EFFECT OF INSTRUCTION USING CONCEPTUAL CHANGE STRATEGIES ON STUDENTS' CONCEPTIONS OF CHEMICAL REACTIONS AND ENERGY

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

BY

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IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
SECONDARY SCIENCE AND MATHEMATICS EDUCATION

SEPTEMBER 2004

Approval of the Graduate School of Natural and Applied Sciences

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ABSTRACT

EFFECT OF INSTRUCTION USING CONCEPTUAL CHANGE STRATEGIES ON STUDENTS' CONCEPTIONS OF CHEMICAL REACTIONS AND ENERGY

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September 2004, 93 pages

The main purpose of the study was to compare the effectiveness of the conceptual change oriented instruction through demonstration and traditionally designed chemistry instruction on 10^{th} grade students' understanding of chemical reactions and energy concepts and attitudes towards chemistry as a school subject.

In this study, 61 tenth grade students from two classes of chemistry course instructed by same teacher from Atatürk Anatolian High School took part. The study was conducted during 2003-2004 fall semester.

This study included two groups which were selected randomly throughout 9 classes. One of the group was defined as control group in which students were taught by traditionally designed chemistry instruction, while the other group defined as experimental group in which students were instructed by conceptual change oriented instruction through demonstrations (CCID). Chemical Reactions and Energy Concepts Test and Attitude Scale toward Chemistry were administered to both groups as a pre-test and post-test to assess the students understanding of chemical reactions and energy concepts and students' attitudes toward chemistry, respectively. Science Process Skills Test was given at the beginning of the study to determine students' science process skills.

The hypotheses were tested by using analysis of covariance (ANCOVA) and two-way analysis of variance (ANOVA). The results showed that CCID caused significantly better acquisition of the scientific conceptions related to chemical reactions and energy concepts than TDCI. The results showed that there was a significant difference between post-test mean scores of students taught with CCID and those taught with TDCI with respect to their attitude toward chemistry as a school subject. A Science process skill was determined as a strong predictor in understanding the concepts related chemical reactions and energy.

Keywords: Conceptual Change Approach, Chemical Reactions and Energy, Demonstration, Misconceptions, Attitude toward Chemistry, Science Process Skills

ÖZ

KAVRAMSAL DEĞİŞİM STRATEJİLERİ KULLANIMINA DAYALI ÖĞRETİMİN KİMYASAL REAKSİYONLAR VE ENERJİ KAVRAMLARINI ANLAMAYA ETKİSİ

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Eylül 2004, 93 sayfa

Bu çalışmanın başlıca amacı kavramsal değime dayalı öğretim yönteminin kullanımının 10. sınıf öğrencilerinin kimyasal reaksiyonlar ve enerji konularındaki kavramları anlamalarına etkisini geleneksel kimya öğretim yöntemi ile karşılaştırarak incelemektir.

Bu çalışma, Atatürk Anadolu Lisesinde aynı öğretmenin iki ayrı sınıfındaki 61 onuncu sınıf öğrencilerinin katılımı ile gerçekleşmiştir. Bu çalışma, 2003-2004 güz döneminde yapılmıştır.

Çalışmada, okulda bulunan 9 onuncu sınıf arasından rarstgele seçilen iki sınıf kullanılmıştır. Bu gruplardan biri deney grubu, diğeri kontrol grubu olarak tanımlamıştır. Kontrol grubunda geleneksel öğretim yöntemleri uygulanırken, deney grubunda kavramsal değişim yaklaşımına dayalı öğretim yöntemi uygulanmıştır. Kimyasal reaksiyonlar ve enerji testi ile kimya tutum ölçeği öğrencilere ilk-test ve son-test olarak dağıtılarak öğrencilerin kimyasal reaksiyonlar

ve enerji konularını anlamaları ve kimyaya karşı olan tutumları değerlendirilmiştir. Öğrencilerin bilimsel işlem becerilerini belirlemek üzere bilimsel işlem beceri testi çalışmanın başında öğrencilere uygulanmıştır.

Bu çalışmanın hipotezleri ortak değişkenli varyans analizi (ANCOVA) ve iki değişkenli varyans analizi kullanılarak test edilmiştir. Analiz sonuçlarıdan, kavramsal değişim yaklaşımı kullanılan öğrencilerin, kimyasal reaksiyonlar ve enerji kavramlarını, geleneksel kimya anlatımı kullanılan gruba göre daha iyi anladıkları tespit edilmiştir. Ayrıca çalışmanın sonunda deney grubundaki öğrencilerin tutumları da olumlu yönde bir değişim göstermiştir. Buna ek olarak, öğrencilerin bilimsel işlem becerileri, öğrencilerin kimyasal reaksiyonlar ve enerji kavramlarını anlamasında belirleyici bir unsur olduğu tespit edilmiştir.

.

Anahtar Kelimeler: Kavram Yanılgısı, Kavramsal Değişim, Kimyasal Reaksiyonlar ve Enerji, Bilimsel İşlem Becerileri, Kimyaya Karşı Tutum

To my mother and father…

ACKNOWLEDGMENTS

I would like to express my deepest gratitude to supervisor of my thesis, Prof. Dr. Ömer Geban, for his guidance, advice, criticism, encouragements, and suggestions throughout the study.

I would also like to thank Figen Çayıroğlu, who is the teacher of the participating students in this study and applied the method of this study, for her assistance, suggestions, enthusiasm, and friendliness.

I am very much thankful to my friends Selin Küçükkancabaş, Huseyin Yıldırım, Esen Uzuntiryaki, Selcen Özkaya Seçil, Selen Sencar, Nursen Azizoğlu for their support.

I am grateful to my sister Seren and her husband Çağrı Dabbağoğlu for their moral support and encouragement.

I would like to offer my sincere thank to my father and mother for their enormous encouraging efforts and moral support.

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LIST OF SYMBOLS

EG	:	Experimental Group
CG	:	Control Group
CCID	:	Conceptual Change Oriented Instruction through Demonstration
TDCI	:	Traditionally Designed Chemistry Instruction
CRECT	:	Chemical Reactions and Energy Concept Test
SPST	:	Science Process Skills Test
ASTC	:	Attitude Scale toward Chemistry as a School Subject
df	:	Degrees of freedom
F	:	Fischer's F Statistics
Sig.	:	Significance level
$\overline{X}$	:	Mean of the sample

CHAPTER 1

INTRODUCTION

For many years, the notion that students come to classes with blank slates was accepted. Moreover, some teachers believe that students come to instruction with incorrect understandings of a subject matter. And, these teachers believe that traditional instruction will easily eliminate or replace these misunderstandings (Gilbert, Osborne, & Fensham, 1982; Pope & Gilbert, 1983). Teachers usually think that it is enough to correct these misunderstandings for students to learn successfully. These teachers usually do not give importance to consider students existing knowledge prior to instruction (Baujaodeu, 1991).

Researches have consistently shown, students come to classrooms with well-established understandings about how and why everything behaves as they do (Posner, Strike, Hewson, & Gertzog, 1982; Resnik, 1983; Strike, 1983). Recent studies have shown that these understandings, whether correct or incorrect, influence students' learning of new scientific conceptions, and may support or hinder learning of scientific concepts (Hewson, 1982; Shuell, 1987).

Conceptions that are inconsistent with the accepted scientific conceptions defined as misconceptions. Researchers have used various other terms for misconceptions, such as preconceptions, alternative conceptions, alternative frameworks, and students' descriptive and explanatory system (Nakhleh, 1992; Nussbaum & Novick, 1982). Preconceptions may or may not be misconceptions; this depends on the consistency between preconceptions and scientific conceptions (Teichert & Stacy, 2002). Students' preexisting beliefs has an important role to gain new scientific knowledge and play essential role in subsequent learning

(Arnaudin and Mintez, 1985; Boujaoude, 1991; Driver and Oldham, 1986; Shuell, 1987; Tsai, 1996). Students' communication with each other, students' personal experience, students' interactions with teachers, other people, and media may cause misconceptions (Gilbert et al., 1982; Gilbert and Zylberstajn, 1985; Griffiths and Preston, 1992). Meaningful learning is very important in school life to eliminate misconceptions.

Ausubel (1968) differentiated meaningful learning and rote learning. He stated that the new knowledge should be related with the students' relevant prior knowledge to occur meaningful learning in learners' cognitive structure. With respect to this, Ausubel noted, "the most important single factor influencing learning is what the learner already knows". Science learning is a process of knowledge construction, and this construction start from prior knowledge (Posner et al., 1982, Gil, 1983; Osborne & Wittrock, 1983; Driver, 1985; Novak, 1987).Hewson ad Hewson (1984) stated that learning a new idea requires the learner to relate the new idea to his or her current concepts.

Many students at all levels struggle to learn chemistry, but usually they can not achieve this (Nakhleh, 1992). These students confront some difficulties to understand fundamental concepts of chemistry (Gabel, Samuael, &Hunn, 1987). Students have trouble to understand advanced concepts due to not fully understand fundamental concepts. One of the reason of this can be stated, teachers do not take into account students' conceptions before the instruction (Hunt and Minstrel, 1997). Because of these, many students have lack of conceptual knowledge for problem solving in chemistry (Gabel & Bunce, 1994).

To understand chemistry is a hard thing for most of the students. Teachers can not teach most of the chemical concepts with only showing simple examples. Atoms molecules, ions, or bonding with particles, nor element and compounds and their chemical characteristics can not be able to demonstrate. Although students can see some chemical events such as physical and chemical changes, state of matter or changes in other properties of substances; like color, several studies showed that these chemical concepts are not fully understood by students (Anderson, 1986, 1990; Ben-Zwi, Eylon, and Silverstein, 1986; BouJoude, 1991; Hesse & Anderson, 1992).

In the past few decades, researches in chemistry education have increased. These researches show that traditional instruction is not sufficient for students to understand concepts deeply, and to integrate students' ideas into coherent conceptual framework (Teichert & Stacy, 2002).

Chemical reactions and energy is one of the subject areas of chemistry. Many studies have focused students' conceptions in thermodynamics. These literature are mainly about the difficulties that students have with the energy concepts (Boo, 1998; Hapkievicz, 1991). An understanding of thermodynamics is very essential for chemistry, especially energy concept is very important to understand some chemistry concepts better such as; the structure of matter, the nature of chemical reactions (Cohen & Ben-Zwi, 1982). Cohen and Ben Zwi (1982) stated that difficulties in thermodynamics can be classified into three categories, which are conceptual difficulties, difficulties in calculation of enthalpy changes, and experimental difficulties.

There is no simple answer the question of "what should be done about science misconceptions". However, researches have shown that, to improve meaningful learning, it is very crucial to understand the difficulties in science learning, and to be aware of new and effective teaching/learning strategies (Gil-Perez and Carrascosa, 1990).

According to the constructivist theory of learning, learners construct knowledge themselves and knowledge is actively constructed by making sense of world, interpreting new information in terms of existing structures (Taber and Watts, 1997). Learners' prior knowledge and experience will affect the particular knowledge that is constructed by an individual (Grayson et al., 2001; Von Glasersfeld, 1992).

Postner et al. (1982) proposed conceptual change strategies, which was based on the assumption that many difficulties in science learning have their origin in the knowledge pupils have acquired prior to instruction and in the ignorance of this knowledge by teachers (Posner et al, 1982). To understand what is conceptual change and how to use in science teaching, it is very important to consider the links between constructivism, which is the another popular idea, and students' conceptions (Hewson,1992). The supporters of conceptual change theory emphasize the central role of the prior knowledge in learning. So, the conceptual change theory shows consistency with the Ausubel's opinion.

But, after the conceptual change theory presented, many question have raised about the possibility of achieving conceptual change. Some researchers worried whether constructing scientific knowledge which takes the place of students' intuitive preconceptions can be achieved. However, some experimental research results (Hewson & Hewson, 1984) showed that an instructional strategy based on the model of conceptual change causes a much better of acquisition scientific conceptions than the traditional based strategy. But, some researcher (Fredette & Lochhead, 1981; Shuel, 1987) emphasized that to achieve conceptual change is very difficult, even when prior conceptions are explicitly consider (Gil-Perez & Carracosa, 1990).

In conceptual change two phases can be specified. In first phase, which is called assimilation, the existing concepts are used to deal with new phenomena. In second phase, which is called accommodation, students' existing concepts are insufficient to grasp new phenomenon. So, these existing concepts must be replaced or reorganized with adequate ones (Posner et al., 1982). Posner et al. (1982) stated four conditions for accommodation:

- There must be dissatisfaction with existing conceptions
- A new conception must be intelligible
- A new conception must appear initially plausible
- A new concept should suggest the possibility of fruitful research program

Hewson and Hewson (1983) proposed what a teaching strategy includes. Possible teaching strategies includes integrating new conceptions with existing conceptions, differentiating existing conceptions into more clearly, defined, separated, but closely related conceptions, exchanging an existing conception for a new one, establishing an appropriate context in which important abstract concepts can be linked with meaningful common experiences. In this study, the effect of conceptual change activities was investigated.

On the other hand, in science education, learning with demonstration provides a suitable learning environment which students have an opportunity to see what is happening in the real situation. During the demonstrations, the conditions, which are necessary to provide conceptual change, are created. Demonstrations are very useful for presenting students the real world situations and catching their attention (Golestaneh, 1998). Demonstrations have a potential to awake students interest, and demonstrations motivate students to seek explanation for their world in terms of chemistry (Hugo, 1993).

In teacher demonstrations, the most crucial thing is to provide a learning environment in which students perceive science demonstrations from a perspective that not differs from that of teachers and scientist (Shepardson, Moje, & Kennard-McLelland, 1994). To provide this, it is very important to take into account students' prior knowledge.

This study compared the conceptual change oriented instruction through demonstration with traditional chemistry instruction. Teacher demonstrations and students discussion, which are based on conceptual change oriented instruction, are used as instructional method in order to activate students' misconceptions related to chemical reactions and energy concepts.

CHAPTER 2

REVIEW OF LITERATURE

The present study includes previous studies which have become an extensive background of this study.

In chemistry education, there is an extensive literature that contains students' understanding of chemistry concepts. Teachers have always aware of students' conceptions before the instruction. Ausubel (1968) stated the importance of prior knowledge by explaining and differentiating meaningful learning and rote learning. To reach meaningful learning, new knowledge and students' existing relavant concepts must be related in students' cognitive structure. For this reason, Ausubel claims that, "the most important single factor influencing learning is what the learner already knows." In the process of learning, then, the important thing is to recognize students' existing knowledge in the acquisition and retention of subject matter knowledge (Ausubel, 1968).

Hewson (1992) stated that learning involves changing one's conceptions in addition to adding new knowledge to what's already there. Learning involves an interaction between new and existing conceptions, and the outcome depends on the nature of interaction. There is an extensive literature that investigated how to facilitate conceptual change in chemistry education. Azizoğlu (2004) conducted a study to promote conceptual change in gases concepts, Bayır (2000) designed a study to facilitate conceptual change in chemical change and conservation of mass concepts. We have to facilitate and promote conceptual change in chemistry education to eliminate students' misconceptions and for a better acquisition of chemistry concepts. Therefore, this study aims to identify the students' preexisting conceptions related to an important field of chemistry, chemical reactions and energy, by having the students to be aware of them and to replace these misconceptions. In order to do this, firstly we will take into account of both current studies and those in the past constructing the literature investigating the meaningful and importance of a number of terms such as misconceptions, conceptual change approach and constructivism, misconceptions in chemical reactions and energy concepts, demonstrations etc. to describe understanding.

2.1 Misconceptions:

Students construct their own concepts. Students' conceptions which are constructed by students sometimes differ from the concepts that instructor holds and try to present. These concepts which are different from scientific ones described different researchers as misconceptions, preconceptions (Driver & Easley, 1978), alternative frameworks (Driver & Ericson, 1983), children's science (Obsorne & Freyberg, 1985), and student's descriptive and explanatory systems (Champagne, Klopfer, and Gunstone, 1982). Nakhleh (1992) defined misconception as a concept that differs from the commonly accepted scientific understanding of the term. Driver (1986) stated that misconceptions are related with the intuitive ideas and preconceptions which are gained before the school instruction.

Dykstra, Boyle, and Monorach (1992) summarized the meaning of alternative conceptions (misconceptions) as:

1. Students, who are confronted with a particular situation, give mistaken answers. These mistaken answers defined as misconceptions.
2. Students have ideas about particular situation and these ideas evoke the mistaken answers. These ideas called as misconceptions.
3. Students have some fundamental beliefs, which are used in a variety of different situation, to explain how the world works. These fundamental beliefs defined as misconceptions.

