CONCEPTUAL CHANGE TEXTS ORIENTED INSTRUCTION IN TEACHING SOLUTION CONCEPTS

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YALÇIN ÜNLÜ

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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

Examining Comittee Members

Prof. Dr. Hamide Ertepınar
Preschool Teacher Education Dept., İstanbul Aydın Univ.

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
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 taught by same teacher in TOKİ Anatolian High School in 2010-2011 spring semester were enrolled in the study. Students were divided in to two groups. Groups were randomly assigned and experimental group was taught 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 yöntemde 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.


Araştırmanın hipotezleri t-testi, çok değişkenli çok-faktörlü kovaryans analizi ve varyans analizi kullanılarak test edilmiştir. Sonuçlar göstermiştir ki kavramsal

Anahtar Kelimeler: Kavramsal değişim metni, geleneksel öğretim yöntemi, kavram yanlışları, çözeltlerde denge.
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<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>CCT</td>
<td>Conceptual Change Text</td>
</tr>
<tr>
<td>CCTI</td>
<td>Conceptual Change Text Oriented Instruction</td>
</tr>
<tr>
<td>TDCI</td>
<td>Traditionally Designed Chemistry Instruction</td>
</tr>
<tr>
<td>EG</td>
<td>Experimental Group</td>
</tr>
<tr>
<td>CG</td>
<td>Control Group</td>
</tr>
<tr>
<td>SECT</td>
<td>Solubility Equilibrium Concept Test</td>
</tr>
<tr>
<td>ASTC</td>
<td>Attitude Scale Toward Chemistry</td>
</tr>
<tr>
<td>SPST</td>
<td>Science Process Skills Test</td>
</tr>
<tr>
<td>F</td>
<td>F statistic</td>
</tr>
<tr>
<td>t</td>
<td>t statistic</td>
</tr>
<tr>
<td>df</td>
<td>Degrees of Freedom</td>
</tr>
<tr>
<td>p</td>
<td>Significance Level</td>
</tr>
<tr>
<td>MS</td>
<td>Mean Square</td>
</tr>
<tr>
<td>SS</td>
<td>Sum of Squares</td>
</tr>
<tr>
<td>N/n</td>
<td>Sample Size</td>
</tr>
<tr>
<td>ANOVA</td>
<td>Analysis of Variance</td>
</tr>
<tr>
<td>MANCOVA</td>
<td>Multivariate Analysis of Covariance</td>
</tr>
</tbody>
</table>
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 approach to teaching. Learning theories address questions like how learning happens, how motivation occurs, what effects development of the students’? In order to use instructing 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 why that teachers
have complicated roles like considering different sources of information and existing theories, evaluating different classroom circumstances and students’ different characteristics, afterwards decide if theories of learning could improve her practical application of instruction.

Constructivist theory of learning draws attention to students' existing beliefs, skills and knowledge. In constructivism, students synthesize new concepts with prior knowledge and new information. The constructivist teacher finds problems and monitors exploration of students, guides inquiry and promotes new thinking patterns. By taking an interactive role, constructivist teacher directs 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 approach 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 students have to accommodate new informations in to their cognitive structure which already harbour inappropriate knowledge. Thus, connecting new information to student’s cognitive 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 this 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’ attitudes toward chemistry before and after the conceptual change text instruction and traditional instruction; (e) observe students’ science process skills.

1.2 Significance of the Study

One of the research areas of chemistry 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 solubility, molarity, ions, chemical 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 priority 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, Kolomoç & 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 difference 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 definitions of 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 of learning 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 by living 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 of duplication. 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 a dynamic approach of building instead of obtaining 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 inactive recipients. 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 connect previous knowledge and new information in order to make new information meaningful. In order to move forward, students must associate and question, dispute and enquire, receive or dispose former knowledge 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 of social interaction is recurrent, whole class debates can provide students the chance of articulating their knowledge and learning from others. Constructivistic approach uses authentic tasks in order to engage learners. Activities are selected from 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 preparation. The examples and activities should point out the required concepts. If the examples are insufficient, learning the concept is difficult. All experiences are not evenly instructional (Dewey, 1938). Quality of the experience is the main determinent. The excellence of perception can 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.

