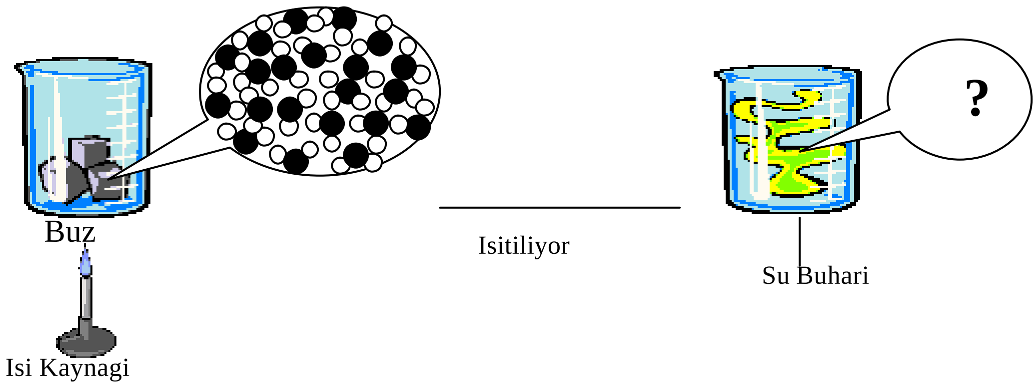
4) Asagida verilen bilgilerden hangisi kimyasal bir degismeden **önce** ve **sonra** aynidir?
a) maddelerin kütlelerinin toplami
b) degismeden önceki ve sonraki toplam molekül sayisi
c) degismeden önceki ve sonraki toplam atom sayisi
d) a ve c

5) Bir cam çaydanlikta bir miktar saf suyun 30 dakika kaynadigini düsünün. Sizce kaynayan suyun içindeki baloncuklar nelerdir?
a) hava
b) oksijen ve hidrojen gazlari
c) su buhari
d) isi

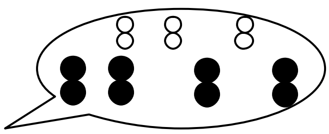
6) Asagidaki sekilde, kapali kaptaki buzun küçük bir miktarinin büyütülmüs hali sagdaki dairede gösterilmektedir.Su buharlastiktan sonra sag taraftaki daire içinde su buharinin büyütülmüs hali nasil görünür?



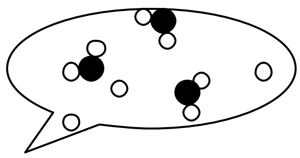
: oksijen
: hidrojen
:su



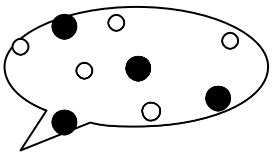
a)



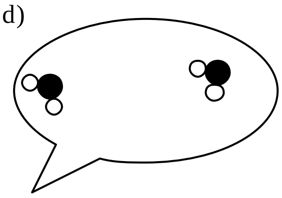
b)



c)



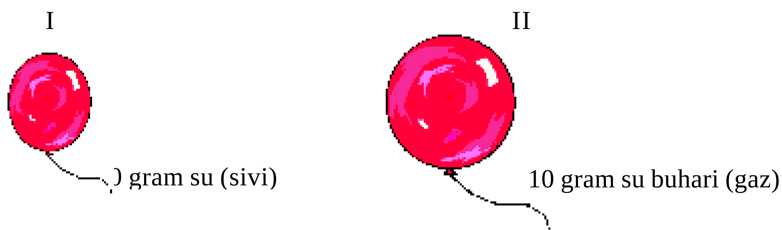
d)



7) 100 gram suda 20 gram tuz çözündügünde karisimin toplam kütlesi nedir?

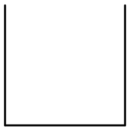
a) 80 gram
b) 100 gram
c) 120 gram
d) 120 gramdan fazla

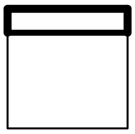
8) Asagidaki balonlardan birinciye 10 gram su, ikinciye 10 gram su buhari konularak agizlari kapatiliyor. Balonlarin içindeki maddelerin yogunluklari arasindaki iliski hangi seçenekte dogru verilmistir?

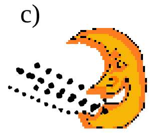


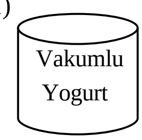
a) I>II   b) II>I   c) I = II   d) bilinmiyor

9) Asagidaki seçeneklerde verilen nesnelerin hangisinde hava yoktur?

a) 
agzi açik kutu

b) 
agzi kapali kutu

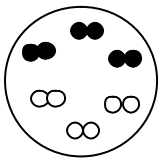
c) 
agzimizdan çikan nefes

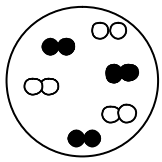
d) 

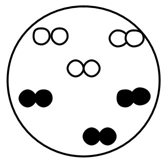
vakumla doldurulmus yogurt kasesi

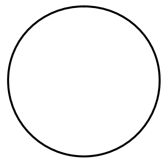
10) Hava baslica azot ve oksijen gazlarindan olusmaktadir. Bir miktar havayi bir balona doldurup büyüterek inceledigimizde görecegimiz sekil asagidakilerden hangisine benzer? Oksijen azottan daha yogun bir gazdir.

Azot:  , Oksijen : 

a) 

b) 

c) 

d) 

BÖLÜM II) ASAGIDAKI SORULARIN "A" BÖLÜMLERINDE SORUNUN YANITINI UYGUN SEÇENEGI YUVARLAK IÇINE ALARAK ISARETLEYIN. "B" BÖLÜMLERIN DE ISE YANITINIZIN NEDENINI DOGRU SEÇENEGI YUVARLAK IÇINE ALARAK AÇIKLAYINIZ.

1) A) Asagida listede verilenlerden hangisi ya da hangileri maddedir?

I. demir çubuk, II. kedi tüyü III. elektrik IV. sicak su V. hava

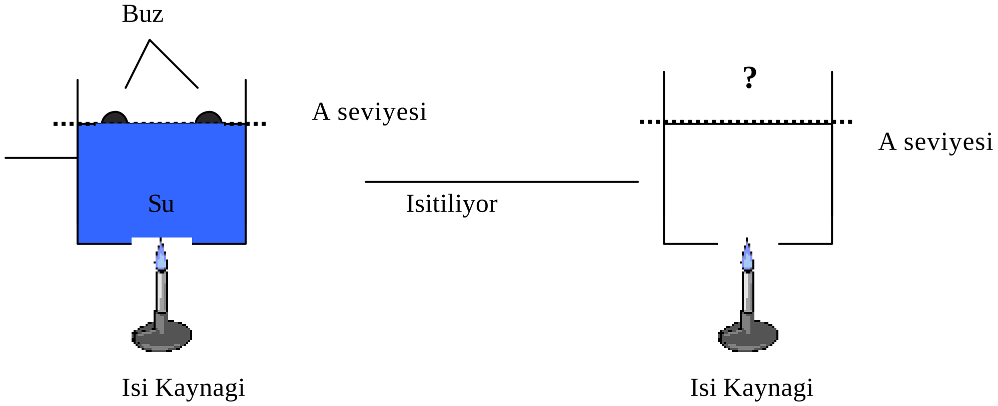
a) demir çubuk, kedi tüyü, hava
b) kedi tüyü, elektrik ve sicak su
c) demir çubuk, kedi tüyü, elektrik ve sicak su
d) demir çubuk, kedi tüyü, sicak su ve hava

B) Madde oldugunu düsündügünüz nesnelerin **neden** madde oldugu asagidaki seçeneklerden hangisinde dogru verilmistir?
a) çünkü gözümüzle görebilir, elimizle dokunabiliriz
b) çünkü cisimdir
c) çünkü uzayda yer kaplar ve belli bir kütlesi vardir
d) çünkü sekli vardir

2) A) Bir kibrit çöpü yandiginda,kütlesinde azalma olur. Bu bilgi dogru mudur / yanlis midir? Asagida uygun yere "X" isareti koyarak yanitlayiniz
1. dogru ________________
2. yanlis_________________

B) Yanitinizin nedeni asagidakilerden hangisidir?
a)atomlar yok edilmedi, kimyasal degisme sonucunda yeniden düzenlendi
b) kibrit çöpü yandiginda kütkesi azalir
c) külün kütlesi, kibrit çöpünden azdir
d) kimyasal degisimler maddeleri yok eder

