CONCEPTUAL CHANGE TEXTS ORIENTED INSTRUCTION IN TEACHING SOLUTION CONCEPTS

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

BY

YALÇIN ÜNLÜ

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

JANUARY 2014

Approval of the thesis:

CONCEPTUAL CHANGE TEXTS ORIENTED INSTRUCTION IN TEACHING SOLUTION CONCEPTS

submitted by YALÇIN ÜNLÜ in partial fulfillment of the requirements for the degree of **Doctor of Philosophy in Secondary Science and Mathematics Education Department,Middle East Technical University** by,

Prof.Dr.Canan Özgen ____________________
Dean,Graduate School of **Natural and Applied Sciences**

Prof.Dr.Ömer Geban ____________________
Head of Department,**Secondary Science and Mathematics Education**

Prof.Dr.Ömer Geban ____________________
Supervisor,,**Secondary Science and Mathematics Education Dept., METU**

Examining Comitte Members

Prof. Dr. Hamide Ertepınar ____________________
Preschool TeacherEducation Dept., İstanbul Aydın Univ.

Prof.Dr.Ömer Geban ____________________
Secondary Science and Mathematics Education Dept., METU

Assoc. Prof. Dr. Esen Uzuntiryaki Kondakçı ____________________
Secondary Science and Mathematics Education Dept., METU

Assoc. Prof. Dr. Yezdan Boz ____________________
Secondary Science and Mathematics Education Dept., METU

Assist. Prof. Dr. Ömer Faruk Özdemir ____________________
Secondary Science and Mathematics Education Dept., METU

Date:31.01.2014

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

Name, Last Name: Yalçın ÜNLÜ

Signature

ABSTRACT

CONCEPTUAL CHANGE TEXTS ORIENTED INSTRUCTION IN TEACHING SOLUTION CONCEPTS

ÜNLÜ, Yalçın

Ph.D., Department of Secondary Science and Mathematics Education
Supervisor: Prof. Dr. Ömer GEBAN

January 2014,125pages

This study was conducted to compare the effectiveness of conceptual change text over traditionally designed chemistry instruction on understanding of solubility equilibrium concepts. Also students' attitudes toward chemistry as a school subject and toward conceptual change texts were investigated. Moreover, students' science process skills and effect of the gender difference were also investigated.

108 11th grade students from four classess of a Chemistry course tought by same teacher in TOKİ Anatolian High School in 2010-2011spring semester were enrolled in the study. Students were divided in to two groups. Groups were randomly assigned and experimental group was tought by conceptual change texts through the lecture and the control group was intructed only with traditionally designed science texts. Both groups were administered Solubility Equilibrium Concept Test and Attitude Scale Toward Chemistry as a School Subject as a pre-test and post-test.Science Process Skill Test was given to all groups at the beginning of the study to determine students' level of science process skills.

The hypothesis were tested by using t- test, MANCOVA and ANCOVA as follow-up test of MANCOVA. The results showed that instruction with conceptual change texts caused a significantly better acquisition of scientific conceptions and elimination of misconceptions related with solubility equilibrium concepts as compared to the traditional instruction. In addition, no significant difference was found between experimental group and control group students with respect to attitudes toward chemistry as a school subject. Besides, results showed that science process skills of the students' accounted the significant portion of variation in their achievement in solubility equilibrium concepts whereas there was no significant effect of gender difference on students’ understanding of solubility equilibrium concepts.

Keywords: Conceptual change text, traditional instruction, misconceptions, solubility equilibrium.

ÖZ

ÇÖZÜNÜRLÜK KAVRAMININ ÖĞRETİMİNDE KAVRAMSAL DEĞİŞİM METİNLERİ ODAKLI EĞİTİM

ÜNLÜ, Yalçın

Doktora, Orta Öğretim Fen ve Matematik Alanları Eğitimi Bölümü
Tez Yöneticisi: Prof. Dr. Ömer GEBAN

Ocak 2014, 125 sayfa

Bu çalışma kavramsal değişim metinlerinin 11inci sınıf kimya öğrencilerinin çözünürlük dengesi konusunu anlamalarına etkisi geleneksel yönteme dayalı öğretim ile karşılaştırılmıştır. Ayrıca, öğrencilerin kimya dersine karşı tutumları ve kavramsal değişim metinlerine karşı tutumları araştırılmıştır. Aynı zamanda, öğrencilerin bilimsel işlem becerileri de araştırılmıştır.

Bu çalışmaya, 2010-2011 ilkbahar döneminde, TOKİAnadolu Lisesinde bir öğretmenin kimya dersi verdiği dört 11. sınıftan, 108 öğrenci katılmıştır. Öğrenciler iki gruba ayrılmıştır. Gruplar rastgele şekilde kavramsal değişim metinleriyle destekli eğitim verilen deney grubu ve yalnızca geleneksel yöntemlere dayalı eğitim verilen kontrol grubu olarak atanmıştır.Her iki gruba da ön test ve son test olarak çözünürlük dengesi testi ve kimya dersine karşı tutum ölçeği verilmiştir. Aynı zamanda çalışmadan önce öğrencilere bilimsel işlem beceri testi verilmiştir.

Araştırmanın hipotezleri t-testi, çok değişkenli çok-faktörlü kovaryans analizi ve varyans analizi kullanılarak test edilmiştir. Sonuçlar göstermiştir ki kavramsal değişim metinleri ile verilen eğitim geleneksel yöntemlere dayalı eğitimle karşılaştırıldığında çözeltilerde denge konusuyla ilgili bilimsel kavramların anlaşılmasında daha etkilidir ve kavram yanılgılılarının giderilmesinde daha etkili olmuştur. Ayrıca deney grubu öğrencileri ile kontrol grubu öğrencileri arasında kimya dersine karşı tutumları göz önüne alındığında istatistiksel bir fark bulunamamıştır. Aynı zamanda bilimsel işlem becerisinin öğrencilerin çözeltilerde denge ile ilgili kavramları anlamalarında önemli bir belirleyici olduğu görülürken, cinsiyet farkının öğrencilerin çözeltilerde denge konusundaki başarısında önemli bir etkisinin olmadığı görülmüştür.

Anahtar Kelimeler: Kavramsal değişim metni, geleneksel öğretimyöntemi, kavram yanılgıları, çözeltilerde denge.

ACKNOWLEDGEMENTS

I would like to thank to my supervisor Prof. Dr. Ömer GEBAN for his guidance, advice, criticism and endless support throughout the research.

I would like to thank to my family for their support, contributions and suggestions.

Finally I would like to thank to my wife Dr.Sibel ÜNLÜ and my son Can ÜNLÜ for their encouragement, patience and support.

TABLE OF CONTENTS

LIST OF TABLES

TABLE

LIST OF FIGURES

FIGURE

LIST OF ABREVIATIONS

CCT	: Conceptual Change Text
CCTI	: Conceptual Change Text Oriented Instruction
TDCI	: Traditionally Designed Chemistry Instruction
EG	: Experimental Group
CG	: Control Group
SECT	: Solubility Equilibrium Concept Test
ASTC	: Attitude Scale Toward Chemistry
SPST	: Science Process Skills Test
F	: F statistic
t	: t statistic
df	: Degrees of Freedom
p	: Significance Level
MS	: Mean Square
SS	: Sum of Squares
N/n	: Sample Size
ANOVA	: Analysis of Variance
MANCOVA	: Multivariate Analysis of Covariance

CHAPTER I

INTRODUCTION

The human capacity for learning is an important characteristic that sets the species apart from all others. Learning is how we acquire knowledge. Learning and cognitive development are complex events in which the learner may be engaging in any of several activities. Included are interacting with others, manipulating objects, using signs and symbols, constructing mental models, and observing and noting the actions and reactions of others.

Learning have been tried to be understood by people for more than thousand years. Argument on how people learn and theories on learning goes as far back as the Greek philosophers.By working with the thoughts of Descartes and Kant, and especially Charles Darwin’s influence made psychologists to begin conducting tests to study how people learn, and to find the best approarch to teaching. Learning theories address questions like how learning happens, how motivation occurs, what effects development of the students’? In order to useinstructing theories to practical instruction, first of all fundamentals of these theories must be solved and afterwards adapting to various circumstances and context should be figured out. Different perspectives to practical application and reasonable interpretation of the outcomes can be gained by these theories (Austin et al., 2001).

No one learning theory can possibly address all the complexities found in the various settings and contexts in which learning can occur. Therefore, a particular theory is chosen for a situation partly as a result of the activities to be studied. Learning theories are useful mechanisms in the design and evaluation of classroom practices and educational products (Gredler, 2005).

However, there is no single theory that can explain all situations occurring in teaching environments that can influence learning concept.This is whay that teachers have complicated roles like consideringdifferent sources of information and existing theories, evaluating different classroom circumstances and students' different characteristics, afterwardsdecideif theories of learning could improve her practical application of instruction.

Constructivist theory of learning draws attention to students' existing beliefs,skillsand knowledge. In constructivism, students synthesize new conceptswith prior knowledge and new information. The constructivist teacher finds problems and monitors exploration of students, guides inquiryand promotes new thinking patterns. By taking an interactive role, constructivist teacherdirects queries and let students to explore.At the end of the instruction, students begin to think of learning as an evolving process. In this study, the constructivist approarch oriented instruction used to activate the student's existing knowledge related to solubility equilibrium concepts.

Numerous studies have been conducted in chemistry education. Results of these studies showed that students come to class with previously earned knowledge which construct their formal learning or experiences (Fetherstonhaugh & Treagust, 1992). This former knowledge is named as preconceptions that conflict with the scientific view which creates misconceptions. Misconceptions have a huge role in learning chemistry concepts (Mulford and Robinson, 2002). Students' misconceptions can interfere with learning process. If these misconceptions integrate into a student's cognitive composition they interfere with subsequent learning. Then studentshave to accommodate new informations in to their cognitive structure which already harbour inappropriate knowledge. Thus, connecting new information to student's cognivtive structure can be very difficult and understanding level can be lower and misunderstandings of the concept may occur. Students' misconceptions should be taken into account to provide conceptual understanding and conceptual change during teaching and learning (Coştu, Ayas & Niaz, 2010).

The teachers must learn students' previous knowledge before teaching in order to prevent students' misconceptions. Some methods like concept mapping, prediction, observation, explanation, interviewing about events, instances and concepts, drawings, diagnostic tests and word association can be used in order to determine students' misconceptions (Ayas et al., 2001; Schmidt, 1997). Also, to prevent misconceptions and promote conceptual change, teachers should implement more effective teaching strategies (Özmen, 2008).

1. 1 Purpose of the study

The purposes of thıs study are as follows: (a) to investigate secondary-school chemistry students' misconceptions in solubility equilibrium concept, (b) to teach solubility equilibrium concept by using CCT, and (c) to determine CCT's effectiveness in overcoming students' misconceptions and learning difficulties, (d) investigate the change in students' attıtudes toward chemistry before and after the conceptual change text instructıon and traditıonal instructıon; (e) observe students' science process skills.

1.2 Significance of the Study

One of the research areas of chemıstry misconceptions is the solubility equilibrium concept. However, solubility equilibrium occupies a central role in high school chemistry curriculum. Solubility equilibrium concept is an important subject in chemistry because this concept is linked to other subjects as solubilıty, molarity, ions, chemıcal equilibrium. There are some research reports concerned with concept of solubility equilibrium concept (Camacho & Good, 1989; Chiu, Chou & Liu, 2002; Gussarsky & Gorodetsky, 1990, Önder &Geban, 2006). Some misconceptions regarding chemical solubility might be the result of instruction that emphasis correct concepts without highlighting common conceptual errors. Chemistry teachers should examine why misconceptions occur and use learning activities to eliminate misconceptions because, it is very difficult to remove misconceptions from the minds of the learners. Since solubility equilibrium concept has a high pirority in chemistry in order to understand other complex subjects, students should understand solubility equilibrium concepts comprehensively.

The conceptual change text (CCT) is one of the most effective methods to overcome misconceptions. Traditional teaching methods may not be adequate to achieve conceptual change in most students (Tekin, Kolomuç & Ayas, 2004). In CCT model, ordinary misconceptions were defined firstly. Second step was to initiation of misconceptions by giving real-life examples. As the last step, by applying teaching method misconceptions were substituted with the correct scientific concepts (Posner et.al., 1982). That's why, we decided to examine the changes in the eleventh-grade students’ conceptions about solubility equilibrium using the conceptual change text oriented instruction with the students from the experimental and control groups. Conceptual change oriented instruction was used to remove students' misconceptions related with solubility equilibrium concept.

Besides, effects of the treatments and the gender difference on students’ attitudes toward chemistry were investigated because, there are many studies reporting that type of instruction affect students’ attitudes toward chemistry as a school subject and attitudes affect the students’ motivation, interest and achievement (Greenfield 1996, Chambers and Andre 1997, Parker 2000). Students’ attitudes towards science are a key factor in chemistry achievement since they are positively correlated. Conceptual change text instruction can facilitate developing positive attitudes towards science.

Also, effects of the gender dıfference and science process skills on students’ understanding of solubility equilibrium concepts were investigated. Lazarowitzshowed that high cognitive skills are required to learn science (2002). Low performance in utilization of science process skills can be taken in to account as important indicator of severe instructional complications (Fraser,2001). Based on these, the findings of our study will give information about the features of the changes that take place as a result of using conceptual change text oriented instruction which is simple to apply in teaching environments and also will give a deep understanding about the nature of students' misconceptions about the solubility equilibrium concepts.

1.3 Definition of the Terms

In this study the terms used are defined as following:

Misconception: students’ existing conceptions that differ from the definitionsof general scientific facts (Driver & Easley, 1978).

Conceptual change instruction: Instructing concepts by eliminating students misconceptions as presenting intelligible, plausible and fruitful.

Traditional instruction: Teacher oriented instruction applied generally in classrooms without considering students previous misconceptions.

Attitude:Students beliefs about a subject and their responses with those beliefs (Fishbein & Ajzen, 1975).

Science Process Skills: Students proficiency to find, interpret and judge evidences under different conditions they encounter.

CHAPTER 2

REVIEW OF RELATED LITERATURE

In this chapter researches relevant to this study is reviewed in order to understand the fundamentals of the constructivism method used during this research and studies including students misconceptions related with solubility equilibrium concepts and also use of conceptual change texts in instruction.

2.1. Constructivism

Various theories oflearning were conducted since many years in order to find an explanation for modification of people's behaviors based on their experiences. Three main categories of learning theories are cognitivism, behaviourism and constructivism. Behaviorism mainly interests on learning of perceptible responses or behaviors and considers learning as a change in behavior rather than a cognitive change. Cognitivism deals with steps leads to learning (Ormrod,2009).

Basically the theory of constructivism says that people build knowledge and understanding of the world byliving through things and revealing those experiences. Learning is a process which knowledge is shaped and constructed by experience and a personal interpretation of the World (Christie, 2005). Constructivism emphasis learning rather than teaching.Helps in development of processes, skills and attitudes.Considers learning styles of the students'and focuses on building up knowledge instead ofduplication. Provides for meaningful, problem based thinking. Extends students beyond content presented to them.

There are diversity of views for the term of constructivism. But in general they agree that (1) learning is andynamicapproarch of buildingistead ofobtaining knowledge, and (2) instruction is a technique of constructing knowledge rather than communicating (Duffy & Cunningham, 1996).

According to Good and Brophy (1994) students are not inactiverecipients. In a new situation, in order to make knowledge beneficial, students must overexert in order to add up the new information that they receive. To fit their confidence students must first own it and than they can manipulate, discover, and create knowledge.

Constructivism requires discussion of implication and expression of former and new knowledge. Students should connectprevious knowledge and new information in order to make new information meaningfull. In order to move forward, students must associate and question, dispute and enquire, receive or disposeformerknowledge and acceptances.

In social environments, students could share and also compare their ideas with others, that’s why constructivist process works best in social surroundings. When students try to resolve contradictory ideas,learning takes place. In small group activities, accomplishment ofsocial interaction is recurrent, whole class debatescan provide students the chance of articulating their knowledge and learning from others. Constructivistic approarch uses authentic tasks in order to engage learners. Activities are selectedfrom real life (Cooperstein and Kocevar-Weidinger, 2004).

In constructivist method, the teacher arranges the conditions of learning that students will learn what is aimed (Gagne, 1985). Design of appropriate activities requires planning and that’s why it is time consuming.Coming upon the right problems and examples greatly increases time of preperation. The examples and activities should point out the required concepts. If the examples are insufficient, learning the concept is difficult. All experiences are not evenlyinstructional (Dewey,1938). Quality of the experience is the main determent. The excellence of perceptioncan be controlled through the choice of activities and determination of configuration.

Although it is difficult and time taking, constructivist learning has a lot of advantages when compared to other instructional methods. A well planned, carefully structured constructivist approach, with the right directed activities may ease students' discovery of concepts and skills development. Complicated concepts become understandable by attaching them to exhibition of an activity. Students build up meaning by activities leading to concepts (Cooperstein and Kocevar-Weidinger, 2004).

The table below (Table 2.1) compares the traditional classroom with the constructivist classroom. It can be seen the constructivist approach has a major implicit in constructing new knowledge.

Traditional Classroom	Constructivist Classroom
Curriculum begins with the parts of the whole. Emphasizes basic skills.	Curriculum emphasizes big concepts, beginning with the whole and expanding to include the parts.
Strict adherence to fixed curriculum is highly valued.	Pursuit of student questions and interests is valued.
Materials are primarily textbooks and workbooks.	Materials include primary sources of material and manipulative materials.
Learning is based on repetition.	Learning is interactive, building on what the student already knows.
Teachers disseminate information to students; students are recipients of knowledge.	Teachers have a dialogue with students, helping students construct their own knowledge.
Teacher's role is directive, rooted in authority.	Teacher's role is interactive, rooted in negotiation.
Assessment is through testing, correct answers.	Assessment includes student works, observations, and points of view, as well as tests. Process is as important as product.
Knowledge is seen as inert.	Knowledge is seen as dynamic, ever changing with our experiences.
Students work primarily alone.	Students work primarily in groups.

Table 2.1 Traditional classroom and constructivist classroom comparison (Thirteen Ed Online, 2004).

In constructivist classrooms students are more engaged in the constituentswhen compared to traditional classrooms, this leads to a more fruitful learning environment. Students were alloweddetermining to the objectivesofinstructionistead ofreceivingcomponentspresented by the instructor. This makes students to store the knowledge they learn for long-term rather than storing it in short-term memory in order to pass an exam. Since learning speed of each students is different, constructivist teachers shouldgive chancestudents to construct their own ways of processing the lesson ingredients. Also constructivist classrooms work in groups in which they let students to work together, discuss the concepts that they may not manage toperceive on their own. The problem solving abilities that are perceived in one class can be spread through the other students' of the classes (Burr, 2003). While conventional teaching methods are efficientin the Bloom's taxonomy’s first four levels,in the further levels of understanding, constructivism is efficient (Ormrod, 2009).

Teachers instructing with constructivistic approarchthink that the information and knowledge that students perceive from schoolshould come from the former practice and knowledgeof the children. Instead of giving to the students a direct lecture, teacher should supply the desired environment for letting students explore the concept being told.According to Brooks and Brooks in traditional classrooms, students are commanded to duplicateparticularprogress and a huge amount of information. When they manage to do this, they are told to be 'learned'. Usually this success is measured or validated by multiple-choice or short-answer tests. The main goal in the constructivist classroom is realconceptioninstead of a behaviour mimicry (Brooks & Brooks, 1999).

2.1.1. Types of Constructivism

Constructivism is a process rather than anindivisable theoretical position. The premises that underlie this processdifferthroughvarious dimensions and have lead to occurance of various types of constructivism. Generally, this process is divided into three wide categories: Cognitive Constructivism, Social Constructivism, and Radical Constructivism.

Cognitive Constructivism. Cognitive constructivism, also called individual or psychological constructivism, is mainly concerned with how individuals build up their knowledge and beliefs (Woolfolk, 2004). According to cognitive constructivism, knowledge acquisition is an adaptative process and emerges from dynamicdigesting by the particular learner. These specific epistemological highlightsresults in determiningfundementals that sustain the exteriorfeatures of knowledge and the confidence that an individualfactendures and is cognizible. Than knowledge is internalized and (re)constructed. This internalization and (re)construction process isclaimed as learning. That is, learning is the process of building accurate internal models or representations that mirror or reflect external structures that exist in the “real” world. This perspective on learning focuses on (a) the procedures or processes of learning, (b) how what is learned is represented or symbolized in the mind, and (c) how these representations are organized within the mind.