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

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

In constructivist classrooms students are more engaged in the constituents when compared to traditional classrooms, this leads to a more fruitful learning environment. Students were allowed determining to the objectives of instruction instead of receiving components presented 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 should give chance students 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 to perceive 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 efficient in the Bloom's taxonomy’s first four levels, in the further levels of understanding, constructivism is efficient (Ormrod, 2009).

Teachers instructing with constructivistic approach think that the information and knowledge that students perceive from school should come from the former practice and knowledge of 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 duplicate particular progress 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 real conception instead of a behaviour mimicry (Brooks & Brooks, 1999).

2.1.1. Types of Constructivism
Constructivism is a process rather than an indivisibale theoretical position. The premises that underlie this process differ through various dimensions and have lead to occurrence 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 dynamic digesting by the particular learner. These specific epistemological highlights results in determining fundamentals that sustain the exterior features of
knowledge and the confidence that an individual fact endures and is cognizible. Than knowledge is internalized and (re)constructed. This internalization and (re)construction process is claimed 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 occasionally even considered needless. Only few radical constructivists, however, completely disregard formal knowledge (Richardson, 1997). Radical constructivism amply includes three epistemological beliefs which are knowledge possession that is an adaptative approach concludes from dynamic learning by the particular learner, representing an empirically deepened intelligence, not an intelligence that illustrate about extrinsic fact (Larochelle, Bednarz, & Garrison, 1998).

The adaptative characteristic of cognition underlines that cognition does not reflect the real life actuality, but instead is a durable 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 cognizable fact and building up individual and consistent actuality. Differing from radical and cognitive constructivism, social constructivism underlines formerly indicated all
epistemological beliefs. These specific epistemological beliefs cause the establishment of nets that preserve the social properties of conception, and the idea that conception emerges from social interaction and language usage, which involves allocation instead of solitary experience (Prawatt & Floden, 1994). Also, this social interaction generally happens inside a socio-cultural framework which leads to bounding of conception to a particular time and place (Gergen, 1995; Vygotsky, 1978). This situation is demonstrated 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 implemented 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 approach.

2.2. Misconceptions

During the journey of learning, misconceptions play 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 preferred by the researcher sheds light to their epistemic considerations. Terminology preference of Sneider and Ohandi (1998) shows that their epistemological belief is replacement of an improper model with a proper one. On the
contrary, the usage of the ‘alternative conception’ term by Hallidén and his colleagues (2002) proves their reliance in a located epistemology.

Misconception means every conception different from accepted scientifical interpretation of the idea. If they integrate into a student’s cognitive framework, they hinder with future acquisition. Afterwards, students try to integrate newly learned concepts in a cognitive framework that harbours improper information. By this way newly acquired 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 exist prior to learning activities and usually reveals following the learning occurs (Gilbert, Osborne, & Fensham, 1982), also occasionally new inaccurate concepts are constructed throughout lessons (Taber, 1995a, 2001).

There is a vast of examples present related with students’ misconceptions in chemistry concepts, like they believe in that metal’s atoms are hard, but liquids have soft atoms (Harrison & Treagust, 1996). A huge part of the students can not differentiate 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 thoroughly it was revealed that knowledge can be developed into emerged frameworks of inter related and reciprocally supporting concepts, that will form complicated conceptions (Taber, 1997a). Occasionally some concepts have to be converted to accommodate the previous information which was a common approach applied widely by scientists. But these accommodated cognitive structures cause misunderstanding the concepts given during the instruction (Taber, 2001).
Defining misconceptions of the students is not always the easiest 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 conventional aspect. They are generally tolerant to traditional teaching methods and construct organized, although erroneous, cognitive formations (Driver & Easley, 1978).