Nakhleh (1992) stated that if students gain these misconceptions, subsequent learning of these students is interfered by these misconceptions. Since the misconceptions are hold in students' cognitive structure, students can not link new conception, which is a scientific conception, with existing knowledge. So, weak understanding or misunderstanding will occur. Schmidt (1995) noted if students have some ideas that differ from the definitions accepted by experts, difficulties arise to solve related problems.

Learners develop their concepts, generalizations, and theories through the use of observations. The quality of observations depends on the quality of preexisting knowledge (Gilbert &Watts, 1983). Knowledge, which is acquired through the interaction with children and environment and brought to school prior to instruction, is termed spontaneous knowledge (Vygotsky, 1986), informal knowledge (Pines & West, 1986), or commonsense knowledge (Olson, 1977). These are necessarily personal and dynamic (Baujaoude, 1991).

Driver (1981) stated that children ideas are different from scientific views and it is quite difficult to alter these ideas with scientific ones. Students generally reject the new ideas, which are scientific ones after the instruction.

Everyday knowledge is the other source of misconceptions. In chemistry classrooms, the words from everyday language are used but these words have different meanings. Prieto et al. (1992) noted that the interaction between students' social and school knowledge causes the formation of students' ideas. During the instruction, teacher should emphasize the everyday phenomena and everyday language which are related to the content. In chemistry classrooms, students' everyday ideas should be investigated firstly and should be encouraged to understand the instructors' ways in the same phenomena which have a function that more fruitful alternative in particular context.

Some of the researchers conducted some studies to identify students misconceptions in chemistry such as: Griffiths and Preston (1992) conducted interviews to identify students conceptions about fundamental characteristics of atoms and molecules, BouJaoude (1991) used the interview-about-events technique to elicit students' understandings about the concept of burning, Australian researchers (Hackling & Garnet, 1985; Garnet at al., 1990; Garnett & Treagust, 1992a, 1992b) conducted interviews identify misconceptions about chemical equilibrium and electrochemistry, Hesse and Anderson (1992) used a written test to investigate students conceptions about chemical change, Russ and Monby conducted clinical interviews to reveal students' understanding about acids and bases.

Gil-Perez and Carroscose (1990) stated that it is not easy to answer the question that "what to do about the science misconceptions". Research on science misconceptions reveal science learning difficulties for better understanding and emphasize the necessity for profound changes in teaching and learning process to improve meaningful learning. This is, undoubtedly, one of the most important outcomes of the research on science misconceptions. Based on these researches, some of the researchers proposed teaching strategies. One of the strategies is conceptual change strategies which are based on the assumptions that difficulties in science learning, the knowledge which is acquired before the instruction and the ignorance of this knowledge by the teachers.

2.2 Misconceptions in Chemical Reactions and Energy:

Many students at all level spend many times to understand chemistry. However, it is not easy to overcome the problems with related chemistry subject. Many researchers try to investigate the reasons. From this point, one of the important and basic topics of the chemistry is chemical reactions and energy. Many students have some difficulties to learn this concept meaningfully. Since they can not relate their existing conceptions with new conceptions, many students are not able to learn this concept meaningfully. As a result, they hold many misconceptions about chemical reactions and energy concept. Understanding chemical reactions and energy concepts is very crucial in chemistry. All changes in matter, whether chemical or physical, are related in the change in energy. And, the usage and production of energy have an enormous impact on society.

To understand chemistry appropriately, it is very important to comprehend the various aspect of energetic concepts. If students understand energy concepts properly, the structure of matter, the nature of chemical reaction, and factors influencing them can be understood better (Cohen & Ben-Zvi, 1982).

The fundamental concepts of chemical reactions and energy (thermodynamics) concepts are heat and temperature. Students have many conceptual difficulties in thermodynamics (Clough & Driver, 1985; Harrison, Grayson & Treagust, 1999). Students who are not able to differentiate between heat and temperature concepts, will confront with the difficulties for deeper thinking about thermodynamic concepts (Yeo & Zadnik, 2001).

Yeo and Zadnik (2001) made a study to develop an instrument for assessing students' understanding in thermal concepts. In their study, they revealed the misconceptions about heat and temperature which were provided from the literature. Students believe that heat is a substance, heat is not energy, temperature is the intensity of the heat, skin or touch can determine the temperature, materials like wool have the ability to warm things up, temperature and heat are the same thing.

Cohen and Ben-Zvi (1982) stated that when students learning chemical reactions and energy concepts, they are confronted many difficulties. These difficulties can be categorized in three sub-dimensions. First one is conceptual difficulties, which means that energy concept is very theoretical. Students confronted some difficulties with relating changes in energy and changes that occur at the molecular level. Secondly, students have some difficulties to calculate enthalpy changes. Students spend many times to dealing with algorithmic problems to calculate energy changes. Third, students have difficulties during the experiments. Measuring temperature changes in various chemical reactions and calculating the corresponding heats of reaction is very difficult for students.

Brosnan (1992) noted that students understand chemical change differently from the chemists' view. In a scientific view chemical change is defined as an interaction of equal partners. However, students always believe that chemical change is a result of interaction of an active agent on passive substances. Andersson (1986) stated that this view is related to students' everyday life.

De Vos and Verdonk (1986) reported students' difficulties in categorizing chemical reactions as exothermic and endothermic. They stated that students believed that burning of a candle is an endothermic reaction. The heat which is needed to initiate burning is caused to think like this. And, these students also believed that burning of a copper is an endothermic reaction, because the oxide is formed only when cooper is heated. Likewise et al. noted that high school students believed that endothermic reactions can not spontaneous, and that all reactions, which occur naturally or without overt application of heat, are exothermic.

Cachapuz and Martins (1987) stated that many of the high school students have misconceptions about the energy changes in reactions. Students held the misconceptions in the sub-subjects such as: reaction in solutions, the nonbonding energy, the bonds being formed in the solutions, chemical changes in which involves a transfer of the energy existing between the water molecules, the resulting temperature of the water depends on the amount of nonbonding energy left.

Ben-Zvi, Eylan, and Silberstein (1982, 1987) reported that students see chemical reactions as an additive process rather than interactive process. This means that students view chemical reactions as a process of addition or gluing of reactants to form products. However, chemical reactions are processes which involve process of bond breaking and bond making. Krajcik (1991) stated that students approach chemical equation as a mathematical puzzle especially during balancing the chemical equations. However, chemical equation is a representation of a dynamic and interactive process.

Cohen and Ben-Zvi (1992) reported that students may develop their misconceptions during learning chemical energetics. This can be caused from the problems that are related large number of abstract concepts (such as heat, energy, temperature, and bond energy). Maurin (1986) stated that freshman students had some misconceptions in energy changes related with neutralization reactions. And, he reported that university 4 students have some problems to understand thermodynamics of chemical reactions.

Boo (1998) conducted a study to investigate students' understanding about chemical bonds and energetics of chemical reactions. He found that majority of students in his study approached chemical bonds as a physical entity. And, these students believed that bond making requires input of energy and bond breaking releases energy. This misconception may comes from the everyday experiences, in such a way that, building any structure requires energy input, and its converse, destruction, releases energy. He found that 48% of the students, who enrolled his study, hold this misconception. This misconception may be result of relating macroscopic world with the microscopic world. This misconception may comes from the biology courses, such as students think that the energy that provided from food comes from breaking of bonds in food, rather than the energy comes from the reaction of food with oxygen. And, some students believed that both bond breaking and bond making procedures require energy.

In the same study, Boo (1997) noted that some students think chemical reactions can not occur if there is no external intervention such as heating.

Cohen and Ben-Zvi (1982) noted that students have some difficulties to understand some concepts in chemical reactions and energy subjects. These are:

1. Students believed that bond dissociation always produce energy, bond formation consumes it.

2. Applications of Hess law require using algorithms to calculate ΔH^o. Students do not always appreciate relation of their calculated results with the occurrence at molecular level.
3. The equation $q=m.C.\Delta t$ is introduced and used very often mechanically.. This lead to lack of understanding in this concept.
4. The unclear definitions of system and surroundings terms may cause the misunderstanding of energy transfer.

Baujadeu (1991) conducted a study to identify and examine students' understandings about the concept of burning. The interview-about-events technique was used in this study. This technique includes demonstrations to attract students' attention and elicit their responses. This study revealed that students' understandings based on the concrete and observable changes that took place during the burning, students usually use their memorized facts to explain their observations, and held inconsistent understandings with scientific conceptions. This research revealed the misconceptions about burning such as; burning always involves fire or flame, substances undergo no chemical change during burning, terms such as evaporation and burning can be used interchangeably when describing burning alcohol, physical and chemical change can be used interchangeably when explaining burning things.

Boujaoude (1991) noted that it was understood that students approached different types of burning for different things. It means that some students think that burning of wax is melting, burning of alcohol is evaporating, and burning of wood is changing into ashes.

Erickson (1979) conducted a study to identify patterns of children beliefs in the area of heat and temperature. He stated that students have some difficulties to distinguish heat and temperature. Some students believed that heat is a type of a substance.

Thomas and Schwens (1999) conducted a study to identify, classify, and characterize undergraduate physical chemistry class students' conceptions of fundamental concepts of thermodynamics. After the classification of these conceptions, these conceptions were compared with those of experts. They showed the prevalent alternative conceptions which are hold by university students about the fundamental concepts of thermodynamics. 75% of students believed that endothermic reactions cannot be spontaneous, 50% of students believed that the addition of energy as a reactant is the driving force behind the presented reaction, 42% of students believed that heat is energy that is added to something, 31% of the students think that the energy shown as a reactant in the presented reaction is an activation energy. They noted that students in advanced undergraduate class for chemistry majors have some difficulties in fundamental concepts of thermodynamics. They stated that it is very difficult to modify students' conceptions via standard instruction.

Golastaneh (1998) conducted a study to propose some demonstrations about thermodynamics. She stated that some students have some difficulties to understand the energy release in an exothermic reaction. Students believed that the energy that released in an exothermic reaction is "produced" such as heat and light. However, this consideration is inconsistent with the conservation laws.

2.3 Constructivism and Conceptual Change Approach

Von Glassersfeld (1989) described constructivism as "theory of knowledge with roots in philosophy, psychology and cybernetics" (p.162). In constructivist perspective knowledge is constructed by the individual through his interactions with his environment. Constructivism emphasizes that the construction of new understanding is done through the combination of prior learning, new information, and readiness to learn. So, students have to construct their own knowledge to use their prior knowledge. Even when information is explicitly presented by teachers or text books, meaningful knowledge acquisition involves interpretation and integration guided by the learner's own prior knowledge.

In constructivism, knowledge is not simply absorbed from a teacher or textbook. Knowledge is actively constructed by learner from using sensory experiences. The learners need to relate their existing knowledge with the new knowledge to be taught (Brown, 1979).

Jonassen (1991) proposed some principles to design learning environments which are based on constructivism.

1. Real world environments, which are relevant to learning context, should be created.
2. In order to solve real-world problems, realistic approaches should be focused.
3. The instructor should act as a coach and analyzer of the strategies when solving the problems.
4. Multiple representations and perspectives on the content should be presented.
5. Instructional goals and objectives should be negotiated.
6. Tools and environment should be provided to help learners interpret the multiple perspective of the world.
7. Learning should be internally controlled and mediated by the learner.

The ideas of conceptual change approach and constructivism are similar. The difference is, whereas constructivism is dealing with general process of learning, conceptual change approach is dealing with the specific conditions whereby existing structures are modified by new information (Weaver, 1998). And, also, conceptual change model is based on constructivist notion, which claims that learning is a process of personal construction of knowledge (Cobern, 1996).

Before thinking about conceptual change, it is helpful to think the word “change” in different aspects. First, in some cases, there is only one entity before and a different one after the change. Here change means extinction of the former stage. Second, in some cases, there is no extinction; change means an exchange of one entity for another. Third, in some cases change means extension. When describing conceptual change with respect to these definitions, extinction does not seem to be appropriate. In literature, there is a common agreement that the process of the student exchanging one idea for another is conceptual change. But, for some, it is believed that students learn things they did not know by making connections to what they already know. From this perspective conceptual change includes both exchange and extension (Hewson, 1992).

Westbrook and Rogers (1996) stated that some strategies that are used for bringing children's thinking into line that of scientist….has became known as conceptual change. Here conceptual change is defined as a set of teaching strategies.

Stofflet (1992) defined the process change a necessary prerequisite for the formation of scientifically validated theories. The focus here is on learning rather than teaching strategies. Duit (1996) explained conceptual change and he stated that learning can be defined with respect to the concept as change from one concept to another or an exchange of concept.

Postner et al. (1982) proposed two types of conceptual change, assimilation is a process which students use existing concepts to deal with new phenomena and accommodation is a process which student must replace or reorganize his concepts.

Fellows (1994) stated that if students demonstrate thinking that moves them toward accepted scientific understandings and the ability to use those understandings to explain, describe, and predict real-world phenomena, it is determined that conceptual change is accomplished.

To learn science in a meaningful way means; realigning, reorganizing, or replacing existing conceptions to accommodate new ideas. This process has been called conceptual change (Smith, Blakeslee, and Anderson, 1993). Hydn et al.

(1995) stated that altering or reorganizing of existing schemata to account new learning is conceptual change.

Postner et al. (1982) suggest that four conditions are necessary for conceptual change to occur in an individual's understanding.

1. There must be dissatisfaction with existing conceptions. Scientists and students are unlikely to make major conceptual changes until they believe that less radical changes will not work.
2. A new conception must be intelligible. The individual must be able to grasp how experience can be structured by a new conception sufficiently to explore the possibilities inherent in it.
3. A new conception must appear initially plausible. Anew conception adopted at least appear to have the capacity to solve problem generated by its predecessors and fit with other knowledge, experience, and help, otherwise it will not appear a plausible choice. ,
4. A new conception should suggest the possibility of a fruitful research program. It should have the potential to be extended, to open up new areas of inquiry, and to have technological and/or explanatory power.

Hewson (1992) stated that conceptual change model has two important components. The first component is the conditions that need to be met in order for a person to experience conceptual change. The second component is the person's conceptual ecology which means that the context in which the conceptual change occurs. In a rich conceptual ecology, students should grasp individual concepts and understand complex interrelationship among those concepts (Ruth, 1989).

Hynd et al. (1997) stated that there may be epistemological, cognitive, affective reasons to understand why conceptual change is difficult. With respect to epistemological view, most of the people believe that their observations of the world are accurate and correct. Conceptual change can only be acquired when people realize that their previous observations and scientific beliefs about the world are inaccurate. According to cognitive view, when students are confronted with conflicting data, they can prefer to discount the data, ignore it, or memorize it rather than undergo conceptual change. In affective view, conceptual change has also been linked to attitudes and motivation. Strike and Postner (1990) stated that "A wider range of factors needs to be taken into account in attempting to describe a learners' conceptual ecology. Motives and goals and the institutional and social sources of them need to be considered" (p.10).

Students come to instruction with a variety of conceptual frameworks that are inconsistent with the accepted, scientific ideas (Anderson & Smith, 1987a; Bishop & Anderson, 1990; Clement, 1982; Driver & Erikson, 1983; Helm & Novak, 1983). Researchers (McCloskey,1983; Maria & Macginitie, 1981; Marshall, 1989) found that individuals whose ideas conflict with new information often disregard or discount the new information in favor of existing knowledge, when it is necessary for their learning to change existing knowledge. Hewson (1992) noted that in order to learn new conception, the status of new conception should be raised. It means the new conception is able to be understood, accepted, and believed its usefulness. If new conception conflicts with the existing conception, it means the existing conception already has high status, and also new conceptions can not be accepted until the status of the existing conception is lowered.

Hewson and Hewson (1983) stated that the interaction between new and existing conceptions provide learning. The outcome is dependent on the nature of the interaction. If these conceptions are consistent with each other, learning proceeds without difficulty. However, they can not be reconciled, learning requires that existing conceptions be restructured or even exchanged for the new to provide learning. When planning educational programs, the knowledge of what the learner brings to a instructional setting should be thought as a vital component (Erickson, 1979). Ausubel (1968) stated that "if I had to reduce all of educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly" (p.VI).

Teachers should employ activities which are based on students' prior knowledge and experiences to make learning meaningful. And these activities are also helpful to construct their own frames of thoughts (Johnson et al.).