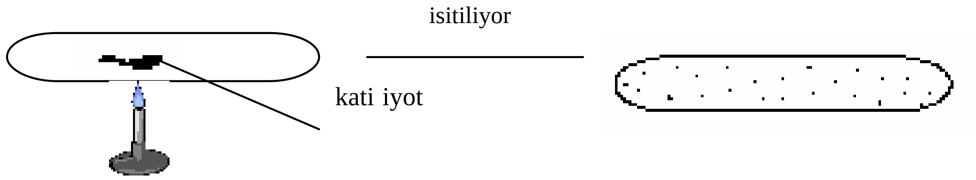
3) A) Iki buz tanesi asagidaki kaptaki suda görüldügü gibi yüzüyor. Kap isitilip, buzlar eridiginde kaptaki suyun seviyesi ne olur?



a) A seviyesinden yukarida
b) A seviyesinde
c) A seviyesinin altinda

B) Yanitinizin nedeni asagidakilerden hangisidir?
a) buz eritildiginde molekülleri genlesir
b) eriyen buzlar suyun seviyesini degistirir (arttirir)
c) suyun yogunlugu buzun yogunlugundan daha fazladir
d) su molekülleri, buz moleküllerinden daha fazla yer kaplar

4)



A) Bir gram kati iyot bir tüpe konuluyor. Tüpün içindeki hava tamamen alindiktan sonra tüpün agzi kapatiliyor. Tüp ve iyodun toplam kütlesi 27 gramdir. Daha sonra tüp isitiliyor ve içindeki kati iyot tamamen gaz hale geliyor. Bu durumda, tüpün toplam kütlesi asagidaki seçeneklerden hangisi dogru olarak verilmistir?
a) 26 gram gelir
b) 27 gram gelir
c) 28 gram gelir
d) 28 gramdan fazla gelir

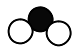
B) Yanitinizin nedeni asagidakilerden hangisidir?
a) gaz bir madde kati bir maddeden daha hafiftir
b) gaz haldeki iyot, kati haldeki iyottan daha hafiftir
c) iyot gazi havadan daha hafiftir
d) Kapali sistemlerde hal degisimi sirasinda kütle korunur

5) A) Demir metali havadaki oksijenle birleserek paslanir. Demir bir çivi tamamen paslandirilirsa, pasli çivinin kütlesi asagidaki seçeneklerden hangisinde dogru verilmistir?
a) paslanmis çivinin kütlesi paslanmamis çivinin kütlesinden daha azdir
b) paslanmis çiviyle paslanmamis çivinin kütlesi aynidir
c) paslanmis çivinin kütlesi paslanmamis çivinin kütlesinden daha fazladir

B) Yanitinizin nedeni asagidakilerden hangisidir?

a) paslanma çiviyi hafifletir
b) pasli çivi, demir ve oksijen içeren bir bilesiktir
c) çivinin en dis tabakasi soyulur
d) çivideki demir yok olur

BÖLÜM III) Bir sinifta element ve bilesiklerle ilgili yapilan etkinlikte ögrencilerden degisik renklerde oyun hamuru kullanarak element ve bilesik modelleri yapmalari istenir. Ögrencilerin yaptigi modeller asagida verilmistir. Bu modellerle ilgili asagidaki sorulari yanitlayiniz.

I.  II.  III.  IV. 

1) Modelleri çizilen maddelerden hangileri **bilesiktir**?

a) I, II　b) I, III　c) II, IV　d) III, IV

2) Modelleri çizilen maddelerden hangileri **elementtir**?

a) yalniz III　b) I, III　c) II, IV　d) III, IV

3) Yukaridaki maddelerden hangileri **molekül**, hangileri **atomdur**?

a) I: molekül, II: molekül, III: atom, IV: molekül
b) I: atom, II: molekül, III: atom, IV: molekül
c) I: atom, II: molekül, III: molekül, IV: molekül
d) hepsi molekül

BÖLÜM IV) Iki ögrenci fiziksel ve kimyasal degismeler konusunu proje olarak sinifta sunacaklardir. Sunumlari için 2 ayri deney yapmaya karar verirler.

I. ögrenci bir miktar suyu isitarak buharlastirir,
II. ögrenci sudan elektrik enerjisi geçirerek suyun elektroliz olmasini saglar

Asagidaki sorulari yapilan deneylere bagli olarak yanitlayiniz.

1) Ögrencilerden hangisi kimyasal, hangisi fiziksel degisime örnek vermistir?

a) I. ögrenci : kimyasal degisim
II. ögrenci: fiziksel degisim

b) I. ögrenci : fiziksel degisim
II. ögrenci: kimyasal degisim

c) ikisi de fiziksel degisime örnek vermistir
d) ikisi de kimyasal degisime örnek vermistir

2) I. ögrenci yaptigi deneyin sonucunda asagida verilen maddelerden hangisini elde etmistir?

a) gaz haldeki oksijen ve hidrojen molekülleri
b) suyun atomlari
c) su buhari molekülleri
d) gaz haldeki oksijen ve hidrojen atomlari

3) II.ögrenci yaptigi deneyin sonucunda asagida verilen maddelerden hangisini elde etmistir?

a) gaz haldeki oksijen ve hidrojen molekülleri
b) suyun atomlari
c) su buhari molekülleri
d) gaz haldeki oksijen ve hidrojen atomlari

APPENDIX C

CONCEPT MAP 1: Matter has four states but it is not possible to study the plasma state, therefore classification is done in three states. Students drew the particles of matter in three different states: Solid, liquid and gas.

MADDENIN HALLERI

Kati cisimlerin belli bir sekli ve hacmi vardir. Kati halde bulunan cisimlerin atomlari birbirine çok yakindir.

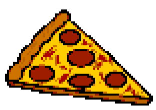
Sivi haldeki madderin belli bir hacmi vadir ancak belli sekilleri yoktur. Bulunduklari kabin seklini alirlar.

Gaz haldeki maddelerin belli bir hacmi ve sekli yoktur. Istedikleri yönde serbestçe hareket ederler.