Derivation of misconceptions can be generally grouped as 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 various 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 hardest 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 the 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 equilibrium 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 learning and conception of chemistry in a meaningful way. Therefore, remediation of misconceptions is important. Several instructional approaches 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>
<thead>
<tr>
<th>Table 2.2. Taxonomy of Misconception Related to Solubility Equilibrium</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. There is no precipitation and dissolution at equilibrium.</td>
</tr>
<tr>
<td>2. Dissolution stops at equilibrium.</td>
</tr>
<tr>
<td>3. Concentrations of the ions produced are equal to the concentration of the salt at equilibrium.</td>
</tr>
<tr>
<td>4. Mass can be used instead of concentration in Ksp calculations.</td>
</tr>
<tr>
<td>5. Coefficients in solubility equilibrium equation have no other meaning than equating the solubility reaction.</td>
</tr>
<tr>
<td>6. Ksp can change at a given temperature.</td>
</tr>
<tr>
<td>7. Ion product (Q) can be used interchangeably with Ksp.</td>
</tr>
<tr>
<td>8. While writing Ksp equations, compounds in solid form should be included.</td>
</tr>
<tr>
<td>9. The rate of dissolving increases with time from mixing the solid with solvent until equilibrium establishes.</td>
</tr>
<tr>
<td>10. There is no relation between Ksp and solubility.</td>
</tr>
<tr>
<td>11. The value of Ksp changes with the amount of solid or ions added at a given temperature.</td>
</tr>
<tr>
<td>12. The value of Ksp always decreases as temperature decreases.</td>
</tr>
<tr>
<td>13. Temperature has no affect on solubility.</td>
</tr>
<tr>
<td>14. At equilibrium, addition of salt affects the equilibrium.</td>
</tr>
<tr>
<td>15. Concentrations of ions will remain constant although common ion is added at equilibrium.</td>
</tr>
<tr>
<td>16. Solubility of sparingly soluble salts is affected by change made in pressure and volume.</td>
</tr>
<tr>
<td>17. In all situations one can compare solubility of salts at equilibrium by just looking at Ksp values.</td>
</tr>
<tr>
<td>18. If system is at equilibrium no other solute that doesn’t contain common ion can dissolve.</td>
</tr>
<tr>
<td>19. There was no precipitation reaction before the system reaches equilibrium.</td>
</tr>
<tr>
<td>20. Large Ksp implies very fast dissolution.</td>
</tr>
</tbody>
</table>

Note. Ksp: solubility product constant
2.4 Conceptual Change

Conceptual change is generally described as changing former concepts with learning. The main aspect of conceptual change is that it changes and even substitutes students' prior concepts 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 disciplines like physics and biology (Posner et al., 1982, Carey, 1985). Later on, disciplines like chemistry, earth science, mathematics, writing, reading, and teacher education utilized conceptual change by widening 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 (although 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 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).
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 built up by individuals through the process of assimilation and accommodation. Due to the modification procedure defined prior cognitive framework alteration; modification was viewed by science educators as the central mechanism for conceptual change (Dole & Sinatra, 1998).
In education of 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 determined that 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 colleagues created a model defining “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 illustrated 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 strategies nowadays have tried to consider investigation related to students’ conceptions of realistic incidents. Conceptual change method of teaching has been emerged from these studies (Hewson, 1991).

Conceptual change teaching including features such as classroom climate, role of teacher 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, chemistry, biology and earth science (Pfundt & Duit, 1991; Carmichael, et al., 1990).

Before starting their education at school, children possess wide amount of concepts related to their real-life environment. Having such an background information can be both useful 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).

![“sage on the stage”](image1.png) ![“guide on the side”](image2.png)

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

Conceptual changing is related to introduction of new concepts 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’ alternate knowledge mainly derive from their way of being taught (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 collaborative. Students 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 colleagues 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 ideas (Vosniadou, 1994).

Aim of conceptual change instruction is 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 approach 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 were stimulated through introduction of conditions intended for arousing an intimation regarding to them. Then, students’ misconceptions are provoked by presenting ordinary misconceptions which then followed up by demonstration of their erroneous. At the end, the instruction presents the correct scientific explanation.

Conceptual change texts are built 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 report that 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, which makes them suitable for developing 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 useful in promoting conceptual 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, Yağmurlu and Boz, 2008), electro-chemical batteries (Yürüklü, 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 texts were not thoroughly introduced. Moreover, the teachers who want to overcome their own misconceptions experience difficulties
During the practice and development of conceptual change texts (Akşınar, 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 approach 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 teaching led to better learning of solubility equilibrium concepts.
2.5 Attitude Toward Science

Students’ attitude is one of the factors affecting their 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 attitude 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, parents educational levels, their jobs, size of the classroom, communication with teacher, their intend in science related career and so on (Bilgin & Karaduman, 2005).