Fellows noted that learning in science requires more than just adding new concepts to knowledge. Science learning entails realignment in thinking and construction of new ideas. This was defined as accommodation (Piaget, 1950). Piaget defined that learner's existing schema does not fit with new information. So, learners require to adjusting existing conceptions or schemas and create new connections to make sense of the new information. Existing schemas are changed and new ways of thinking, which are based on new information and found useful, are constructed.

Learning is defined as a process of active construction which is shaped by students' prior knowledge and construction. Teachers' information which includes both conscious and unconscious comments and statements are chosen by students. Students choose this information; to which they can give their own meaning, with respect to their previous conceptions (Nieswandt, 2001). This selected information is interpreted and drawn inferences based on students' stored information (Nakhleh, 1992).

Research has shown that most instruction is highly ineffective when the aim is conceptual change (Carey, 1986; Driver and Easly, 1978; Roth, Smith, and Anderson 1983; Smith and Lott, 1983). In fact, conceptual change is accomplished difficultly. Students usually memorize facts and terminology without changing their theories about how the world works (McCloskey, 1983). Fellows (1994) stated that students are able to pass their exams by memorizing facts or using algorithms. However, when they are asked to describe, explain, and make interpretations about real world phenomena, the memorized fats and algorithms are found useless.

To accomplish conceptual change, cognitive conflict should be created in students' cognitive structure. Cognitive conflict is the major instrument for change. First, students' everyday relevant conceptions discovered and they are exposed to discrepant event to create cognitive conflict (Scott, Asoko, and Driver, 1992). And, also before the new conception accepted, the new concept should be fruitful and more helpful for the students understanding and interpreting the phenomena in their world (Postner et al., 1982).The new conception has to be seen challenging old beliefs. Then students can change their conceptions accordingly.

To create conceptual change in student, the teaching strategies should be realistic with respect to teachers' and students' abilities (Weaver, 1997). Hewson and Hewson proposed possible teaching strategies. First one is integration; the aim in the interaction is to integrate existing conception with the new conception. Second one is differentiation: the aim in differentiation is to provide clear definitions of their existing conceptions and is to explain that what is plausible in one situation is no longer in different, more complex one. Third one is exchange: since a student is not going to exchange a plausible conception for one which is seem to be implausible, It becomes necessary to create dissatisfaction to show that the new conception has more explanatory and predictive power than the old. The last one is conceptual bridging; the aim is to establish an appropriate context in whish abstract concepts can be linked with meaningful common experiences.

Many researchers (Dreyfus, Jungwirth, & Eliowitch, 1990; Dykstra et al., 1992; Nuassbaum & Novisck, 1982) described conceptual change learning as process involving discussion of students in which students' conceptions are expressed by questioning and dialogue. Although it has some deficiencies, constructivist and conceptual change theorists claims that it is more effective in creating learning (Weaver, 1998).

Hewson and Hewson (1984) conducted a study to examine students' alternative conceptions and instructional strategies to effect the learning of scientific conceptions. These conceptions involved mass, volume, and density.

There were two groups. One of the groups was assigned to control group, which was exposed traditional strategy and materials, the other class was assigned to experimental group, which was exposed conceptual change oriented instruction by sing specials instructional strategy and materials. Pre and post test were used to assess conceptual change that occurred in both groups. The results showed that experimental group which explicitly deal with student alternative conceptions, acquired significantly larger improvement in scientific conceptions.

Niaz (2002) was conducted a study a study to construct a teaching strategy, which was based on conceptual change approach and facilitate conceptual change in freshman students' understanding of electrochemistry. There were two groups in this study which were control and experimental group. Students in experimental group were instructed with respect to teaching experiments, which were based conceptual change approach; whereas those in control group were instructed with respect to solve problems without experimental format. Results showed that the difference in performance of the experimental and control groups on posttests was statistically significant. It was concluded that teaching experiments which were based on conceptual change approach facilitating students understanding of electrochemistry.

Fellows (1994) conducted a study to examine students' understanding and conceptual changes in the nature of matter and physical changes by using paper and pencil pretest and posttest. Students' writings were used to provide qualitative data about their understandings of the goal concepts. The results showed that written and oral language opportunities, which explain, interpret, and integrate new information in the existing schema, support learning. When students accomplish conceptual change, they demonstrate thinking which is closer to accepted scientific understandings and they demonstrate the ability to use those understanding to explain, describe and predict real world phenomena.

In order to support conceptual change, many study, which were related with developing teaching units in chemistry, were conducted. These were emphasize teaching “gases and their properties” (Anderson, Bach & Nussbaum, 1996), the studies of Berheimer (Berkheimer et all.), the longitudinal studies (Johnson,1998), children’s learning in science (Lichtfeld,1996).

Neieswandt (2001) conducted a project to improve students’ learning of basic concepts of chemistry. These concepts were pure substances and mixtures, air and combustion, metal oxides, oxidation and reduction, carbon in gas, atoms and bonding. Her aim was to design an introductory chemistry course, containing these teaching units, based on the theoretical considerations of constructivism and conceptual change model. In this study, there were 81 ninth grade students at different classes. Explanatory test design without control group was chosen to examine individual learning processes. The other aim of the study was try to assess the degree to which students accept the scientific concepts and use them for interpreting the phenomena in their surrounding world. The results showed that there is need to teach chemical concepts in different context. Each different context gives students different opportunities to practices the new concept on similar tasks as well as to apply it to everyday phenomena. In order to accomplish conceptual change in chemistry concepts, it is very crucial to understand students’ everyday conceptions in chemistry.

2.4 Demonstrations in Chemistry:

Most of the researchers agree that traditional instruction, which does not into account existing beliefs of students, is largely ineffective in changing students’ misconceptions (Hestenes, Wells, and Swackhamer, 1992). The traditional approach to science instruction is very ineffective to evolve students’ interest and develop conceptual understanding of the subject matter (Anderson & Smith, 1987; Bell, 1981; Bishop & Anderson, 1990; Driver, 1983; Haidar & Abraham, 1991; Hewson & Hewson, 1988; Tobias, 1990). Textbooks that are used in traditional instruction often disregard the real world applications of science concepts. Some textbooks include applications that are not related to the main body of the text (Golastaneh, 1998). Studies have sown that traditional textbook and lecture paradigm in which students' role defined as recipients of facts is not the most effective way to teach (Dykstra, Boyle, & Monarch, 1992; Yager, 1991).

When we look the definition of the word "demonstration", we see that the word derived from the Latin word "monstrate" which means to show or point out and the word "de" is a reinforcing device. But, to be able to recognize what is demonstrated, students should have prior knowledge and theoretical framework about the presented demonstration (Roth at al., 1997). Demonstrations (Candela, 1996) defined as "activities in which students must reassert or validate information previously stated by textbook or the teacher".

It is very crucial to relate the students' understandings with visible aspects of activities that students observe inside and outside the classroom. Teachers should design classroom observable activities, which give students the opportunity to use their understandings in explaining phenomena. These classroom activities should also give students opportunities to test and change their misunderstandings and create more scientific ones (Baujaoude, 1991).

Students can be motivated by presenting real world, attention catching applications and phenomena. Students always find the learning environments that are based demonstrations funny and natural. The demonstrations should be valuable. The valuable demonstration can be provided by qualifying its visual aspect, modifying its though-provoking elements, and encouraging students to investigate the cause effect relationship (Golastaneh, 1998). Candela (1996) stated that the discourse plays an important role in scientific knowledge construction within classroom interaction.

Demonstrations are often used to show scientific principles in action. However there may be some problems with this practice. Many researchers (Feyarebend, 1976; Hanson, 1965, Hodson, 1992, Rorty, 1989) stated that observation and interpretation is the same thing. Interpretations form from the existing understandings and observations depends on what one already knows. So students should know the principles before the demonstration. This is the prerequisite to understand the intended phenomena with demonstrations (Roth et al., 1997).

To encourage conceptual change through laboratory activities or demonstrations the process of developing hypotheses, designing experiments or watching demonstrations, and analyzing data should be integrated with conceptual knowledge. In here the most crucial phase is analyzing results for creating conceptual change. If the students only asked to verify whether the demonstration results are correct or not, the conflicting data may be ignored and misconceptions may never overcome (Dreyfus, Jungwirth, & Eliovitch, 1990; Rowell & Davson, 1983). Also, Dykstra noted that conceptual change is not encouraged by presenting students only the information, because such statements, includes this information, make little sense in the context of students' existing beliefs.

Baujadeu (1991) conducted a study to identify and examine students' understandings about the concept of burning. She stated that students should be given an opportunity to test and change their alternative conceptions with scientific one. To do this, teachers should, as much as possible, select and range classroom activities to provide students observable examples of scientific concepts and to reduce the possibility of over generalizing from a limited number of salient examples.

Demonstrations are always found useful activities to attract students' interest. And, demonstrations always motivate students to explain their world in terms of chemistry. If demonstrations can be used to explain the issues that are very important in students' daily life, students will be more reception. It is very important to develop relevant activities with the curriculum, and also it is very crucial to select concepts that are worth to continue to develop (Hugo, 1993). Hugo (1993) stated that acid rain concept is a good example for this.

Roth et al. (1997) investigated important points that should be accounted before and during presentation of demonstrations. These points are:

- Students confront some difficulties to differentiate important part of the demonstration because of the insufficient voice of teachers.
- Students come to demonstrations with different conceptions and frameworks that are inappropriate with scientific concepts and these concepts interfere the development of a discourse, which is suitable for the situation at hand.
- The superficial similarities images and discourse, which are seen in other demonstrations may interfere the development of scientific conceptions and discourse.
- Students may confront some difficulties to connect scientific conceptions that teachers talk with their knowledge about physical systems.
- Teachers should give opportunities to students to engage their tasks with demonstrations.
- Teachers should give opportunities to students to test their knowledge that are inappropriate with scientific ones.

Vygotsky (1984) indicated that guided questions, examples, and demonstrations, as well as the imitation of a guided activity done by adults, can also propitiate reasoning and a constructive relationship of children with knowledge.

Weaver (1998) conducted a study to understand the science class environment to propose changes in methodology. The results of this study and research of the literature, which were related to conceptual change, were combined to understand whether these teaching practices were successful or not. It was found that the hands-on activities, laboratory activities and demonstrations are more enjoyed by students and it is mentioned in literature that these kinds of activities can promote conceptual change when combined with discussion and reflection. And also, it is more useful and enjoyable for students when these activities are related with their daily lives and experiences.

Students are more interested in laboratory work, hands-on activities and demonstrations than other traditional classroom activities. In literature, it can be seen that there is a positive relationship between interest and student performance (Simpson, Kabolla, Oliver, &Crawley, 1994). If laboratory and hands-on activities does not include relevant real life subject matter, it is very difficult to maintain students' interest (Weaver, 1998). Also, Weaver (1998) implied that students, who indicated enjoyment about subject matter, stated that they found it more important than other part of the curriculum.

In the light of related literature, it can be concluded that misconceptions effect students' subsequent learning. Although different teaching strategies have been used, students continue to hold their wrong conceptions. However, conceptual change strategies are effective to eliminate students' misconceptions. For this reason, this study mainly focuses on comparing the effectiveness of conceptual change oriented instruction through demonstration versus traditionally designed chemistry instruction on not only understanding of chemical reaction and energy concepts but also their attitudes towards chemistry as a school subject.

CHAPTER III

PROBLEMS AND HYPOTHESES

3.1 The Main Problem and Subproblems

3.1.1 The Main Problem

The main purpose of this study is to investigate the effectiveness of conceptual change oriented instruction through demonstration (CCID) over traditionally designed chemistry instruction (TDCI) on 10^{th} grade students' understanding of chemical reactions and energy concepts, and attitudes towards chemistry as a school subject.

3.1.2 The Subproblems

1. Is there a significant difference between the effects of conceptual change oriented instruction through demonstration (CCID) and traditionally designed chemistry instruction (TDCI) on students' understandings of chemical reactions and energy concepts when students' science process skills are controlled?

2. Is there a significance difference between the performance of males and females with respect to understanding of chemical reactions and energy concepts when students' science process skills are controlled?

3. Is there a significant effect of interaction between gender difference and treatment with respect to students' understanding of chemical reactions and energy concepts when students' science process skills are controlled?

4. What is the contribution of students' science process skills to their understanding of chemical reactions and energy concepts?

5. Is there a significance difference between the effects of conceptual change oriented instruction through demonstration (CCID) and traditionally designed chemistry instruction (TDCI) with respect to students' attitudes toward chemistry as a school subject?

6. Is there a significance difference between male and females with respect to their attitudes toward chemistry as a school subject?

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

3.2 Hypotheses

H_o1: There is no significant difference between post-test mean scores of the students taught with conceptual change oriented instruction through demonstration (CCID) and those taught with traditionally designed chemistry instruction (TDCI) with respect to understanding of chemical reactions and energy concepts when students' science process skills are controlled as a covariate.

H_o2: There is no significant difference between post-test mean scores of males and those of females with respect to their understanding of chemical reactions and energy concepts when students' science process skills are controlled as a covariate.

H_o3: There is no significant effect of interaction between gender difference and treatment with respect to understanding of chemical reactions and energy concepts when students' science process skills are controlled as a covariate. .

H_o4: There is no significant contribution of students' science process skills to their understanding of chemical reactions and energy concepts.

H_o5: There is no significant difference between post-test mean scores of the students taught with conceptual change oriented instruction through demonstration (CCID) and those taught with traditionally designed chemistry instruction (TDCI) with respect to attitudes toward chemistry as a school subject.

H_o6: There is no significant difference between post-attitude mean scores of males and females with respect to attitudes toward chemistry as a school subject.

H_o7: There is no significant effect of interaction between gender difference and treatment on students' attitude toward chemistry as a school subject.

CHAPTER IV

DESIGN OF THE STUDY

4.1 The Experimental Design

In this study, Non-equivalent control group design as a part of quasi experimental design was used (Gay, 1987).

Table 4.1 research design of the study

Groups	**Pre-test**	**Treatment**	**Post-test**
Experimental Group	CRECT ASTC SPST	CCIDD	CRECT ASTC
Control Group	CRECT ASTC SPST	TDCI	CRECT ASTC

In this table, CRECT represents Chemical Reactions and Energy Concept Test. CCID is Conceptual Change Oriented Instruction through Demonstration and TDCI is Traditionally Designed Chemistry Instruction. SPST represents Science Process Skill Test. ASTC is Attitude Scale toward Chemistry.

To examine the effect of treatment and to control students' previous knowledge in chemical reaction and energy concepts and attitudes towards chemistry before treatment, CRECT and ASTC were administered to the students in both groups. At the end of the treatment, these tests were administered to students in both groups.

4.2. Subjects of the Study

In this study, 61 tenth grade students (40 male and 21 female) were used from two classes of a chemistry course from Atatürk Anatolian High School taught by the same teacher in the 2003-2004 fall semester. This sample was chosen by a convenience sampling. Two instruction method used in the study were randomly assigned to groups. The experimental group who received Conceptual Change Oriented Instruction through Demonstration consisted of 31 students while the control group who received Traditionally Designed Chemistry Instruction consisted of 30 students.

4.2 Variables

This study involved two types of variable. Independent variables are the variables that are believed to make a difference on one or more other variables. In experimental studies these variables can be manipulated. The difference, or effect, of the independent variable is called the dependent variable. Dependent variable is dependent on what happens to the independent variable.

4.3.1 Independent Variables

The independent variables of this study were; treatment (conceptual change oriented instruction through demonstration) and traditionally designed chemistry instruction, gender and science process skill.

4.3.2 Dependent Variables

The dependent variables in this study were; understanding of chemical reactions and energy concepts and their attitudes toward chemistry as a school subject.

4.4 Instruments

4.4.1 Chemical Reactions and Energy Concepts Teat (CRECT)

This test consisted of 20 multiple choice questions, five of them were taken from the literature (Yeo & Zadnik, 2001) and the rest of the questions were developed by the researcher. The items used in the test have four alternatives. These items were related to chemical reaction and energy. These test classified into four categories with respect to its related concepts: Heat and temperature, energy concept related with bond dissociation and bond formation, endothermic and exothermic reactions, Hess law.

During the development stage of the test, first, the alternative conceptions of the students about chemical reactions and energy concepts were determined from the related literature (BouJaoude, 1991; Lewis & Linn, 1994; Boo, 1997; Thomas & Schwenz, 1998; Granville, 1985, Cohen & Ben-Zvi, 1982). Second, pilot study was conducted to determine students' alternative conceptions and these alternative conceptions compared with the students alternative conceptions that were provided from literature. The taxonomy of the misconceptions and the corresponding questions are given in Table 4.2.