KATI

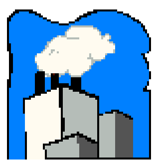
SIVI

GAZ



Pizza

çorba

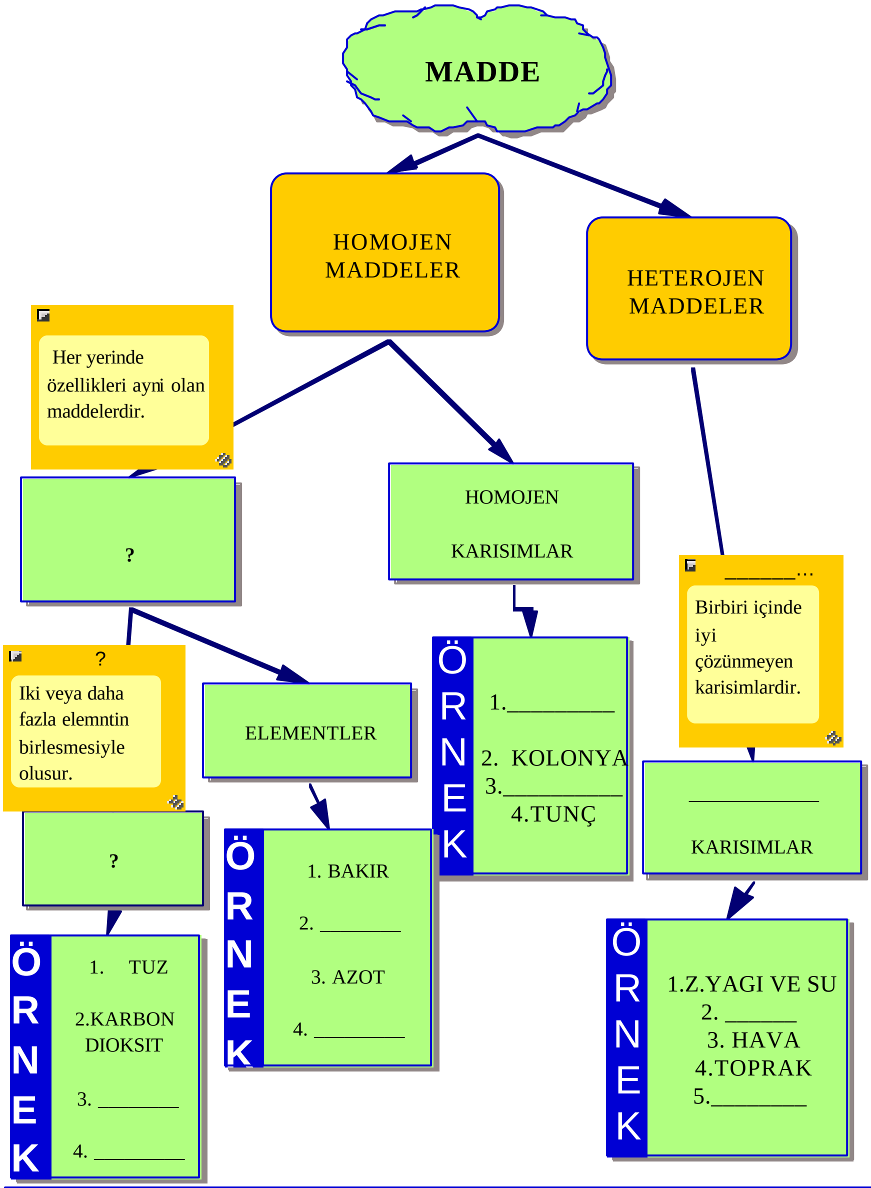


bacadan çikan duman

<u>Proje:</u>Maddenin üç hali ile ilgili bilgiler yukarida verilmistir.
Bu bilgileri kullanarak maddenin kati, sivi ve gaz haldeki taneciklerin yapisini gösteren bir sema hazirlayiniz

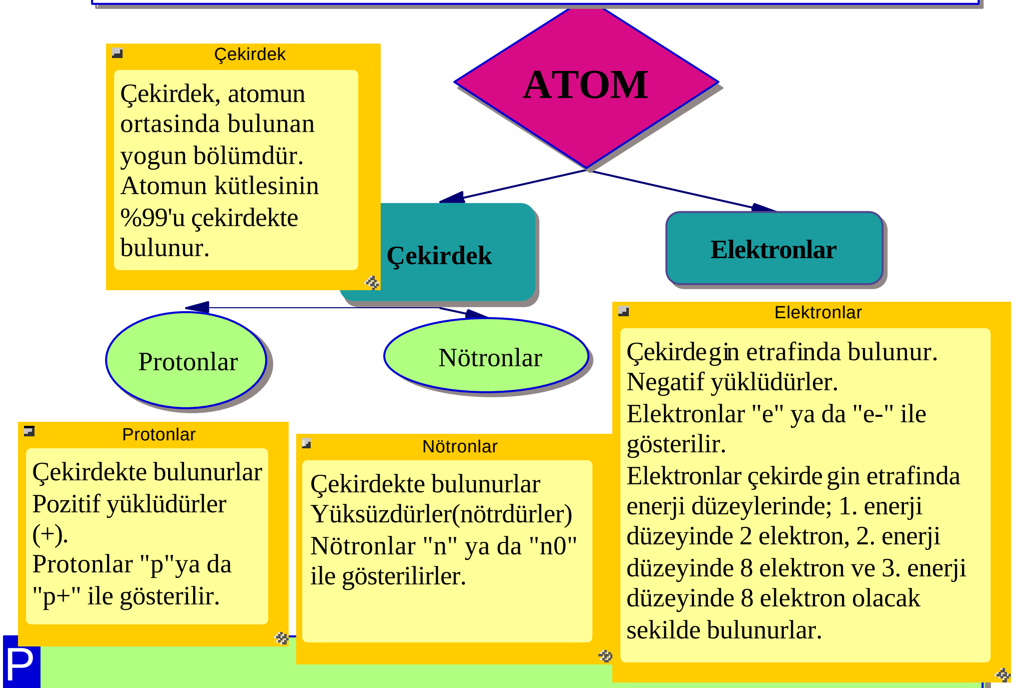
Note: The yellow note boxes do not appear on the page, the students open them as they need help.

CONCEPT MAP 2: Students fill out the concept map with appropriate matter concepts



Note: The yellow note boxes do not appear on the page, the students open them as they need help.

CONCEPT MAP 3: Students draw the models of Carbon, Berilyum and Fluorine atoms



PROJE

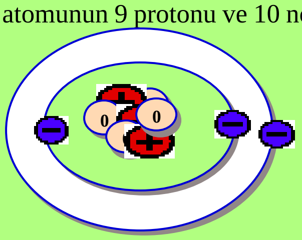
Yukaridaki tablodaki bilgileri okuyunuz. Bu bilgilerden yararlanarak asagida bilgileri verilen nötr atomlarin modellerini çiziniz.

1. Karbon atomunun 6 protonu, 6 nötronu ve 6 elektronu vardir.

2. Berilyum atomunun 4 protonu, 5 nötronu ve 4 elektronu vardir.

3. Flor atomunun 9 protonu ve 10 nötronu vardir.

ÖRNEK:



Örnekteki atomun 4 nötronu, 3 protonu ve 3 elektronu vardir.

Note: The yellow note boxes do not appear on the page, the students open them as they need help.

APPENDIX D

FEN BILGISI TUTUM ÖLÇEGI

Açiklama: Bu ölçekte, Fen Bilgisi dersine iliskin tutum cümleleri ile her cümlenin karsisinda TAMAMEN KATILIYORUM, KATILIYORUM, KARARSIZIM, KATILMIYORUM ve HIÇ KATILMIYORUM olmak üzere bes seçenek verilmistir. Her cümleyi dikkatle okuduktan sonra kendinize uygun seçenegi isaretleyiniz.

		TAMAMEN KATILIYORUM	KATILIYORUM	KARARSIZIM	KATILMIYORUM	HIÇ KATILMIYORUM
1	Fen Bilgisi çok sevdigim bir alandir.	○	○	○	○	○
2	Fen Bilgisi ile ilgili kitaplar okumaktan hoslanirim.	○	○	○	○	○
3	Fen Bilgisinin günlük yasantida çok önemli yeri yoktur.	○	○	○	○	○
4	Fen Bilgisi ile ilgili ders problemlerini çözmekten hoslanirim.	○	○	○	○	○
5	Fen Bilgisi konulariyla ilgili daha çok sey ögrenmek istiyorum.	○	○	○	○	○
6	Fen Bilgisi dersine girerken sikinti duyarim.	○	○	○	○	○
7	Fen Bilgisi derslerine zevkle girerim.	○	○	○	○	○
8	Fen Bilgisi derslerine ayrilan sürenin daha fazla olmasini isterim.	○	○	○	○	○
9	Fen Bilgisi dersine çalisirken canim sikilir.	○	○	○	○	○
10	Fen Bilgisi konularini ilgilendiren günlük olaylar hakkinda daha fazla bilgi edinmek isterim.	○	○	○	○	○
11	Düsünce sistemimizi gelistirmede Fen Bilgisi ögrenimi önemlidir.	○	○	○	○	○
12	Fen Bilgisi çevremizdeki dogal olaylarin daha iyi anlasilmasinda önemlidir.	○	○	○	○	○
13	Dersler içinde Fen Bilgisi dersi sevimsiz gelir.	○	○	○	○	○
14	Fen Bilgisi konulari ile ilgili tartismaya katilmak bana cazip gelmez.	○	○	○	○	○
15	Çalisma zamaninin önemli bir kismi Fen Bilgisi dersine ayirmak isterim.	○	○	○	○	○

APPENDIX E

BILIMSEL ISLEM BECERI TESTI

AÇIKLAMA**:** Bu test, özellikle Fen ve Matematik derslerinizde ve ilerde üniversite sinavlarinda karsiniza çikabilecek karmasik gibi görünen problemleri analiz edebilme kabiliyetinizi ortaya çikarabilmesi açisindan çok faydalidir. Bu test içinde, problemdeki degiskenleri tanimlayabilme, hipotez kurma ve tanimlama, islemsel açiklamalar getirebilme, problemin çözümü için gerekli incelemelerin tasarlanmasi, grafik çizme ve verileri yorumlayabilme kabiliyelerini ölçebilen sorular bulunmaktadir. Her soruyu okuduktan sonra kendinizce uygun seçenegi yalnizca cevap kagidina isaretleyiniz.

Bu testin orijinali James R. Okey, Kevin C. Wise ve Joseph C. Burns tarafindan gelistirilmistir. Türkçeye çevrisi ve uyarlamasi ise Prof. Dr. Ilker Özkan, Prof. Dr. Petek Askar ve Prof. Dr. Ömer Geban tarafindan yapilmistir.