When students 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, 9th 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 generated higher positive attitudes toward chemistry when compared to traditional teaching. They explained this situation as interactive participation 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 beneficial interaction regarding 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 acquisition 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 conception 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 prior misconceptions. Also, studies revealed that conceptual change method improve students’ attitudes towards the subject. Because of this, during conducting this research we also investigated the outcome of teaching method over their attitudes towards 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 difference between the effects of traditionally designed chemistry instruction and conceptual change text based instruction on students’ understanding of solubility equilibrium concept when the effect of students’ science 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

$H_01$: 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.

$H_02$: 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.

$H_03$: 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 skills is controlled as a covariate.

$H_04$: There is no significant contribution of students’ science process skills to their understanding of solubility equilibrium concept.
**H₀5**: 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.

**H₀6**: 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.

**H₀7**: 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.

**H₀8**: 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.

**H₀9**: 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.

**H₀10**: 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). Scheme of the research is given in the table below.

Table 4.1 Research Design of the Study

<table>
<thead>
<tr>
<th>Groups</th>
<th>Pre-test</th>
<th>Treatment</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group (EG)</td>
<td>SECT, ASTC, SPST</td>
<td>CCTI</td>
<td>SECT, ASTC</td>
</tr>
<tr>
<td>Control Group (CG)</td>
<td>SECT, ASTC, SPST</td>
<td>TDCI</td>
<td>SECT, ASTC</td>
</tr>
</tbody>
</table>

Descriptions of the abbreviations were as follows:

**SPST**: Science Process Skill Test  
**ASTC**: Attitude Scale toward Chemistry  
**SECT**: Solubility Equilibrium Concept Test  
**TDCI**: traditionally designed chemistry instruction  
**CCTI**: conceptual change text oriented instruction

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 towards chemistry 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 research are 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 approach (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 scored science process skills checked for controlling 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 comprehension evaluated 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), Attitude Scale toward Chemistry (ASTC), and Science 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 question. 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 aspects a 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 degree and mean item discrimination index, ITEMAN programme was enforced. They were \( (p_j) = 0.45 \) and \( (r_{jx}) = 0.48 \) 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 on comprehension 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

<table>
<thead>
<tr>
<th>Misconceptions</th>
<th>Corresponding Item Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Believing that at equilibrium there is no precipitation and dissolution.</td>
<td>18</td>
</tr>
<tr>
<td>Believing that at equilibrium dissolution stops.</td>
<td>5</td>
</tr>
<tr>
<td>Believing that at equilibrium the concentrations of the ions produced is equal to the concentration of the salt.</td>
<td>4</td>
</tr>
<tr>
<td>Believing that mass can be used instead of concentration in Ksp calculations.</td>
<td>3</td>
</tr>
<tr>
<td>Believing that coefficients in solubility equilibrium equations have no other meaning then equating the solubility reaction.</td>
<td>1, 4, 12</td>
</tr>
<tr>
<td>Believing that at a given temperature Ksp can change.</td>
<td>2</td>
</tr>
<tr>
<td>Believing that ion product (Qi) can be used interchangeably with Ksp.</td>
<td>18</td>
</tr>
<tr>
<td>Believing that compounds in solid form should be included while writing Ksp equations.</td>
<td>1</td>
</tr>
<tr>
<td>Believing that the rate of dissolving increases with time from mixing the solid with solvent until equilibrium establishes.</td>
<td>5</td>
</tr>
<tr>
<td>Believing that amount (moles) can be used instead concentration (molarity) in Ksp calculation.</td>
<td>3</td>
</tr>
<tr>
<td>Believing that at a given temperature the value of Ksp changes with the amount of solid or ions added.</td>
<td>2</td>
</tr>
<tr>
<td>Believing that the value of Ksp always decreases as temperature decreases.</td>
<td>20</td>
</tr>
<tr>
<td>Believing that temperature has no affect on solubility.</td>
<td>2, 20</td>
</tr>
<tr>
<td>Believing that at equilibrium addition of salt affects the equilibrium.</td>
<td>2</td>
</tr>
<tr>
<td>Believing that at equilibrium the concentrations of ions will remain constant although common ion is added.</td>
<td>2</td>
</tr>
<tr>
<td>Believing that in all situations one can compare solubility of salts at equilibrium by just looking at Ksp values.</td>
<td>18</td>
</tr>
<tr>
<td>Believing that if system is at equilibrium no other solute that doesn’t contain common ion can dissolve.</td>
<td>2</td>
</tr>
<tr>
<td>Believing that before the system reaches equilibrium there was no precipitation reaction.</td>
<td>18</td>
</tr>
<tr>
<td>Believing that large Ksp implies very fast dissolution.</td>
<td>19</td>
</tr>
<tr>
<td>Believing that there is no relation between Ksp and solubility.</td>
<td>3</td>
</tr>
<tr>
<td>Believing that any substance that contains H is an acid, OH is a base.</td>
<td>11</td>
</tr>
<tr>
<td>Believing that H2O can not act as an acid or base only serve as a solvent.</td>
<td>8</td>
</tr>
<tr>
<td>Believing that pH value shows the number of H atom that an acid contains.</td>
<td>11</td>
</tr>
<tr>
<td>Believing that pH value shows the number of H+ ion that an acid can give.</td>
<td>13, 17</td>
</tr>
<tr>
<td>Believing that the strength of an acid depends on the number of hydrogen atom and base depends on the number of hydroxide molecule.</td>
<td>10</td>
</tr>
<tr>
<td>Believing that strong acids have a higher pH than weak acids.</td>
<td>19</td>
</tr>
<tr>
<td>Believing that strong acids are more concentrated than dilute acids.</td>
<td>14</td>
</tr>
<tr>
<td>Believing that strong acids contain more hydrogen bond than weak acids.</td>
<td>10</td>
</tr>
<tr>
<td>Believing that reactions of acids and bases always result in a neutral solution.</td>
<td>21</td>
</tr>
<tr>
<td>Believing that acidity increase as pH value increase.</td>
<td>14</td>
</tr>
</tbody>
</table>
4.4.2 Science Process Skills Test (SPST)