In CRECT test, each question had one correct answer and four distracters. The items were related to the chemical reactions and energy concepts. There were 20 items totally in the test. For the content validity the test was examine by a group of expert in chemistry education and by the course teacher for the appropriateness of the items.

Table 4.2 Taxonomy of CRECT's Questions that Include Students' Misconceptions About Chemical Reactions and Energy

MISCONCEPTIONS	ITEMS
1. Heat is a substance	**3**
2, Heat is not energy	**3**
3. Temperature is the 'intensity' of heat.	**2**
4. Skin or touch can determine the temperature	**1**
5. Materials like wool have the ability to warm things up.	**4**
6. The temperature of an object depends on its size.	**18**
7. Bond dissociation releases energy, while bond formation consumes energy.	**6, 7, 13, 17, 19**
8. The definitions of the terms system and surroundings cannot be distinguished in the context of energy transfer.	**10, 20**
9. Burning of a candle is an endothermic reaction.	**7, 9, 13**
10. Hess law is a simple arithmetical calculation and students do not think what has occurred at molecular level.	**4**
11. Chemical bonds are seen as a physical entity.	**19**
12. Endothermic reactions cannot be spontaneous.	**9, 14**
13. All reactions that occur naturally, i.e. without overt application of heat, are exothermic.	**15**
14. Heat and temperature are the same thing.	**2, 5**
15. Some students visualize the chemical equation as a mathematical puzzle rather than as a symbolic representation of a dynamic and interactive process.	**4**
16. Bond breaking and bond making processes are view as requiring energy.	**1, 17, 19**
17. Chemical reactions cannot occur if there is no external intervention such as heating.	**20**
18. Some student think heat to be a type of substance that can accumulate an object and some student thinks that with respect to this idea, temperature is simply to measure of the amount of heat held by an object.	**2, 9**
19. Burning (combustion reactions) involve fire or a flame.	**14**
20. A spontaneous reaction is always exothermic.	**20**
21. Some student seemed to perceive different types of burning for different things. i.e. Burning wax was melting, burning of alcohol was evaporating and burning of wood was changing into ashes.	**16**

The reliability of the test found to be 0.74. This test was given to students in both groups as a pre-test to control students' understanding of chemical reactions and energy concepts at the beginning of the instruction. It was also given to both groups as a post-test to compare the effectiveness of two instructions on understanding of chemical reactions and energy concepts (see Appendix B).

4.4.2 Attitude Scale Toward Chemistry (ASTC)

This test was developed by Geban et al. (1994) to measure students' attitudes toward chemistry as a school subject. This scale is 5 point likert type scale (fully agree, agree, undecided, partially agree, fully disagree) which is consisted of 15 items. The reliability was to be found 0, 83. This test was given to student both groups as a pre-test and post-test (see Appendix C).

4.4.3 Science Process Skill Test

The test was originally developed by Okey, Wise and Burns (1982). It was translated and adapted into Turkish by Geban, Aşkar and Özkan (1992). This test consisted of 36 four-alternative multiple choice questions. The reliability of the test was found to be 0, 85. This test includes five subsets designed to measure the different aspects of science process skills. These are identifying variables, identifying and stating hypothesis, 6 items for operationally defining, 3 items for designing investigations, and 6 items for graphing and interpreting data (see Appendix D).

4.5 Treatment

This study was conducted over four-week period during the 2003-2004 fall semester. 61 tenth grade students from two chemistry classes of same teacher were participated in the study. One of these classes were assigned as the experimental group in which the instruction was designed with respect to conceptual change through demonstration, the other class was assigned as the control group in which the instruction was designed with respect to traditional approach. During the treatment, the chemical reactions and energy topics were covered as part of the regular curriculum in the chemistry course. The classroom instruction was five 40-minute sessions per week. The concepts studied with both control and experimental group (conceptual change oriented instruction through demonstration and traditionally designed chemistry instruction) are as follows:

I. Fundamental Concepts of Chemical Reactions and Energy
   i. Heat and Temperature
   ii. Units of Energy
   iii. System and Surroundings
II. Bond Dissociation and Bond Formation
   i. The Meaning of Enthalpy
   ii. Calculation of Heats of Reaction
III. Endothermic and Exothermic Reactions
   i. Graphs of Endothermic and Exothermic Reactions
IV. Calorimetry
V. Hess's Law
   i. Solving Problems About Hess's Law

In the control group, the teacher used lecture and discussion methods. The students were instructed with traditionally designed chemistry texts. These traditional texts were prepared on the basis of chemistry textbook chosen by school. Also, students in the control group used some worksheets provided by chemistry teacher. At the beginning of the lesson, teacher gave the texts to the students and asked them to read these texts silently. After that, she started to give the lecture.

The experimental group was instructed by using the conceptual change oriented instruction through demonstration. With this strategy, instruction was designed to maximize student active involvement in the learning process. The teacher started the lecture with an inquiry question to activate students' prior knowledgeand misconceptions and promote the interaction in class. With this question, teacher attempted to create a discussion environment and tried to explore students' inappropriate conceptions about the related concepts. The teacher took some notes about the responses and used these answers (both the correct and incorrect) in the class discussions. Teacher acted as a guide in this discussion and directed students to understand their conceptions were not sufficient to explain some phenomena (dissatisfaction). The students who answered correctly were intellectually rewarded by the teacher, and those who answered incorrectly were faced with the "conflict" between what they thought and what they learned subsequently. This conflict is a positive element in the learning process. After that, teacher gave same information about what to be taught. Teacher explained some phenomena and concepts related to chemical reactions and energy. Teacher did this because observation and interpretation are identical. Observation and interpretation depends on what one already knows. So, students should have known some principles about the concepts before the demonstration. In order to provide this before the demonstration, teacher presented some major concepts about the subject matter (to make demonstration and concepts intelligible). After that, teacher started to demonstrations that related the taught concepts. During the demonstrations, students participated actively by teachers questions and real world integrations to be given. Demonstrations were conducted before the class demonstration to understand whether it works and some questions prepared to attract students' attention. There were five demonstrations. These demonstrations related with the real world phenomena and events that occur naturally. Demonstrations were about enthalpy, endothermic reactions, exothermic reactions, calorimetry, and heat of neutralization (see Appendix E). These demonstrations were done to prove the plausibility of the concepts that were taught. And with these demonstrations students learned the concepts deeply and made connections with real world situations and their prior knowledge (plausibility). After the demonstration, students continued to discuss the events that related with chemical reactions and energy concepts. In these discussions, the main purpose was to prove the usefulness of the learned conceptions. To provide this, students tried to give some examples about the natural events that are related to their new conceptions (fruitfulness of new conceptions).

At the end of the treatment, Chemical Reactions and Energy Concept Test (CRECT) and Attitude Scale toward Chemistry (ASTC) were administered to both groups as post-tests.

4.6 Analysis of Data

ANCOVA was used to determine the effectiveness of two different instructional methods on understanding on understanding of chemical reactions and energy concepts by controlling the effect of students' science process skills as a covariance revealed the contribution science process skills to the variation in understanding. To determine the effect of treatment on students' attitudes towards chemistry as a school subject and the gender effect on students' attitudes, two- way ANOVA was used.

4.7 Assumptions and Limitations

4.7.1 Assumptions:

1. The teacher was not biased during the treatment.
2. Students in experimental group did not interact with the students in control group.
3. All subjects in both groups were accurate and sincere in answering the question of measuring instruments.
4. The tests were administered under standard conditions.

4.7.2 Limitations

1. The subjects of the study were limited to 61 10^{th} grade students.
2. The study was limited to the unit of chemical reactions and energy concepts.

CHAPTER V

RESULTS AND CONCLUSIONS

5.1 Results

The hypotheses stated in chapter 3 were tested at a significance level of 0.05. Analysis of Covariance (ANCOVA) and Analysis of Variance (ANOVA) were used to test these hypotheses. In this study, statistical analyses were carried out by using the SPSS/PC (Statistical Package for Personal Computers).

In order to find students previous knowledge about chemical reactions and energy and prior attitudes toward chemistry as a school subject, the chemical reactions and energy concepts test (CRECT) and attitude scale toward chemistry (ASTC) were given to students before the treatment.

The results showed that there was no significant difference at the beginning of the treatment between the CCID group and the TDCI group in terms of students understanding of chemical reactions and energy concept achievement ($t=0,406$, $p>0.05$); and attitude toward chemistry as a school subject ($t=1.167$, $p>0.05$).

Hypothesis 1:

To answer the question posed by hypothesis 1 stating that there is no significant difference between post-test mean scores of the students taught with conceptual change oriented instruction through demonstration (CCID) and those taught with traditionally designed chemistry instruction (TDCI) with respect to understanding of chemical reactions and energy concepts when science process skill is controlled as a covariate, analysis of covariance (ANCOVA) was used. The analysis of the data is summarized in Table 5.1.

Table 5.1 ANCOVA Summary (Understanding)

Source	df	SS	MS	F	P
Covariate (SPS)	1	15,217	15,217	5,158	0,027
Treatment	1	716,004	716,004	242,684	0,000
Gender	1	3,33	3,33	0,001	0,973
Treatment*Gender	1	5,56	5,56	0,019	0,891
Error	56	165,22	2,950		

The analysis results showed that there was a significant difference between the post-test mean scores of the students taught by CCID and those taught by TDCI with respect to the understanding of chemical reactions and energy concepts when science process skill is controlled as a covariate (F=242,68; p<0,05). The CCID group scored significantly higher than TDCI group (X (CCID) = 16.24, X (TDCI) = 8.4).

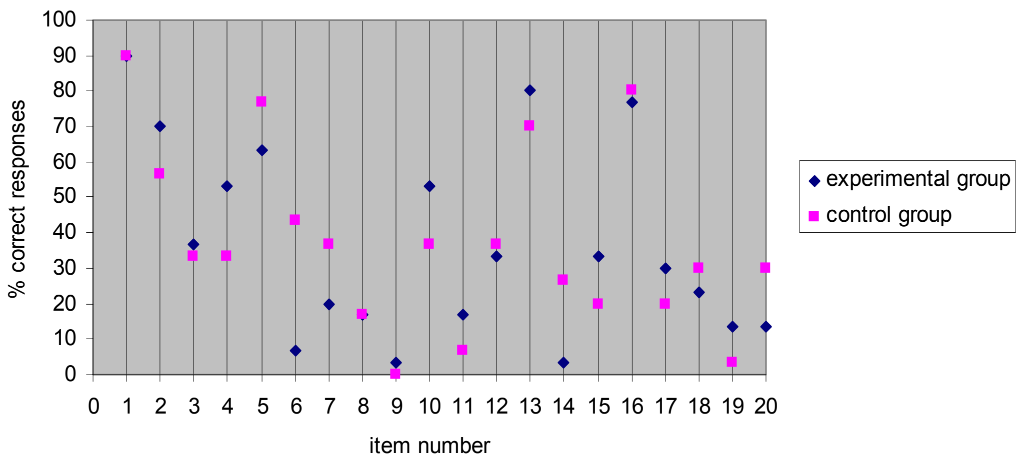

Figure 5.1 Comparison between pre-test scores and scores of CCID group and that of TDCI group

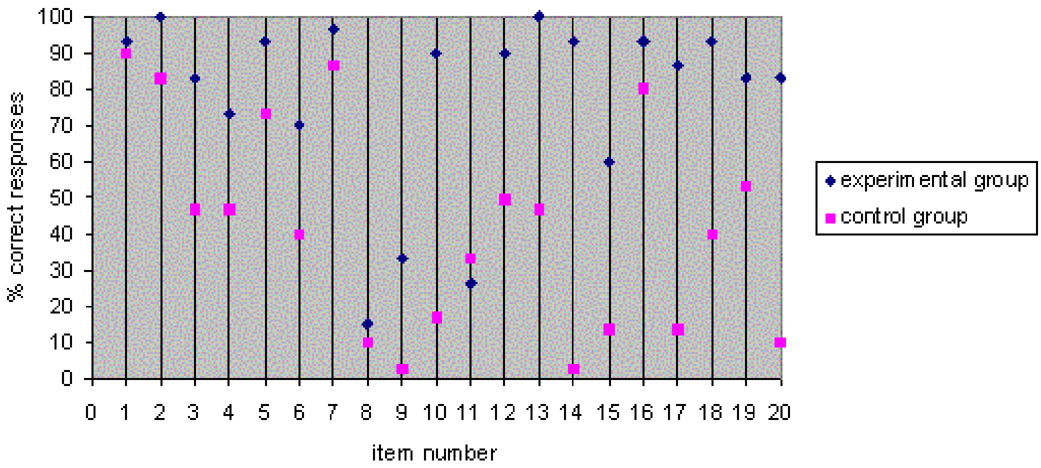

Figure 5.2 Comparison between post-test scores and scores of CCID group and that of TDCI group

Looking the answers that were figured above, there was a difference between control group and experimental group with respect to students' responses given in post CRECT. For example, before the treatment, for an item dealing with heat and temperature (item 5), 76.7% of the students in control group and 63.3% of the students in experimental group selected the desired answer. After the treatment, the majority of the experimental group (93.3%) and 73.3% of the students in control group selected the desired answer. Similarly, in another item (item6) students were asked to understand the released energy and consumed energy during bond dissociation and bond formation. Before the treatment, 43.3% of the students in control group and 6.7% of the students in experimental group selected the correct answer. After the treatment, while the percentage of the students who selected desired answer in the experimental group increased to 70%, the percentage of the students who selected the desired answer in the control group decreased to 40%.

Question 9 was mainly about the exothermic and endothermic reactions. In this question, before the treatment, 0% of the students in control group and 3.3% of the students in experimental group answered this question correctly. After the treatment, while the percentage of the students who selected the correct answer was the same (3%), the percentage of the students who selected the correct response increased to 33.3%. For question 12, which is about the Hess's law, before the treatment, 36.7% of the students in control group responded correctly and 33.3% of the students in experimental group selected the desired answer. After the treatment, while 50% of the students in control group selected correct answer, the percentage of the students who selected desired answer in the experimental group increased to 90%.

These results showed that the students in experimental group who were thought with conceptual change oriented instruction had better acquisition of scientific conceptions than those in the control group who were thought by traditional instruction with respect to chemical reactions and energy concepts.

Hypothesis 2:

To answer the question posed by hypothesis 2 which states that there is no significant difference between post-test mean scores of males and those of females with respect to understanding of chemical reactions and energy concepts when science process skill is controlled as a covariate, analysis of covariance (ANCOVA) was used. The effect of gender on understanding of chemical reactions and energy concepts is given in Table 5.1. The result showed that there was no significant mean difference between male and female in terms of understanding chemical reactions and energy concepts ($F = 0,001$; $p>0.05$). The mean post-test scores were 12, 30 for males and 12, 57 for females.

Hypothesis 3:

To test hypothesis 3 which states that there is no significant effect of interaction between gender difference and treatment with respect to understanding of chemical reactions and energy concepts when science process skill is controlled as a covariate, analysis of covariance (ANCOVA) was used. Table 5.1 also gives the interaction effect on understanding of chemical reactions and energy concepts. The findings revealed that there was no significant interaction effect between gender difference and treatment on students' understanding of chemical reactions and energy concepts (F = 0,019; p>0.05).

Hypothesis 4:

To test hypothesis 4 which states that there is no significant contribution of students' science process skills to their understanding of chemical reactions and energy concepts, analysis of covariance (ANCOVA) was used. The contribution of science process skill to the understanding of chemical reactions and energy concepts was revealed in Table5.1. It was indicated that science process skills made a statistically significant contribution to the variance in understanding chemical reactions and energy concepts (F= 5,158, p<0.05).

Hypothesis 5:

To answer the question posed by hypothesis 5 which states that there is no significant difference between post-test mean scores of the students taught with conceptual change oriented instruction through demonstration (CCID) and those taught with traditionally designed chemistry instruction (TDCI) with respect to attitudes toward chemistry as a school subject, two-way analysis of variance (ANOVA) was used. The results were shown in Table 5.4.

Table 5.2 ANOVA Summary (Attitude)

Source	df	SS	MS	F	P
Treatment	1	709,653	709,653	7,098	0,010
Gender	1	7,047	7,047	0,070	0,792
Treatment*Gender	1	15,622	15,622	0,156	0,694
Error	57	5699,086	99,984		

The results showed that there was a significant difference between post-test mean scores of students taught with CCID and those taught with TDCI with respect to their attitude toward chemistry as a school subject. Students that are taught with conceptual change oriented instruction through demonstration had more positive attitudes (X= 59, 96) than those taught traditionally designed chemistry instruction (X=52, 46).