1. Bir basketbol antrenörü, oyuncularin güçsüz olmasindan dolayi maçlari kaybettklerini düsünmektedir. Güçlerini etkileyen faktörleri arastirmaya karar verir. Antrenör, oyuncularin gücünü etkileyip etkilemedigini ölçmek için asagidaki degiskenlerden hangisini incelemelidir?

a. Her oyuncunun almis oldugu günlük vitamin miktarini.

b. Günlük agirlik kaldirma çalismalarinin miktarini.

c. Günlük antreman süresini.

d. Yukaridakilerin hepsini.

2. Arabalarin verimliligini inceleyen bir arastirma yapilmaktadir. Sinanan hipotez, benzine katilan bir katki maddesinin arabalarin verimliligini artidigi yolundadir. Ayni tip bes arabaya ayni miktarda benzin fakat farkli miktarlarda katki maddesi konur. Arabalar benzinleri bitinceye kadar ayni yol üzerinde giderler. Daha sonra her arabanin aldigi mesafe kaydedilir. Bu çalismada arabalarin verimliligi nasil ölçülür?

a. Arabalarin benzinleri bitinceye kadar geçen süre ile.

b. Her arabanin gittigi mesafe ile.

c. Kullanilan benzin miktari ile.

d. Kullanilan katki maddesinin miktari ile.

3. Bir araba üreticisi daha ekonomik arabalar yapmak istemektedir. Arastirmacilar arabanin litre basina alabilecegi mesafeyi etkileyebilecek degiskenleri arastimaktadirlar. Asagidaki degiskenlerden hangisi arabanin litre basina alabilecegi mesafeyi etkileyebilir?

a. Arabanin agirligi. **b.** Motorun hacmi. **c.** Arabanin rengi **d.** a ve b.

4. Ali Bey, evini isitmak için komsularindan daha çok para ödenmesinin sebeplerini merak etmektedir. Isinma giderlerini etkileyen faktörleri arastirmak için bir hipotez kurar. Asagidakilerden hangisi bu arastirmada sinanmaya uygun bir hipotez degildir?

a. Evin çevresindeki agaç sayisi ne kadar az ise isinma gideri o kadar fazladir.

b. Evde ne kadar çok pencere ve kapi varsa, isinma gideri de o kadar fazla olur.

c. Büyük evlerin isinma giderleri fazladir.

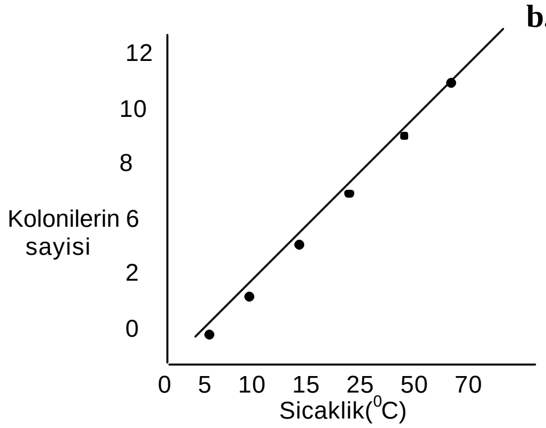
d. Isinma giderleri arttikça ailenin daha ucuza isinma yollari aramasi gerekir.

5. Fen sinifindan bir ögrenci sicakligin bakterilerin gelismesi üzerindeki etkilerini arastirmaktadir. Yaptigi deney sonucunda, ögrenci asagidaki verileri elde etmistir:

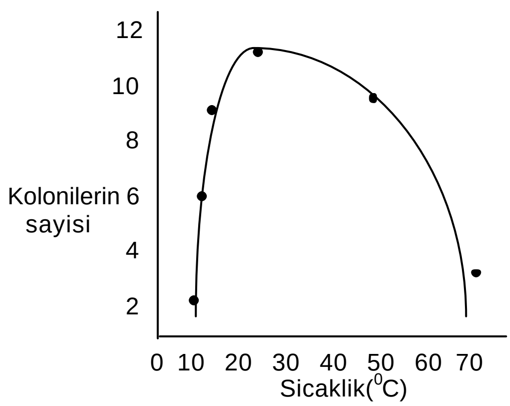
Deney odasinin sicakligi (^{0}C)	Bakteri kolonilerinin sayisi
5	0
10	2
15	6
25	12
50	8
70	1

Asagidaki grafiklerden hangisi bu verileri dogru olarak göstermektedir?

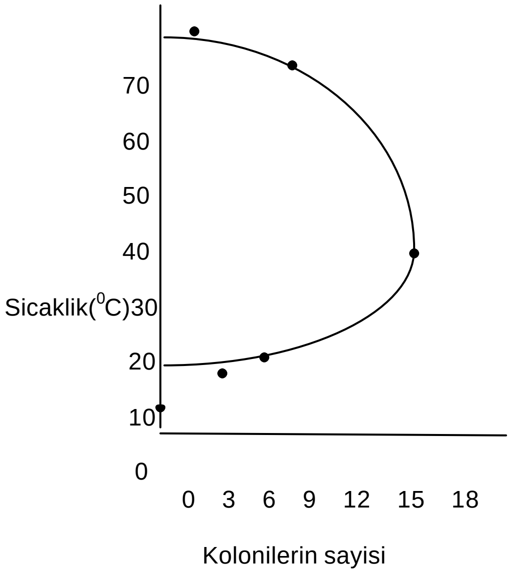
a.



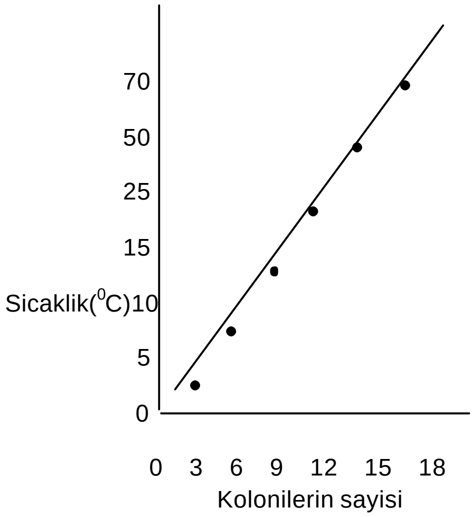
b.



c.



d.



6. Bir polis sefi, arabalarin hizinin azaltilmasi ile ugrasmaktadir. Arabalarin hizini etkileyebilecek bazi faktörler oldugunu düsünmektedir. Sürücülerin ne kadar hizli araba kullandiklarini asagidaki hipotezlerin hangisiyle sinayabilir?

a. Daha genç sürücülerin daha hizli araba kullanma olasiligi yüksektir.

b. Kaza yapan arabalar ne kadar büyükse, içindeki insanlarin yaralanma olasiligi o kadar azdir.

c. Yollarde ne kadar çok polis ekibi olursa, kaza sayisi o kadar az olur.

d. Arabalar eskidikçe kaza yapma olasiliklari artar.

7. Bir fen sinifinda, tekerlek yüzeyi genisliginin tekerlegin daha kolay yuvarlanmasi üzerine etkisi arastirilmaktadir. Bir oyuncak arabaya genis yüzeyli tekerlekler takilir, önce bir rampadan (egik düzlem) asagi birakilir ve daha sonra düz bir zemin üzerinde gitmesi saglanir. Deney, ayni arabaya daha dar yüzeyli tekerlekler takilarak tekrarlanir. Hangi tip tekerlegin daha kolay yuvarlandigi nasil ölçülür?

a. Her deneyde arabanin gittigi toplam mesafe ölçülür.

b. Rampanin (egik düzlem) egim açisi ölçülür.

c. Her iki deneyde kullanilan tekerlek tiplerinin yüzey genislkleri ölçülür.

d. Her iki deneyin sonunda arabanin agirliklari ölçülür.

8. Bir çiftçi daha çok misir üretebilmenin yollarini aramaktadir. Misirlarin miktarini etkileyen faktörleri arastirmayi tasarlar. Bu amaçla asagidaki hipotezlerden hangisini sinayabilir?