36 multiple choice questions with four alternatives were included to the test which was built 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, design 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 to define and control if science process skills has 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 instruction for determining any variation between the groups of the study. Throughout the treatment, solubility equilibrium concepts were instructed as a part of the common eleventh 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 approach. The regular classroom instruction was teacher oriented instruction. 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 chose homework questions from the textbook, which were same with the homework questions of experimental group.

Experimental group students were instructed by a conceptual change based method where conceptual change texts were implemented. Conceptual change texts identified common misconceptions and promptly warned students that may have these 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 them was to canalize students find out the 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 H₂SO₄ (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. While the teacher explains the scientific concept, observation of representative events by the students makes these concepts more intelligible for them (intelligibility).

More over, real-life examples were presented to the students to improve the conception of solubility equilibrium concepts. For example, after explaining the neutralization reactions, the teacher mentioned that hydrangea flower color can be determined by the relative acidity of the soil. An acidic soil flower color is blue, whereas an alkaline 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 students (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 students 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 students throughout 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 to define the usefulness of two different instructional methods and gender on the understanding of solution equilibrium related concepts and students’ attitudes toward chemistry as a school subject.

Prior to the treatment, an independent t-test was implemented in order to identify if 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 attitude toward chemistry 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 the experimental group.
- The teacher was objective throughout 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 outcomes revealed from the testing of the hypotheses declared in Chapter III. The significance level was set to 0.05 for 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 equilibrium concept pre- and post test scores, chemistry attitudes pre- and post-test results and science process skills test results of 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