Hypothesis 6:

To answer the question posed by the hypothesis 6 stating that there is no significant difference between post-attitude mean scores of males and females in terms of attitude, two-way analysis of variance was used. Table 5.2 revealed that there was no significant mean difference between male and female students with respect to their attitudes toward chemistry a as school subject (F= 0. 70; p>0.05). Male students' mean score was 56, 47 and female students' mean score was 55, 90 with respect to their attitudes toward chemistry as a school subject.

Hypothesis 7:

To test hypothesis 7 which states that there is no significant effect of interaction between gender difference and treatment on students' attitude toward chemistry as a school subject, two-way analysis of variance was run. It was found that there was no significant interaction effect between gender difference and treatment on students' attitudes toward chemistry as a school subject (F= 0,156; p>0.05).

5.2 Conclusions

The following conclusions can be deducted from the results:

1. The Conceptual Change Oriented Instruction through Demonstration (CCID) caused a significantly better acquisition of scientific conceptions related to chemical reactions and energy concepts and

elimination of misconceptions than the traditionally designed chemistry instruction.

2. The instruction based on conceptual change instruction produced higher positive attitudes towards chemistry as a school subject than traditionally designed chemistry instruction.
3. Science process skill had a contribution to the students' understanding of chemical reactions and energy concepts.
4. The effect of gender difference on students' understanding of chemical reactions and energy concepts and attitudes towards chemistry as a school subject was not statistically significant.

CHAPTER VI

DISCUSSION, IMPLICATION AND RECOMMENDATIONS

This chapter involves discussion of results, implications and recommendations for further research**.**

6.1 Discussion

The main purpose of this study was to compare the effectiveness of conceptual change oriented instruction through demonstrations and traditionally designed science instruction on 10th grade students' understanding of chemical reactions and energy concepts and attitudes toward chemistry as a school subject.

As it was mentioned in Chapter 4, Chemical Reactions and Energy Concepts Test was administered to all subjects in both group before and after the treatment. It was found that there was no significant difference between the pretest mean scores of the two groups. From this result it was concluded that both groups were equal with respect to understanding of chemical reactions and energy concepts before the treatment. Chemical Reactions and Energy Concepts Test was given to all students as a post-test at the end of the treatment to compare the effects of two different instructions (CCID vs. TDCI) on students' understanding of chemical reactions and energy concepts. Subjects in experimental group using conceptual change oriented instruction through demonstration had significantly higher post-test mean scores on the Chemical Reactions and Energy Concepts Test than the traditional science instruction group after the treatment. The instruction based on conceptual change approach caused a significantly better acquisition of scientific conceptions related to chemical reactions and energy and elimination of misconceptions than traditionally designed chemistry instruction.

Difficulties in understanding chemical reactions and concepts can be stated in two main topics. First one is conceptual difficulties which mean that the concepts that are taught in this unit are very theoretical. Second, students have some difficulties to calculate energy changes (Cohen and Ben Zvi, 1982). Students' fundamental knowledge about this topic is not sufficient to understand more complex ones. Heat and temperature concepts are the fundamental for chemical reactions and energy concepts. Uzuntiryaki, Ceylan, and Geban (2004) conducted a study to investigate the relationship between freshman students' knowledge about heat and temperature concepts and their understanding of thermochemistry concepts. They found that there is a positive significant correlation between freshman students' knowledge about heat and temperature and their knowledge about chemistry. Therefore, in order to understand chemical reactions and energy concepts properly, heat and temperature concepts should be comprehended. The students' misconceptions about heat and temperature concepts should be eliminated for better understanding of chemical reactions and energy concepts.

On the other hand, students have a lot of misconceptions about chemical reactions and energy concepts. For example, most of the students believe that bond dissociation releases energy, while bond formation consumes energy. In addition to this, students can not differentiate exothermic reactions and endothermic reactions. And, students confronted some difficulties to calculate enthalpy changes.

Ausubel stated that (1968) "If I had to reduce all educational psychology to just one principle, I would say this: The most important factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly". Therefore, students' prior knowledge and students' misconceptions are very crucial. So, when teaching chemical reactions and energy concepts, the teachers should identify students' prior knowledge and misconceptions and try to exchange these misconceptions with the scientific and plausible conceptions.

Conceptual change approach provides strategies which take into account students' prior knowledge and their misconceptions. So, conceptual change approach was used in experimental group. In this group, students actively involved the learning process. In order to identify students' conceptions teacher started the lecture with questions. Teacher acted as a guide and tried to create dissatisfaction with presenting some phenomena that can not be explained by students' misconceptions (dissatisfaction). Before the demonstrations, teachers explained some phenomena that were related with chemical reactions and energy concepts. This must be done because observation and interpretation are identical and these depend on what one already knows. In addition to this, in order to make the new conception intelligible teacher should explain some principles and concepts which are related to chemical reaction and energy concepts (to make concepts intelligible). After these procedures, demonstrations were conducted to prove the plausibility of the concepts that were taught. With these demonstrations students learned the concepts deeply and made connections with real world situations and their prior knowledge (plausibility). After the demonstrations, students searched some examples about the natural events that are related to their new conceptions (to make new conceptions fruitful). Students' active involvement as mentally in the experimental groups may caused a better understanding of conceptions than the activities used in control groups.

On the other hand, in the control group which was instructed by traditionally designed chemistry instruction, the teacher used the lecture method. She explained the facts and gave some examples. Students did not actively involve the lesson they only listen their teacher and tried to give some notes. She presented the right way to solve some problems that were related to chemical reactions and energy concepts. However, she did not give opportunity to the students to interpret some phenomena.

The alternative conceptions that are hold by students before the instruction may arise as a result of interaction of students with each other, students' experience, student-teacher interaction, interaction with other people, or through the media (Gilbert et al., 1982; Gilbert and Zylberstajn, 1985; Griffiths and Preston, 1992). In experimental group, students were encouraged to discover their alternative conceptions. Teacher created discussion environment to understand the source of students' misconceptions. To identify the source of students' misconceptions is very crucial to exchange these misconceptions with scientific one. However, in control group, students existing conceptions were not discovered. Teacher transmitted the factual knowledge to the students who were passive listener.

There is a consistency between the findings in our study and those of the researches by Niaz (2002), Hewson and Hewson (1983), Özkan, Tekkaya, Geban (2004), Eryılmaz (2002). In these studies, conceptual change strategies were used to remedy students' misconceptions and better acquisition of scientific conceptions. These researchers found that the studednts' performance in experimental groups were significantly better than those in control group with respect to understanding of scientific conceptions. And these studies investigated that the conceptual change approach was effective in remedying students' misconceptions in scientific concepts.

Science process skill test was used to identify whether there was a significant difference between the two groups in terms of students science process skills. In this study, it was investigated that there was a significant difference between experimental and control group with respect to students' science process skills. The result indicated a significant contribution of students' science process skills to their understanding of chemical reactions and energy concepts Therefore, this variable was controlled as a covariate. The chemical reactions and energy topic have difficult and abstract concepts. So, in order to understand these concepts properly, students hev intellectual ability such as science process skills. Science process skills represent the level of students' intellectual ability to identify variables, identify and state the hypotheses, design investigations and graph and interpret data.

Another purpose of the present study was to investigate the effect of treatment (conceptual change oriented instruction vs. traditionally designed chemistry instruction) on students' attitude towards chemistry as a school subject. It was investigated that students that are taught with conceptual change oriented instruction through demonstration had more positive attitudes than those are taught traditionally designed chemistry instruction. Conceptual change oriented instruction through demonstration gives students opportunity to actively involve to lesson. Students always find the learning environments that are based demonstrations funny and natural and this motivates students (Hugo, 1993; Golastaneh, 1998). Moreover, demonstrations are always found useful activities to attract students' interest. These factors might cause students in experimental group to have more positive attitudes.

Also, this study investigated whether there was a significant mean difference between male and female students with respect to understanding chemical reactions and energy concepts when students' science process skills were controlled. The findings indicated that there was no significant mean difference between male and female students. Also, there is no significant interaction between gender difference and treatment in terms of understanding chemical reactions and energy concepts when students' science process skills were controlled. This meant that, there was no significant difference between male and female students who were instructed based on conceptual change oriented instruction and those who were instructed through traditionally designed chemistry instruction. The reason might be the fact that since the school where the treatment was conducted was a Anatolian High school, students who are members of these type of schools are selected by an examination. So, students had similar backgrounds or experiences. Bayır (2000) also showed that there was no statistically significant difference between male and female students with respect to achievement related to chemical change and conversation of mass concepts after the treatment. And also, in this study, it was concluded that there is no significant mean difference between males and females with respect to their attitudes toward chemistry as a school subject, either.

In short, this study showed that students had difficulties in understanding chemical reactions and energy concepts and held several misconceptions. The conceptual change oriented instruction promotes students' acquisition of new conceptions as a consequence of the remediation of alternative conceptions and integration of new conceptions with existing conceptions.

6.2. Implications

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

1. Conceptual change approach based strategies is very effective to promote students meaningful learning. This approach takes into account students' previous knowledge and integrates it with the new knowledge. If students can not link between the new knowledge and existing knowledge, it is very difficult for them to understand the concepts that will be taught. Students should understand the fundamental concepts properly and after that should deal more complex ones. If the students does not able to grasp the fundamental concepts and does not relate their new ideas with existing concepts, they would create alternative conceptions and misconceptions in their mind. Well-designed conceptual based instruction is very effective to relate new conceptions and existing conceptions.
2. Chemistry teachers should aware conceptual change approach's principles and design their lessons with respect to this approach. They should be aware of students' prior knowledge and misconceptions. They should examine the reason of the occurrence of the misconceptions. The role of teachers is to facilitate and support their thinking for conceptual change. And also, in universities, teacher education programs especially methods of science courses should include some topics related to conceptual change approach. Teachers should be informed about

the usage and importance of conceptual change oriented instruction.

3. Learning to teach chemistry is very difficult task. Prospective teachers should be given opportunities to apply their understandings about conceptual change approach on high school students. Universities and schools should work together to create more fully developed conceptual change teachers.
4. Curriculum programs should be based on conceptual change perspective and textbooks should be revised and designed based on conceptual change approach.
5. In chemistry, conceptual change based demonstrations should be developed and a guide book included efficient demonstrations that are based on conceptual change approach related to different chemistry topics might be designed.
6. Teachers should be aware of students' attitudes towards chemistry as a school subject. They must know that attitudes affect the students' achievement and should seek to improve students' attitudes.

6.3 Recommendations

On the basis of findings from this study, the researcher recommends that;

1. Similar studies can be conducted for different courses and for different grade levels.
2. Further study can be conducted in different schools to provide a generalization for Turkey.
3. The sample size can be increased for further studies to obtain more accurate results.
4. Further research can be conducted to evaluate students' motivation, interest in demonstrations, reasoning abilities, and learning styles effect on students' performance in chemistry topic.

5. The videotaped demonstrations can be used instead of actual demonstrations. A study that includes videotaped demonstrations can be conducted.

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APPENDIX A

INSTRUCTIONAL OBJECTIVES

1. To distinguish the meaning of heat and temperature.
2. To summarize units of energy.
3. To explain system and surroundings.
4. To differentiate system and surroundings.
5. To describe chemical bonds.
6. To explain the meaning of bond energy.
7. To describe enthalpy.
8. To understand heats of reaction.
9. To interpret the relation between bond breaking energy, bond formation energy and heats of a reaction.
10. To describe exothermic reactions.
11. To describe endothermic reactions
12. To distinguish exothermic and endothermic reactions with respect to reactions' energy flow.
13. To analyze the graphs related to exothermic and endothermic reactions.
14. To describe the heats of combustion.
15. To calculate heats of a reaction with calorimeter.
16. To explain the Hess's law.
17. To solve problems related to Hess's law.

APPENDIX B

KİMYASAL REAKSİYONLAR VE ENERJİ TESTİ

1. Metal bir cetvel ile odun bir cetveli elimizde tuttuğumuzda, metal cetvelin daha soğuk olduğunu hissederiz. Bu durumu sizce aşağıdaki cümlelerin hangisi daha iyi açıklamaktadır?

A) Metal cetvel elimizdeki ısıyı odun cetvele göre daha hızlı iletir.
B) Odun doğal olarak daha sıcak bir nesnedir.
C) Odun cetvel daha fazla ısı içermektedir
D) Soğuk metalde daha iyi hissedilir
E) Soğuk olmak metallerin özelliğidir.

2. Bir gurup öğrenci radyodan hava durumunu dinliyor. Sunucu " bu akşamki hava sıcaklığı dün akşam 10 ^oC olan hava sıcaklığından daha soğuk; yaklaşık 5 ^oC olacak" diyor. Bu durumda gurupdaki insanlardan hangisinin yorumu sizce daha doğrudur?

A) Ayşe " bu akşam dün akşama göre 2 kat daha soğuk olacak " diyor.
B) Ali "Ayşe'nin bu yaklaşımı yanlış bir yaklaşım, 5 ^oC, 10 ^oC den iki kat daha soğuk anlamına gelmez " diyor.
C) Ahmet " Ayşe'nin yaklaşımı kısmen doğru ama, 10 ^oC, 5 ^oC den iki kat daha sıcak demeliydi" diyor.
D) Mehmet "Bana görede Ayşe'nin yaklaşımı kısmen doğru, 5 ^oC, 10 ^oC nin yarısı kadar soğuk " diyor.
E) Pınar " Hava sıcaklıklarını tam olarak kıyaslabilmek için hissetmek gereklidir" diyor.

3. Bir bisiklet pompası ile tekerlek şişirirken pompanın ısınmasını ağağıdakilerden hangisi açıklamaktadır?

A) Sıcaklık pompaya transfer edilmiştir.
B) Elimizden pompaya ısı akışı olmuştur.
C) Pompanın metal oluşu sıcaklığın artmasına neden olmuştur.
D) Enerji pompaya transfer edilmiştir.
E) Pompanın içindeki hava ısınmaya neden olmuştur.

4. İki şişe su düşünelim ve herbirinin içerisinde 20 ^{o}C de su olduğunu varsayalım İki şişeden birinin ıslak diğerini kuru yün parçası ile saralım. 20 dk sonra şişelerin içerisindeki suyun sıcaklıklarını ölçelim. Islak yün ile sarılan 18 ^{o}C, kuru yün ile sarılan 22 ^{o}C de olduğunu görmüş olalım. Sizce bu deney sırasında oda sıcaklığı kaç ^{o}C olabilir?

A) 26 ^{o}C
B) 21 ^{o}C
C) 20 ^{o}C
D) 18 ^{o}C
E) 17 ^{o}C

5. İki kutu süt düşünelim; birisi dolapta diğeride mutfak rafının üzerinde olsun. İkisine birden dokunalım. Buz dolabından çıkan sütü daha soğuk hissedeceğizdir. Bunun nedeni, soğuk kutu;

A) daha fazla soğuk içermektedir.
B) daha az ısı içermektedir.
C) daha zayıf bir ısı iletkenidir.
D) ısıyı elimizden daha hızlı iletmektedir.
E) soğuğu elimize daha fazla iletmektedir.

6. Kimyasal bir reaksiyonda,

I. Bağ kopması sırasında enerji açığa çıkar.

II. Bağ oluşumu sırasında enerji tüketilir.

III. Hem bağ oluşumu hem bağ kopması için enerji gereklidir.

Yargılarından hangisi veya hangileri yanlıştır?

A) yanlız I

B) yanlız II

C) yanlız III

D) I ve II

E) I, II ve III

7. Aşagıdaki olaylardan hangisi endotermiktir?

A) suyun yoğunlaşması

B) mumun yanması

C) metalin yanması

D) bağ kırılması

E) bağ oluşumu

8. Isı veren tepkimelerde (ekzotermik)

I. Toplam entalpi azalır.

II. Düşük sıcaklıklarda ürünler daha kararlıdır.

III. Aktifleşmiş kompleksin potansiyel enerjisi ileri ve geri tepkimelerde aynıdır.

Yargılarından hangisi yada hangileri doğrudur?

A) yalnız I

B) yalnız II

C) I ve II

D) II ve III

E) I, II ve III

9. Aşağıdaki yargılardan hangisi doğrudur?

A) Bir tepkimede bağ oluşumu sırasında enerji tüketilir.

B) Mumun yanması endotermik bir reaksiyondur.

C) Suyun yoğunlaşması ekzotermik bir reaksiyondur.