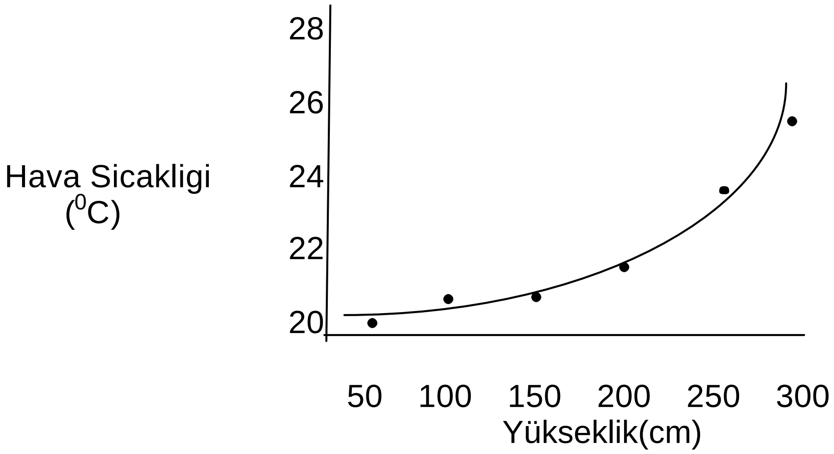
a. Tarlaya ne kadar çok gübre atilirsa, o kadar çok misir elde edilir.

b. Ne kadar çok misir elde edilirse, k**a**r o kadar fazla olur.

c. Yagmur ne kadar çok yagarsa , gübrenin etkisi o kadar çok olur.

d. Misir üretimi arttikça, üretim maliyeti de artar.

9. Bir odanin tabandan itibaren degisik yüzeylerdeki sicakliklarla ilgli bir çalisma yapilmis ve elde edilen veriler asagidaki grafikte gösterilmistir. Degiskenler arasindaki iliski nedir?



a. Yükseklik arttikça sicaklik azalir.

b. Yükseklik arttikça sicaklik artar.

c. Sicaklik arttikça yükseklik azalir.

d. Yükseklik ile sicaklik artisi arasinda bir ilski yoktur.

10. Ahmet, basketbol topunun içindeki hava arttikça, topun daha yüksege siçracagini düsünmektedir. Bu hipotezi arastirmak için, birkaç basketbol topu alir ve içlerine farkli miktarda hava pompalar. Ahmet hipotezini nasil sinamalidir?

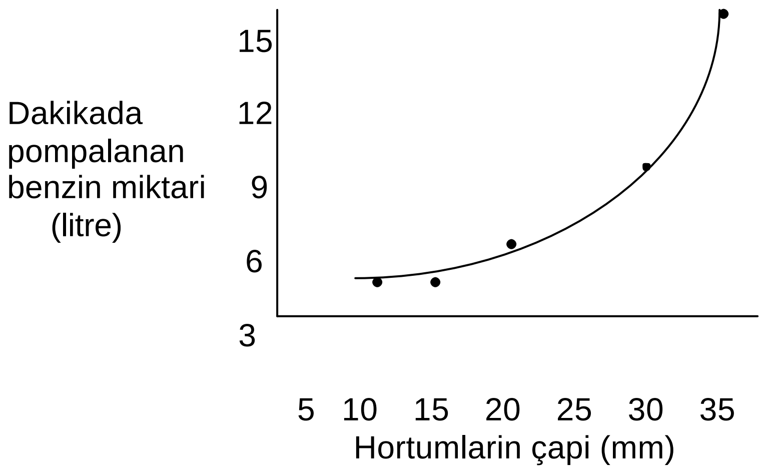
a. Toplari ayni yükseklikten fakat degisik hizlarla yere vurur.

b. Içlerinde farli miktarlarda hava olan toplari, ayni yükseklikten yere birakir.

c. Içlerinde ayni miktarlarda hava olan toplari, zeminle farkli açilardan yere vurur.

d. Içlerinde ayni miktarlarda hava olan toplari, farkli yüksekliklerden yere birakir.

11. Bir tankerden benzin almak için farkli genislikte 5 hortum kullanilmaktadir. Her hortum için ayni pompa kullanilir. Yapilan çalisma sonunda elde edilen bulgular asagidaki grafikte gösterilmistir.



Asagidakilerden hangisi degiskenler arasindaki iliskiyi açiklamaktadir?

a. Hortumun çapi genisledikçe dakikada pompalanan benzin miktari da artar.

b. Dakikada pompalanan benzin miktari arttikça, daha fazla zaman gerekir.

c. Hortumun çapi küçüldükçe dakikada pompalanan benzin miktari da artar.

d. Pompalanan benzin miktari azaldikça, hortumun çapi genisler.

Önce asagidaki açiklamayi okuyunuz ve daha sonra 12, 13, 14 ve 15 inci sorulari açiklama kismindan sonra verilen paragrafi okuyarak cevaplayiniz.

Açiklama: Bir arastirmada, bagimli degisken birtakim faktörlere bagimli olarak gelisim gösteren degiskendir. Bagimsiz degiskenler ise bagimli degiskene etki eden faktörlerdir. Örnegin, arastirmanin amacina göre kimya basarisi bagimli bir degisken olarak alinabilir ve ona etki edebilecek faktör veya faktörler de bagimsiz degiskenler olurlar.

Ayse, günesin karalari ve denizleri ayni derecede isitip isitmadigini merak etmektedir. Bir arastirma yapmaya karar verir ve ayni büyüklükte iki kova alir. Bumlardan birini toprakla, digerini de su ile doldurur ve ayni miktarda günes isisi alacak sekilde bir yere koyar. 8.00 - 18.00 saatleri arasinda, her saat basi sicakliklarini ölçer.

12. Arastirmada asagidaki hipotezlerden hangisi sinanmistir?

a. Toprak ve su ne kadar çok günes isigi alirlarsa, o kadar isinirlar.

b. Toprak ve su günes altinda ne kadar fazla kalirlarsa, o kadar çok isinirlar.

c. Günes farkli maddelari farkli derecelerde isitir.

d. Günün farkli saatlerinde günesin isisi da farkli olur.

13. Arastirmada asagidaki degiskenlerden hangisi kontrol edilmistir?

a. Kovadaki suyun cinsi.

b. Toprak ve suyun sicakligi.

c. Kovalara koyulan maddenin türü.

d. Herbir kovanin günes altinda kalma süresi.

14. Arastirmada bagimli degisken hangisidir?

a. Kovadaki suyun cinsi. **b.** Toprak ve suyun sicakligi.

c. Kovalara koyulan maddenin türü. **d.** Herbir kovanin günes altinda kalma süresi.

15. Arastirmada bagimsiz degisken hangisidir?

a. Kovadaki suyun cinsi. **b.** Toprak ve suyun sicakligi.

c. Kovalara koyulan maddenin türü. **d.** Herbir kovanin günes altinda kalma süresi.

16. Can, yedi ayri bahçedeki çimenleri biçmektedir. Çim biçme makinasiyla her hafta bir bahçedeki çimenleri biçer. Çimenlerin boyu bahçelere göre farkli olup bazilarinda uzun bazilarinda kisadir. Çimenlerin boylari ile ilgili hipotezler kurmaya nbaslar. Asagidakilerden hangisi sinanmaya uygun bir hipotezdir?

a. Hava sicakken çim biçmek zordur.

b. Bahçeye atilan gürenin miktari önemlidir.

c. Daha çok sulanan bahçedeki çimenler daha uzun olur.

d. Bahçe ne kadar engebeliyse çimenleri kesmekte o kadar zor olur.

17, 18, 19 ve 20 nci sorulari asagida verilen paragrafi okuyarak cevaplayiniz.

Murat, suyun sicakliginin, su içinde çözünebilecek seker miktarini etkileyip etkilemedigini arastirmak ister. Birbirinin ayni dört bardagin herbirine 50 ser mililitre su koyar. Bardaklardan birisine 0 ^{0}C de, digerine de sirayla 50 ^{0}C, 75 ^{0}C ve 95 ^{0}C sicaklikta su koyar. Daha sonra herbir bardaga çözünebilecegi kadar seker koyar ve karistirir.

17. Bu arastirmada sinanan hipotez hangisidir?

a. Seker ne kadar çok suda karistirilirsa o kadar çok çözünür.

b. Ne kadar çok seker çözünürse, su o kadar tatli olur.

c. Sicaklik ne kadar yüksek olursa, çözünen sekerin miktari o kadar fazla olur.

d. Kullanolan suyun miktari arttikça sicakligi da artar.