Radical constructivism. Within cognitive constructivism, at the extreme end, a type of constructivism known as radical constructivism can be found with von Glasersfeld (1998) as most important adherent. Radical constructivism is not only unconcerned with correct representations of the outside world, it states that there is no reality or truth. Reality is idiosyncratic, cognitive reality and is therefore dependent on the individual that perceives this reality. Formal knowledge receives a minor role in radical constructivism, because knowledge depends on individual perceptions. By taking this situation in to consideration, the function of instruction is not clear and occasionaly even considered needless. Only few radical constructivists, however, completely disregard formalknowledge (Richardson, 1997). Radical constructivism amplyincludes three epistemological beliefs which are knowledge possession that is an adaptative approarchcocludes from dynamiclearning by the particular learner, representing an empirically deependendintelligance, not anintelligance that illustrateaboutextrinsicfact (Larochelle, Bednarz, & Garrison, 1998).

The adaptative characteristic of cognitionunderlines that cognition does not reflect the real life actuality, but instead is aendurable model of knowledge (von Glasersfeld, 1995). Also, Staver (1995) says that, “knowledge is knowledge of the knower, not knowledge of the external world; improving knowledge means improving its viability or fit in, but not match with, an external world”.

Social constructivism. Social constructivism places between cognitive constructivism and radical constructivism according to transfer of cognizible fact and building up individual and consistent actuality. Differing from radical and cognitive constructivism, social constructivism underlinesformerly indicated all epistemological beliefs. These specific epistemological beliefscause toestablishtenets that preserve the social properties of conception, and the idea that conceptionemerges from social interaction and language usage, which involves allocation instead of solitary experience (Prawatt & Floden, 1994). Also, this social interaction generally happensinside a socio-cultural framework which leads to bounding of conception to a particular time and place (Gergen, 1995; Vygotsky, 1978). This situation is demostrated by Bakhtin (1984), “truth is not to be found inside the head of an individual person, it is born between people collectively searching for truth, in the process of their dialogic interaction”.

In studies where constructivist method was impelemented, in improving students’ conception and success, constructivist teaching is significantly impressive. In our study we tested the potency of the constructivist teaching with respect to traditional method. The results of the study showed that the students instructed by constructivist method learned solubility equilibrium concepts more efficiently than the students instructed by traditional approarch.

2.2. Misconceptions

During the jouney of learning, misconceptions plays a very important role and they can interact with students’ process of learning scientific concepts (Palmer, 2001; Taber, 2000). Because of this, teaching technique selection is a major determent in avoidance of students’ misconceptions (Pekmez, 2010).

There are many terms related to misconception nomenclature is being discussed in the literature which were preferred by different researchers. It’s been told that “[M]any researchers object to the term ‘misconception’ because, from the student’s viewpoint, the ideas expressed are logical‘Preconceptions’, naive theories’, and ‘alternative frameworks’ have been proposed as better terms for students’ personal views that are at odds with modern scientific theories.”by Sneider and Ohadi (1998).

Terminology preffered by the researcher sheds light to their epistemicconsiderations. Terminology preference of Sneider and Ohandi (1998) shows that their epistemological belief isreplacementof animproper model with a proper one. On the contrary, the useage of the ‘alternative conception’ termby Hallidén and his colleagues (2002) prooves their reliance in a located epistemology.

Misconception means every conceptiondifferent from accepted scientifical interpretation of the idea. If they integrate into a student’s cognitive framework, theyhinder with futureacquisation. Afterwards, studentstry to integrate newly learnedconcepts in a cognitive frameworkthat harboursimproperinformation. By this way newly accuired knowledge may not be linked to students’ cognitive framework correctly, and poor acquisition and misinterpretation of the conception may take place (Tekin et al., 2004).

A huge list of literature regarding to students from schools, universities and undergraduates misconception about scientific concepts associated to the curriculum they were instructed (Pfundt & Duit, 1991; Driver et al., 1994). These concepts may existprior to learning activities and usuallyreveals following the learning occurs (Gilbert, Osborne, & Fensham, 1982), also occassionaly new inaccurateconcepts are constructedthroughout lessons (Taber, 1995a, 2001).

There is a vast of examples present related with students’ misconceptions in chemistry concepts, like they believe in that metal’satoms are hard, but liquids have soft atoms (Harrison & Treagust, 1996). A huge part of the students can notdifferentiate the characteristics of a substance and an atom (Ben-Zvi, Eylon, and Silberstein,1986). According to the students atoms or molecules are tiny portions of the uninterrupted substance. All of these misconceptions students gained formerly related to atoms and molecules concepts will interfere with following conception (Griffiths & Preston, 1992).

When investigated throughlyit was revealed that knowledge can be developed into emergedframeworks of inter related and reciprocallysupporting concepts, that will form complicated conceptions.(Taber, 1997a).Occasionally some concepts have to be converted to accommodate the previous information whixh was a common approarch applied widely by scientists. Bu these accommodated cognitive structures cause misunderstanding the concepts given during the instruction (Taber, 2001).

Defining misconceptions of the students is not always the easisest mission to be accomplished because of their origin and various levels of cognitive skills. When we reviewed the literature, it can be seen that wide list of studies conducted to determine students' misconceptions (Taber, 1997b; Bodner, 1991; Kind, 2004; Lewis, 1996; Thomas & Schwenz, 1998).

A study conducted regarding the students' misconceptions of scientific concepts disclosed that all of these misconceptions have a concentional aspect. They are generally tolerant to traditional teaching methods and construct organized, although erroneous, cognitiveformations (Driver & Easly, 1978).

Derivation of misconceptions can begenerallygroupedas follows:

1. Existing conception of chemical concepts is not sufficient for revealing new ideas.

2. Exaggerated reduction to promote acquisition.

3. Wrong chemistry arising from teachers wrong understanding of chemical concepts.

4. Local misunderstanding of ideas (Chu & Hong, 2010).

2.3. Students' Misconceptions In Solubility Equilibrium Concepts

The concepts related with solubility equilibrium are generally considered as the most troublesome concept to instruct and conceive in chemistry lessons, that's why it has been investigated widely by vaious researchers (Barker, 2000). For many years, various studies were conducted on comprehension of solution concept and students' previous conceptions. In chemistry, chemical equilibrium has a major role and considered to be one of the harderst concepts to be thought between other chemical concepts (Solomonidou & Stavridou, 2001; Piquette & Heikkinen, 2005; Özmen, 2008),also it has a tight relation with other concepts like acid-base, solubility, and reactions of oxidation-reduction (Quilez-Pardo & Solaz-Portoles, 1995, Voska & Heikkinen, 2000).

Solubility equilibrium plays a critical role in curriculum of high school chemistry. Various concepts have to be instructed before revealing the aspects of solubility equilibrium concepts. Because of this,determination of students previous conceptions is crucial in designing solubility equılibrium teaching activities (Önder & Geban, 2006).

Misconceptions students have with respect to solubility equilibrium concept obtained from literature were given in Table 2.2 (Önder&Geban, 2006).

In the present study, Solubility Equilibrium Conception Test used was mainly developed according to the reported misconceptions.

According to the reviewed literature it can be concluded that misconceptions hinder learningand conception of chemistry in meaningful way. Therefore, remediation of misconceptions is important. Several instructional approarches which are consistent with constructivist view of learning are developed to remove and remediate misconceptions. These models stress the importance of conceptual change in remediation of misconceptions so that meaningful learning can be achieved. Therefore, if meaningful learning is aimed it is important to understand what conceptual change is.

Table 2.2. Taxonomy of Misconception Related to Solubility Equilibrium.

1. There is no precipitation and dissolution at equilibrium.
2. Dissolution stops at equilibrium.
3. Concentrations of the ions produced are equal to the concentration of the salt at equilibrium.
4. Mass can be used instead of concentration in Ksp calculations.
5. Coefficients in solubility equilibrium equation have no other meaning then equating the solubility reaction.
6. Ksp can change at a given temperature.
7. Ion product (Qi) can be used interchangeably with Ksp.
8. While writing Ksp equations, compounds in solid form should be included.
9. The rate of dissolving increases with time from mixing the solid with solvent until equilibrium establishes.
10. There is no relation between Ksp and solubility.
11. The value of Ksp changes with the amount of solid or ions added at a given temperature.
12. The value of Ksp always decreases as temperature decreases.
13. Temperature has no affect on solubility.
14. At equilibrium, addition of salt affects the equilibrium.
15. Concentrations of ions will remain constant although common ion is added at equilibrium.
16. Solubility of sparingly soluble salts is affected by change made in pressure and volume.
17. In all situations one can compare solubility of salts at equilibrium by just looking at Ksp values.
18. If system is at equilibrium no other solute that doesn't contain common ion can dissolve.
19. There was no precipitation reaction before the system reaches equilibrium.
20. Large Ksp implies very fest dissolution.
Note. Ksp: solubility product constant

2.4Conceptual Change

Conceptual change is generally describes as changing former cocncepts with learning. The main aspect of conceptual change is it changes and even substitutes students prior concept that they utilize in problem solving, revealing uncommon.

Conceptual change was utilized at the beginning in order to give a different point of view in teaching concepts of different disciplineslike physics and biology (Posner et al., 1982, Carey, 1985). Later on disciplines like chemistry, earth science, mathematics, writing, reading, and teacher education utilized conceptual changeby widenining its usage (Hewson, 1992).

Cognitive psychologists have traditionally focused more attention on describing the structure and function of knowledge than on change and growth in knowledge (e.g., Anderson & Pearson, 1984; Rumelhart, 1980; Spiro, 1980). However, change (elthogh not labeled as such) has been a central topic of study in cognition if one considers that in general, cognitive psychologists view "learning" as synonymous with "change".

The conceptual linkage of change and learning within cognitive psychology probably has a number of historical roots (Figure 2.1). Behavioural psychologists equated learning with a change in behaviour. Piaget described the processes and mechanisms whereby children come to change their ways of thinking and their ways of thinking and their views of the world. Beginning in the 1960s, cognitive information processing led theorists to posit methods for substitution in the organization of knowledge primarily through the possession of novel schemata and substitutions in prior schemata (Anderson & Pearson, 1984; Rumelhart & Norman, 1981).

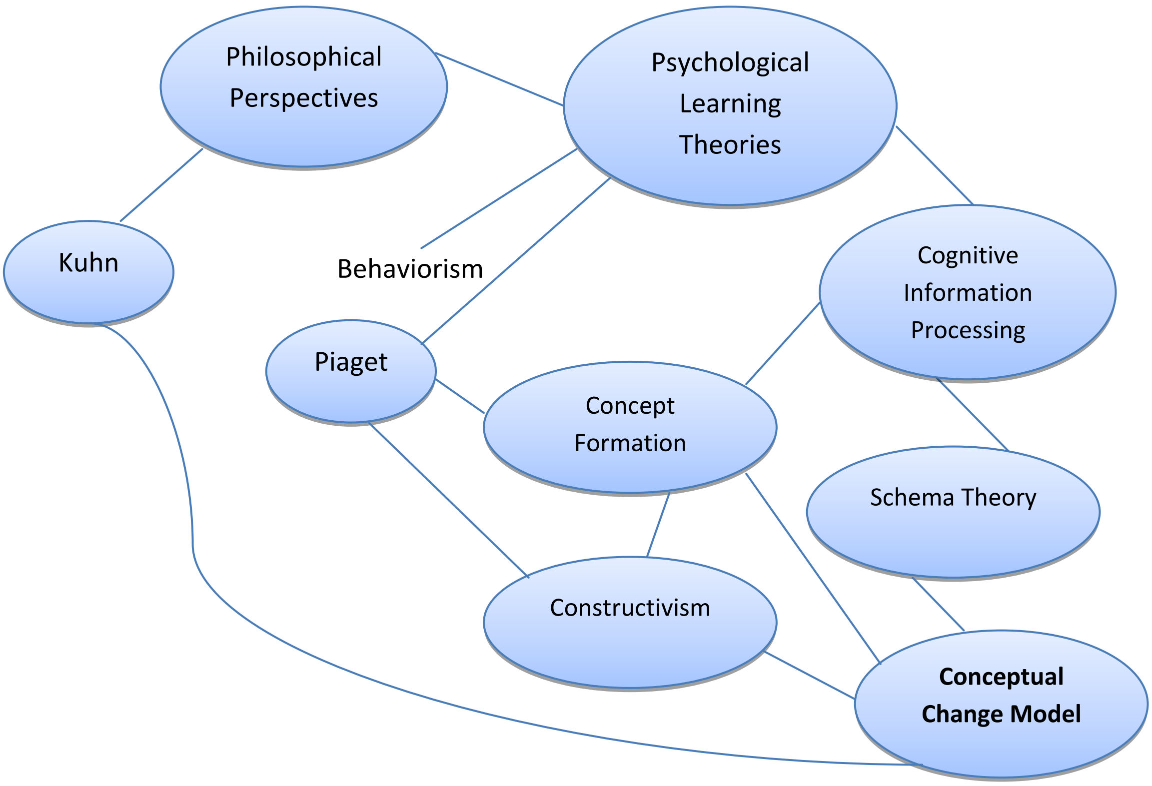


Figure 2.1 Routes of change (adapted from Dole&Sinatra, 1998).

Cognitive psychologists have always been interested in concepts, how they come to be represented in memory, how their meaning is constructed, and how such meanings change. Concepts are central constructs in cognition because they constitute "units of mental representation" (Carey, 1992). In their instance, the site of change is mental representation of conceptual knowledge.

During the 1980s, science educators adapted a cognitive constructivist view of knowledge consistent with cognitive psychology and Piagetian theory to explain how children acquire knowledge about scientific phenomena (White & Tisher, 1986). According to this constructivist perspective, conception is not transferred from instructor to learner but builded up by individuals through the process of assimilation and accommodation. Due to the modificationprocedure defined prior cognitive framework alteration; modification was viewed by science educators as the central mechanism for conceptual change (Dola & Sinatra, 1998).

In educationof science, a lot of research has been conducted (and being conducted) on pointing out the previous ideas and misconceptions which students harbour in science classrooms. Researchers determinedthat how hard it has been tried to change with instruction in order to reverse, a big portion of these misconceptions are persistent (Viennot, 1979, Driver & Easley, 1978). Posner and his colleugescreated a modeldefining “the substantive dimensions of the process by which people’s central, organising concepts change from one set of concepts to another set, incompatible with the first” (1982). Defined model is illlustrated in the Figure 2.2.

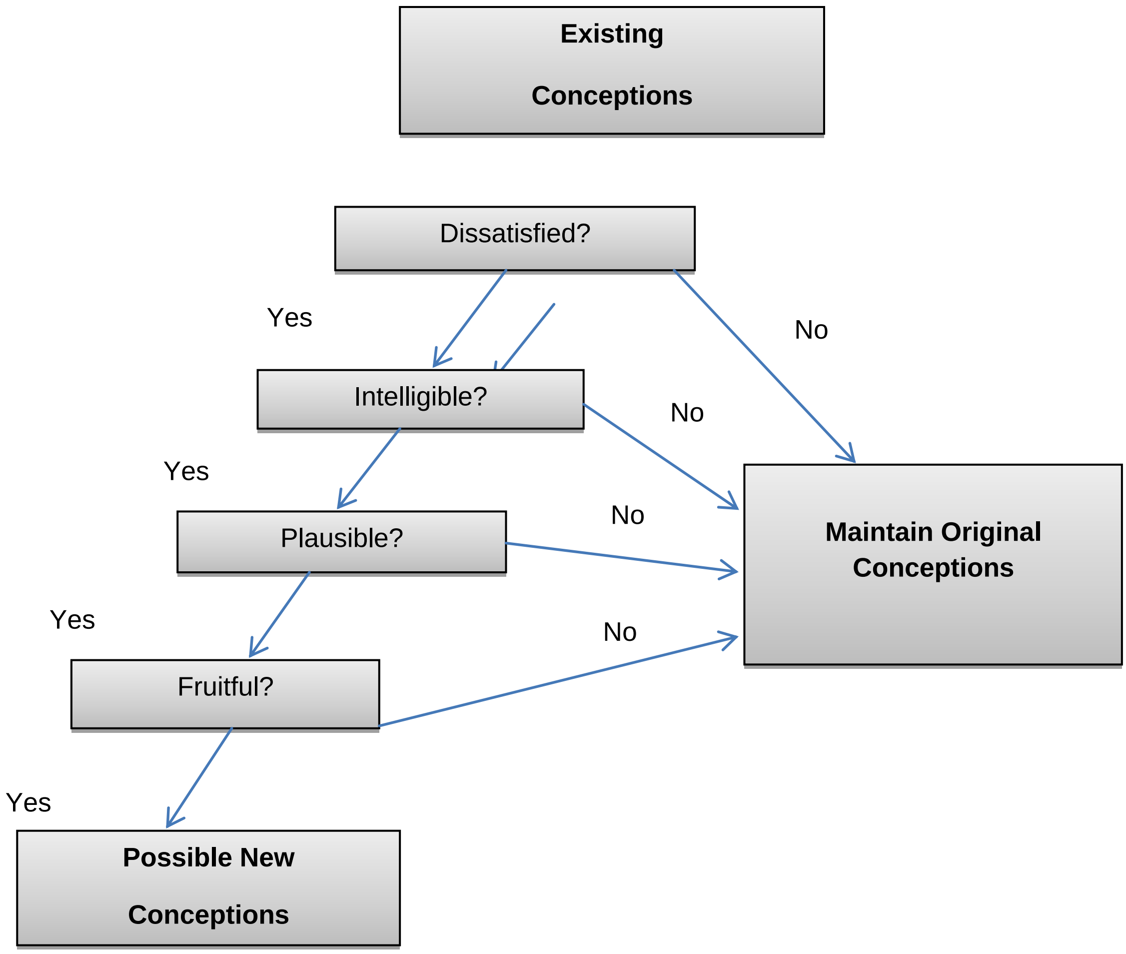


Figure 2.2 Conceptual Change Model (Posner et al., 1982).

In order to conceptual change takes place, four conditions of the conceptual change model must be encountered. Following defines these conditions (Posner et al., 1982):

1. Previous conceptions dissatisfaction.

2. Understandable new conception.

3. Reasonable new conception.

4. Fruitful investigation areas suggesting new conception(Posner et. al., 1982).

Science educators have used conceptual change as the theoretical framework for explaining a multitude of studies showing how individuals fail to develop conceptual understandings about numerous scientific phenomena (e.g., Carey, 1985; Chin & Brewar, 1993; West & Pines, 1985). Further, the model has been used to propose instructional interventional that have proven promising in helping students change their preconceptions or naive theories about scientific phenomena (Dole & Sinatra, 1998).

A lot of study conducted on teaching strategiesnowadays have tried to considerinvestigationrelated to students' conceptions of realisticincidents. Conceptual change method of teaching has been emerged from these studies (Hewson, 1991).

Conceptual change teaching includingfeatuers such as classroom climate, role ofteacher and role of students are proved to be successful for students educated in elementary, middle and high school, and in college for introducing concepts related with various fields like physics, chemıstry, biology and earth science (Pfundt & Duit, 1991; Carmichael, et al., 1990).

Before starting their education at school, children possess wide amount of concepts relaed to their real-life environment. Having such an background information can be both usefull and also problematic for receiving new information in terms of interaction. Because of this conceptual change has an important role in restructuring prior concepts (Read, 2004).

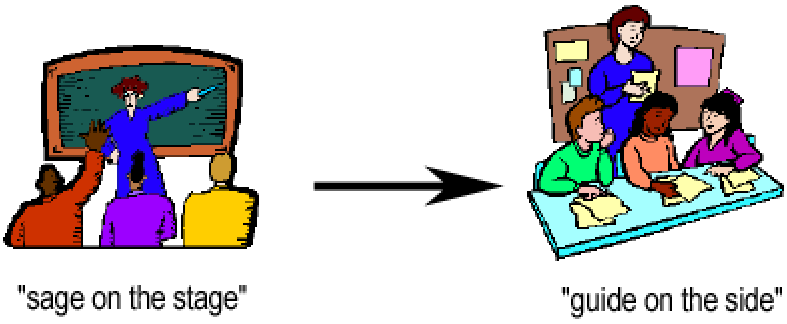


Figure 2.3 Constructivist teaching illustration of concept changing (Davis, 2001).

Conceptual changing is related to introduction of new conepts as far as improvement of the teachers' instructional abilities. In a constructivist classroom teachers' role as an instructor, changes from "sage on the stage" to a "guide on the side" (Figure 2.3) (Davis, 2001, Tallman & Tastad, 1998).