D) Endotermik reaksiyonlar kendiliğinden gerçekleşebilir

E) Demirin paslanması endotermik bir reaksiyondur.

10. Laboratuvar şartlarında bir tüpün içerisinde bir tepkime gerçekleştirdiğimizi düşünürsek;

I. Tüp içerisinde yürüttüğümüz tepkimeye ortam adı verilir

II. Tüp, sistemi ortamdan ayıran sınırdır

III. İçinde bulunduğumuz laboratuvar ise sistemdir.

Yargılarından hangisi veya hangileri doğrudur?

A) yalnız I

B) yalnız II

C) yalnız III

D) I ve II

E) I, II ve III

11. $CO\ (g) + \frac{1}{2} O_2\ (g) \longrightarrow CO_2\ (g)$

tepkimesinin entalpisi (ΔH) biliniyor. Buna göre;

I. $\Delta H>0$ dır

II. CO nun molar yanma ısısı ΔH' a eşittir.

III. CO_2 oluşum ısısı. ΔH'a eşittir.

Yukarıda verilen yargılardan hangisi yada hangileri doğrudur?

A) yalnız I

B) yalnız II

C) I ve II

D) II. ve III

E) I, II ve III

12. NO_2 (g) + H_2 (g) $\longrightarrow$ NO + H_2O (g)

tepkimesinin ΔH değerini hesalayabilmek için;

I. ½ N_2 + 1/2O_2 (g) $\longrightarrow$ NO (g) tepkimesinin ΔH ‘ı

II. H_2O (g) $\longrightarrow$ H_2 (g) + ½ O_2 (g) tepkimesinin ΔH ‘ı

III. N_2 (g) + O_2 (g) $\longrightarrow$ NO_2 (g) tepkimesinin ΔH ‘ı

değerlerinden hangileri bilinmelidir?

A) I, II, ve III

B) I ve II

C) II ve III

D) I veIII

E) Yanlız III

13. I. Kırağı oluşumu

II. Suyun buharlaşması

III. Nemli havada bırakılan gümüşün kararması

IV. Mumun yanması

V. Bağ oluşumu

Yukarıdaki yargılardan hangisi yada hangileri endotermik (ısı alan) türden değildir?

A) Hepsi

B) I, II, V

C) I, II, IV, V

D) I, III, IV, V

E) I, II

14. I. Endotermik reaksiyonlar kendiliğinden gerçekleşmez.

II. Ateş ve alev olmayan bir reaksiyon yanma reaksiyonu değildir.

III. Nemli havada bırakılan gümüşün kararması ekzotermik bir reaksiyondur.

Yukarıdaki yargılardan hangisi yada hangileri doğrudur?

A) yalnız I

B) yalnız II

C) yalnız III

D) I ve II

E) I ve III

15. Aşağıdakileren hangisi ekzotermik reaksiyonların özelliklerinden biri değildir?

A) Ekzotermik reaksiyonlarda ısı açığa çıkar.

B) Ekzotermik reaksiyonlarda düşük sıcaklıklarda ürünler daha kararlıdır

C) Yanma tepkimeleri ekzotermiktir.

D) Doğada kendiliğinden meydana gelen reaksiyonlar ekzotermiktir.

E) Ekzotermik reaksiyonların çoğunda tepkimeye bir miktar ısı verip tepkimeyi başlattıktan sonra tepkime kendiliğinden gerçekleşir.

16. Yanma reaksiyonları için;

I. Ateş ve alev içermeyen reaksiyonlar yanma reaksiyonu değildir.

II. Ekzotermik reaksiyonlardır.

III. Yanma reaksiyonları temel anlamda farklı nesneler için farklılık gösterir.

Yargılarından hangisi veya hangileri doğrudur?

A) yalnız I

B) yalnız II

C) yalnız III

D) I ve II

E) I ve III

17. $X_2 \rightarrow 2X$ dönüşümü endotermik

$2Y \rightarrow Y_2$ dönüşümü ise ekzotermiktir.

Buna göre;

I. bağ oluşumu sırasında enerji açığa çıkar.

II. bağların kırılması enerji gerektirir

III. bağ oluşumu için $\Delta H>0$ dır

Yukarıda verilenlerden hangisi veya hangileri doğrudur?

A) yalnız I

B) yalnız II

C) I ve II

D) II ve III

E) I, II ve III

18. Ahmet buzdolabında bir gündür beklemekte olan bir kutu kolayı ve plastik şişe kolayı aynı anda dışarı çıkarıyor. Sonra hemen kutu kolanın içerisine bir termometre daldırıyor ve sıcaklığın 7 ^oC olduğunu görüyor. Size göre plastik şişenin ve içerisindeki kolanın sıcaklığı kaç derece olabilir?

A) Her ikisinin sıcaklığıda 7 ^oC den azdır.

B) Her ikisinin sıcaklığıda 7 ^oC dir.

C) Her ikisinin sıcaklığıda 7 ^oC den fazladır.

D) Kolanın sıcaklığı 7 ^oC, şişenin sıcaklığı 7 ^oC den fazladır.

E) Kolanın miktarına ve şişenin büyüklüğüne bağlıdır.

19. Aşağıdakilerden hangisi kimyasal bağların özelliklerinden biridir?

A) Atomları bir arada tutmayı sağlayan fiziksel yapılardır.

B) Sadece atomlar arasında elektron alış-verişi veya elektron ortak kullanımı ile olur.

C) Bağlar elektrostatik güçlerdir.

D) Kimyasal bir tepkimede bağların kırılması sonucunda enerji açığa çıkar.

E) Kimyasal bir tepkimede bağların oluşumuda bağların kırılmasıda enerji gerektirir.

20. I. Sabit sıcaklıkta, sisteme verilen ısı, sistemin potansiyel enerjisini arttırır.

II.Kimyasal reaksiyonların meydana gelebilmesi için ısı vermek gibi dışarıdan bir müdahale gereklidir.

III. Kendiliğinden meydana gelen bütün reaksiyonlar ekzotermik reaksiyonlardır.

Yukarıda verilen ifadelerden hangisi yada hangileri doğrudur?

A) yalnız I

B) yalnız II.

C) yalnız III

D) II ve III

E) I, II veIII

APPENDIX C

KİMYA DERSİ TUTUM ÖLÇEĞİ

AÇIKLAMA**:** Bu ölçekte, Kimya dersine ilişkin tutum cümleleri ile her cümlenin karşısında "Tamamen Katılıyorum", "Katılıyorum", "Kararsızım", "Katılmıyorum" ve "Hiç Katılmıyorum" olmak üzere beş seçenek verilmiştir. Her cümleyi dikkatle okuduktan sonra kendinize uygun seçeneği işaretleyiniz.

			Tamamen Katılıyorum	Katılıyorum	Kararsızım	Katılmıyorum	Hiç Katılmıyorum
1.	Kimya çok sevdiğim bir alandır	......	○	○	○	○	○
2.	Kimya ile ilgili kitapları okumaktan hoşlanırım	......	○	○	○	○	○
3.	Kimyanın günlük yaşantıda çok önemli yeri yoktur	......	○	○	○	○	○
4.	Kimya ile ilgili ders problemlerini çözmekten hoşlanırım	......	○	○	○	○	○
5.	Kimya konularıyla ilgili daha çok şey öğrenmek isterim	......	○	○	○	○	○
6.	Kimya dersine girerken sıkıntı duyarım	......	○	○	○	○	○
7.	Kimya derslerine zevkle girerim	......	○	○	○	○	○
8.	Kimya derslerine ayrılan ders saatinin daha fazla olmasını isterim	......	○	○	○	○	○
9.	Kimya dersini çalışırken canım sıkılır	......	○	○	○	○	○
10.	Kimya konularını ilgilendiren günlük olaylar hakkında daha fazla bilgi edinmek isterim	......	○	○	○	○	○
11.	Düşünce sistemimizi geliştirmede Kimya öğrenimi önemlidir	......	○	○	○	○	○
12.	Kimya, çevremizdeki doğal olayların daha iyi anlaşılmasında önemlidir	......	○	○	○	○	○
13.	Dersler içinde Kimya dersi sevimsiz gelir	......	○	○	○	○	○
14.	Kimya konularıyla ilgili tartışmaya katılmak bana cazip gelmez	......	○	○	○	○	○
15.	Çalışma zamanımın önemli bir kısmını Kimya dersine ayırmak isterim	......	○	○	○	○	○

APPENDIX D

BİLİMSEL İŞLEM BECERİ TESTİ

AÇIKLAMA: Bu test, özellikle Fen ve Matematik derslerinizde ve ilerde üniversite sınavlarında karşınıza çıkabilecek karmaşık gibi görünen problemleri analiz edebilme kabiliyetinizi ortaya çıkarabilmesi açısından çok faydalıdır. Bu test içinde, problemdeki değişkenleri tanımlayabilme, hipotez kurma ve tanımlama, işlemsel açıklamalar getirebilme, problemin çözümü için gerekli incelemelerin tasarlanması, grafik çizme ve verileri yorumlayabilme kabiliyetlerini ölçebilen sorular bulunmaktadır. Her soruyu okuduktan sonra kendinizce uygun seçeneği yalnızca cevap kağıdına işaretleyiniz.

Bu testin orijinali James R. Okey, Kevin C. Wise ve Joseph C. Burns tarafından geliştirilmiştir. Türkçeye çevrisi ve uyarlaması ise Prof. Dr. İlker Özkan, Prof. Dr. Petek Aşkar ve Prof. Dr. Ömer Geban tarafından yapılmıştır.

1. Bir basketbol antrenörü, oyuncuların güçsüz olmasından dolayı maçları kaybettiklerini düşünmektedir. Güçlerini etkileyen faktörleri araştırmaya karar verir. Antrenör, oyuncuların gücünü etkileyip etkilemediğini ölçmek için aşağıdaki değişkenlerden hangisini incelemelidir?

a. Her oyuncunun almış olduğu günlük vitamin miktarını.

b. Günlük ağırlık kaldırma çalışmalarının miktarını.

c. Günlük antrenman süresini.

d. Yukarıdakilerin hepsini.

2. Arabaların verimliliğini inceleyen bir araştırma yapılmaktadır. Sınanan hipotez, benzine katılan bir katkı maddesinin arabaların verimliliğini artırdığı yolundadır. Aynı tip beş arabaya aynı miktarda benzin fakat farklı miktarlarda katkı maddesi konur. Arabalar benzinleri bitinceye kadar aynı yol üzerinde giderler. Daha sonra her arabanın aldığı mesafe kaydedilir. Bu çalışmada arabaların verimliliği nasıl ölçülür?

a. Arabaların benzinleri bitinceye kadar geçen süre ile.

b. Her arabanın gittiği mesafe ile.

c. Kullanılan benzin miktarı ile.

d. Kullanılan katkı maddesinin miktarı ile.

3. Bir araba üreticisi daha ekonomik arabalar yapmak istemektedir. Araştırmacılar arabanın litre başına alabileceği mesafeyi etkileyebilecek değişkenleri araştırmaktadırlar. Aşağıdaki değişkenlerden hangisi arabanın litre başına alabileceği mesafeyi etkileyebilir?

a. Arabanın ağırlığı.

b. Motorun hacmi.

c. Arabanın rengi

d. a ve b.

4. Ali Bey, evini ısıtmak için komşularından daha çok para ödenmesinin sebeplerini merak etmektedir. Isınma giderlerini etkileyen faktörleri araştırmak için bir hipotez kurar. Aşağıdakilerden hangisi bu araştırmada sınanmaya uygun bir hipotez değildir?

a. Evin çevresindeki ağaç sayısı ne kadar az ise ısınma gideri o kadar fazladır.

b. Evde ne kadar çok pencere ve kapı varsa, ısınma gideri de o kadar fazla olur.

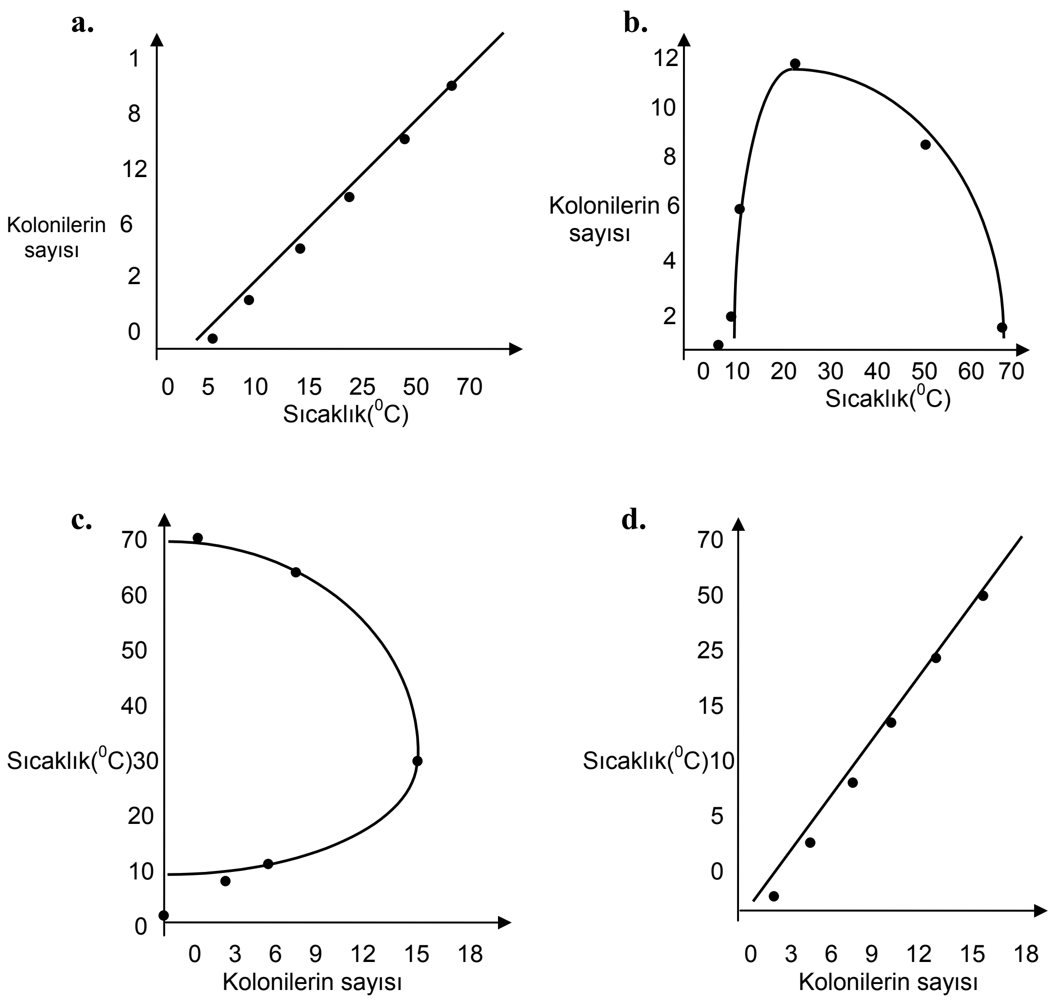
c. Büyük evlerin ısınma giderleri fazladır.

d. Isınma giderleri arttıkça ailenin daha ucuza ısınma yolları araması gerekir.

5. Fen sınıfından bir öğrenci sıcaklığın bakterilerin gelişmesi üzerindeki etkilerini araştırmaktadır. Yaptığı deney sonucunda, öğrenci aşağıdaki verileri elde etmiştir:

Deney odasının sıcaklığı (^{0}C)	Bakteri kolonilerinin sayısı
5	0
10	2
15	6
25	12
50	8
70	1

Aşağıdaki grafiklerden hangisi bu verileri doğru olarak göstermektedir?



6. Bir polis şefi, arabaların hızının azaltılması ile uğraşmaktadır. Arabaların hızını etkileyebilecek bazı faktörler olduğunu düşünmektedir. Sürücülerin ne kadar hızlı araba kullandıklarını aşağıdaki hipotezlerin hangisiyle sınayabilir?

a. Daha genç sürücülerin daha hızlı araba kullanma olasılığı yüksektir.

b. Kaza yapan arabalar ne kadar büyükse, içindeki insanların yaralanma olasılığı o kadar azdır.

c. Yollarda ne kadar çok polis ekibi olursa, kaza sayısı o kadar az olur.

d. Arabalar eskidikçe kaza yapma olasılıkları artar.