18. Bu arastirmada kontrol edilebilen degisken hangisidir?

a. Her bardakta çözünen seker miktari.

b. Her bardaga konulan su miktari.

c. Bardaklarin sayisi.

d. Suyun sicakligi.

19. Arastirmanin bagimli degiskeni hangisidir?

a. Her bardakta çözünen seker miktari. **b.** Her bardaga konulan su miktari.

c. Bardaklarin sayisi. **d.** Suyun sicakligi.

20. Arastirmadaki bagimsiz degisken hangisidir?

a. Her bardakta çözünen seker miktari. **b.** Her bardaga konulan su miktari.

c. Bardaklarin sayisi. **d.** Suyun sicakligi.

21. Bir bahçivan domates üretimini artirmak istemektedir. Degisik birkaç alana domates tohumu eker. Hipotezi, tohumlar ne kadar çok sulanirsa, o kadar çabuk filizlenecegidir. Bu hipotezi nasil sinar?

a. Farkli miktarlarda sulanan tohumlarin kaç günde filizlenecegine bakar.

b. Her sulamadan bir gün sonra domates bitkisinin boyunu ölçer.

c. Farkli alnlardaki bitkilere verilen su miktarini ölçer.

d. Her alana ektigi tohum sayisina bakar.

22. Bir bahçivan tarlasindaki kabaklarda yaprak bitleri görür. Bu bitleri yok etmek gereklidir. Kardesi "Kling" adli tozun en iyi böcek ilaci oldugunu söyler. Tarim uzmanlari ise "Acar" adli spreyin daha etkili oldugunu söylemektedir. Bahçivan alti tane kabak bitkisi seçer. Üç tanesini tozla, üç tanesini de spreyle ilaçlar. Bir hafta sonra her bitkinin üzerinde kalan canli bitleri sayar. Bu çalismada böcek ilaçlarinin etkinligi nasil ölçülür?

a. Kullanilan toz ya da spreyin miktari ölçülür.

b. Toz ya da spreyle ilaçlandiktan sonra bitkilerin durumlari tespit edilir.

c. Her fidede olusan kabagin agirligi ölçülür.

d. Bitkilerin üzerinde kalan bitler sayilir.

23. Ebru, bir alevin belli bir zaman süresi içinde meydana getirecegi isi enerjisi miktarini ölçmek ister. Bir kabin içine bir liter soguk su koyar ve 10 dakika süreyle isitir. Ebru, alevin meydana getirdigi isi enerjisini nasil öiçer?

a. 10 dakika sonra suyun sicakliginda meydana gelen degismeyi kayeder.

b. 10 dakika sonra suyun hacminde meydana gelen degismeyi ölçer.

c. 10 dakika sonra alevin sicakligini ölçer.

d. Bir litre suyun kaynamasi için geçen zamani ölçer.

24. Ahmet, buz parçaciklarinin erime süresini etkileyen faktörleri merak etmektedir. Buz parçalarinin büyüklügü, odanin sicakligi ve buz parçalarinin sekli gibi faktörlerin erime süresini etkileyebilecegini düsünür. Daha sonra su hipotezi sinamaya karar verir: Buz parçalarinin sekli erime süresini etkiler. Ahmet bu hipotezi sinamak için asagidaki deney tasarimlarinin hangisini uygulamalidir?

a. Herbiri farkli sekil ve agirlikta bes buz parçasi alinir. Bunlar ayni sicaklikta benzer bes kabin içine ayri ayri konur ve erime süreleri izlenir.

b. Herbiri ayni sekilde fakat farkli agirlikta bes buz parçasi alinir. Bunlar ayni sicaklikta benzer bes kabin içine ayri ayri konur ve erime süreleri izlenir.

c. Herbiri ayni agirlikta fakat farkli sekillerde bes buz parçasi alinir. Bunlar ayni sicaklikta benzer bes kabin içine ayri ayri konur ve erime süreleri izlenir.

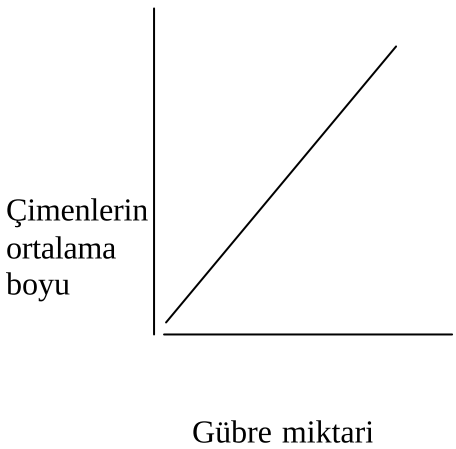
d. Herbiri ayni agirlikta fakat farkli sekillerde bes buz parçasi alinir. Bunlar farkli sicaklikta benzer bes kabin içine ayri ayri konur ve erime süreleri izlenir.

25. Bir arastirmaci yeni bir gübreyi denemektedir. Çalismalarini ayni büyüklükte bes tarlad yapar. Her tarlaya yeni gübresinden degisik miktarlarda karistirir. Bir ay sonra, her tarlada yetisen çimenin ortalama boyunu ölçer. Ölçüm sonuçlari asagidaki tabloda verilmistir.

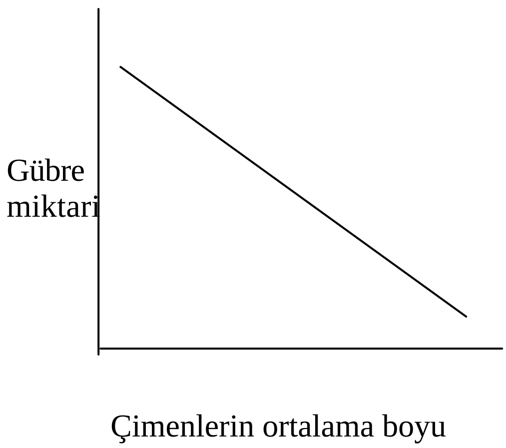
Gübre miktari (kg)	Çimenlerin ortalama boyu (cm)
10	7
30	10
50	12
80	14
100	12

Tablodaki verilerin grafigi asagidakilerden hangisidir?

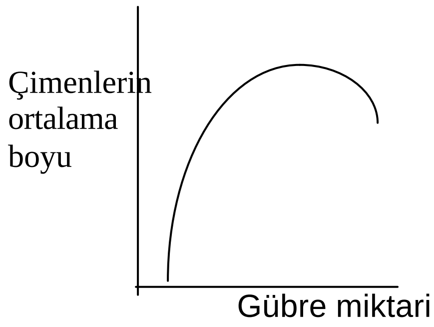
a.



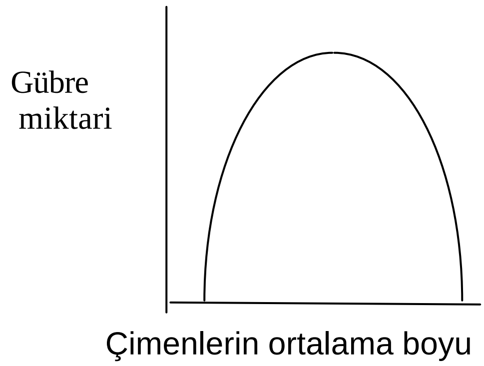
b.



c.



d.



26. Bir biyolog su hipotezi test etmek ister: Farelere ne kadar çok vitamin verilirse o kadar hizli büyürler. Biyolog farelerin büyüme hizini nasil ölçebilir?

a. Farelerin hizini ölçer.

b. Farelerin, günlük uyumadan durabildikleri süreyi ölçer.

c. Hergün fareleri tartar.

d. Hergün farelerin yiyecegi vitaminleri tartar.

27. Ögrenciler, sekerin suda çözünme süresini etkileyebilecek degiskenleri düsünmektedirler. Suyun sicakligini, sekerin ve suyun miktarlarini degisken olarak saptarlar. Ögrenciler, sekerin suda çözünme süresini asagidaki hipotezlerden hangisiyle sinayabilir?