Students has an intention of building alternate comprehension and cognitive models. Taber believes that students' alternateknowledge mainly derive from their way of being tought (Taber, 2001b). Failing in introduction of new concepts leads to development of alternate concepts by students (Taber & Coll, 2002).

For the success of conceptual change based instruction learning environment must be collaborativeStudents should feel safe enough to discuss their opinions and have opportunity to taking into account of other point of views (Bruning et al., 1999; Scott et al.,1991). This"safety factor" is really matters in conceptual change teaching. In a conducted study, Dreyfus and his colleuges revealed that self-confidence loss in students causes achievement fall (1990).

Applying conceptual change based instruction successfully, requires experience for teacher and students. Traditional instruction familiarized students may have difficulties in adapting discussion based instruction methods (Scott, Asoko, & Driver, 1991). In this case teacher must play more active role for adaptation of the students to the interactive instruction.

Conceptual change based instruction requires more time for preparation of instruction when compared to traditional direct teaching. Teacher also should provide the required encouraging environment for promoting students to argue their own ieas(Vosniadou, 1994).

Aim of conceptual change instructionis to promote adoption of more fruitfull concepts by removing prior misconceptions of students. Students much more easily discard their misconceptions if they evaluate them when compared to unexamined conceptions (Davis, 2001).

There are many conceptual change theories which aim to replace or restructure misconceptions with that of scientific ones to facilitate learning. The major difference between the conceptual change theories is the way they explain the change.

According to the related literature, it can be claimed that conceptual change is a necessity for meaningful learning to occur. Our study is also devoted to the students' conceptions and conceptual change in solubility equilibrium concepts. Analysis of the results showed experimental group students had better achievement than the traditionally instructed group.

2.4.1 Conceptual Change and Conceptual Change Texts

For encouraging conceptual change, one of the most efficient teaching methods is applying conceptual change texts (Guzzetti et al., 1992). This study also utilizes conceptual change texts to define the efficiency of the conceptual change approarch on improving students' solubility equilibrium concepts understanding.

The conceptual change text (CCT) is considered to be a very efficient method for eliminating misconceptions. Traditional techniques may not be adequate to achieve conceptual change in most students. In CCT model, ordinary misconceptions were defined firstly. As a second step, misconceptions werestimulatedthroughintroduction ofconditions intended forarousing anintimationregarding to them. Then, students' misconceptions are provoked by presentingordinary misconceptions which then followed up by demonstration of their erroneous. At the end, the instruction presents the correct scientific explanation.

Conceptual change texts are builded up especially for revealing students misconceptions and for eliminating them by instructing the right concept. In order to achieve this, concepts are presented with questions and students' probable answers which are not scientifically wrong are revealed for creation of dissatisfaction. Afterwards, scientifically satisfying explanations, which are more plausible and intelligible, are introduced. Various studies reportsthat conceptual change texts are very important for promoting conceptual change and eliminating misconceptions (Baser & Geban 2007; Calık et al. 2007; Ozmen et al. 2009; Palmer 2003; Uzuntiryaki & Geban 2005; Yuruk 2007). Also conceptual change texts can be applied in large classes,whichmakes them suitable for developing countries countries that possess crowded classes for education (Çetingül & Geban, 2011).

Conceptual change texts are texts that activate the students' misconceptions, present common misconceptions, and try to make the learner comprehend explanations that are scientifically accepted. According to Guzzetti (2000), conceptual change texts are very usefull in promotingconceptual change and make permanent conceptual changes. Conceptual change texts were applied in different scientific subjects such as blood circulation (Alkhawaldeh, 2007), resolution balance (Önder and Geban, 2006) energy in chemical reactions (Taştan, Yalçınkaya and Boz, 2008), electro-chemical batteries (Yürük, 2007) and cellular respiration (Al Khawaldeh and Al Olaimat, 2009). Conceptual change texts contribute positively to correct conceptual mistakes in all subject areas. When the relevant literature is reviewed, it can be seen that how to prepare conceptual change textswere not thoroughly introduced. Moreover, the teachers who want to overcome their own misconceptions experience difficulties during the practise and development of conceptual change texts (Akpınar, Turan and Tekataş, 2004; Yip, 2004; Taşlı, 2005).

According to Hynd (2001), making students believe in the newly presented situation in conceptual change texts was achieved in three ways. The first one is one-way form. The message is presented in this form, but discussions of opposite views are not made. The second form is two-way, non-refutable form. In this form, two ways of examining the subject are presented, and the writer prefers one of them. However, it is not emphasized why the wrong idea is wrong. The third form is discussion of refutation. Both right and wrong ideas take place in the conceptual change texts prepared for this study, and the justifications of right and wrong ideas are given and the why the right idea was preferred is also discussed. It is stated in the literature that conceptual change texts in such forms are accepted more by the students (Guzzetti, 2000; Hynd, 2001). Guzzetti (2000) emphasizes that for the texts to provide conceptual change, it is not enough to read the text, but after the texts are read discussions must be made in regard to the scientific explanations given in the text.

Guzzetti and his colleagues stated that conceptual change texts' effects are limited for the students who have difficulty in reading and writing(1995). It was also emphasized that conceptual change texts have the possibility to easily change into teacher-centred applications, and in order to overcome this, it is suggested that the students do research on their own, make experiments and obtain results by preparing texts (Hynd, 2001).

Based on the implications in the literature, conceptual change approarch seems to be a reasonable strategy in enhancing students' understanding of chemistry concepts. It is a very efficient tool in leading conceptual change and overcoming misconceptions. This research aimed to examine the improvement of conceptual change in solubility equilibrium concepts and students' attitudes toward chemistry as a school subject when their science process skills were controled. Experimental group instructed with conceptual change oriented teaching method and control group instructed with traditional method. Results of this study revealed that conceptual change oriented teachingleaded better learning of solubility equilibrium concepts.

2.5 Attitude TowardScience

Students' attitude is one of the factors affectingtheir learning. According to Fishbein and Ajzen attitude have three components that are cognitive, affective (emotional) and behavioral. Cognitive component consist of the ideas and beliefs, which the individual holds towards the attitute object. While affective component refers to the feelings and emotions, behavioral component includes action tendencies towards the attitude object. However, later these three components of attitudes are distinguished and they suggest that the term "attitude" be reserved only for affective dimension which states favorability toward an object. Cognitive dimension label as "beliefs" and behavioral dimension label as "behavioral intensions"(1975).

Students' attitudes towards science are influenced by various factors which are; sex, age, parentseducational levels, their jobs, size of the classroom, comunication with teacher, their intend in science related career and so on (Bilgin & Karaduman, 2005).

When studnts are active participants at lessons their attitudes towards science affected positively and positive attitude influences students' science achievement in a positive direction (Bristow, 2000; Freedman, 1997).

Uzuntiryaki and Geban (2004) investigated the influence of constructivism oriented instruction on students' attitude toward chemistry. The study was applied on 42, 9^{th}grade chemistry students for the chemical bonding concepts. In the constructivist group, students' prior knowledge activated and student-student interaction promoted during instruction. The results showed that constructivist based instruction generatedhigher positive attitudes toward chemistry when compared to traditional teaching. They explained this situation as interactiveparticipation of students to activities, also to have a chance to use their prior knowledge produced favourable feelings toward science. They concluded that attitude is an important variable for better understanding and had a positive affect in students' achievement.

For improving students' attitudes towards chemistry more student oriented teaching as applied in this study should be implemented.

2.6. Science Process Skills

Science process skills are defined by proficiency to discover, explain and assess evidences in various circumstances they experience. Through these skills, individuals can observe, predict, make inferences, analyze data, formulate hypothesis and perform experiments (Harlen, 1999; Lazarowitz 2002). In this sense there are beneficialinteractionregarding students' science process skills and their accomplishments in science (Padilla, 2004; Walters & Soyibo, 2001).

According to conducted studies, by using appropriate teaching methods, science process skills could be instructed in classrooms (Rapudi, 2004). In another study science process skills is claimed to be an integral part of science instruction (Wynne, 1999). Conducted researches revealed that students' scientific concept accuisation is greatly influenced by their science process skills (Uzuntiryaki, 2003; Çelebi, 2004; Ceylan, 2004; Yavuz, 2005).

When the literature is summarized; it can be obviously seen that students have trouble in conception of solubility equilibrium concepts, and their misconceptions related to solubility equilibrium are persistant. These misconceptions influences coneption of new knowledge in a negative manner. Presented research applied conceptual change text based teaching in order to enhancing comprehension of solubility equilibrium concepts and eliminating their pior misconceptions. Also, studies revealed that conceptual change methodimprove students' attitudes towards the subject. Because of this, during conducting this research we also investigated the outcome of teaching methodover their attitudestowards chemistry.

CHAPTER 3

PROBLEMS AND HYPOTHESIS

3.1 The Main Problem and Sub-problems

3.1.1 The Main Problem

The purpose of this study is to investigate the effectiveness of conceptual change text oriented instruction over traditional instruction on eleventh grade students' understanding of solubility equilibrium concept and their attitudes toward chemistry as a school subject.

3.1.2 The Sub-problems

1. Is there a significant dıfference between the effects of tradıtionally desıgned chemıstry instructıon and conceptual change text based instructıon on students' understanding of solubility equilibrium conceptwhen the effect of students' scıence process skills are controlled as a covariate?

2. Is there a significant mean difference between boys and girls with respect to their understanding of solubility equilibrium concept?

3. Is there a significant effect of interaction between gender difference and treatment with respect to students' understanding of solubility equilibrium concept?

4. Is there any contribution of students' science process skills to the variation in their achievement in solubility equilibrium concept?

5. Is there a significant mean difference between the effects of traditionally designed chemistry instruction and conceptual change text oriented instruction on students' attitudes toward chemistry as a school subject?

6. Is there a significant mean difference between boys and girls with respect to their attitudes toward conceptual change texts?

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. Hypothesis

$H_0$1: There is no significant difference between post-test mean scores of the students taught with instruction based on conceptual change approach and students taught with instruction based on traditional methods in students' understanding of solubility equilibrium concept and attitudes toward chemistry as a school subject when students' science process skills are controlled as a covariate.

$H_0$2: There is no significant difference between post-test mean scores of boys and those of girls with respect to their understanding of solubility equilibrium concept and their attitudes towards chemistry when students' science process skills are controlled as a covariate.

$H_0$3: There is no significant effect of interaction between gender and treatment with respect to students' understanding of solubility equilibrium concepts and students' attitudes toward chemistry as a school subject when the effect of students' science process sills is controlled as a covariate.

$H_0$4: There is no significant contribution of students' science process skills to their understanding of solubility equilibrium concept.

$H_0$5: There is no significant difference between post-test mean scores of the students taught with conceptual change texts oriented instruction and those taught with traditionally designed chemistry instruction with respect to understanding of solubility equilibrium concepts when students' science process skills are controlled as a covariate.

$H_0$6: There is no significant difference between post-test mean scores of boys and those of girls with respect to their understanding of solubility equilibrium concepts when students' science process skills are controlled as a covariate.

$H_0$7: There is no significant effect of interaction between gender difference and treatment with respect to understanding of solubility equilibrium concepts when students' science process skills are controlled as a covariate.

$H_0$8: There is no significant difference between post-test mean scores of the students taught with conceptual change texts oriented and those taught with traditionally designed chemistry instruction with respect to students' attitudes towards chemistry as a school subject when students' science process skills are controlled as a covariate.

$H_0$9: There is no significant difference between post-test mean scores of boys and those of girls with respect to their attitudes towards chemistry when students' science process skills are controlled as a covariate.

$H_0$10: There is no significant effect of interaction between gender difference and treatment with respect to students' attitudes towards chemistry when students' science process skills are controlled as a covariate.

CHAPTER 4

DESIGN OF THE STUDY

4.1 The Experimental Design of the Study

For this conducted study experimental and traditional teaching methods' efficiency were determined with randomized pre-test and post-test control group design (Gay, 1987). Sheme of the research is given in the table below.

Table 4.1 Research Design of the Study

Groups	**Pre-test**	**Treatment**	**Post-test**
Experimental Group (EG)	SECT ASTC SPST	CCTI	SECT ASTC
Control Group (CG)	SECT ASTC SPST	TDCI	SECT ASTC

Descriptions of the abreviations were as follows:

SPST: Scıence Process Skıll Test
ASTC: Attıtude Scale toward Chemıstry
SECT: Solubility Equilıbrium Concept Test
TDCI: traditionally designed chemistry instructıon
CCTI : conceptual change text orıented insturction

How dependent variables were influenced by the application of the instruction method and the effect of former knowledge related to solution equilibrium, science process skills, attitudes towardschemistry were checked by three pre-tests (SECT, ASTC, SPST) which all subjects included in this study responded to. Following the application of instruction method, SECT and ASTC were given to students of each group.

4.2 Sample of the Study

The subjects of this researchare eleventh grade students from four chemistry classes where the chemistry course is thought in 2010-2011 spring semester were chosen randomly from the possible classes in TOKİ Anatolian High School. Control group and experimental group classes were randomly defined. Same chemistry teacher lectured experimental and control groups. The data examined in this research study were collected from 54 students instructed by conceptual change method (experimental group) and 54 students instructed by traditional approarch (control group). Therefore, in this study in total 108 eleventh grade students (58 male and 50 female) participated.

4.3 Variables

4.3.1 Independent Variables

Two different instruction method (conceptual change text oriented instruction and traditionally designed chemistry instruction) and gender were the independent variables. Also, SPST scoredscıence process skillschecked for controling their integrated process skills at the beginning of the treatment and to identify its' effect on their achievement of solubility equilibrium concepts.

4.3.2 Dependent Variables

Solubility equilibrium concept comprehensionevaluated by SECT, students' attitudes toward chemistry as a school subject and their attitudes toward conceptual change texts measured by ASTS are the dependent variables of this study.

4.4 Instruments

In this study there were three tools administered for collecting data on acquired research questions. These were Solubility Equilibrium Concept Test (SECT), Attıtude Scale toward Chemıstry (ASTC), and Scıence Process Skills Test (SPST).

4.4.1 Solubility Equilibrium Concept Test (SECT)

The SECT was emerged by the researcher considering the objectives of national curriculum related with the concept and misconceptions reported in the literature (Gennaro, E. D., 1981; Prieto et al., 1989; Lee et al., 1993; Abraham et al., 1994; Ebenezer & Erickson, 1996, Önder & Geban, 2006) that students hold about solubility equilibrium (see Appendix A). Test consisted of 21 multiple choice questions. One correct answer and four distracters were assigned to each questıon. Distracters reflect alternate conceptions or misconceptions of students' regarding the item.

Prepared text the text was examined by a group of experts in science education in order to reveal content validity, and the by the course instructor for the suitability of the questions for instructional objectives. Before using of this test in its actual aim, to evaluate its reliability and validity aspectsa pilot test was carried out. For reliability analysis, KR–20 was used and it resulted 0.82 for the SECT. Also in order to determine the mean difficulty degreeand mean item discrimination index, ITEMAN programme was enforced. They were (pj) = 0.45 and (rjx) = 0.48 respectively. These findings showed that prepared test is valid and reliable.

Test was given to all groups both as a pre-test to check students' knowledge of solubility equilibrium concepts at the prior to instruction and to define the effect of treatments oncomprehension of concepts of solubility equilibrium,as a post-test.

Table 4. 2 Taxonomy of misconceptions investigated by the items in SECT and their corresponding item numbers

Misconceptions	**Corrresponding Item Number**
Believing that at equilibrium there is no precipitation and dissolution.	18
Believing that at equilibrium dissolution stops.	5
Believing that at equilibrium the concentrations of the ions produced is equal to the concentration of the salt.	4
Believing that mass can be used instead of concentration in Ksp calculations.	3
Believing that coefficients in solubility equilibrium equations have no other meaning then equating the solubility reaction.	1,4,12
Believing that at a given temperature Ksp can change.	2
Believing that ion product (Qi) can be used interchangeably with Ksp.	18
Believing that compounds in solid form should be included while writing Ksp equations.	1
Believing that the rate of dissolving increases with time from mixing the solid with solvent until equilibrium establishes.	5
Believing that amount (moles) can be used instead concentration (molarity) in Ksp calculation.	3
Believing that at a given temperature the value of Ksp changes with the amount of solid or ions added.	2
Believing that the value of Ksp always decreases as temperature decreases.	20
Believing that temperature has no affect on solubility.	2, 20

Table 4. 2 (Continued)

Believing that at equilibrium addition of salt affects the equilibrium.	2
Believing that at equilibrium the concentrations of ions will remain constant although common ion is added.	2
Believing that in all situations one can compare solubility of salts at equilibrium by just looking at Ksp values.	18
Believing that if system is at equilibrium no other solute that doesn't contain common ion can dissolve.	2
Believing that before the system reaches equilibrium there was no precipitation reaction.	18
Believing that large Ksp implies very fest dissolution.	19
Believing that there is no relation between Ksp and solubility.	3
Believing that any substance that contains H is an acid, OH is a base.	11
Believing that H2O can not act as an acid or base only serve as a solvent.	8
Believing that pH value shows the number of H atom that an acid contains.	11
Believing that pH value shows the number of H+ ion that an acid can give.	13, 17
Believing that the strength of an acid depends on the number of hydrogen atom and base depends on the number of hydroxide molecule.	10
Believing that strong acids have a higher pH than weak acids.	19
Believing that strong acids are more concentrated than dilute acids.	14
Believing that strong acids contain more hydrogen bond than weak acids	10
Believing that reactions of acids and bases always result in a neutral solution.	21
Believing that acidity increase as pH value increase.	14

4.4.2 Science Process Skills Test (SPST)

36 multiple choice questions with four alternatives were included to the test which was builded up by Burns, Okey and Wise (1985) in English. Özkan, Aşkar and Geban translated into Turkish (1992).Purpose of development was to measure students' intellectual abilities to identify variables, identify and state the hypotheses, operationally define, designe investigations and graph and interpret the data (see Appendix C). Internal consistency (Cronbach's alpha) of the test was found to be 0.85. It was given to all students before applying treatment in order todefine and control if science process skillshas an effect throughout the study.

4.4.3 Attitude Scale Toward Chemistry (ASTC)

"Students' attitudes toward chemistry as a school subject" is determined with a scale developed by Geban et al. (1994). This scale includes 15 items in Turkish which were scaled 5 point Likert type (fully agree, agree, undecided, partially agree, fully disagree). There are both positive and negative statements in the test. Reliability (Cronbach's alpha) of the test was found to be 0.83. It was given to all students in the study as pretest and post-test (See Appendix B).

4.5 Treatment (CCTI vs. TDCI)

This research was carried out over four weeks in the 2010-2011 spring semester at Toki Anatolian High School and 108 11th grade students in four chemistry classes instructed with the same teacher were recruited in this study.

There were two groups of students: one experimental group and one control group in this study. Two teaching methods were designated randomly to the classes. Both groups were conducted SCET, ASTS and SPST as pre-tests prior to instructionfor determining any variation between the groups of the study. Thoughout the treatment, solubility equilibrium concepts were instructed as a part of the common e

leventh grade chemistry curriculum. The classroom instruction of the groups were four 45-minute school term per week.

In the control group students were instructed only with traditional approarch. The regular classroom instruction was teacher orientedinstruction. The students were instructed only with traditionally designed science texts.Lecturer instructed and discussed the concepts by the teacher directed questions. Sometimes students directed some questions. The teacher answered the questions and asked new questions to understand if the instructed concept was understood. At the end of the lesson, teacher choosed homework questions from the textbook, which were same with the homework questions of experimental group.

Experımental group students were instructed by a conceptual change based method where conceptual change texts were implemented. Conceptual change texts identified common misconceptions and promptlywarned students that may havethese type of misconceptions. Teacher provided an environment in which students discover their misconceptions and find out the correct answers because students had the chance to compare their misconceptions with the correct concepts. Activities depending upon conceptual change texts were introduced to students which were designed considering students' grade level and their prior knowledge (see Appendix D).

At the beginning of each text students are presented with a question and are asked to answer it. Each CCT was designed to help students realize their misconceptions; that is, made them to realize inadequacy of their prior knowledge and help them to replace these misconceptions with alternative scientific conceptions.For instance, "what will produce,if an acid and a base react?" question was directed to the students during the lecture of neutralisation reactions. Students gave different answers to this question.Some of their answers were "reactions of acids and bases always result in a neutral solution". Afterwards for promoting the dissatisfaction of prior knowledge,the teacher directed questions related with number of moles of acid and base or if the acid and base was weak or not. The purpose of asking themwasto canalize students find outthe wrong conceptions and dissatisfying them (dissatisfaction).