7. Bir fen sınıfında, tekerlek yüzeyi genişliğinin tekerleğin daha kolay yuvarlanması üzerine etkisi araştırılmaktadır. Bir oyuncak arabaya geniş yüzeyli tekerlekler takılır, önce bir rampadan (eğik düzlem) aşağı bırakılır ve daha sonra düz bir zemin üzerinde gitmesi sağlanır. Deney, aynı arabaya daha dar yüzeyli tekerlekler takılarak tekrarlanır. Hangi tip tekerleğin daha kolay yuvarlandığı nasıl ölçülür?

a. Her deneyde arabanın gittiği toplam mesafe ölçülür.

b. Rampanın (eğik düzlem) eğim açısı ölçülür.

c. Her iki deneyde kullanılan tekerlek tiplerinin yüzey genişlikleri ölçülür.

d. Her iki deneyin sonunda arabanın ağırlıkları ölçülür.

8. Bir çiftçi daha çok mısır üretebilmenin yollarını aramaktadır. Mısırların miktarını etkileyen faktörleri araştırmayı tasarlar. Bu amaçla aşağıdaki hipotezlerden hangisini sınayabilir?

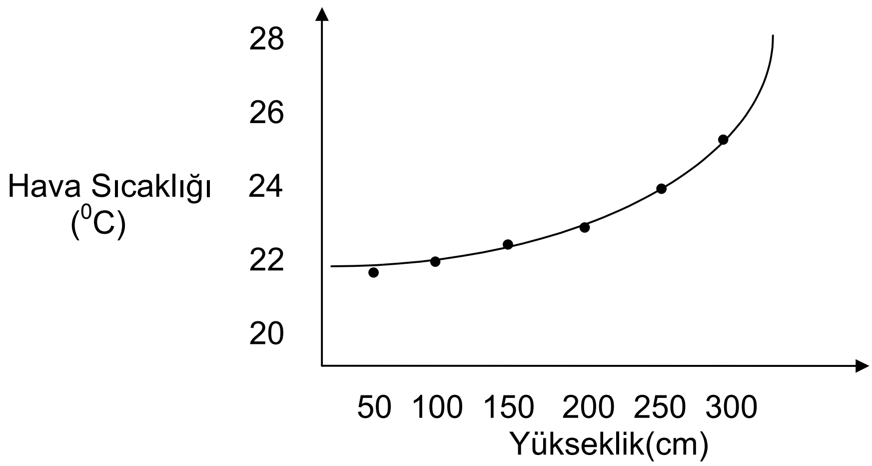
a. Tarlaya ne kadar çok gübre atılırsa, o kadar çok mısır elde edilir.

b. Ne kadar çok mısır elde edilirse, kar o kadar fazla olur.

c. Yağmur ne kadar çok yağarsa , gübrenin etkisi o kadar çok olur.

d. Mısır üretimi arttıkça, üretim maliyeti de artar.

9. Bir odanın tabandan itibaren değişik yüzeylerdeki sıcaklıklarla ilgili bir çalışma yapılmış ve elde edilen veriler aşağıdaki grafikte gösterilmiştir. Değişkenler arasındaki ilişki nedir?



a. Yükseklik arttıkça sıcaklık azalır.

b. Yükseklik arttıkça sıcaklık artar.

c. Sıcaklık arttıkça yükseklik azalır.

d. Yükseklik ile sıcaklık artışı arasında bir ilişki yoktur.

10. Ahmet, basketbol topunun içindeki hava arttıkça, topun daha yükseğe sıçrayacağını düşünmektedir. Bu hipotezi araştırmak için, birkaç basketbol topu alır ve içlerine farklı miktarda hava pompalar. Ahmet hipotezini nasıl sınamalıdır?

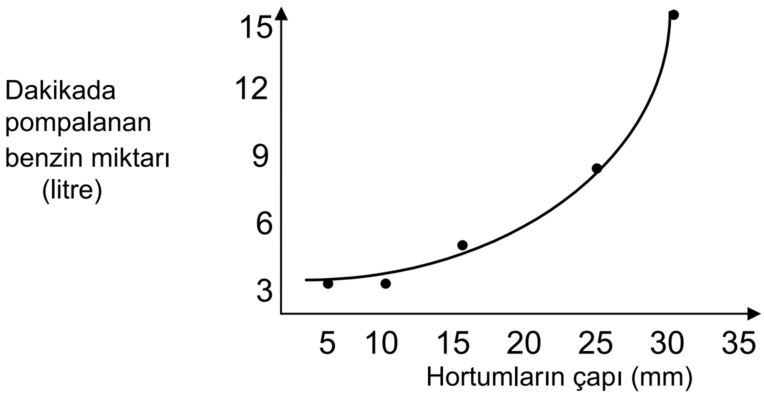
a. Topları aynı yükseklikten fakat değişik hızlarla yere vurur.

b. İçlerinde farklı miktarlarda hava olan topları, aynı yükseklikten yere bırakır.

c. İçlerinde aynı miktarlarda hava olan topları, zeminle farklı açılardan yere vurur.

d. İçlerinde aynı miktarlarda hava olan topları, farklı yüksekliklerden yere bırakır.

11. Bir tankerden benzin almak için farklı genişlikte 5 hortum kullanılmaktadır. Her hortum için aynı pompa kullanılır. Yapılan çalışma sonunda elde edilen bulgular aşağıdaki grafikte gösterilmiştir.



Aşağıdakilerden hangisi değişkenler arasındaki ilişkiyi açıklamaktadır?

a. Hortumun çapı genişledikçe dakikada pompalanan benzin miktarı da artar.

b. Dakikada pompalanan benzin miktarı arttıkça, daha fazla zaman gerekir.

c. Hortumun çapı küçüldükçe dakikada pompalanan benzin miktarı da artar.

d. Pompalanan benzin miktarı azaldıkça, hortumun çapı genişler.

Önce aşağıdaki açıklamayı okuyunuz ve daha sonra 12, 13, 14 ve 15 inci soruları açıklama kısmından sonra verilen paragrafı okuyarak cevaplayınız.

Açıklama: Bir araştırmada, bağımlı değişken birtakım faktörlere bağımlı olarak gelişim gösteren değişkendir. Bağımsız değişkenler ise bağımlı değişkene etki eden faktörlerdir. Örneğin, araştırmanın amacına göre kimya başarısı bağımlı bir değişken olarak alınabilir ve ona etki edebilecek faktör veya faktörler de bağımsız değişkenler olurlar.

Ayşe, güneşin karaları ve denizleri aynı derecede ısıtıp ısıtmadığını merak etmektedir. Bir araştırma yapmaya karar verir ve aynı büyüklükte iki kova alır. Bunlardan birini toprakla, diğerini de su ile doldurur ve aynı miktarda güneş ısısı alacak şekilde bir yere koyar. 8.00 - 18.00 saatleri arasında, her saat başı sıcaklıklarını ölçer.

12. Araştırmada aşağıdaki hipotezlerden hangisi sınanmıştır?

a. Toprak ve su ne kadar çok güneş ışığı alırlarsa, o kadar ısınırlar.

b. Toprak ve su güneş altında ne kadar fazla kalırlarsa, o kadar çok ısınırlar.

c. Güneş farklı maddeleri farklı derecelerde ısıtır.

d. Günün farklı saatlerinde güneşin ısısı da farklı olur.

13. Araştırmada aşağıdaki değişkenlerden hangisi kontrol edilmiştir?

a. Kovadaki suyun cinsi.

b. Toprak ve suyun sıcaklığı.

c. Kovalara koyulan maddenin türü.

d. Herbir kovanın güneş altında kalma süresi.

14. Araştırmada bağımlı değişken hangisidir?

a. Kovadaki suyun cinsi.

b. Toprak ve suyun sıcaklığı.

c. Kovalara koyulan maddenin türü.

d. Herbir kovanın güneş altında kalma süresi.

15. Araştırmada bağımsız değişken hangisidir?

a. Kovadaki suyun cinsi.

b. Toprak ve suyun sıcaklığı.

c. Kovalara koyulan maddenin türü.

d. Herbir kovanın güneş altında kalma süresi.

16. Can, yedi ayrı bahçedeki çimenleri biçmektedir. Çim biçme makinesiyle her hafta bir bahçedeki çimenleri biçer. Çimenlerin boyu bahçelere göre farklı olup bazılarında uzun bazılarında kısadır. Çimenlerin boyları ile ilgili hipotezler kurmaya başlar. Aşağıdakilerden hangisi sınanmaya uygun bir hipotezdir?

a. Hava sıcakken çim biçmek zordur.

b. Bahçeye atılan gübrenin miktarı önemlidir.

c. Daha çok sulanan bahçedeki çimenler daha uzun olur.

d. Bahçe ne kadar engebeliyse çimenleri kesmek de o kadar zor olur.

17, 18, 19 ve 20 nci soruları aşağıda verilen paragrafı okuyarak cevaplayınız.

Murat, suyun sıcaklığının, su içinde çözünebilecek şeker miktarını etkileyip etkilemediğini araştırmak ister. Birbirinin aynı dört bardağın herbirine 50 şer mililitre su koyar. Bardaklardan birisine 0 ^{0}C de, diğerine de sırayla 50 ^{0}C, 75 ^{0}C ve 95 ^{0}C sıcaklıkta su koyar. Daha sonra herbir bardağa çözünebileceği kadar şeker koyar ve karıştırır.

17. Bu araştırmada sınanan hipotez hangisidir?

a. Şeker ne kadar çok suda karıştırılırsa o kadar çok çözünür.

b. Ne kadar çok şeker çözünürse, su o kadar tatlı olur.

c. Sıcaklık ne kadar yüksek olursa, çözünen şekerin miktarı o kadar fazla olur.

d. Kullanılan suyun miktarı arttıkça sıcaklığı da artar.

18. Bu araştırmada kontrol edilebilen değişken hangisidir?

a. Her bardakta çözünen şeker miktarı.

b. Her bardağa konulan su miktarı.

c. Bardakların sayısı.

d. Suyun sıcaklığı.

19. Araştırmanın bağımlı değişkeni hangisidir?

a. Her bardakta çözünen şeker miktarı.

b. Her bardağa konulan su miktarı.

c. Bardakların sayısı.

d. Suyun sıcaklığı.

20. Araştırmadaki bağımsız değişken hangisidir?

a. Her bardakta çözünen şeker miktarı.

b. Her bardağa konulan su miktarı.

c. Bardakların sayısı.

d. Suyun sıcaklığı.

21. Bir bahçıvan domates üretimini artırmak istemektedir. Değişik birkaç alana domates tohumu eker. Hipotezi, tohumlar ne kadar çok sulanırsa, o kadar çabuk filizleneceğidir. Bu hipotezi nasıl sınar?

a. Farklı miktarlarda sulanan tohumların kaç günde filizleneceğine bakar.

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

c. Farklı alanlardaki bitkilere verilen su miktarını ölçer.

d. Her alana ektiği tohum sayısına bakar.

22. Bir bahçıvan tarlasındaki kabaklarda yaprak bitleri görür. Bu bitleri yok etmek gereklidir. Kardeşi "Kling" adlı tozun en iyi böcek ilacı olduğunu söyler. Tarım uzmanları ise "Acar" adlı spreyin daha etkili olduğunu söylemektedir. Bahçıvan altı tane kabak bitkisi seçer. Üç tanesini tozla, üç tanesini de spreyle ilaçlar. Bir hafta sonra her bitkinin üzerinde kalan canlı bitleri sayar. Bu çalışmada böcek ilaçlarının etkinliği nasıl ölçülür?

a. Kullanılan toz ya da spreyin miktarı ölçülür.

b. Toz ya da spreyle ilaçlandıktan sonra bitkilerin durumları tespit edilir.

c. Her fidede oluşan kabağın ağırlığı ölçülür.

d. Bitkilerin üzerinde kalan bitler sayılır.

23. Ebru, bir alevin belli bir zaman süresi içinde meydana getireceği ısı enerjisi miktarını ölçmek ister. Bir kabın içine bir litre soğuk su koyar ve 10 dakika süreyle ısıtır. Ebru, alevin meydana getirdiği ısı enerjisini nasıl ölçer?

a. 10 dakika sonra suyun sıcaklığında meydana gelen değişmeyi kaydeder.

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

c. 10 dakika sonra alevin sıcaklığını ölçer.

d. Bir litre suyun kaynaması için geçen zamanı ölçer.

24. Ahmet, buz parçacıklarının erime süresini etkileyen faktörleri merak etmektedir. Buz parçalarının büyüklüğü, odanın sıcaklığı ve buz parçalarının şekli gibi faktörlerin erime süresini etkileyebileceğini düşünür. Daha sonra şu hipotezi sınamaya karar verir: Buz parçalarının şekli erime süresini etkiler. Ahmet bu hipotezi sınamak için aşağıdaki deney tasarımlarının hangisini uygulamalıdır?

a. Herbiri farklı şekil ve ağırlıkta beş buz parçası alınır. Bunlar aynı sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.

b. Herbiri aynı şekilde fakat farklı ağırlıkta beş buz parçası alınır. Bunlar aynı sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.

c. Herbiri aynı ağırlıkta fakat farklı şekillerde beş buz parçası alınır. Bunlar aynı sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.

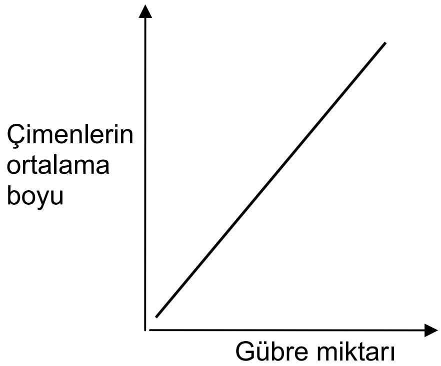
d. Herbiri aynı ağırlıkta fakat farklı şekillerde beş buz parçası alınır. Bunlar farklı sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.

25. Bir araştırmacı yeni bir gübreyi denemektedir. Çalışmalarını aynı büyüklükte beş tarlada yapar. Her tarlaya yeni gübresinden değişik miktarlarda karıştırır. Bir ay sonra, her tarlada yetişen çimenin ortalama boyunu ölçer. Ölçüm sonuçları aşağıdaki tabloda verilmiştir.

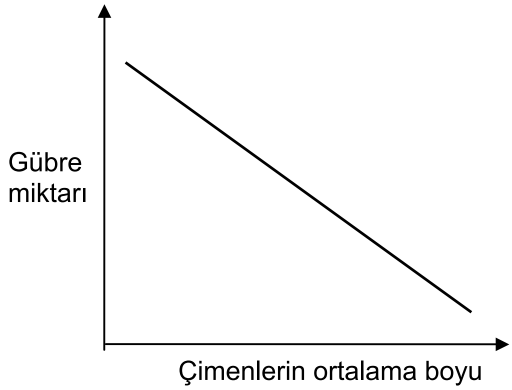
Gübre miktarı (kg)	Çimenlerin ortalama boyu (cm)
10	7
30	10
50	12
80	14
100	12

Tablodaki verilerin grafiği aşağıdakilerden hangisidir?

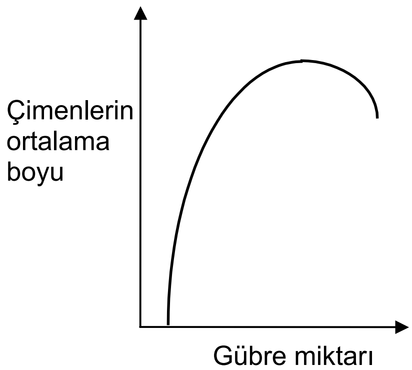
a.



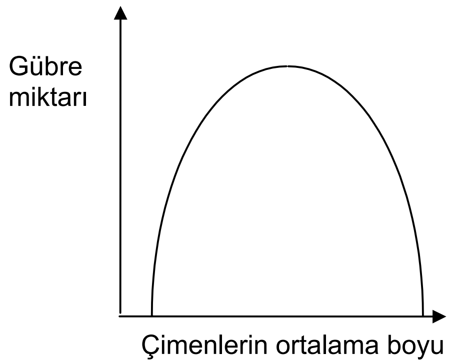
b.



c.



d.



26. Bir biyolog şu hipotezi test etmek ister: Farelere ne kadar çok vitamin verilirse o kadar hızlı büyürler. Biyolog farelerin büyüme hızını nasıl ölçebilir?

a. Farelerin hızını ölçer.

b. Farelerin, günlük uyumadan durabildikleri süreyi ölçer.

c. Hergün fareleri tartar.

d. Hergün farelerin yiyeceği vitaminleri tartar.