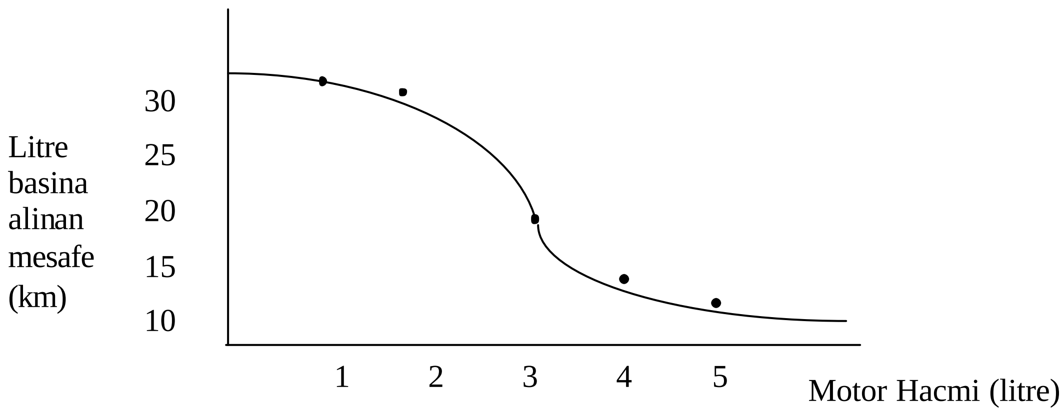
a. Daha fazla sekeri çözmek için daha fazla su gereklidir.

b. Su sogudukça, sekeri çözebilmek için daha fazl akaristirmak gerekir.

c. Su ne kadar sicaksa, o kadar çok seker çözünecektir.

d. Su isindikça seker daha uzun sürede çözünür.

28. Bir arastima grubu, degisik hacimli motorlari olan arabalaiin randimanlarini ölçer. Elde edilen sonuçlarin garfigi asagidaki gibidir:



Asagidakilerden hangisi degiskenler arasindaki iliskiyi gösterir?

a. Motor ne kadar büyükse, bir litre benzinle gidilen mesafe de o kadar uzun olur.

b. Bir litre benzinle gidilen mesafe ne kadar az olursa, arabanin motoru o kadar küçük demektir.

c. Motor küçüldükçe, arabanin bir litre benzinle gidilen mesafe artar.

d. Bir litre benzinle gidilen mesafe ne kadar uzun olursa, arabanin motoru o kadar büyük demektir.

29, 30, 31 ve 32 nci sorulari asagida verilen paragrafi okuyarak cevaplayiniz.

Topraga karitirilan yapraklarin domates üretimine etkisi arastirilmaktadir. Arastirmada dört büyük saksiya ayni miktarda ve tipte toprak konulmustur. Fakat birinci saksidaki toraga 15 kg, ikinciye 10 kg, üçüncüye ise 5 kg. çürümüs yaprak karistirilmistir. Dördüncü saksidaki topraga ise hiç çürümüs yaprak karistirilmamistir.

Daha sonra bu saksilara domates ekilmistir. Bütün saksilar günese konmus ve ayni miktarda sulanmistir. Her saksidan elde edilen domates tartilmis ve kaydedilmistir.

29. Bu arastirmada sinanan hipotez hangisidir?

a. Bitkiler günesten ne kadar çok isik alirlarsa, o kadar fazla domates verirler.

b. Saksilar ne kadar büyük olursa, karistirilan yaprak miktari o kadar fazla olur.

c. Saksilar ne kadar çok sulanirsa, içlerindeki yapraklar o kadar çabuk çürür.

d. Topraga ne kadar çok çürük yaprak karistirilirsa, o kadar fazla domates elde edilir.

30. Bu arastirmada kontrol edilen degisken hangisidir?

a. Her saksidan elde edilen domates miktari **b.** Saksilara karistirilan yaprak miktari.

c. Saksilardaki torak miktari. **d.** Çürümüs yapak karistirilan saksi sayisi.

31. Arastirmadaki bagimli degisken hangisidir?

a. Her saksidan elde edilen domates miktari **b.** Saksilara karistirilan yaprak miktari.

c. Saksilardaki torak miktari. **d.** Çürümüs yapak karistirilan saksi sayisi.

32. Arastirmadaki bagimsiz degisken hangisidir?

a. Her saksidan elde edilen domates miktari **b.** Saksilara karistirilan yaprak miktari.

c. Saksilardaki torak miktari. **d.** Çürümüs yapak karistirilan saksi sayisi.

33. Bir ögrenci minatislarin kaldirma yeteneklerini arastirmaktadir. Çesitli boylarda ve sekillerde birkaç miknatis alir ve her miknatisin çektigi demir tozlarini tartar. Bu çalismada miknatisin kaldirma yetenegi nasil tanimlanir?

a. Kullanilan miknatisin büyüklügüyle.

b. Demir tozlarini çeken miknatisin agirligiyla

c. Kullanilan miknatisin sekli ile.

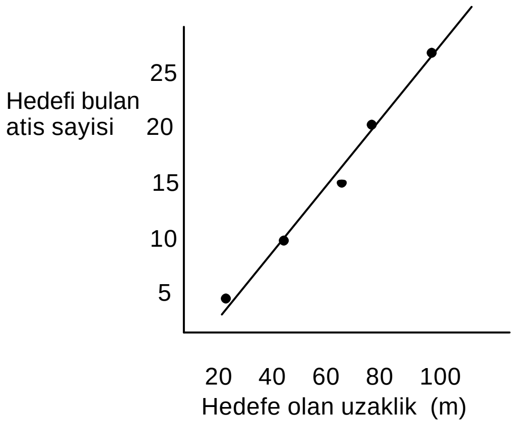
d. Çekilen demir tozlarinin agirligi ile.

34. Bir hedefe çesitli mesafelerden 25 er atis yapilir. Her mesafeden yapilan 25 atistan hedefe isabet edenler asagidaki tabloda gösterilmistir.

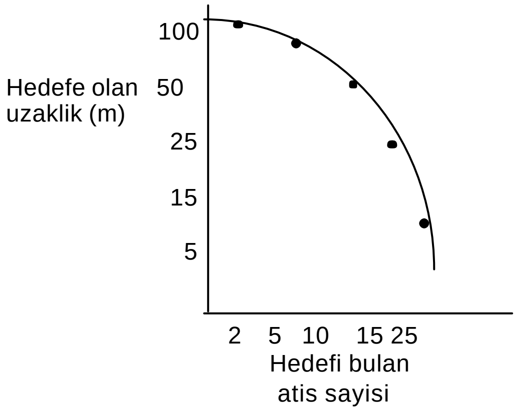
Mesafe(m)	Hedefe vuran atis sayisi
5	25
15	10
25	10
50	5
100	2

Asagidaki grafiklerden hangisi verilen bu verileri en iyi sekilde yansitir?

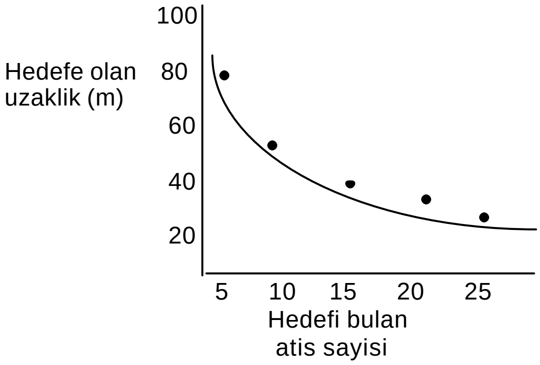
a.



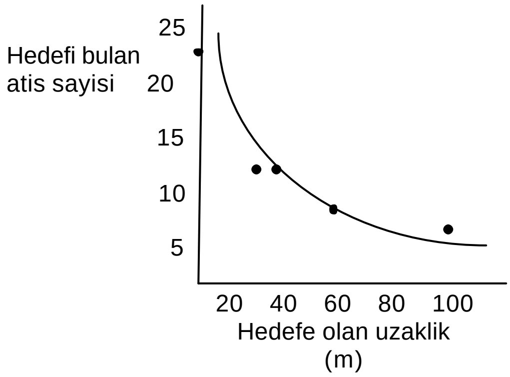
b.



c.



d.



35. Sibel, akvaryumdaki baliklarin bazen çok haraketli bazen ise durgun olduklarini gözler. Baliklarin hareketliligini etkileyen faktörleri merak eder.Baliklarin hareketliligini etkileyen faktörleri hangi hipotezle sinayabilir?

a. Baliklara ne kadar çok yem verilirse, o kadar çok yeme ihtiyaçlari vardir.

b. Baliklar ne kadar hareketli olursa o kadar çok yeme ihtiyaçlari vardir.

c. Su da ne kadar çok oksijen varsa, baliklar o kadar iri olur.

d. Akvaryum ne kadar çok isik alirsa, baliklar o kadar hareketli olur.