Afterwards,students were introduced with the concepts.For instance, equal moles of the reaction between NaOH (sodium hydroxide) and HCl (hydrochloric acid) was shown to students. This reaction results in a neutral solution.The teacher performed another reaction of equal moles between NaOH (sodium hydroxide) and H_2SO_4 (sulphuric acid).This reaction does not result in a neutral solution. Therefore, equal numbers of moles of acid and base are needed for neutralization reaction. The teacher performed reaction between weak acid and strong base, also performed reaction between strong acid and weak base. Whileteacher explains the scientific concept, observation of representative events by the students makes theseconcepts more intellıgible for them (intelligibility).

More over, real-life examples were presented to the students to improve the conception of solubility equilibrium concepts. For example, after explaning the neutralization reactions, the teacher mentioned that hydrangea flower color can be determined by the relative acitidy of the soil. An acidic soil flower color is blue, whereas an alakaline soil flower color is pink. If the farmer wants to change the color of hydrangea blue to pink, adds dolomitic lime to the soil. This will help to raise the pH. So that, newly learned concepts were promoted to utilize in problem solving, the aim was making these concepts plausible for stundets (plausibility).

At the end the teacher assigned homework to the students for applying newly learned concept to a particular occasion. The teacher expected from students to find some real-life examples corelated to neutralization reaction. These examples discussed in the following lesson. These newly learned conceptions helps stundets to reveal novel incidents, they were called as fruitful for students (fruitfulness).

After the treatment, both groups were conducted ASTS and SECT as post-test to define student’s understandings of solution equilibrium concept and attitudes toward science as a school subject.

4.6 Threats to Internal Validity

For this study, random sampling was used for choosing the high school and the classes that will be the subject of research. As a result of this, threats to internal validity were determined as characteristics of the subjects, effect of history, threat of maturation, location threat, mortality effect, collection of data and collector bias, and implementation effects. Throughout conducting the study the defined threats were aimed to be supervised.

In this study, students' previous achievement and students' science process skills in both EGs and CGs were assessed at the beginning of the study. Also for minimizing the influence of these differences on post test applied at the end of the study, these variables used as covariate. Adding to this, both EGs and CGs subjects were at the same grade level and almost the same age. However, students were not assigned to both EGs and CGs randomly other subject characteristics may correlate with dependent variable.

To avoid the influence of history, research datas were gathered in small intervals in a synchronized manner from both groups. To prevent maturation threat, study was conducted for four weeks to avoid dullness and causing tiredness. For avoiding the interaction of given answers to the pre-test results and post-test results an interval of four weeks was assigned.

There were no discontinuation of the studentsthroughout the treatment in both groups and in both pre-tests and post tests in this study. In addition, all individuals answered all of the items. Therefore the mortality effect which means lose of subject during the study was controlled.

Similar conditions were created for both groups by arranging the size and setting of the class the same. Also both groups were educated by the same teacher. For preventing bias in data gathering, all data were gathered under same circumstances by the same instructor. Tests and application of the instruction methods were performed at students' everyday classrooms, by this way location threat which means the possibility of effects of locations on students' responds was controlled.

4.7 Analysis of Data

For the analysis of the data obtained from the conducted study Multivariate Analysis of Covariance (MANCOVA) which controls the impact of students' science process skills as a covariate was implemented in order todefine the usefullness of two differentinstructional methods and gender on the understanding of solution equilibrium related conceptsand students' attıtudes toward chemıstry as a school subject.

Prior to the treatment, an independent t-test was implemented in order to identifyif there is a statistically significant mean difference between the control and experimental groups concerning their science process skills, previous knowledge about solubility equilibrium concepts and prior attıtude toward chemıstry as a school subject.

4.8 Assumptions and Limitations

4.8.1. Assumptions

- Students in the control group did not communicate with the students in experimental group.
- The teacher was objectivethroughout the treatment.
- Students answered the questions in the instruments sincerely and accurately.
- The tests were conducted under standard conditions.
- It is assumed that the provided conceptual change texts were enough sufficient for students to alter their conceptions.

4.8.2. Limitations

- The subjects of the conducted research were limited to eleventh grade students of a public high school.
- The research was restricted with only 108 students from four classes.
- The study was restricted with the unit of "solubility equilibrium".

CHAPTER 5

RESULTS AND CONCLUSIONS

This chapter includes the outcomesrevealed from the testing of the hypotheses declared in Chapter III. The significance level was set to 0.05for testing the hypotheses. MANCOVA, MANOVA and t-test were implemented to test the hypothesis. Statistical analyses were conducted with SPSS 16.00 (Statistical Package for Social Sciences) (Noruis, 1991).

5.1 Descriptive Statistics

Descriptive statistics of the solubility equlibrium concept pre- and post test scores, chemistry attıtudes pre- and post-test results and scıence process skills test resultsof the control and experimental groups were performed. Results were given in Table 5.1

Table 5.1 Descriptive Statistics Related to SECT, ASTC and SPST for both Control and Experimental Groups

Control Group

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
PreSECT	54	10	21	16,37	2,317	-,386	-,135
SECT	54	12	20	16,54	2,143	-,441	-,476
PreASTC	54	20	71	46,07	14,426	-,096	-1,154
ASTC	54	20	73	46,89	14,078	-,095	-1,052
SPST	54	15	34	30,11	3,367	,716	1,842

Experimental Group

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
PreSECT	54	10	20	16,94	2,184	-1,732	1,880
SECT	54	18	21	19,94	,712	-,572	,793
PreASTC	54	17	70	47,83	13,528	-,307	-,783
ASTC	54	20	70	48,41	12,772	-,202	-,788
SPST	54	26	35	30,76	2,163	,323	-,452

Solubility equilibrium concept test scores range from 10 to 21. If the scores are high, it can be said that greater understanding in solubility equilibrium concept and consequently more achievement in the concept occured. According to Table 5.1, pre-test and post-test results of the solubility equilibrium concept test indicates that the mean score increase is 3.00 in the experimental group while the mean score increase is 0.17 in the control group. The students in the experimental group were more successful and acquired more understanding in solubility equilibrium concept than students in the control group.

Attitudes scale toward chemistry scores range from 17 to 73 and higher scores means more positive attitudes toward chemistry. The mean scores of the ASTC in experimental group increases 0,58 points and the mean scores of the ASTC increases of 0.82 point in control group when comparing the pretest and post test scores of the students.

Science process skills test scores range from 15 to 35 and higher scores showthat abilities in solving science problems are higher. As given in Table 5.1, the mean score of SPST is 30.76 for experimental group and 30.11 for control group which means science process skills of the students are equal across groups.

The Table 5.1presents minimum, maximum, standard deviation, skewness, and kurtosis values of descriptive statistics. According to the kurtosis and skewness values shown in Table 5.1. it can be concluded that the normality of the distribution of variables can be acceptable in the study.

Table 5.2 Descriptive Statistics Related to SECT, ASTC and SPST for Male and Female

Gender		N	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
Female	PreSECT	51	12	21	17,25	1,874	-,614	,224
	SECT	51	12	20	16,96	1,990	-,673	-,166
	PreASTC	51	20	71	45,12	12,457	-,450	-,464
	ASTC	51	20	73	46,75	12,691	-,475	-,459
	SPST	51	15	35	28,33	3,508	-1,224	1,109
Male	PreSECT	57	10	20	16,60	1,963	-,921	1,293
	SECT	57	12	20	16,16	2,202	-,229	-,568
	PreASTC	57	17	70	44,12	14,691	,078	-1,175
	ASTC	57	20	70	45,86	13,887	,104	-1,061
	SPST	57	21	35	28,79	3,678	-,275	-,574

For boys and girls, descriptive statistics was given in Table 5.2. For females, mean of the preSECT score is a little bit high when compared tothe scores of males, which is 17.25 for females and 16.60 for males. Nevertheless, post-SECT mean score for boys and girls are almost equal, which are 16.96 and 16.16, respectively. Pre-attitude mean score for girls is slenderely higher than the girls score; it is 45.12 for boys; 44.12 for girls. Post-attitude test mean scores for boys is 45.86 and for girlsfound as, 46.75.

Assumptions of the Multivariate Analysis of Covariance (MANCOVA)

In order to apply MANCOVA, assumptions of MANCOVA were controlled for applicability. Multivariate normality was the first assumption checked. In order to control multivariate normality, skewness and Kurtosis values were calculated for dependent variables for both experimental and control groups. Table 5.1 and Table 5.2 gives the skewness and kurtosis values for post-achievement and post-attitude scores.Because values spread between +2 and -2, it indicates that data is normally distributed.

Box’s test was performed in order to check the second assumption which is homogeneity of covariance matrices. Given in the Table 5.3, Box’s test approved that the data validates this assumption (F=0.865, p>0.05).

Table 5.3 Box's Test of Equalıty of Covarıance Matrıces

Box's M	8,063
F	0,865
df1	9
df2	1,172E5
Sig.	0,556

Levene’s Test of Equality of Error Variances was also conducted. Given in the Table5.4, results revealed that this assumption was also met.p values were higher than 0.05; F=0929, p>0.05 for post-attıtude scores and F=0.362, p>0.05 for post-SECT scores.

Table 5.4 Levene's Test of Equality of Error Variances

	F	df1	df2	Sig.
ASTC	0,929	3	104	0,430
SECT	0,362	3	104	0,780

Homogeneity of slopes was also controlled for conducting MANCOVA. By controlling this assumption its been controlledifthe slopes of the covariate to the dependent variable are equal. Table 5.5 showes that mutual effectbetween fixed factors and covariate is not statistically significant for the post-SECT scores F=0.048, p>0.05 and similar for the post-ASTC scores F=0.04, p>0.05. According to the results, this assumption is met also.

Table 5.5 Evaluation of the Homogenity of Slopes Assumption

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power
Corrected Model	ASTC	551,992	3	183,997	1,023	,386	,029	3,069	,271
	SECT	17,575	3	5,858	1,298	,279	,036	3,895	,338
Intercept	ASTC	245912,676	1	245912,676	1,367E3	,000	,929	1367,136	1,000
	SECT	29510,223	1	29510,223	6,540E3	,000	,984	6539,980	1,000
Gender	ASTC	397,193	1	397,193	2,208	,140	,021	2,208	,313
	SECT	17,349	1	17,349	3,845	,053	,036	3,845	,493
Treatment	ASTC	145,621	1	145,621	,810	,370	,008	,810	,145
	SECT	,003	1	,003	,001	,981	,000	,001	,050
Gender * Treatment	ASTC	,648	1	,648	,004	,952	,000	,004	,050
	SECT	,217	1	,217	,048	,827	,000	,048	,055
Error	ASTC	18706,924	104	179,874					
	SECT	469,277	104	4,512					
Total	ASTC	264933,000	108						
	SECT	30022,000	108						
Corrected Total	ASTC	19258,917	107						
	SECT	486,852	107						

The final assumption, independency of observations was also validated because students contributed to the study worked alone through the instruments presented during the research.

After validating the assumptions, MANCOVA was conducted to test the hypotheses given in Chapter III. Significance level was set to 0.05 for all hypothesis.

5.2 Results of Testing Null Hypotheses

Prior to the instruction three pretests,which are SECT, ASTS and SPST, applied to all subjects and an independent t-test was used to determine whether there existed a statistically significant mean difference between the control and experimental groups with respect to their science process skills, prior knowledge in solubility equilibrium concepts and prior attitude toward chemistry as a school subject.

The pre-test results of the SECT, ASTS and SPST showed that there was no significant mean difference between the experimental and control groups before the treatment in terms of understanding of solubility equilibrium concept ($t=1,07$, $p>0.05$), attıtudes toward chemistry ($t=2,589$, $p>0.05$), science process skills ($t=12,44$, $p>0.05$).

5.2.1 Hypothesis 1

This hypothesis claimed that there is no significant mean difference between the post-test scores of the students taught with traditionally designed chemistry instruction and those taught with conceptual change text orıented instructıon with respect to achievement related to solubility equilibrium conceptand attitudes toward chemistry as a school subjectwas tested by using MANCOVA by controlling the effect of students' science process skills. Results of the studyweregiven in Table 5.6.

Table 5.6 MANCOVA Results

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Wilks' Lambda	,329	1,042E2	2,000	102,000	,000	,671
SPST	Wilks' Lambda	,940	3,299	2,000	102,000	,042	,060
Gender	Wilks' Lambda	,963	1,978	2,000	102,000	,144	,037
Treatment	Wilks' Lambda	,483	54,612	2,000	102,000	,000	,517
Gender * Treatment	Wilks' Lambda	,980	1,030	2,000	102,000	,361	,020

The results of the analyzed data revealed that a significant mean difference between the post-test scores of the experiment and control group regarding to students' understanding of solubility equilibrium concept (Wilks'λ=0.483, F: 54,612- p: 0,000) is observed. The partial eta-squared value; .517 indicates that about 52% of multivariate variance of dependent variables was associated with treatment.

5.2.2 Hypothesis 2

Hypothesis 2 which stated that there is no significant difference between the post-test mean scores of boys and girls in their comprehension of solubility equilibrium conceptand attitudes toward chemistry is analysed by MANCOVA when effect of students' science process skills is controlled as a covariate. Table 5.6 shows the effect of gender difference on students' understanding of solubility equilibrium concept. Results of the covariance analysis showed that there was no significant mean difference between boys and girls in terms of comprehension of solubility equilibrium concept (Wilks'λ=0.963, F: 1,978- p: 0,144).

5.2.3 Hypothesis 3

Hypothesis 3 claimed that there is no significant effect of interaction between gender and treatment regarding to students' understanding of solubility equilibrium concepts and attitudes toward chemistry as a school subject when the effect of students' science process skills is controlled as a covariate.MANCOVA results were given in Table 5.6. Results showed that there was no statistically importanteffect of interaction between gender and treatment on students' understanding of solubility equilibrium concepts concept (Wilks'λ=0.980, F: 1,030- p: 0,361).

5.2.4 Hypothesis 4

According to Hypothesis 4 there is no significant contrıbution of students' science process skills to their comprehension of solubility equilibrium concept. The statement was analysed with MANCOVA and according to the outcomes science process skills has an important effect on students' acquisition of concepts realted to solubility equilibrium (Wilks'λ=0.940, F: 3.279- p: 0,042).

5.2.5 Hypothesis 5

Hypothesis 5 which stated that there is no significant mean difference between students taught with conceptual change texts and students taught with traditional instruction is analysed by analysis of covariance (ANCOVA) which was conducted as a follow-up test to the MANCOVA. The results of ANCOVA are presented at the Table 5.7.

Table 5.7 Results of ANCOVA as follow-up test of MANCOVA

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	SECT	349,936	4	87,484	35,796	,000	,582
	ASTC	552,645	4	138,161	,761	,553	,029
Intercept	SECT	488,625	1	488,625	199,930	,000	,660
	ASTC	2460,913	1	2460,913	13,550	,000	,116
SPST	SECT	11,908	1	11,908	4,873	,030	,045
	ASTC	,653	1	,653	,004	,952	,000
Gender	SECT	4,776	1	4,776	1,954	,165	,019
	ASTC	393,321	1	393,321	2,166	,144	,021
Treatment	SECT	267,116	1	267,116	109,295	,000	,515
	ASTC	82,082	1	82,082	,452	,503	,004
Gender * Treatment	SECT	5,084	1	5,084	2,080	,152	,020
	ASTC	,664	1	,664	,004	,952	,000
Error	SECT	251,730	103	2,444			
	ASTC	18706,271	103	181,614			
Total	SECT	36682,000	108				
	ASTC	264933,000	108				
Corrected Total	SECT	601,667	107				
	ASTC	19258,917	107				

The null hypothesis is rejected at 0.05 significance level. According to this, analysis revealed that there was a significant effect of instruction on students' comprehension of solubility equilibrium concepts; $F = 109,295$, $p<0.05$, $\eta 2=0,515$.

Figure 5.1 represents the % of correct responses for the questions in the post-SECT conducted with both experimental and control groups. As it can be seen from the figure, there was substantive differences between the experimental and control group on several items of SECT in the favour of the experimental group especially in the students' answers to the questions 4, 9, 11, 14 and 16.

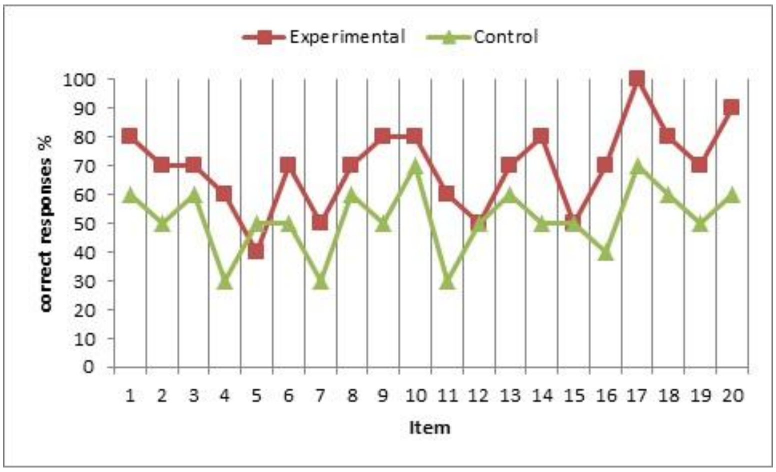


Figure 5.1 Comparison between post-SECT scores of the CCTI and the TDCI group.

5.2.6 Hypothesis 6

Hypothesis 6 claimed that there is no significant mean difference between males and females with respect to comprehension of solubility equilibrium concepts when students' science process skills are controlled as a covariate.By using ANOVA, this statement is tested and according to the concluded results presented in Table 5.7 no difference were detected amongboys and girlsregarding their acquisation of concepts of solubility equilıbrıum, (F:1,954- p:0,165, η2:0,019).

5.2.7 Hypothesis 7

Hypothesis 7 stated that there is no statistically important impact of interaction between gender difference and treatment with respect to students' comprehension of solubility equilibrium concepts. According to results in Table 5.7, mutual effect of gender and treatment is insignificant (F: 2,080- p:0,152- η2:0,020).

5.2.8 Hypothesis 8

Hypothesis 8 stated that there is no statistically important difference between post-test mean scores of the students taught with conceptual change texts oriented and those taught with traditionally designed chemistry instruction with respect to students' attitudes towards chemistry as a school subject when students' science process skills are controlled as a covariate.According to results in Table 5.7,instruction on attitude towards chemistry as a school subject has no statistically significant effect (F: 0,452- p:0,503- $\eta 2$:0,004).

5.2.9 Hypothesis 9

Hypothesis 9 stated that there is no significantdifference between post-test mean scores of boys and girls with respect to their attitudes towards chemistry when students' science process skills are controlled as a covariate. Results revealed thatthe posttest mean scoresof boys and girls with respect to their attitudes towards chemistry when students' science process skills are controlled as a covariate is not statistically different(F: 02,166- p:0,144- $\eta 2$:0,021).

5.2.10 Hypothesis 10

In this hypothesis it is stated that "There is no significant effect of interaction between gender difference and treatment with respect to students' attitudes towards chemistry when students' science process skills are controlled as a covariate." Results showed that interaction between gender and treatment has no significant effect (F: 0,004- p:0,952- $\eta 2$:0,000).

5.3 Conclusions

From acquired results of the conducted study the following conclusions can be deduced:

1. The CCTI induced better understanding of scientific conceptions related to solubility equilibrium concepts than TDCI.

2. Both CCTI and TDCI produced statistically same positive attitudes toward chemistry as a school subject.

3. Science process skillsis an importantforecaster for the success of students in concepts related to solubility equilibrium.

4. Treatment, gender difference and interaction between gender and treatment on students' achievement related to solubility equilibrium concepts has no significant effect.

5. Treatment, gender difference and interaction between gender and treatment on students' attitudes toward chemistry effect were insignificant.

CHAPTER VI

DISCUSSION, IMPLICATIONS, AND RECOMMENDATIONS

6.1 Discussion

The main aim of this conducted research was to compare the efficinecy of conceptual change text oriented instruction over traditional designed based chemistry teaching on eleventh grade students' perception of concepts related to solubility equilibrium and their attitudes toward chemistry as a school subject. Also efficiency of gender difference and science process skills on the students' conception of solubility equilibrium concepts, gender difference effects on students' attıtudes toward chemistry were investigated.

During constructing the cognition which is a dynamic cognitive operation, learner must make effort for applying conceptual change. Also previous conceptions seriously affect the process of learning. In addition, Read (2004) showed that teaching methods can aslo cause misconcepptions as far as correcting them.