27. Öğrenciler, şekerin suda çözünme süresini etkileyebilecek değişkenleri düşünmektedirler. Suyun sıcaklığını, şekerin ve suyun miktarlarını değişken olarak saptarlar. Öğrenciler, şekerin suda çözünme süresini aşağıdaki hipotezlerden hangisiyle sınayabilir?

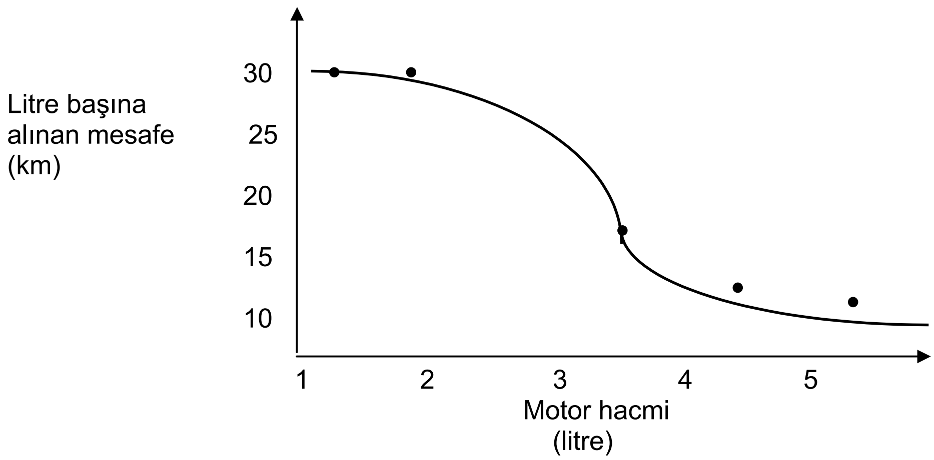
a. Daha fazla şekeri çözmek için daha fazla su gereklidir.

b. Su soğudukça, şekeri çözebilmek için daha fazla karıştırmak gerekir.

c. Su ne kadar sıcaksa, o kadar çok şeker çözünecektir.

d. Su ısındıkça şeker daha uzun sürede çözünür.

28. Bir araştırma grubu, değişik hacimli motorları olan arabaların randımanlarını ölçer. Elde edilen sonuçların grafiği aşağıdaki gibidir:



Aşağıdakilerden hangisi değişkenler arasındaki ilişkiyi 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, arabanın motoru o kadar küçük demektir.

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

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

29, 30, 31 ve 32 nci soruları aşağıda verilen paragrafı okuyarak cevaplayınız.

Toprağa karıştırılan yaprakların domates üretimine etkisi araştırılmaktadır. Araştırmada dört büyük saksıya aynı miktarda ve tipte toprak konulmuştur. Fakat birinci saksıdaki torağa 15 kg., ikinciye 10 kg., üçüncüye ise 5 kg. çürümüş yaprak karıştırılmıştır. Dördüncü saksıdaki toprağa ise hiç çürümüş yaprak karıştırılmamıştır.

Daha sonra bu saksılara domates ekilmiştir. Bütün saksılar güneşe konmuş ve aynı miktarda sulanmıştır. Her saksıdan eled edilen domates tartılmış ve kaydedilmiştir.

29. Bu araştırmada sınanan hipotez hangisidir?

a. Bitkiler güneşten ne kadar çok ışık alırlarsa, o kadar fazla domates verirler.

b. Saksılar ne kadar büyük olursa, karıştırılan yaprak miktarı o kadar fazla olur.

c. Saksılar ne kadar çok sulanırsa, içlerindeki yapraklar o kadar çabuk çürür.

d. Toprağa ne kadar çok çürük yaprak karıştırılırsa, o kadar fazla domates elde edilir.

30. Bu araştırmada kontrol edilen değişken hangisidir?

a. Her saksıdan elde edilen domates miktarı.

b. Saksılara karıştırılan yaprak miktarı.

c. Saksılardaki toprak miktarı.

d. Çürümüş yaprak karıştırılan saksı sayısı.

31. Araştırmadaki bağımlı değişken hangisidir?

a. Her saksıdan elde edilen domates miktarı

b. Saksılara karıştırılan yaprak miktarı.

c. Saksılardaki toprak miktarı.

d. Çürümüş yaprak karıştırılan saksı sayısı.

32. Araştırmadaki bağımsız değişken hangisidir?

a. Her saksıdan elde edilen domates miktarı.

b. Saksılara karıştırılan yaprak miktarı.

c. Saksılardaki toprak miktarı.

d. Çürümüş yapak karıştırılan saksı sayısı.

33. Bir öğrenci mıknatısların kaldırma yeteneklerini araştırmaktadır. Çeşitli boylarda ve şekillerde birkaç mıknatıs alır ve her mıknatısın çektiği demir tozlarını tartar. Bu çalışmada mıknatısın kaldırma yeteneği nasıl tanımlanır?

a. Kullanılan mıknatısın büyüklüğü ile.

b. Demir tozlarını çeken mıknatısın ağırlığı ile.

c. Kullanılan mıknatısın şekli ile.

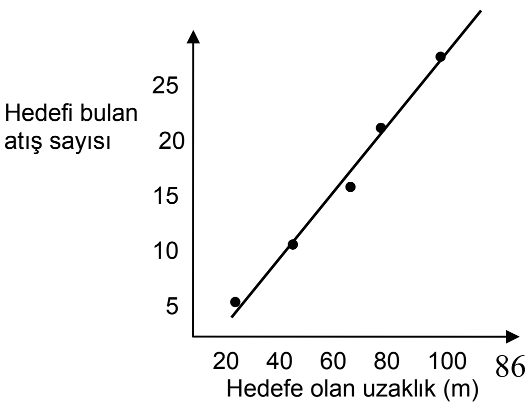
d. Çekilen demir tozlarının ağırlığı ile.

34. Bir hedefe çeşitli mesafelerden 25 er atış yapılır. Her mesafeden yapılan 25 atıştan hedefe isabet edenler aşağıdaki tabloda gösterilmiştir.

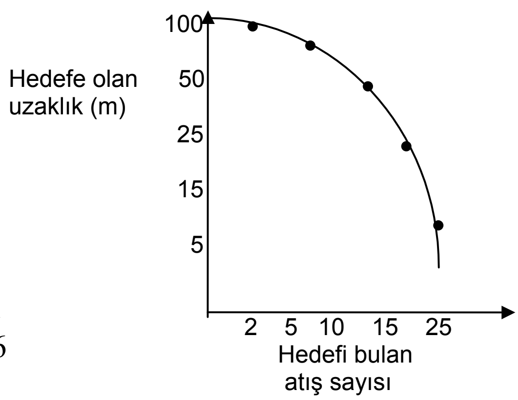
Mesafe(m)	Hedefe vuran atış sayısı
5	25
15	10
25	10
50	5
100	2

Aşağıdaki grafiklerden hangisi verilen bu verileri en iyi şekilde yansıtır?

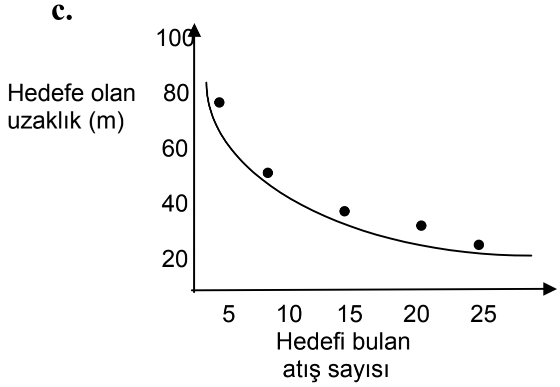
a.



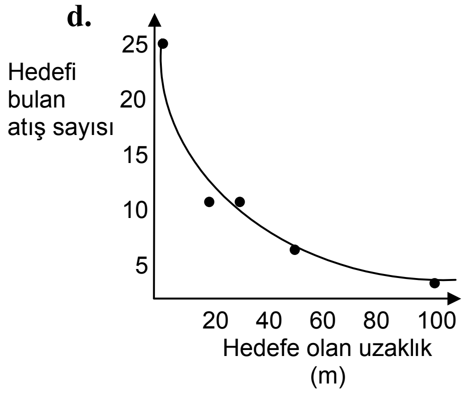
b.



c.



d.



35. Sibel, akvaryumdaki balıkların bazen çok hareketli bazen ise durgun olduklarını gözler. Balıkların hareketliliğini etkileyen faktörleri merak eder.Balıkların hareketliliğini etkileyen faktörleri hangi hipotezle sınayabilir?

a. Balıklara ne kadar çok yem verilirse, o kadar çok yeme ihtiyaçları vardır.

b. Balıklar ne kadar hareketli olursa o kadar çok yeme ihtiyaçları vardır.

c. Suda ne kadar çok oksijen varsa, balıklar o kadar iri olur.

d. Akvaryum ne kadar çok ışık alırsa, balıklar o kadar hareketli olur.

36. Murat Bey'in evinde birçok elektrikli alet vardır. Fazla gelen elektrik faturaları dikkatini çeker. Kullanılan elektrik miktarını etkileyen faktörleri araştırmaya karar verir. Aşağıdaki değişkenlerden hangisi kullanılan elektrik enerjisi miktarını etkileyebilir?

a. TV'nin açık kaldığı süre.

b. Elektrik sayacının yeri.

c. Çamaşır makinesinin kullanma sıklığı.

d. a ve c.

APPENDIX E

DEMONSTRATIONS SAMPLES BASED ON CONCEPTUAL CHANGE CONDITIONS

CHEMICAL REACTIONS AND ENERGY

Exothermic and Endothermic Reactions

Teacher: Last lesson you learned the meaning of heat and temperature and their difference, units of energy, meaning of system and surroundings concepts, meaning of enthalpy concept. In this lesson, you will learn exothermic and endothermic reactions and their properties. You had an assignment search: What are exothermic and endothermic reactions? Yes, tell me what you understand when you confronted the words “exothermic” and “endothermic”? What are the properties of an exothermic reaction? Give me some examples about exothermic reactions in our real life? What are the properties of endothermic reactions? Can you give me an example about endothermic reactions?

With these questions, teacher attempted to create a discussion environment and tried to investigate students’ preconceptions about the exothermic and endothermic concepts. Teacher took some notes about the answers and acted as a guide through the discussion.

Teacher: As you know, all of the chemical reactions occur with releasing heat or absorbing heat. If a reaction releases heat (heat out) from system to surroundings, it is an *exothermic* reaction. If a reaction absorbs heat from surroundings, it is an *endothermic* reaction.

Some students could not differentiate between endothermic and exothermic reactions. But after the explanation, teacher asked same questions and understood the scientific definition.

Teacher: The sign of ΔH indicates whether heat is absorbed or released in the change. (Teacher wrote the representation of this to the board.)

$\Delta H = H_{final} – H_{initial} = H_{products} - H_{reactants}$

In exothermic reactions: $H_{final} < H_{initial}$ $\Delta H < 0$

In endothermic reactions: $H_{final} > H_{initial}$ $\Delta H > 0$

Teacher: Can you tell me, is burning of a candle exothermic reaction or endothermic reaction?

(Some students answered this question as “burning of a candle is an endothermic reaction”)

Teacher: Why do you think burning of a candle is an endothermic reaction?

(Students explained this like this: “it is an endothermic reaction because we need heat to initiate burning)

Teacher: It is and exothermic reaction. All of the combustion reactions are exothermic *(dissatisfaction)*.

Students who answered this question correctly were intellectually rewarded, and those who answered incorrectly were faced with the “conflict” between their previous knowledge and their new knowledge.

(To create intelligibility and plausibility of new conception teacher burn a candle and explain how the combustion reactions occur.)

Teacher tried to explain the properties of endothermic reactions and endothermic reactions. She explained the principles and gave some examples about these kinds of reactions. Teacher explained the heat that was given to initiate burning was the flame to create catching fire temperature, it was not the energy that was used to continue the reaction After the candle reached the catching fire temperature, the reaction continued spontaneously *(intelligibility)*. This situation explained with performing a demonstration.

Demonstration: (Catching fire of phosphor)

White phosphor is dissolved in 50 ml CS_2. A piece of paper is getting wet with this solution. And this wet paper is held with tongs. After that, this paper is shake from right to left quickly. We will see that the paper is catching fire.

With this demonstration, it was confirmed that the principles that explains the burning of a candle and those burning of coal are the same. The different thing is the catching fire temperature of different substances. And this reaction is an example of exothermic reactions *(plausibility)*.

Teacher: Ok, as you see from the demonstration, combustion reactions are exothermic reactions. Can you give some examples about combustion reactions that do not involve fire or flame?

(With this question, the teacher understood that some students thought that all combustion reactions involve fire or flame. After that teacher gave some examples about combustion reactions that do not involve fire or flame.)

Teachers interpret the graphs that were belong to exothermic and endothermic reactions.

After that teacher conducted another demonstration to comprehend students' conceptions about exothermic and endothermic reactions. It is very difficult to find endothermic examples to demonstrate students. So, this demonstration is very effective to illustrate the conceptions that were learned about endothermic reactions.

Demonstration (Evaporation of ether)

50 ml ether is filled into a beaker. A pipe is put inside the beaker and a wet cartoon is put under the beaker. The ether inside the beaker is blown through the pipe. This is done for fasten the evaporation of ether. It is seen that the ether will evaporate. While the ether evaporating, the cartoon will stick to beaker (Figure E.1). The reason of this is there are ice pieces between cartoon and beaker. The reason for occurrence of ice can be explained by the absorbing heat during the evaporation process.

This is an example of endothermic process. The ether inside the beaker absorbed heat from the water that contained by cartoon. The water inside the cartoon turned to ice pieces *(plausibility)*.

During the demonstrations, it was emphasized that endothermic reactions can be spontaneous and a spontaneous reaction is not always exothermic.

At the end of the lesson teacher assigned homework which requires the application of new conceptions to the new situations.

Teacher: Okay, I think you are ready to investigate new situations about exothermic and endothermic reactions. You will find examples about exothermic and endothermic reactions that are confronted in our daily lives. This is your homework. We will discuss your answers next lesson *(fruitfulness)*.

Figure E.1 Evaporation of ether

Bond breaking and bond making processes:

Teacher started to lesson with the questions to explicit students' preconceptions about bond breaking and bond making processes. In literature, most of the students think that bond dissociation releases energy, while bond formation consumes energy. Teacher knew this misconception from the literature and tried to investigate whether student hold the same misconception. After the answers that students gave, teacher understood most of students in the class hold this misconception. Teacher asked some questions to provide dissatisfaction between students' preconceptions and scientific conceptions. After that, teacher explained the scientific concepts and principles about these concepts. These were mainly about bond energy, enthalpy, heat of formation, heat of combustion, heat of formation *(intelligibility)*. After that, teacher conducted a demonstration to illustrate bond breaking and bond dissociation processes.

Demonstration (Dissolving of NaOH)

3,25 gr NaOH is dissolved in 150 ml water.

Initiate temperature of water is 9 ^{0}C

Final temperature of the solution is 14 ^{0}C

We assume that the total solution is 153,25 gr. C of the solution is 1 cal/g or 4,18 joule/g

From the equation of $Q_{dissolving} = m \times c \times \Delta t$

$$Q_{dissolving} = 153{,}25 \times 4{,}18 \times (14-9) = 3202{,}925 \text{ joule}$$

The dissolution heat of the 3,25 NaOH is 3202,925 joule.

So, dissolution heat of the 1 mole NaOH is calculated like this:

(40 x 3202,925) – 3,25 = 41639 joule / mole = 41,639 k.j / mole

Dissolution enthalpy of NaOH is 41,639 kj/mole.

In this demonstration the important point is to prove the students the point that during the bond breaking process, energy is required and during the bond formation process energy is released. The following equations explain the energy fow during the dissolving of NaOH.

$$NaOH(I) + energy \longrightarrow Na^+ + OH^-$$

$$Na^+ + OH^- \longrightarrow Na^+(aq) + OH^-(aq) + energy$$

NaOH (I) is surrounded by H_2O molecules. Water has dipole property which means one side of the water molecules is positive the other side of the water molecules is negative. Because of this reason, an interaction between Na ions and negative side of water, and OH ions and positive side of water occur. During this process, energy releases. This energy is bigger than the energy that required breaking bonds between Na and OH ions. So, this reaction is an exothermic reaction.

With this demonstration teacher tried to remedy the misconception that bond dissociation releases energy, while bond formation consumes energy *(plausibility)*.

At the end of the lesson teacher gave students homework to apply their new knowledge to other situations *(fruitfulness)*.