36. Murat Bey'in evinde birçok electrikli alet vardir. Fazla gelen elektrik faturalari dikkatini çeker. Kullanilan elektrik miktarini etkileyen faktörleri arastirmaya karar verir. Asagidaki degiskenlerden hangisi kullanilan elektrik enerjisi miktarini etkileyebilir?

a. TV nin açik kaldigi süre. **b.** Elektrik sayacinin yeri.

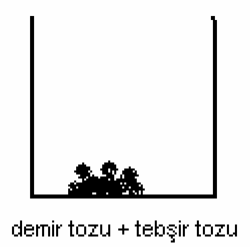
c. Çamasir makinesinin kullanma sikligi. **d.** a ve c.

APPENDIX F

DEMO 1: KARISIM HAZIRLAMA
Malzemeler:

Tebesir tozu, demir tozu, su, ispirto, 3 adet cam bardak, seker, tatli kasigi

Islem Basamaklari



Demir tozu ve tebesir tozunu bardagin içine koyarak iyice karistiriniz.

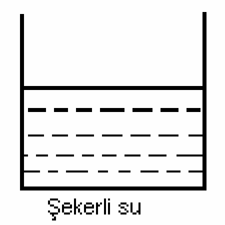
Demir tozu ve tebesir tozu hala görünüyor mu?

____

Demir tozu ve tebesir tozu birbiri içinde iyice karisti mi?

____

Bu hangi tür karisima örnektir?________________________

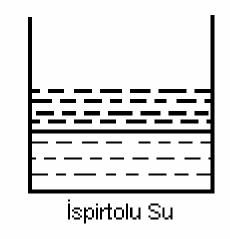


Bardagi yariya kadar suyla doldurunuz

Üzerine bir tatli kasigi seker ekleyin ve iyice karistiriniz

Seker suyla iyice karisti mi? sekeri hala suyun içinde görebiliyor musunuz?__________________

Bu karisim hangi tür karisima örnektir?__________



Bardagi yariya kadar suyla doldurunuz.

Üzerine bardagin ¼'ü kadar ispirto ekleyin ve karistiriniz.

Ispirto suyla tamamen karisti mi? _____________

Bu hangi tür karisima örnektir?

Sorular

1.Bu etkinlikte hangi maddeler en iyi karisti?

2. Buradaki gibi karisim hazirlayabileceginiz iki örnek veriniz.

3. Kirli hava, kirli su hangi tür karisimlara örnektir? Nedenini açiklayiniz.

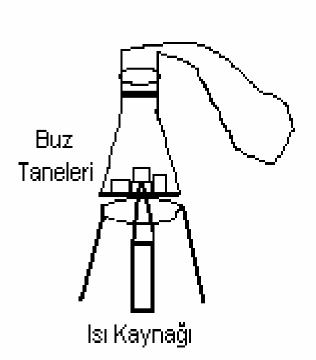
DEMO 2: ISI ALAN MADDE HAL DEGISTIRIR

Malzemeler :

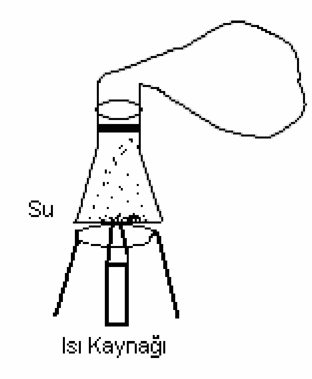
Balon, Erlen, saç ayak, buz taneleri, isi kaynagi

Islem Basamaklari **:**

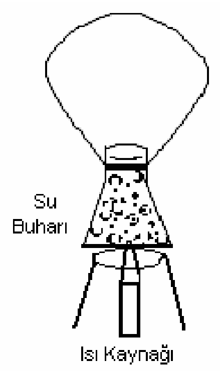
1. Buz parçasini erlenin içine atin.
2. Balonu erlenin agzina geçirip saç ayagin üzerine koyun
3. Isi kaynagini erlenin altina koyup, fitilini yakin
4. Erlen isindikça içindeki buzda degisiklik gözlemledin mi?________________
5. Erlendeki suyu isitmaya devam edin. Balon sismeye basladi mi?______________
6. Balonun doldurup sismesine hangi gaz neden olmustur?_____________________
7. Simdi isi kaynagini erlenden uzaklastirin ve sogumaya birakin.
8. Balonda nasil bir degisim gözlemledin? ________



Sekil I



Sekil II



Sekil III

Düsünelim.

Sicak su buhariyla dolu balonu alip buz dolabina koysaniz balonda nasil bir degisme gözlemlerdiniz?

APPENDIX G

CORRECT RESPONSE PERCENTAGES

Parts	Questions	Experimental Group	Control Group
Part I	1	80	80
	2	72,5	60
	3	65	67,5
	4	47,5	42,5
	5	62,5	65
	6	20	7,5
	7	75	57,5
	8	52,5	52,5
	9	82,5	72,5
	10	37,5	35
Part II	1a	95	77,5
	1b	95	82,5
	2a	50	55
	2b	47,5	50
	3a	90	85
	3b	87,5	75
	4a	57,5	55
	4b	45	50
	5a	60	52,5
	5b	55	52,5
Part III	1	77,5	75
	2	67,5	60
	3	55	50
Part IV	1	62,5	60
	2	57,5	55
	3	25	20

APPENDIX H

AN EXAMPLE OF A LESSON PLAN ON THE PARTICLE MODEL OF SOLIDS, LIQUIDS AND GASES

LESSON I (40 MINUTES):

Ögretmen: Tüm maddenin taneciklerden olustugunu ve bu taneciklerin hareketli oldugunu konusmustuk. Ayrica dogada maddelerin 3 farkli halde bulunabildigini ve bu hallerin kati, sivi ve gaz haller oldugunu biiliyoruz. Kati, sivi ve gazlarin özelliklerin kisaca hatirlamak gerekirse, katilari hangi, özelliklerinden taniyabiliriz?

(students tells physical properties of solids, liquids and gases)

Sivilarin katilardan farkli özellikleri nelerdir?

(students express their ideas)

Hava, gaz haldeki maddelere güzel bir örnektir, sizce hava söyledigimiz bu özellikleri tasiyor mu? Bir maddenin gaz olabilmesi için ne gibi özellikleri olmasi gerekir?

(students express their ideas)

(Teacher showing the erlenmeyer with ice cubes in it, asks the students to observe the properties they have told earlier)

Simdi buzun hal degistirmesi ile ilgili bir gösteri deneyi yapacagim. Sizin de buzun hal degistirmesi sirasinda kütlesinin ve hacminin nasil degistigini gözlemlemenizi istiyorum. (Phase changes of ice activity is performed. See Appendix F). (*During the* *activity teacher asks questions related with the particle model solids, liquids and gases to activate student misconceptions).*

At the end of the activity the properties of solids, liquids and gases are summarised. The students are given the information that the coming period they will be going to the computer lab. To do a project consisting of a concept map related with the particle model of matter in different states.

LESSON II (80 MINUTES) :

Ögretmen: Geçen derste kati, sivi ve gaz haldeki maddelerin özellikleri, taneciklerinin dagilimi ile ilgili konusmustuk. Bugün, bu özellikleri kullanarak kati, sivi ve gaz haldeki maddelerin taneciklerin dizilisini olusturunuz.

(*The teacher presents the work she prepared with Inspiration about the states of matter.She asks the students to carry out the project given at the bottom of her work. See Appendix C for teacher work. In this project the students draw the particle model of solid, liquid and gas particles. Students get a print out of their work when they are done*).

In the last 10 minutes, the students are asked to evaluate their own work examining the teacher's work given at the beginning of the lesson.

VITA

Ayse Yavuz was born in Yenisehir, Bursa on January 28, 1972. She graduated from Bursa Özel Namik Sözeri High School in 1990. She received her B.S. degree in Faculty of Education, Department of Chemistry Education from the Middle East Technical University in June 1994. She worked in several different schools including Anatolian Schools and Private Schools. She has been working at Enka High School since September 2002. She won a Teacher Exchange Scholarship from Fulbright and taught Science in South Kingstown Jr. High School Rhode Island, USA in the school year 1999-2000. Her main interest areas are quality education, curriculum development and teaching Science in different ability classrooms. She has done one presentation in National Congress and one presentation in an International Symposium.