Studies showed that, students' previous conceptions about the concepts being told plays a major role in understanding, more attention should be given to these misconceptions while preparing the curricula and teaching media. Conception of scientific subjects meaningfully is very important for reaching the aim of the programmed science instructions (Kiliç & Saglam, 2009). In order to succeed, this research investigated the efficiency of conceptual text change instruction on preventing students' misconceptions.

The literature review presented that misconception hinder learning;therefore, misconceptions should be taken very seriously and any effort should be made to remedy them. This is one of the reasons of conducting such a study in order to serve chemistry instruction. The presented study aimed to explore the efficiency of conceptual change texts oriented instruction on eleventh grade students' conception of solubılity equilıbrium concepts.

As indicated before, Solubility Equilibrium Concept Test was distributed to both groups as a pre and post test. Pre-test results showed that groups were indifferent in terms of solubility equilibrium. They were equal regarding their prior knowledge in solubility equilibrium concepts. Despite this, a statistically important difference was recorded between the post test results of the control and experimental groups. Conceptual change text oriented instructed group has higher scores than traditional design instructed ones. According the findings of the study it can be concluded that for constructing knowledge related to scientific concepts and removing misconceptions related to these, conceptual change text based instruction is very effective over traditional instruction.

In a study conducted by Sendur and Toprak, conceptual change texts were proven to beeffectivefor facilitating students' perception of alkenes (2013). In another study, the efficiency of conceptual change text instruction combined with discussion web tactics on students' understanding of human circulatory system concepts was investigated. Results of this research showed that conceptual change based learning coused a higher acquisation of human circulatory system concepts (Alkhawaldeh, 2013a).A study pursued by Alkhawaldeh investigated CCT and traditional instruction effect on teaching concepts of genetics on 10th grade students'. Results of the conducted study revealed that conceptual change text based instruction is also effective in introducing genetic concepts (Alkhawaldeh, 2013b).

Instruction based on conceptual change text requires asking questions by teacher in order to reveal and activate students' prior knowledge, as a first step. As the following step, until the students discover their various ideas about the concepts, discussions were carried out. These discussion sessions cause the students to link their existing knowledge with the newly introduced ones. This step was important for conceptual change because students become aware of that their previous knowledge is not sufficient for explaining the concepts being discussed. By focusing on students' incorrect ideas and discussing incorrectness of them, teacher directs questions and introduces real life examples in order to reach a higher acquisition of the concepts introduced during the lesson.

Then, students' misconceptions related to solubility equilibrium following by evidence that they are wrong are presented. It is explained to students that many students have several misconceptions like these. In addition, why students construct such alternative conceptions were also explained with correct scientific explanations. The learner must know what it means and easily understand the conception. Therefore, CCTs are prepared so that every student can easily understand and comprehend what is written. By this way, students realized that newly learned concepts were more efficient in interpreting the conditions. As a last step, the session of instruction ended with a query which involves the newly learned concept. Activities that involve presenting and developing ideas helped students to practice and strengthen the conceptual understanding.

In the traditionally instructed control group, teacher introduces concepts to inactive students that only listen and no discussions were involved in the lecture. Teacher also directed some questions, with out considering students previous knowledge, later described the correct answers. Traditional instruction does not take into account students' previous knowledge which can deeply affect the process of learning. As a result, different from experimental group, students were not given the opportunity to combine their previous conception with the newly introduced ones in order to make learning meaningful. If students were given the opportunity to remediate their misconceptions and construct appropriate knowledge, since students construct new knowledge by relating itwith already existing knowledge, they could be much more successful. If proper relationships are not formed, meaningful learning can not occur.

In this study, the relation between difference of gender and acquisation of solubility equilibrium concept is also investigated. As a result of investigation it was observed that gender difference has no major effect on solubility equilibrium concepts understanding. In other words, conceptual change approarch and traditional method do not differ significantly. This can be explained by the students from both groups showed similar attitudes which was measured during the study or by their similar chemistry backgrounds. We also investigated the effect of gender difference and treatment interaction on conception of solubility equilibrium. Results showed that gender and treatment interaction is not effective on solubility equilibrium concepts aquisation. Also, Çakır and his colleuges indicated that understanding of chemistry concepts was not influenced by interaction between gender and treatment (2002). In fact, conception of chemistry by students and their attıtudes toward chemıstry can be affected by many factors such as age; their perceptions change as they get older, teachers' sex, their interaction with teacher, teachers' interactions with students, their perceptions of the classroom environment, perceptions of the topic etc.That's why, there are also some studies reporting the contrary (Bunce & Gabel, 2002).

Also, effect of science process skills of the students' acquisition of solubility equilibrium concept analysed. SPST was given prior to the treatment to define if there was a divergence between the groups incly-uded to the study in terms of scıence process skills. Results of the study showed that higher science process skills effect the acquisition of solubility equilibrium concepts. A similar study was conducted by Çetingül & Geban. They investigated the influence of conceptual change based teaching on comprehension of acids and base concepts, also effect of gender and scıence proess skills were studied. Results of the study showed that science process skills influences comprehension of the concepts likewise the instruction method but gender difference has no consequence on acquisition of the acids and bases concepts (2011). Therefore,solubility equilibrium concept and instruction based on developing students' science process skills gains importance if enhancing students' understanding of solubility equilibrium is desired.

Attitudes of students after the treatment toward chemistry were investigated. Results of the EG and CG students revealed indifferent with respect to their attitude toward chemistry. In other words, after the treatment EG and CG students had similar attitudes toward chemistry. But from the results of the study it can obviously be seen that students in the EG achieved better when compared to students in the CGT in learning concepts related to solubility equilibrium. They became aware of their misconceptions and prior knowledge and had a more interactive lesson with teacher guided discussion sessions. All of these encouraging results should lead to a more positive attitude towards chemistry. Duration of the treatment application can cause this result. Due to the limited time of application EG students' attitude showed no significant differenciation, students might need more time to change their attitudes. But different conductedinvestigations showing the positive contribution of conceptual chagne text instruction to the attitude towards chemistry. In a study Ceylan & Geban enquired the efficiency of conceptual change based theory of learning on comprehensing chemical reactions and concepts of energy and theır attıtudes towards chemistry as a school subject. Results of the investigation revealed thatteaching methodology has positive contribution to both understanding concepts and attitudes of the students (2010). Gender also has no signifıcantly important effect on theirattitude toward chemıstry as a school subject. This can result from their education environment which they were equally treated.

To sum up, as a result of study it has been shown that students possess several misconceptions about solubility equilibrium concept and as a result of this have difficulty in learning these scientific phenomena. By implementing conceptual change text basedlecturing,improvedcomprehension of scientific concepts had been achieved.

6.2 Implications

The undermentioned implications can be concluded from the results of the conducted research:

Reviewed literature showed that a huge amount of studies were conducted regarding to the effect of misconceptions in students' cognitive development and their understanding of newly learned concepts. Conceptual change text method is presented as a good candidate for the remedy of misconceptions. Represented study supports these findings. According to the evaluated results it can be concluded that prior to starting lecturing a scientific concept, teachers should firstly identify students' prior knowledge and misconceptions regarding the subject and for remediation of these misconceptions implement CCT.

Conceptual change texts should be carefully designed in order to cover the instructed concept in details and for promoting easier lerning they could be visually supported by computer animations, simulations or various visual media files. Although students could be educated through conceptual change texts, these can not be solely enough to succeed. A well designed classroom is also crucial for promoting the debates which students could actively participate (Guzzetti et al., 1992; Hynd et al., 1994; Eryılmaz, 2002).

To conduct a resembling research, review of literature should be fully implemented and communicating with other researcher who conducted similer studies and benefit from their experiences could be usefull. Also by using some determined activities, the gap in the investigation of resembling studies soft spots could be filled.

6.3 Recommendations

Depending on the findings of this study, followings can be recommended:

Further researchs can be performed with a greaterstudy group coming from various schools.

A similar research can be performed with students with different ages and from different grades.

Same instructional method could be applied to otherdistinctive subjects of chemistry courses for validating the positive contribution in understanding chemistry concepts.

A similar study can be conducted for a longer period to see if the instructional method will make any difference in the attitudes of students after the treatment toward chemistry.

REFERENCES

Abraham, M. R., Williamson, V. M., & Westbrook, S. L. (1994). A cross-age study of understanding of five chemistry concepts. Journal of Research in Science Teaching, 31(2), 147-165.

Akpınar, B., Turan, M. & Tekataş, H. (2004).The Proficiency of Class Teachers from the Viewpoints of Prospective Teachers,Paper presented at the 13th National Educational Sciences Assembly. İnönü University. Turkey. July 6-9, 2004.

Alkhawaldeh, S. A. (2007). Facilitating conceptual change in ninth grade students' understanding of human circulatory system concepts, Research in Science & Technological Education, *25* (3), 371–385.

Alkhawaldeh, S. A. (2013a). Enhancing Ninth Grade Students' Understanding of Human Circulatory System Concepts Through Conceptual Change Approach.The European Journal of Social & Behavioural Sciences.

Al Khawaldeh, S. A. (2013b). Prediction/discussion-based learning cycle versus conceptual change text: comparative effects on students' understanding of genetics. Research in Science & Technological Education, 31(2), 168-183.

Al Khawaldeh, S. A. & Al Olaimat, A. M. (2009). The Contribution of Conceptual Change Texts Accompanied by Concept Mapping to Eleventh-Grade Students Understanding of Cellular Respiration Concepts, J Sci Educ Technol, DOI 10.1007/s10956-009-9185-z.

Anderson, R. C., & Pearson, P. D. (1984).A schema-theoretic view of basic processes in reading comprehension.Handbook of reading research, 1, 255-291.

Arena, P. (1996).The role of relevance in the acquisition of science process skills. Australian Science Teachers’ Journal, 42 (4), 24-38.

Austin, K., Orcutt, S., Rosso, J. (2001). How People Learn: Introduction to Learning Theories. The Learning Classroom: Theory into Practice. A Telecourse for Teacher Education and Professional Development.Stanford University School of Education.

Ayas, A., Karamustafaoğlu, S., Cerrah, L., & Karamustafaoğlu, O. (2001).Fen Bilimlerinde Öğrencilerdeki Kavram Anlama Seviyelerini ve Yanılgılarını Belirleme Yöntemleri Üzerine Bir İnceleme. Paper presented at the X. National Educational Sciences Conference, Abant Izzet Baysal University, Bolu, Turkey.

Barker, V. (2000). Beyond appearances: students’ misconceptions about basic chemical ideas. Royal Society of Chemistry, London.Retrieved August, 9, 2007.

Baser, M., & Geban, Ö. (2007).Effectiveness of conceptual change instruction on understanding of heat and temperature concepts.Research in science & technological education, 25(1), 115 – 133.

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

Bilgin, İ. & Karaduman, A. (2005).İşbirlikli öğrenmenin 8.sınıf öğrencilerinin fen dersine karşı tutumlarına etkisinin incelenmesi. İlköğretim-Online, 482), 32-45.

Bodner, G. M. (1991). I have found you an argument: The conceptual knowledge of beginning chemistry graduate students. Journal of Chemical Education, 68 (5), 385-388.

Bristow, B. R. (2000). The effects of hands-on instruction on 6th grade students’ understanding of electricity and magnetism. Dissertation abstracts international, 39 (01), 30A. (University Microfilms No. AAT1400301)

Brooks, J. G. and M. G. Brooks (1999). In Search of Understanding: The Case for Constructivist Classrooms. Alexandria, Association for Supervision and Curriculum Development.

Brotherton, P.N. & Preece, P.F.W. (1995). Science Process Skills: Their nature and interrelationships. Research in Science and Technological Education,13,1.

Brown, J. S., Collins, A., & Duguid, P. (1989).Situated cognition and the culture of learning. Educational Researcher, 18(1), 32-42.

Brown, I. & Story, E.L. (1979). Investigations of children's attitude towards science fostered by a field based science methods. Science Education,62 (1), 67-71.

Bruning, R. H., Schraw, G. J., & Ronning, R. R. (1999).Cognitive Psychology and Instruction. Upper Saddle River, NJ: Prentice-Hall.

Burns, J. C., Okey, J. R., & Wise, K. C. (1985). Development of an integrated process skill test: TIPS II. Journal of Research in Science Teaching, 22(2), 169-177.

Burr, N. (2003, January 30). Traditional Classroom vs. Constructivist Classroom. Retrieved October 17, 2009, from Johannes Gutenburg Universitat:http://www.fask.unimainz.de/user/kiraly/English/gruppe1/grundlagen_comparison.html

Calık, M., Ayas, A. & Coll, R. (2007). Enhancing pre-service elementary teachers' conceptual understanding of solution chemistry with conceptual change text, International Journal Of Science And Mathematics Education, 5, 1-28.

Camacho, M. & Good, R. (1989). Problem solving and chemical equilibrium: Successful vs. unsuccessful performance. Journal of Research in Science Teaching, 26 (3), 251-272.

Carey, S. (1985). Conceptual change in childhood (1st ed.). Cambridge, MA: MIT Press.

Carey, S. (1992). The origin and evolution of everyday concepts. In R.N. Giere (Ed.) Minnesota studies in the philosophy of science: Vol. XV. Cognitive models of science (pp.89-128). Minneapolis: University of Minnesota Press.

Carmichael, P., Driver, R., Holding, B., Phillips, I., Twigger, D., & Watts, M. (Eds.). (1990). Research on students' conceptions in science: A bibliography (1st ed.). Leeds, UK: Children's Learning in Science Research Group, University of Leeds.

Cetingul, I., & Geban, O. (2011).Using conceptual change texts wıth analogies for misconceptions in acids and bases. Hacettepe University Journal of Education, (41), 112-123.

Ceylan, E. (2004) Effect of Instruction Using Conceptual Change Strategies on Students' Conceptions of Chemical Reactions and Energy. Unpublished master thesis, Middle East Technical University Secondary Science and Mathematics Education, Ankara.

Ceylan, E. & Geban, O. (2010). Promoting Conceptual Change in Chemical Reactions and Energy Concepts through the Conceptual Change Oriented Instruction. Eğitim ve Bilim, 35 (157), 48-56.

Chang, C. (2002). Does computer assisted instruction + problem solving = Improved science outcomes? A pioneer study. Journal of Educational Research, 95 (3) 143-150.

Chi, M.T.H. (1992). Conceptual change within and across ontological categories: Examples from learning and discovery in science. In R.N. Giere (Ed.) Minnesota studies in the philosophy of science: Vol. XV. Cognitive models of science (pp. 129-186). Minneapolis: University of Minnesota Press.

Chiu, M., Chou, C. & Liu, C (2002). Dynamic processes of conceptual change: Analysis of constructing mental models of chemical equilibrium. Journal of Research in Science Teaching, 39 (8), 688-712.

Christie, A. (2005). Constructivism and its implications for educators.http://alicechristie.com/edtech/learning/constructivism/index.htm

Chu, C. K., & Hong, K. Y. (2010).Misconceptions in the teaching of chemistry in secondary schools in Singapore & Malaysia.

Cooperstein, Susan E., & ElizabethKocevar-Weidinger.(2004). Beyond active learning: A constructivist approach to learning.Reference Services Review 32 (2): 141-48.

Coştu, B., Ayas, A., Niaz, M. (2010).Promoting conceptual change in first year students' understanding of evaporation. Chemistry Education Research and Practice, 11, 5-16.

Çalık, M., & Ayas, A. (2005).A cross-age study on the understanding of chemical solutions and their components. International Education Journal, 6(1), 30-41.

Çelebi, Ö.(2004). Effect of Conceptual Change Oriented Instruction on Rempving Misconceptions About Phase Changes. Unpublished master thesis, Middle East Technical University Secondary Science and Mathematics Education, Ankara.

Davis, J. (2001). Conceptual Change.In M. Orey (Ed.), Emerging perspectives on learning, teaching, and technology.Retrieved 07/2013, from http://projects.coe.uga.edu/epltt.

Dewey, J. (1938).Experience and Education, Macmillan, New York, NY.

diSessa, A. (1993). Towards an epistemology of physics. Cognition and Instruction, 10, 105 – 225.

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

Driver, R., Squires, A., Rushworth, P., & Wood-Robinson, V. (1994). Making sense of secondary science: Research into children's ideas, London: Routledge.

Dreyfus, A., Jungwirth, E., & Eliovitch, R. (1990). Applying the "cognitive conflict" strategy for conceptual change—some implications, difficulties, and problems. Science Education, 74(5), 555-569.

Duffy, T., & Cunningham, D. (1996). Constructivism: Implications for the design and delivery of instruction. In Jonassen, D. H. (Ed.), Handbook of Research for Educational Communications and Technology, New York: Simon and Schuster, 170-198.

Duffy, T. M. & Jonassen, D. H. (1992). Constructivism: New implications for instructional technology. In T. M. Duffy & D. H. Jonassen (Eds.), Constructivism and the technology of instruction: A conversation (pp. 1-16). Hillsdale, NJ: Lawrence Erlbaum Associates.

Ebenezer, J. V., & Ericson, G. L. (1996). Chemistry students' conceptions of solubility: A phenomenography. Science Education, 79(1), 1-17.

Erdemir, A., Geban, Ö.,& Uzuntiryaki, E. (2000). Freshman students' misconceptions in chemical equilibrium. Hacettepe Universitesi Egitim Fakultesi Dergisi, 18, 79-84.

Eryılmaz A (2002). Effects of conceptual assingments and conceptual change discussion on students' misconceptions and achievement regarding force and motion. Journal of Research in Science Teaching, 31(10): 1001-1015.

Fetherstonhaugh, T., Treagust, D. F. (1992). Students' understanding of light and its properties: Teaching to engender conceptual change. Science Education, 76, 653-672.

Fishbein, M.,& Ajzen,I.,(1975). Belief, Attitude, Intention, and Behavior: an introduction to Theory and Research. Reading, MA: Addison-Wesley.

Fosnot, C. T. (1996). Constructivism: A psychological theory of learning. In C. T. Fosnot (Ed.). Constructivism: Theory, perspectives, and practice (pp. 8-33). New York: Teacher College Press.

Freedman, M.P. (1997).Relationships among laboratory instruction, attitude towardscience, and achievement in science knowledge. Journal of Research in ScienceTeaching, 34 (4), 343-357.

Haladyna, T., Olsen, R., & Shaughnessy, J. (1982).Relations of student, teacher, and learning environment variables to attitudes toward science. Science Education, 66, 671-687.

Hallidén, O., Petersson, G., Scheja, M., Ehrlén, K., Haglund, L., Österlind, K. & Stenlund, A. (2002).Situating the question of conceptual change.In M. Limón & L. Mason (Eds.).Reconsidering Conceptual Change: Issues in Theory and Practice (pp. 137 – 148). Amsterdam: Kluwer.

Harlen, W. (1999). Purposes and procedures for assessing science process skills.Assessment in Education,6, 129-144.

Harrison, A. G. & Treagust, D. F. (1996). Secondary students' mental models of atoms and molecules: Implications for teaching chemistry. Science Education, 80(5), 509-534.

Hewson, P. W. (1991). Conceptual change instruction. Paper presented at annual meeting, National Association for Research in Science Teaching, Fontana, WI.

Hewson, P. W. (1992). Conceptual change in science teaching and teacher education. In a meeting on “Research and Curriculum Development in Science Teaching,” under the auspices of the National Center for Educational Research, Documentation, and Assessment, Ministry for Education and Science, Madrid, Spain.

Hynd, C. (2001). Persuasion and its role in meeting educational goals.Theory into Practice, 40 (4), 270-277.

Gagne, R.M. (1985). The Conditions of Learning.Holt, Rinehart & Winston, New York, NY.

Garnett, Patrick J., Garnett, Pamela J., & Hackling, M.W. (1995). Students’ alternative conceptions in chemistry: A review of research and implication for teaching and learning. Studies in Science Education, 25, 69-95.

Gay, L. R. (1987). Educational research: Competencies for analysis and application. Columbus: Merrill Publishing Company.

Geban, O., Askar, P. & Ozkan, I. (1992). Effect of computer simulated experiments and problem solving approaches on high school students. Journal of Educational Research, 86(1), 5-10.

Geban, Ö., Ertepınar, H., Yılmaz, G., Altın, A. & Şahbaz, F. (1994). Bilgisayar destekli eğitimin öğrencilerin fen bilgisi başarılarına ve fen bilgisi ilgilerine etkisi. I. Ulusal Fen Bilimleri Eğitimi Sempozyumu: Bildiri Özetleri Kitabı, 1-2, 9 Eylül Üniversitesi, İzmir.

Gennaro, E. D. (1981). Assessing junior high students' understanding of density and solubility. School Science and Mathematics, 81(5), 399-404.

Good, T.L. and Brophy, J.E. (1994). Looking in Classrooms, HarperCollins College Publishers, New York, NY

Gentner, D., Brem, S., Ferguson, R. W., Markman, A. B., Levidow, B. B., Wolff, P. & Forbus, K. D. (1997). Analogical reasoning and conceptual change: A case study of Johannes Kepler. The Journal of the Learning Sciences. 6 (7), 3 – 40.

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

Gredler, M. E. (2005). Learning and Instruction: Theory into Practice. Upper Saddle River, N.J. : Pearson/Merrill Prentice Hall.

Griffiths, A.K. (1994). A critical analysis and synthesis of research on students' chemistry misconceptions, in Schmidt, H.-J. (ed.), Proceedings of the 1994 International Symposium Problem Solving and Misconceptions in Chemistry and Physics, pp. 70-99. ICASE [The International Council of Associations for Science Education] Publications.

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

Gussarsky, E., & Gorodetsky, M. (1990). On the concept of chemical equilibrium: The associative framework. Journal of Research in Science Teaching, 27(3): 197-204.

Guzzetti B, Snyder TE, Glass GV (1992). Promoting conceptual change in science: Can texts be used effectively? Journal of reading, 35(8): 642-649.

Guzzetti, B. J., Hynd, C. R., Skeels, S. A., & Williams, W. O. (1995). Improving high school physics texts: Students speak out, Journal of Reading,36, 656-663.

Guzzetti, B. J. (2000). Learning counter-intuitive science concepts: What have we learned from over decade of research?,Reading & Writing Quarterly, 16, 89–98.

Kind Vanessa. (2004). Beyond Appearances: Students' misconceptions about basic chemical ideas. 2nd Edition, School of Education, Durham University, UK.

Lazarowitz, S. M. R. (2002). Computer simulations in the high school: Students'cognitive stages, science process skills and academic achievement in microbiology.International Journal of Science Education, 24(8), 803-821.

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

May, J. M. & McMillan, J.H. (1979). A study of factors influencing attitudes towards science of junior high school students-Mexican american Pupils. Journal of Research in Science Teaching, 16(3), 197-198.

Mayer, R. E. (2002). Understanding conceptual change: A commentary. In M. Limón & L. Mason (Eds.).Reconsidering Conceptual Change: Issues in Theory and Practice (pp. 101 – 111). Amsterdam: Kluwer.

Mulford D. R., & Robinson W. R. (2002), An inventory for alternate conceptions among firstsemester general chemistry students. Journal of Chemical Education, 79, 739-744.

Mulholland, J. & Wallace, J. (1995). Knowing and learning about science and teaching in a setting: A narrative study. Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, San Francisco,April.

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

O'Connell, J. (2001). Salt Myths and Urban Legends. Retrieved from http://www.scbbqa.com/myths/Salt.html

Ormrod, J. (2009). Human Learning. Upper Saddle River: Pearson Prentice Hall.

Önder, I., & Geban, Ö. (2006). The Effect of Conceptual Change Texts Oriented Instruction on Students' Understanding of the Solubility Equilibrium Concept. Hacettepe University Journal of Education, 30, 166-173.

Özmen, H. (2008). Determination of students' alternative conceptions about chemical equilibrium: a review of research and the case of Turkey, Chemistry Education Research and Practice, 9, 225-233.

Özmen, H., Demircioglu H. & Demircioglu G. (2009). The effects of conceptual change texts accompanied with animations on overcoming 11th grade students' alternative conceptions of chemical bonding. Computers and Education, 52 (3), 681-695.

Padilla, J. M. (2004). The science process skills. http://www.educ.sfu.ca/narstsite/publication/research/ skill.htm [2004, November 14]

Palmer, D. (2001). Students' alternative conceptions and scientifically acceptable conceptions about gravity.International Journal of Science Education, *23*(7), 691–706.

Palmer, D. H. (2003).Investigating the relationship between refutational text and conceptual change.Science education, 87, 663-684.

Parker, V. (2000). Effects of a science intervention program on middle-grade studentachievement and attitudes. School Science and Mathematics, 100 (5), 236-242.

Pekmez, E. S. (2010). Using analogies to prevent misconceptions about chemical equilibrium. Asia-Pacific Forum on Science Learning and Teaching, 11(2), 1-35.

Pfundt, H. & Duit, R. (1991). Bibliography: Students' alternative frameworks and science education. IPN Reports in Brief, Germany: University of Kiel.

Pınarbaşı, T. & Canpolat, N. (2003).Students' understanding of solution chemistry concepts. Journal of Chemical Education, 80(11), 1328-1332.

Posner, G. J., Strike, K. A., Hewson, P. W., & Gertzog, W. A. (1982). Accommodation of a scientific conception: Toward a theory of conceptual change. Science Education, 66(2), 211-27.

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

Rapudi, M .A. (2004). The effect of cooperative learning on the development of learners' science process skills: a case study by Mashapa Alpheus Rapudi.

Read, J. R. (2004). Children's misconception and conceptual change in science education. Available from http://acell.chem.usyd.edu.au/Conceptual-Change.cfm

Resnick, L. B. (1986). Introduction. In L. B. Resnick (Ed.), Knowing, learning, and instruction: Essays in honor of Robert Glaser (pp.1-24). Hillsdale, NJ: Lawrence Erlbaum Associates.

Resnick, L. B. (1987). Learning in school and out. Educational Researcher, 16, 13-20.

Richardson, V. (1997). Constructivist teaching and teacher education: Theory and practice. In V. Richardson (Ed.), Constructivist teacher education.Building a world of new understandings (pp. 3-14). Washington, DC: Falmer Press.

Rumelhart, D.E. (1980). Schemata: The building blocks of cognition. In R.J. Spiro, B. C. Bruce, & W. F. Brewer (Eds.) Theoretical issues in reading comprehension: Perspectives and cognitive psychology, linguistics, artificial intelligence, and education (pp. 33-58). Hillside, NJ: Lawrence Erlbaum Associates, Inc.

Rumelhart, D.E. & Norman, D.A. (1981). Accretion, tuning and restructuring: Three models of learning. In J. W. Cotton & R. Klatzky (Eds.), Semantic factors in cognition (pp. 37-90). Hillside, NJ: Lawrence Erlbaum Associates, Inc.

Sendur, G. & Toprak, M. (2013).The role of conceptual change texts to improve students' understanding of alkenes.Chemistry Education Research and Practice.

Schafer, G. (1984). Teaching science out of school: With special reference to biology. Hamburg: International Union of Biological Sciences Commission for Biological Education.

Schank, R. (1997). Virtual learning: A revolutionary approach to building a highly skilled workforce. New York: McGraw-Hill.

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

Schuman, L. A. (1987). Plans and situated actions. New York: Cambridge University Press.

Scott, P., Asoko, H., & Driver, R. (1992). Teaching for conceptual change: A review of strategies. In R. Duit, F. Goldberg & H. Niedderer (Eds.), Research in Physics Learning: Theoretical Issues and Empirical Studies (pp. 310-329). Kiel, Germany: Institute for Science Education at the University of Kiel.

Sneider, C. I. & Ohadi, M. M. (1998).Unraveling students’ misconceptions about the Earth’s shape and gravity.Science Education. 82, 265 – 284.

Spada, H. (1994). Conceptual change or multiple representations?Learning and Instruction. 4, 113 – 116.

Spiro, R. J. (1980). Constructive processes in prose recall. In R.J. Spiro, B.C. Bruce & W. F. Brewer (Eds.) Theoretical issues in reading comprehension: Perspectives and cognitive psychology, linguistics, artificial intelligence, and education (pp. 245-278). Hillside, NJ: Lawrence Erlbaum Associates, Inc.

Taber, K. S. (1995a). Prior learning as an epistemological block?: The octet rule - An example from science education, paper presented at the European Conference on Educational Research, September 1995, University of Bath - available via Education-line, at http://www.leeds.ac.uk/educol/

Taber, K.S. (1997a). Understanding chemical bonding - The development of A level students' understanding of the concept of chemical bonding. Ph.D. thesis, University of Surrey.

Taber, K. S. (1997b). Student understanding of ionic bonding: Molecular versus electrostatic framework? School Science Review, 78, 85-95.

Taber, K. S. (1999a). Alternative conceptual frameworks in chemistry. Education in Chemistry, 36b(5)135-137.

Taber, K. (2000). Chemistry lessons for universities: a review of constructivist ideas. University Chemistry Education, 4(2), 63–72.

Taber, K. S. (2001). Constructing chemical concepts in the classroom?: Using research to inform practice. Chem. Educ. Res. Pract., 2(1), 43-51.

Taber, K. S. (2001a). Building the structural concepts of chemistry: Some considerations from educational research. Chemical Education: Research and Practice, 2, 123-158. [http://www.uoi.gr]

Taber, K. S. (2001b). The mismatch between assumed prior knowledge and the learners' conceptions: A typology of learning impediments. Educational Studies, 27 (2), 159-171.

Taber, K. & Coll, R. (2002).Bonding. In J. K. Gilbert, O. D. Jong, R. Justy, D. F., Treagust, & J. H. Van Driel (eds.), Chemical education: Towards research-based practice, pp. 213-234. Dordrecht: Kluwer.

Taşlı, İ. (2005). Examples of concept puzzles related to 4th –7th grade units of social sciences program, Journal of National Education, 166.

Taştan, Ö., Yalçınkaya, E. & Boz, Y. (2008). Effectiveness of conceptual change text-oriented instruction on students' understanding of energy in chemical reactions, Journal of Science Education & Technology, 17, 444–453.

Tekin, S., Colomuç, A., & Ayas, A. (2004). Can I Teach Solubility Concept Through Using Conceptual Change Texts More Effectively. J. Turkish Sci. Educ, 2(2).

Thirteen Ed Online (2004). Constructivism as a paradigm for teaching and learning. http://www.thirteen.org/edonline/concept2class/constructivism/index.html

Thomas, P. L., & Schwenz, R. W. (1998). College Physical Chemistry students' conceptions of equilibrium and fundamental thermodynamics. Journal of Research in Science Teaching, 35 (10), 1151-60.

Uzuntiryaki, E. (2003). Effectiveness of Constructivist Approach on Students' Understanding of Chemical Bonding Concepts. Phd Thesis. Middle East Technical University Secondary Science and Mathematics Education, Ankara.

Uzuntiryaki, E. & Geban, Ö. (2004). Promoting Students' Attitudes toward Chemistry Using Instruction Based on Constructivist Approach.European Association for Research on Learning and Instruction, 4th European Symposium Conceptual Change: Philosophical, Historical, Psychological, and Educational Approaches, Delphi, Greece.

Uzuntiryaki, E., & Geban, O. (2005). Effect of conceptual change approach accompanied with concept mapping on understanding of solution concepts. Instructional science, 33, 311-339.

von Glasersfeld, E. (1996). Introduction: Aspects of constructivism. In C. T. Fosnot (Ed.). Constructivism: Theory, perspectives, and practice (pp. 3-7). New York:

Teacher College Press.

Vosniadou, S. (1994). Capturing and modeling the process of conceptual change. Learning and instruction, 4(1), 45-69.

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

White, R.T., Tisher, R.P. (1986). Research in science education (Vol. 16). Papers from the annual conference of the Australian Science Educaion Research Association. Adelaide, South Australia: Australian Science Education Research Association.

Woolfolk, A. E. (2004). Educational Psychology (9th ed.). Needham Heights, MA: Allyn and Bacon.

Yavuz, A. (2005). Effectiveness of Conceptual Change Instruction Accompanied with Demonstrations and Computer Assisted Concept Mapping on Students' Understanding of Matter Concepts. Phd Thesis. Middle East Technical University Secondary Science and Mathematics Education, Ankara.

Yip, D. Y. (2004). Questioning skills for conceptual change in science instruction, Journal of Biological Education,38 (2), 76-83.

Yuruk, N. (2007). The Effect of Supplementing Instruction with Conceptual Change Texts on Students' Conceptions of Electrochemical Cells. Journal of science education and technology, 16, 515-523.

APPENDIX A

ÇÖZELTİLERDE DENGE TESTİ

Yönerge: Bu test sizin çözeltilerde denge konusundaki kavramları ne derecede öğrendiğinizi değerlendirmek için hazırlanmıştır. Testte toplam yirmi bir (21) tane çoktan seçmeli soru vardır.Her bir sorunun dört tane seçeneği ancak sadece bir tane doğru cevabı vardır. Soruları cevaplarken dikkatli olmanız ve cevapları cevap anahtarına işaretlemeniz gerekmektedir!

1)Çözünme denklemi verilen $Cu_3(PO_4)_2$'in çözünürlük çarpımı ($K_Ç$) için aşağıdakilerden hangisi doğrudur?

$Cu_3(PO_4)_{2\,(k)} \Leftrightarrow 3\,Cu^{+2}_{(suda)} + 2PO^{-3}_{4(suda)}$

A) $K_Ç = \dfrac{[Cu^{+2}]^3[PO^{-3}{}_4]^2}{[Cu_3(PO_4)_2]}$

B) $K_Ç = [Cu^{+2}]^3[PO^{-3}{}_4]^2$

C) $K_Ç = 3[Cu^{+2}]2[PO^{-3}{}_4]$

D) $K_Ç = \dfrac{[Cu^{+2}]\,[PO^{-3}{}_4]}{[Cu_3(PO_4)_2]}$

E) $K_Ç = [Cu^{+2}]^{+2}[PO^{-3}{}_4]^3$

2) Belirli bir sıcaklıkta AgI çözeltisi katısı ile dengededir.

$AgI_{(k)} \Leftrightarrow Ag^{+}_{(suda)} + I^{-}_{(suda)}$

Bu çözeltiye aynı sıcaklıkta bir miktar NaI eklendiğinde Ag^+ ve I^- iyonları derişimi nasıl değişir?

$[Ag^+]$	$[I^-]$	$K_{çç}$
A) Azalır	Artar	Değişmez
B) Değişmez	Artar	Artar
C) Azalır	Artar	Artar
D) Artar	Azalır	Değişmez
E) Azalır	Azalır	Azalır

3) 25^oC'de 9.09 gram $PbSO_4$ katısı 300 L suda çözünerek doygun olmayan $PbSO_4$ çözeltisi hazırlanıyor.Buna göre,

I. $PbSO_4$ katısının mol sayısı
II. $K_{çç}$
III. $[Pb^{+2}]$
IV. SO_4^{-2} iyonlarının mol sayısı

($PbSO_4$=303)

İfadelerinden hangileri hesaplanabilir?

A) Yalnız II B)III ve IV C) I ve III

D) I,III ve IV E)II,III ve IV

4) Sudaki çözünürlüğü 5.10^{-3} M olan XY_2 tuzunun aynı sıcaklıktaki çözünürlük çarpımı kaçtır?

A) 5.10^{-5} B) 5.10^{-6} C) 5.10^{-7} D) 5.10^{-9}
E) 5.10^{-12}

5) Suda çözünme tepkimesi

$PbI_{2(k)} \Leftrightarrow Pb^{+2}_{(suda)} + 2I^-_{(suda)}$

olarak verilen CaF_2 tuzunun,katısı ile dengede olan sulu çözeltisi ile ilgili,

I. Çökme hızı çözünme hızına eşittir.

II. $K_{çç}=[Pb^{+2}][I^-]^2$ dir.

III. $[Pb^{+2}]$ = s molar ise $K_{çç}=4s^3$ tür

yargılarından hangileri doğrudur?

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

E) I,II ve III

6) Aşağıdakilerden hangisi hidrojen klorürün(HCl) eşlenik bazıdır?

A) H_2O B) Cl^- C) H_3O^+ D) OH^- E) H^+

7) Verilen dengede proton veren tanecik veya tanecikler hangileridir?

$HClO_4 + H_2O \Leftrightarrow ClO_4^- + H_3O^+$

1 2 3 4

A) Yalnız 1 B) Yalnız 4 C) 1 ve 4

D) 2 ve 3 E) 1 ve 2

8) Sulu çözeltide gerçekleşen,

I. $OCl^- + H_2O \Leftrightarrow HOCl + OH^-$

II. $HClO_2 + H_2O \Leftrightarrow ClO^-_2 + H_3O^+$

III. $HF + H_2O \Leftrightarrow F^- + H_3O^+$

tepkimelerinin hangilerinde H_2O asit gibi davranmıştır?

A) Yalnız I B) Yalnız II C) Yalnız III

D) I ve II E) II ve III

9) pH=1 olan 200 ml HCl çözeltisiyle pH=13 olan kaç ml KOH çözeltisi tamamen nötürleşir?

A) 25 B) 50 C) 100 D) 200

E) 400

10) Bir bazın kuvvetini anlamak için aşağıdakilerden hangisinin bilinmesi yeterlidir?

I. derişiminin

II. yapısındaki hidroksit (OH) atomu sayısı

III. sudaki iyonlaşma yüzdesini

IV. pOH değerinin

A) Yalnız II B) Yalnız III C) II ve III

D) II ve IV E) I ve II

11) NH_3,CH_3COOH,H_2Omaddeleriyle ilgili olarak aşağıdaki ifadelerden hangisi veya hangileri doğrudur?

I.NH_3 yapısında H bulundurduğu için asittir.

II. CH_3COOH yapısında OH bulundurduğu için bazdır.

III.H_2O hem asit hem de baz olarak davranabilir.

IV.Eşit derişimli çözeltilerinde NH_3'ün pH değeri CH_3COOH'ün pH değerinden daha büyüktür.

A) Yalnız IV B) Yalnız III C) I ve II

D) III ve IV E) I, II ve III

12) 0.4 M NaBr çözeltisinde CuBr nin çözünürlüğü kaç molardır?

(CuBr için $K_{çç} = 4 \times 10^{-8}$)

A) 2×10^{-4} B) 2×10^{-7} C) 1×10^{-8}

D) 1×10^{-7}E) 4×10^{-8}

13) 0.2 M HX çözeltisinin pH değeri 2 dir.

HX in aynı sıcaklıktaki iyonlaşma yüzdesi kaçtır?

A) 5 B) 4 C) 3 D) 2 E) 1

14) Aşağıda bazı çözeltilerin derişimleri ve pH değerleri verilmiştir.

Derişim(M)	p(H)
I. 0.1	13
II. 0.1	5
III. 0.001	3
IV. 0.01	2
V 0.1	1

Bu çözeltilerden hangisi kuvvetli asit yada baz değildir?

A) I B) II C) III D) IV E) V

15) Aynı sıcaklıkta hazırlanan üç çözeltinin çözünen mol sayısı ve hacmi aşağıda verilmiştir.

1. 0.1 mol KOH içeren 1 L sulu çözelti

2. 0.1 mol AgOH içeren 1 L sulu çözelti

3. 0.1 mol HCl içeren 1 L sulu çözelti

Buna göre bu çözeltilerle ilgili,

I.İyonlaşma yüzdeleri 1=3>2 dir.

II. pH değerleri 1>2>3 tür.

III. Molar derişimleri 1=2=3 tür.

Yargılarından hangileri doğrudur?

(HCl: Kuvvetli asit, KOH: Kuvvetli baz, AgOH: Zayıf baz)

A) Yalnız III B) II ve III C) I ve II

D) I ve III E) I, II ve III

16) HNO_2nin t°C deki asitlik sabiti $K_a=1.10^{-5}$ tür.

Aynı sıcaklıktaki 0.1 M HNO_2 çözeltisinin pH değeri kaçtır?

A) 5 B) 4 C) 3
D) 2 E) 1

17) H^+ iyonları derişimi 10^{-2} M olan oda sıcaklığındaki sulu bir çözeltinin pOH değeri kaçtır?

A) 14 B) 12 C) 10 D) 2 E) 1

18) Durum Açıklama

I. $Q<K_{çç}$ Aşırı doymuş çözelti oluşur

II. $Q=K_{çç}$ Sistem dengededir

III. $Q>K_{çç}$ Çökelme olmaz

Yukarıdaki durumlardan hangilerinin karşısında verilen açıklamalar yanlıştır?

A) Yalnız I B) Yalnız II C) I ve III

D) I ve II E) I,II,III

19)

Baz K_b değeri 25°C

I. Dietil amin $(C_2H_5)_2NH$ 6.9. 10^{-4}

II. Amonyak (NH_3) 1.8.10^{-5}

III. Anilin$(C_5H_5NH_2)$ 7.4.10^{-10}

Yukarıdaki çizelgede bazı bazlar K_b değerleri ile birlikte verilmiştir.Bu değerlere göre eşit derişimli sulu çözeltiler için aşağıdaki eşitliklerden hangisi veya hangileri doğrudur?

a) Bazlık kuvvetleri I>II>III
b) Ayrışma oranları III>II>I
c) p H oranları I>II>III

A) Yalnız a B) Yalnız b C) a ve b

D) a ve c E) a,b,c

20) Belirli bir sıcaklıkta katısı ile dengede olan $X(OH)_2$ bazının çözünme denklemi,

$X(OH)_2(k) \leftrightarrow X^{+2}_{(suda)} + 2OH^-_{(suda)}$ ($\Delta H<0$)

Şeklindedir.Sıcaklığı arttırsak aşağıda verilen ifadelerden hangileri doğru olur?

I. $K_{çç}$ azalır
II. Çözünürlük (mol/L) azalır.
III. OH^- iyonu derişimi artar
IV. X^{+2} iyonu derişimi artar

A) Yalnız I B) Yalnız II C) I ve II

D) II ve III E) III ve IV

21) Aşağıdakilerden hangisinde verilen I.maddenin sulu çözeltisi II.maddenin sulu çözeltisine eklendiğinde eşdeğerlik noktasında pH>7 olur?

	I	II
A)	HCl	NaOH

B) CH_3COOH

NaOH

C) HCl

NH_3

D) HNO_3

KOH

E) HBr

NH_3

APPENDIX B

KİMYA DERSİ TUTUM ÖLÇEĞİ

Açıklama: Bu ölçek, kimya dersine ilişkin tutumunuzu ölçmek için hazırlanmıştır.

Her cümleyi dikkatle okuduktan sonra kendinize uygun seçeneği işaretleyiniz.

AD: SOYAD: SINIF:	TAMAMEN KATILIYORUM	KATILIYORUM	KARARSIZIM	KATILMIYORUM	HİÇ KATILMIYORUM
1.Kimya çok sevdiğim bir alandır.					
2. Kimya ile ilgili kitapları okumaktan hoşlanırım.					
3. Kimyanın günlük yaşantıda çok önemli bir yeri yoktur.					
4. Kimya ile ilgili ders problemleri çözmek hoşuma gider.					
5. Kimya konularıyla ilgili daha çok şey öğrenmek isterim.					
6. Kimya dersine girerken sıkıntı duyarım.					
7. Kimya dersine zevkle çalışırım.					
8. Kimya dersine ayrılan ders saatinin daha fazla olmasını isterim.					
9. Kimya dersine 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 anlaşılmasında önemlidir.					
13. Dersler içinde kimya dersi sevimsiz gelir.					
14. Kimya konularıyla ilgili tartışmaya katılmak cazip gelmez.					
15. Çalışma zamanımın önemli bir kısmını kimya dersine ayırmak isterim.					

APPENDIX C

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 kabiliyelerini 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 kaybettklerini 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 antreman süresini.

d. Yukarıdakilerin hepsini.

2. Arabaların verimliliğini inceleyen bir araştırma yapılmaktadır. Sınanan hipotez, benzine katılan bir katkı maddesinin arabaların verimliliğini arttırdığı 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 değşkenleri araştımaktadırlar.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 sebeblerini 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.

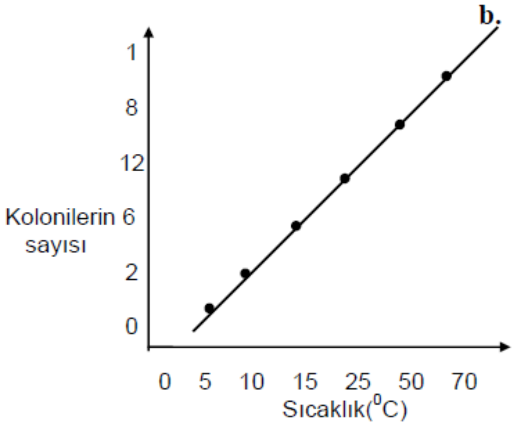
d. Isınma giderleri arttıkça ailenin daha ucuza ısınma yolları araması gerekir.

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

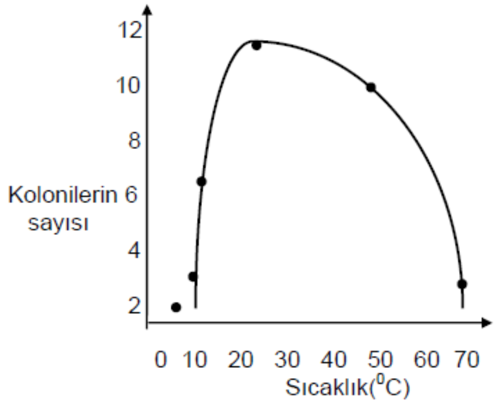
	Deney odasının sıcaklığı (^{0}C)	Bakteri kolonilerinin sayısı
5	0	
	10	2
	15	6

Aşağıdaki grafiklerden hangisi bu verileri doğru olarak göstermektedir?

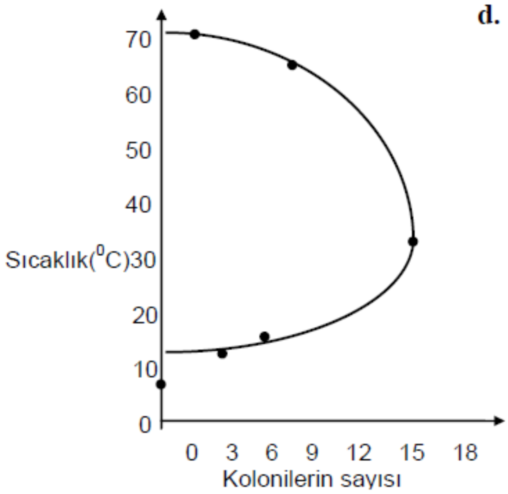
a.



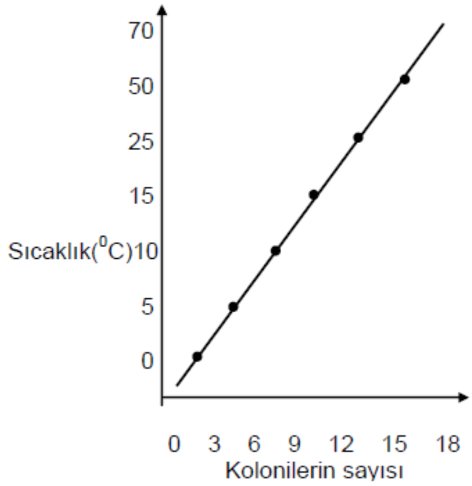
b.



c.



d.



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. Yollarde 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. Br oyuncak arabaya geniş yüzeyli tekerlekler takılır, önce bir rampadan (eğiik 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 genişlkleri 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?

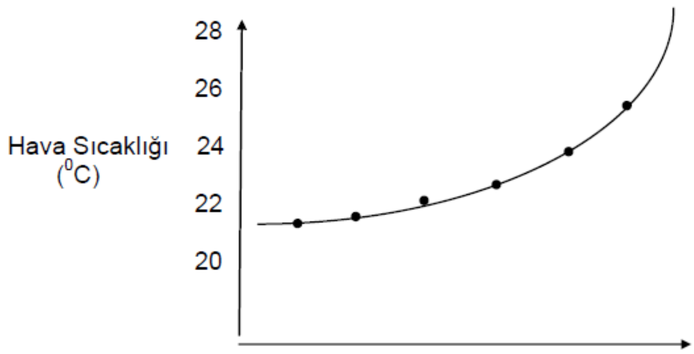
a. Tarlaya ne kadar çok gübre atılırsa, o kadar çok mısır elde edilir.

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 ilgli 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 ilşki yoktur.

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

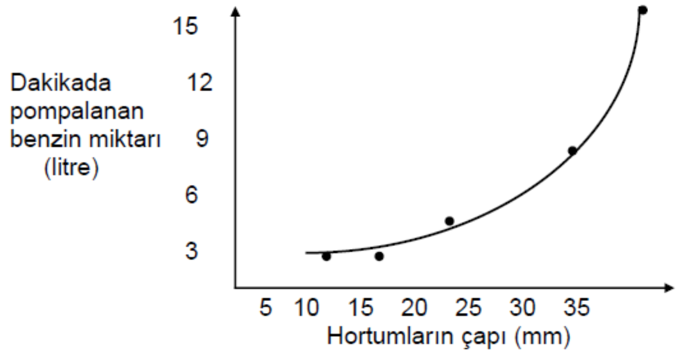
a. Topları aynı yükseklikten fakat değişik hızlarla yere vurur.

b. İçlerinde farlı 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.Bumlardan 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.Güneşfarklı maddelari 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 makinasıyla her hafta bir bahçedeki çimenleri biçer. Çimenlerin boyu bahçelere göre farklı olup bazılarında uzun bazılarında kısadır.Çimenlerin boyları ile ilgili hipotezler kurmaya nbaşlar.Aşağıdakilerden hangisi sınanmaya uygun bir hipotezdir?

a. Hava sıcakken çim biçmek zordur.

b. Bahçeye atılan gürenin miktarı önemlidir.

c. Daha çok sulanan bahçedeki çimenler daha uzun olur.

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

17, 18, 19 ve 20 nci 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. Kullanolan 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 liter soğuk su koyar ve 10 dakika süreyle ısıtır.Ebru, alevin meydana getirdiği ısı enerjisini nasıl öiçer?

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.

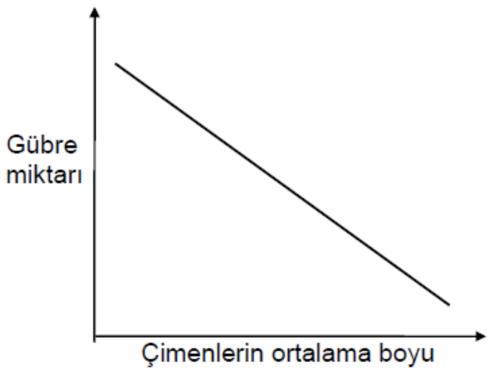
25. Bir araştırmacı yeni bir gübreyi denemektedir. Çalışmalarını aynı büyüklükte beş tarlad yapar. Her tarlaya yeni gübresinden değişik miktarlarda karıştırır.Bir ay sonra, her tarlada yetişen çimenin ortalama boyunu ölçer.Ölçüm sonuçları aşağıdaki tabloda verilmiştir.

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

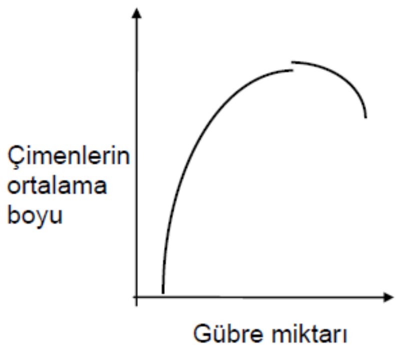
Tablodaki verilerin grafiği aşağıdakilerden hangisidir?

a.

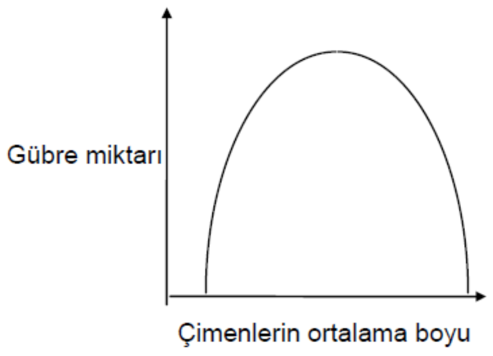
b.



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?

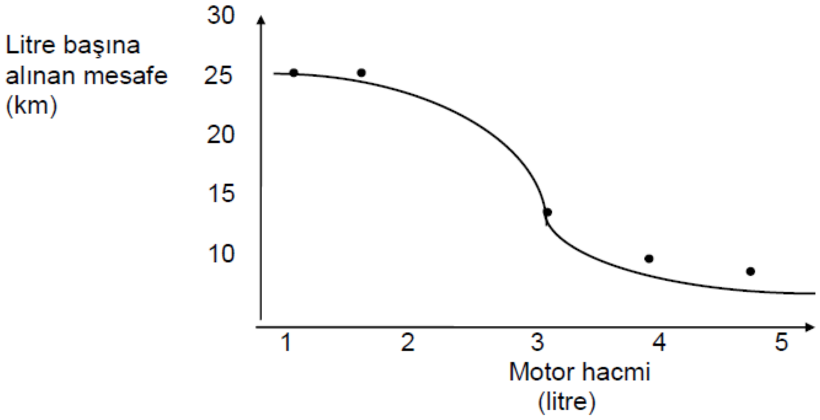
a. Daha fazla şekeri çözmek için daha fazla su gereklidir.

b. Su soğudukça, şekeri çözebilmek için daha fazl akarıştırmak gerekir.

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

d. Su ısındıkça şeker daha uzun sürede çözünür.

28. Bir araştıma grubu, değişik hacimli motorları olan arabalaıın randımanlarını ölçer. Elde edilen sonuçların garfiği 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 karıtırılan 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 torak miktarı.

d. Çürümüş yapak karıştırılan saksı sayısı.

31. Araştırmadaki bağımlı değişken hangisidir?

a. Her saksıdan elde edilen domates miktarı

b. Saksılara karıştırılan yaprak miktarı.

c. Saksılardaki torak miktarı.

d. Çürümüş yapak karıştırılan saksı sayısı.

32. Araştırmadaki bağımsız değişken hangisidir?

a. Her saksıdan elde edilen domates miktarı

b. Saksılara karıştırılan yaprak miktarı.

c. Saksılardaki torak miktarı.

d. Çürümüş yapak karıştırılan saksı sayısı.

33. Bir öğrenci mınatısların 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 üle.

b. Demir tozalrını çeken mıknatısın ağırlığı ile.

c. Kullanılan mıknatısın şekli ile.

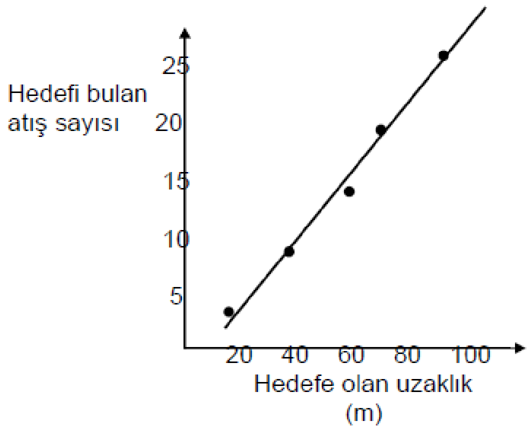
d. Çekilen demir tozlarının ağırlığı ile.

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

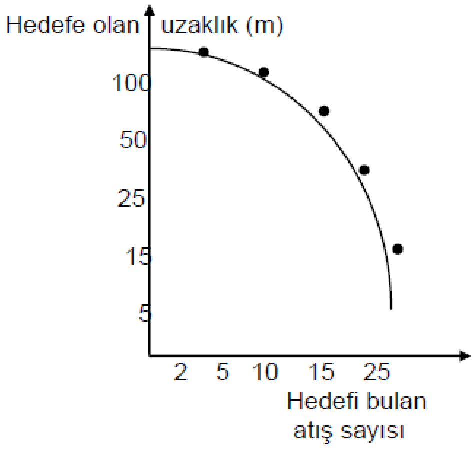
Mesafe(m)	Hedefe vuran atış sayısı
5	25
15	10
25	10
50	5
100	2

Aşağıdaki grafiklerden hangisi verilen bu verileri en iyi şekilde yansıtır?

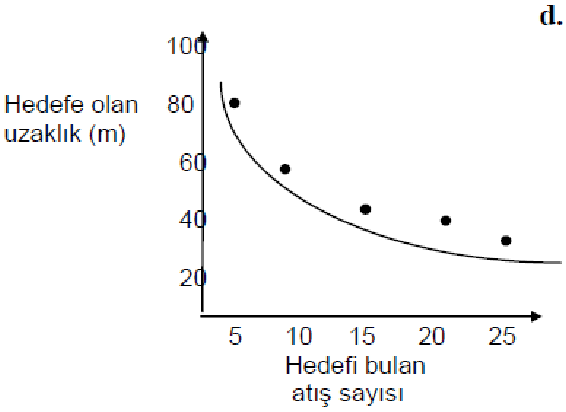
a.



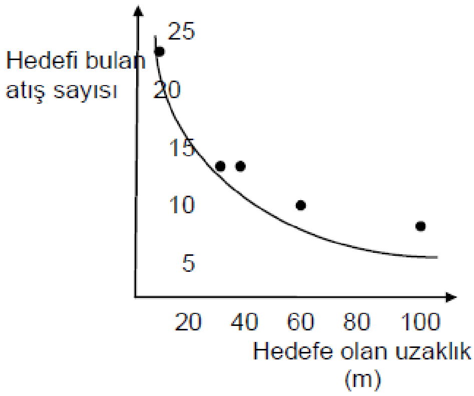
b.



c.



d.



35. Sibel, akvaryumdaki balıkların bazen çok haraketli 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. Su da 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 electrikli 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 D

AKTİVİTE 1

Katısı ile dengede olan Ag_2SO_4 çözeltisi için$K_{ÇÇ}$bağıntısının X cinsinden ifadesini nedir?

$Ag_2SO_{4\,(katı)} \Leftrightarrow 2Ag^{+}_{(suda)} + SO_4^{-2}{}_{(suda)}$ $K_{ÇÇ} = 1.6 \times 10^{-5}$

Not: $SO_4^{-2}{}_{(suda)}$ iyonunun derişimini X kabul ederek çözünüz

I. $K_{ÇÇ} = (2X)^2 . X$

II. $K_{ÇÇ} = X^2.X$

III. $K_{ÇÇ} = 2X.X$

Yazınları okumadan önce aşağıda boş bırakılan kısma cevabını ve nedenini yazınız.

....

....

....

……

……

…………………………………

Bazı öğrenci arkadaşlar Ag^{+} iyon derişimini SO_4^{-2} iyon derişiminin iki katı olarak düşünürler.Nitekim aranızda II denklemi seçen varsa bu kavram yanılgısına onlarda sahip olabilirler.II.denklemi seçenler eşitliği yanlış kurulmuştur çünkü her bir mol SO_4^{-2} iyonu oluşumu için iki mol Ag^{+} iyonu oluşmaktadır.Dolayısı ile Ag^{+} iyonu derişimi SO_4^{-2} iyon derişiminin iki katıdır ve aşağıdaki gibi bir eşitlikle ifade eldir.

$$\left[Ag^{+}\right] = 2\left[SO^{-2}{}_{4}\right]$$

Bazı öğrenci arkadaşlar tarafından yapılan diğer yanlışlık da çözünürlük çarpımı ($K_{çç}$) yazarken Ag^{+} derişimini SO_4^{-2} derişiminin iki katı olarak aldık, neden tekrar karesini alıyoruz diye düşünürler.Bu düşüncenin kaynağı denklemi denkleştirirken zaten derişimleride ayarlıyoruz yanılgısından kaynaklanmaktadır Aranızda III denklemi seçen varsa bu kavram yanılgısına onlarda sahip olabilirler.. $K_{çç}$ bağıntısı yazılırken Ag^{+} iyonu derşiminin karesini almamızın nedeni ise $K_{çç}$ bağıntısının tanımından gelmektedir.Yani çözünürlük çarpımı

$K_{çç}$ çözünürlük dengesinde yer alan iyonların molar derişimlerinin katsayıları üstel olarak yazıldıktan sonraki çarpımıdır.

DOĞRUSU nedir?$K_{çç}$ bağıntısı nasıl yazılır?

Yukarıda katısı ile dengede çözelti için $K_{çç}$ ifadesi

$K_{çç}$= $\left[Ag^{\wedge+}\right]^2 . \left[SO^{-2}{}_4\right]$ şeklinde olur. $K_{çç}$ = $(2X)^2 . X$

AKTİVİTE 2

Belirli bir sıcaklıkta katısı ile dengede olan $PbCl_2$ çözeltisinin çözünürlük çarpımı $K_{çç}$ ifadesi aşağıdakilerden hangisi gibi olur?

$$PbCl_2 \Leftrightarrow Pb^{+2}_{(suda)} + 2Cl^{-}_{(suda)}$$

I. $K_{çç} = \frac{[Pb^{+2}]\,[Cl^{-}]}{[PbCl_2]}$

II. $K_{çç} = \frac{[Pb^{+2}]\,[Cl^{-}]^2}{[PbCl_2]}$

III. $K_{çç} = [Pb^{+2}]\,[Cl^{-}]^2$

IV. $K_{çç} = [Pb^{+2}]\,2[Cl^{-}]$

Yazınları okumadan önce aşağıda boş bırakılan kısma cevabını ve nedenini yazınız.

……

……

……

……

…………………………………………………………………………

I ve II denklemi seçen varsa kimyasal reaksiyonlarda denge bağıntısını yazarken, ürünlerin derişiminin girenlerin derişimine bölerek yazıldığını anımsamalarından dolayıdır.Fakat genelde öğretmenler ve kitaplar örneklerini gaz tepkimelerinden oluşturduğu için öğrenci arkadaşlarımız $K_{çç}$ denklemine katıları da yazma yanılgısına düşmektedir.Oysa denge bağıntısı yazılırken katıların derişimi ALINMAZ.Çünkü katıların miktarındaki azalma hacmindeki azalma ile doğru orantılı olduğu için katıların derişimi değişmeyecektir.

DOĞRUSU nedir?$K_{çç}$ bağıntısı nasıl yazılır?

$$PbCl_2 \Leftrightarrow Pb^{+2}_{(suda)} + 2Cl^{-}_{(suda)}$$

Bu denge tepkimesinin denge sabiti

$$K_c = \frac{\left[Pb^{+2}\right]\left[Cl^{-}\right]^2}{\left[PbCl_2\right]}$$ şeklindedir.

Bu denge ifadesinden $K_c\left[PbCl_2\right] = \left[Pb^{+2}\right]\left[Cl^{-}\right]^2$ bulunur.Hem K_c hem de $PbCl_2$ katısının derişimi sabit olduğundan,iki sabit sayının çarpımı yine sabit bir sayı olacaktır.Dolayısı ile yeni ifade, $K_c \,.\left[PbCl_2\right] = K_{çç} = \left[Pb^{+2}\right]\left[Cl^{-}\right]^2$ şeklinde yazılır ve BELİRLİ bir SICAKLIKTA böyle hesaplanır.Kimyasal reaksiyonlarda çözünürlük çarpımı sabiti yazılırken KATILAR DAHİL EDİLMEZ. Çözünürlük çarpımı ($K_{çç}$)çözünürlük dengesinde yer alan iyonların molar derişimlerinin katsayıları üstel olarak yazıldıktan sonraki çarpımıdır.$PbCl_2$ katısının çözünmesine ilişkin çözünürlük sabiti $K_{çç} = \left[Pb^{+2}\right]\left[Cl^{-}\right]^2$ ile bulunur.

AKTİVİTE 3

$NaOH_{(suda)} + HCl_{(suda)} \rightarrow NaCl_{(suda)} + H_2O_{(s)}$

Reaksiyonunda olduğu gibi kuvvetli bir baz olan NaOH ile kuvvetli bir asit olan HCl eşdeğer miktarlarda karıştırıldığında ortamda hangi iyonlar bulunur? Bu iyonlar ortamın pH değerini etkiler mi?Zayıf asitlerin kuvvetli bazlarla veya kuvvetli asitlerin zayıf bazlarla olan eşdeğer karışımlarında ph=7 olabilir mi?

Yazınları okumadan önce aşağıda boş bırakılan kısma cevabını ve nedenini yazınız.

……
……
……
…

HCl ve NaOH bileşiklerinin her ikisi de kuvvetli olup suda tamamen iyonlaşırlar.Her iki çözeltinin eşit derişimlerindeki H^+ ve OH^- iyonları birbirlerini nötürleştirecektir.Yani nötürleşme tepkimesinin eşdeğerlik noktasında pH= 7 olur.

$2NaOH_{(suda)} + H_2SO_{4(suda)} \leftrightarrow Na_2SO_{4(suda)} + H_2O$

Peki reaksiyonunda olduğu gibi kuvvetli bir baz olan NaOH ile kuvvetli ir asit olan H_2SO_4 çözeltilerinde eşit mol sayılarında karıştırdığımızda notr çözelti elde edilir mi?

Yazınları okumadan önce aşağıda boş bırakılan kısma cevabını ve nedenini yazınız. 

………

………

…………………………………

NaOH çözeltisinde 1 mol OH^- iyonu H_2SO_4 çözeltisinden 2 mol H^+ iyonu oluşacağı için karışım tam nötrleşemez.Bu yüzden NaOH çözeltisinden 2 mol içeren çözelti alınmalıdır.Böylece nötrleşme tepkimelerinde asit ve bazın tesir değerliği de önemlidir.Nötrleşme tepkimeleri için

$M_A.V_A.T_A = M_B.V_B.T_B$ olmalıdır.

M_A : Asidin molaritesi, V_A:Asidin hacmi, TA:Asidin tesir değeliği

Derelerin ırmaklara, ırmakların denizlere karışması yani derenin ırmaklaşması veya ırmağın denizleşmesi asit baz tepkimelerine uyarlanabilir.Eğer kuvvetli bir baza eşdeğer miktarda zayıf bir asit eklenirse, kuvvetli baz zayıf asitten dağa fazla iyonlaşacağı için ortamda H^+ iyonlarından daha fazla OH^- iyonları olacaktır.Bu durumda ortamdaki bütün H^+ iyonları eşit sayıdaki OH^- iyonları tarafından nötralize edilecektir.Kuvvetli baz zayıf aside göre daha fazla iyonlaştığı için ortamda OH^- iyonu kalacağı için oluşan çözelti bazik özellik gösterir.Örneğin eşdeğer miktarda CH_3COOH ve NaOH karışımında pH 7 olur.Aynı şekilde zayıf bir baz çözeltisine eşdeğer miktarda kuvvetli bir asit eklendiğinde H^+ iyonlarının bir kısmı OH^- nötrleştirdikten sonra ortamda H^+ iyonları kalacağı için çözelti asidik özellik gösterir.Örneğin eşdeğer miktarda HCl ve NH_3 karışımda pH 7 den küçük olur.

Bazı bitkiler toprağın pH ına göre farklı renkte çiçek verir.Örneğin asitli topraklarda sadece mavi çiçekli ortanca yetişirken nötr veya bazik topraklarda pembe çiçekli ortanca yetişir.Asitli topraklarda yetişen mavi çiçekli ortancanın pembe çiçekli olmasını isteyen çiftçi toprağa bazik olan kireç tozu serperek toprağın asitliğini azaltır.

AKTİVİTE 4

CH_3COOH,$HCOOH$,NH_3,PH_3gibi maddelerin hangileri asit,hangileri bazdır?Yapısında H^+ iyonu bulunduran her maddeyi asit,OH^- bulunduran her maddeyi baz diye tanımlamak doğrumudur?H_2O sadece çözücümüdür? Hem asit hem baz gibi davranabilir mi?

Yazınları okumadan önce aşağıda boş bırakılan kısma cevabını ve nedenini yazınız.

……

……

……

……

…………………………………………………………………………

Bu tepkimelerin ilk ikisi asit son ikisi ise tepkimelerde baz özellik gösterir.Örneğin,

I.$CH_3COOH_{(suda)} + H_2O_{(s)} \leftrightarrow CH_3COO^-_{(suda)} + H_3O^+(suda)$

ASİT1 BAZ2BAZ1ASİT2

II. $NH_{3(suda)} + H_2O_{(s)} \leftrightarrow NH^+_{4suda)} + OH^-_{(suda)}$

BAZ1 ASİT2ASİT1BAZ2

Bronsted-Lowry asit-baz tanımına göre proton veren(H^+) madde asit, proton alan madde bazdır.

I.reaksiyonda ileri yönde CH_3COOH proton verdiği için asit,H_2O ise proton aldığı için bazdır.Geri yönde CH_3COO^-proton aldığı için baz, H_3O^+ proton verdiği için asittir.

II.reaksiyonda ileri yönde NH_3 proton aldığı için baz, H_2O proton verdiği için bazdır.Geri yönde ise NH^+_4 proton verdiği için baz, OH^- proton aldığı için bazdır.

Dikkat ederseniz H_2OI. tepkimde baz, II.tepkimede ise asittir.Yani

H_2Osadece çözücü olmakla kalmayıp tepkimelerde asit ve baz gibi davranabilmektedir.

Bronsted-Lowry tanımına göre CH_3COOH/CH_3COO^-ve H_2O/H_3O^+ gibi çiftlere eşlenik(konjuge) asit-baz çifti denir.

AKTİVİTE 5

Herhangi bir asidin derişimi değiştikçe ayrışma yüzdesi bundan nasıl etkilenir? 10^{-1}M HCN ile 10^{-3} M HCN ’den hangisinin ayrışma yüzdesi daha çoktur?

Yazınları okumadan önce aşağıda boş bırakılan kısma cevabını ve nedenini yazınız.

……

……

……

…

Zayıf bir asit olan HCN ise suda tam olarak iyonlarına ayrışmaz.HCN’nin ne kadarının iyonlaştığını gösteren asitlik sabiti $K_a = 4.9.10^{-10}$ dur.

$HCN_{(suda)} \Leftrightarrow H^{+}_{(suda)} + CN^{-}_{(suda)}$

Başlangıç (M) :	0,1	0	0
Değişme (M):	-x	+x	+x
Dengede (M):	0,1-x	x	x

$$K_a = \frac{[H^+]\,[CN^-]}{[HCN]}$$

HCN çok az iyonlaştığı göre x, 0.1’den çok küçük bir değer olmalıdır ve 0.1’in yanında ihmal edilir.0.1-x $\cong$ 0.1 alınır.

$K_a = \frac{(x).(x)}{0.1-x}$, $4.9.10^{-10} = \frac{x^2}{0.1}$, $x=7.10^{-6}$, pH= $-\log(7.10^{-6})$, pH_1= 5.15

0.1M HCN'den 7.10^{-6} iyonlaştı ise

100M X

X=%0.007 iyonlaşır.

Aynı hesaplamaları 10^{-3} M HCN için tekrar edersek $x=7.10^{-7}$ çıkar, pH_2=6.15

0.001M HCN'den 7.10^{-7} iyonlaştı ise

100M X

X=%0.07 iyonlaşır.

Asidin derişimi artıkça,asid daha az iyonlaşacağından ortamdaki H^+iyonları azalacaktır. H^+iyonu derişiminin azalması,pH değerinin artması yani asidin şiddetin azalması anlamına gelmektedir.pH 0'a yaklaşırsa asitlik kuvveti artar,pH 14'e yaklaşırsa bazlık kuvveti artar. Görüldüğü gibi,10^{-1} M HCN daha düşük pH değerine sahiptir ve daha asidiktir.

Sonuç olarak asitin derişimi artıkça ayrışma yüzdesi azalır.

Benzer durum bazlar içinde geçerlidir.

1M $(C_2H_5)_2NH$ (dietil amin),0.5 M dietil amine göre daha az iyonlaşır.1M dietil amin daha az iyonlaştığından,ortamdaki OH^- derişimi 0.5M dietil amine göre daha az olacaktır.OH^- iyonunun derişimin azalması p OH değerinin artması yani bazın şiddetini artıracağından 1M   dietil amin,0.5 M dietil amine göre daha baziktir.

Sonuç olarak bazın derişimi artıkça ayrışma yüzdesi azalır

AKTİVİTE 6

Asitlik sabitinin büyüklüğü artıkça asidin şiddeti azalır mı,artar mı?0.1 M CH_3COOH mı daha asidiktir,0.1 M HCN mi?($K_{CH3COOH}$=1.8.10^{-5},K_{HCN}=4.9.10^{-10})

Yazınları okumadan önce aşağıda boş bırakılan kısma cevabını ve nedenini yazınız.

………

………

………

…

CH_3COOH'ın pH'ını hesaplayalım.

$CH_3COOH_{(suda)} \Leftrightarrow H^+_{(suda)} + CN^-_{(suda)}$

Başlangıç (M) :	0,1	0	0
Değişme (M):	-x	+x	+x
Dengede (M):	0,1-x	x	x

CH_3COOH çok az iyonlaştığı göre x, 0.1'den çok küçük bir değer olmalıdır ve 0.1'in yanında ihmal edilir.0.1-x$\cong$0.1 alınır.

$K_a = \frac{(x).(x)}{0.1-x}$, $1.8.10^{-5} = \frac{x^2}{0.1}$, x=1.3.$10^{-3}$, pH= -log(1.3.$10^{-3}$), pH=2.89

HCN'nin pH'ını hesaplayalım.

$HCN_{(suda)} \Leftrightarrow H^+_{(suda)} + CN^-_{(suda)}$

Başlangıç (M) :	0,1	0	0
Değişme (M):	-x	+x	+x
Dengede (M):	0,1-x	x	x

$K_a = \frac{[H^+][CN^-]}{[HCN]}$

$K_a = \frac{(x).(x)}{0.1-x}$, $4.9.10^{-10} = \frac{x^2}{0.1}$, $x=7.10^{-6}$, pH= -log(7.10^{-6}), pH= 5.15

0.1 M CH_3COOH,0.1M HCN'ye göre daha asidiktir.Asitlik sabiti artıkça,asit daha çok iyonlaşacağından ortamdaki H^+iyonu derişimi artacaktır.Ortamdaki H^+ iyonu derişimi arttığı zaman pH daha küçük bir değer alır, dolayısıyla daha asidik olur.

K_a değeri ne kadar küçükse asit o kadar zayıftır.

Benzer durumu bazlara uyarlarsak K_b değeri artıkça,baz daha çok iyonlaşacağından ortamdaki OH^-iyonu derişimi artacaktır.Ortamdaki OH^- iyonu derişimi arttığı zaman, p OH daha küçük bir değer alır,dolayısı ile daha az bazik olur.

K_b değeri ne kadar küçükse baz o kadar kuvvetlidir.

AKTİVİTE 7

Doymamış çözeltilerde $K_{\text{çç}}$'den bahsedilebilir mi?

Yazınları okumadan önce aşağıda boş bırakılan kısma cevabını ve nedenini yazınız. 

………

………

………

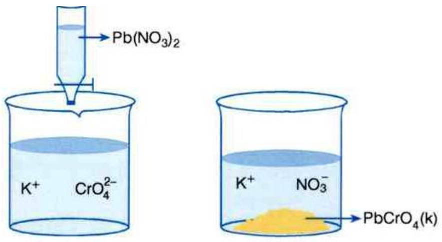
…

$K_{\text{çç}}$ dengede olan bir çözeltinin iyon derişimlerinin katsayısı üstel olarak yazıldıktan sonraki çarpımıdır.Doymamış bir çözeltide denge durumdan bahsedemeyiz.Bu nedenle $K_{\text{çç}}$ hesaplaması yapamayız.Kimya test kitaplarında sorular genelde belirli bir sıcaklıktaki doymuş çözeltiler için sorulduğundan dolayı,bazı öğrenciler doymamış çözeltilerde de $K_{\text{çç}}$ değerinin hesaplanabileceği kavram yanılgısına düşmektedirler.

O zaman biz doymamış çözetlilerde iyon derişimi çarpımı ile neyi hesaplıyoruz?İyon çarpımı(Q) ile $K_{\text{çç'yi}}$ karşılaştırarak,denge reaksiyonun hangi yöne yürüyeceğini tayin edeceğimiz değeri hesaplamış oluyoruz.Q değeri çözeltilerin karıştırılması anında çökecek iyonların derişimleri $K_{\text{çç}}$ bağıntısında yerine konarak hesaplanır.

İki elektrolit çözelti karıştırıldığında iyon derişimlerine bağlı olarak bir katının oluşup sıvı fazdan ayrılmasına çökelme,bu katıya çökelek denir,bu tür reaksiyonlara ise çökelme reaksiyonları denir.

Örneğin $Pb(NO_3)_2$ çözeltisiyle K_2CrO_4 çözeltisini karıştıralım.Karıştırma sonucunda suda az çözünen $PbCrO_4$ bileşiği oluşur ve az çözündüğünden çöker.Suda çok çözünen KNO_3 tuzu ise çözeltide iyonlaşmış halde kalır.K^+ ve NO_3^- iyonları çökelmeye katılmaz.Bu iyonlara seyirci iyonlar denir.Olaya ilişkin tepkimeler şöyledir.



Şekil - 1 Şekil - 2

İyon denklemi:

$$Pb^{+2}_{(suda)} + 2NO_3^-{}_{(suda)} + 2K^+_{(suda)} + CrO_4^{2-}{}_{(suda)} \rightarrow PbCrO_{4(k)} + 2K^+_{(suda)} + 2NO_3^-{}_{(suda)}$$

↓

çöker

Net tepkime ise,

$$Pb^{2+}(suda) + CrO_4^{2-}(suda) \rightleftharpoons PbCrO_4(k)$$

İki elektrolit çözelti karıştırıldığında dengenin hangi yöne yürüyeceğini tahmin etmek için ise üç durum oluşur.

1.Durum($Q< K_{çç}$): İyonların derişimleri yeterli olmadığından herhangi bir çökelme olmaz.Çözeltide katı varsa $Q= K_{çç}$ olana kadar çözünür.Çözeltide katı yoksa çökme olmaz ve denge yoktur.

2.Durum($Q= K_{çç}$):Bu çözelti doymuştur ve ve sistem dengededir.Çökme ve çözünme hızı birbirine eşittir.

3.Durum ($Q > K_{çç}$):Bu çözelti aşırı doymuştur.Sistem dengede değildir.Q değerinin küçülmesi gerekir.Bunun içinde iyonların bir kısmı $Q = K_{çç}$ oluncaya kadar çöker.Son durumda katısı ile dengede çözelti oluşur.

APPENDIX E

SAMPLE LESSON PLAN

Before starting each lesson, every student from experimental group, received conceptual change texts. By this way, every student before the lesson received related conceptual change texts. They were encouraged to read these texts at home before the lessons. While starting the lessons, instructor directed several queriesaiming to activate their previous knowledge and ideas. Moreover, it was aimed students to realize their pre owned misconceptions. In other words, conflicting situations were presented to make students realize that alternative conceptions they have do not work anymore. This is compatible with Posner's first condition (Posner et al. 1982). It was indicated that in order to achieve conceptual change, first of all there must be dissatisfaction with existing conception since students do not easily accept new conceptions.

Teacher told students to read conceptual change texts individually. The teacher waited until all the students finished reading and asked whether everybody understood what is written in conceptual change texts. Then, groups were formed where each group was containing 4 or 5 students. The groups were made heterogeneous in terms of chemistry achievement by placing students with same chemistry achievement in different groups. In other words, each group was containing students with different chemistry achievement in order to prevent forming groups that are consisted of students with all high ability or low ability. Therefore every group had an opportunity to realize different explanations to the situations given. Each group went on conceptual change texts and discussed the conflicting situation written in these texts. During the discussion, teacher encouraged each student to participate discussions in order to prevent domination of discussions by one or few students. By this way,each student in the group explained their ideas and thoughts related to conflicting situation.

Than, students would realize that every student has different explanations to same concept. After the discussions each group was supposed to give a common answer to the teacher. This complies with Posner et al's (1982) second condition for conceptual change. It was indicated that a new conception must be intelligible. In other words, students should understand what the new conception means. Therefore, within group discussions could help students to understand what the concept means and could explain it with their own words.

By explaining their thoughts; students in each group had an opportunity to see the thoughts of other students. They have realized that there can be different explanations for the same situation. Then the teacher explained that some of these explanations are inconsistent with scientific view. In addition, the teacher explained why students may have misconceptions about the subject of interest. The teacher presented the scientific explanation of the concept. In addition several examples were given by students and the teacher related to the concept discussed in the lesson. In order to make easier to understand the scientific explanation the teacher presented numerious daily life examples. These are in agreement with Posner et al's (1982) third and fourth conditions for conceptual change. They indicated that in order to achieve conceptual change the new conception must appear initially plausible and should suggest the possibility of a fruitful research program. Since the concept is explained as clearly as possible students could find it plausible and the daily life examples could help students to realize that what is taught is fruitful.

After that teacher told students to summarize what they have learned in the lesson in order to see whether there is any point left unclear, every concept is well understood and reveal if students still have misconceptions. At the end of the lesson students were told to find daily life examples and explain the relationship of these examples to the discussed subject.

VITA

PERSONAL INFORMATION

Surname, Name : Ünlü, Yalçın

Nationality : Turkish (TC)

Date and Place of Birth:05 October 1978, Afyon

Marital Status : Married

Email : yalcinunlu@hotmail.com

EDUCATION

Degree	Institution	Year of Graduation
MS	METU Secondary Science and Mathematics Education	2006
BS	METU Geological Engineering	2002
High School	Arı Science High School, Ankara	1996

FOREIGN LANGUAGES

Advanced English

HOBBIES

Reading, history, movies, swimming