<table>
<thead>
<tr>
<th>Control Group</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>PreSECT</td>
<td>54</td>
<td>10</td>
<td>21</td>
<td>16.37</td>
<td>2.317</td>
<td>-0.386</td>
<td>-1.135</td>
</tr>
<tr>
<td>SECT</td>
<td>54</td>
<td>12</td>
<td>20</td>
<td>16.54</td>
<td>2.143</td>
<td>-0.441</td>
<td>-1.476</td>
</tr>
<tr>
<td>PreASTC</td>
<td>54</td>
<td>20</td>
<td>71</td>
<td>46.07</td>
<td>14.426</td>
<td>0.096</td>
<td>-1.154</td>
</tr>
<tr>
<td>ASTC</td>
<td>54</td>
<td>20</td>
<td>73</td>
<td>46.89</td>
<td>14.078</td>
<td>-0.095</td>
<td>-1.052</td>
</tr>
<tr>
<td>SPST</td>
<td>54</td>
<td>15</td>
<td>34</td>
<td>30.11</td>
<td>3.367</td>
<td>0.716</td>
<td>1.842</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Experimental Group</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>PreSECT</td>
<td>54</td>
<td>10</td>
<td>20</td>
<td>16.94</td>
<td>2.184</td>
<td>-1.732</td>
<td>1.880</td>
</tr>
<tr>
<td>SECT</td>
<td>54</td>
<td>18</td>
<td>21</td>
<td>19.94</td>
<td>7.12</td>
<td>-0.572</td>
<td>0.793</td>
</tr>
<tr>
<td>PreASTC</td>
<td>54</td>
<td>17</td>
<td>70</td>
<td>47.83</td>
<td>13.528</td>
<td>-0.307</td>
<td>-0.783</td>
</tr>
<tr>
<td>ASTC</td>
<td>54</td>
<td>20</td>
<td>70</td>
<td>48.41</td>
<td>12.772</td>
<td>-0.202</td>
<td>-0.788</td>
</tr>
<tr>
<td>SPST</td>
<td>54</td>
<td>26</td>
<td>35</td>
<td>30.76</td>
<td>2.163</td>
<td>0.323</td>
<td>-0.452</td>
</tr>
</tbody>
</table>
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 occurred. 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 show that 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 5.1 presents 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

<table>
<thead>
<tr>
<th>Gender</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>PreSECT</td>
<td>51</td>
<td>12</td>
<td>21</td>
<td>17.25</td>
<td>1.874</td>
<td>-0.614</td>
</tr>
<tr>
<td></td>
<td>SECT</td>
<td>51</td>
<td>12</td>
<td>20</td>
<td>16.96</td>
<td>1.990</td>
<td>-0.673</td>
</tr>
<tr>
<td></td>
<td>PreASTC</td>
<td>51</td>
<td>20</td>
<td>71</td>
<td>45.12</td>
<td>12.457</td>
<td>-0.450</td>
</tr>
<tr>
<td></td>
<td>ASTC</td>
<td>51</td>
<td>20</td>
<td>73</td>
<td>46.75</td>
<td>12.691</td>
<td>-0.475</td>
</tr>
<tr>
<td></td>
<td>SPST</td>
<td>51</td>
<td>15</td>
<td>35</td>
<td>28.33</td>
<td>3.508</td>
<td>-1.224</td>
</tr>
<tr>
<td>Male</td>
<td>PreSECT</td>
<td>57</td>
<td>10</td>
<td>20</td>
<td>16.60</td>
<td>1.963</td>
<td>-0.921</td>
</tr>
<tr>
<td></td>
<td>SECT</td>
<td>57</td>
<td>12</td>
<td>20</td>
<td>16.16</td>
<td>2.202</td>
<td>-0.229</td>
</tr>
<tr>
<td></td>
<td>PreASTC</td>
<td>57</td>
<td>17</td>
<td>70</td>
<td>44.12</td>
<td>14.691</td>
<td>0.078</td>
</tr>
<tr>
<td></td>
<td>ASTC</td>
<td>57</td>
<td>20</td>
<td>70</td>
<td>45.86</td>
<td>13.887</td>
<td>0.104</td>
</tr>
<tr>
<td></td>
<td>SPST</td>
<td>57</td>
<td>21</td>
<td>35</td>
<td>28.79</td>
<td>3.678</td>
<td>-0.275</td>
</tr>
</tbody>
</table>

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 to the 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 slenderly 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 girls found 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 Equality of Covariance Matrices

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Box's M</td>
<td>8.065</td>
</tr>
<tr>
<td>F</td>
<td>0.865</td>
</tr>
<tr>
<td>df1</td>
<td>9</td>
</tr>
<tr>
<td>df2</td>
<td>1.172E5</td>
</tr>
<tr>
<td>Sig.</td>
<td>0.556</td>
</tr>
</tbody>
</table>

Levene’s Test of Equality of Error Variances was also conducted. Given in the Table 5.4, results revealed that this assumption was also met. p values were higher than 0.05; F=0.929, p>0.05 for post-attitude scores and F=0.362, p>0.05 for post-SECT scores.

**Table 5.4** Levene's Test of Equality of Error Variances

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTC</td>
<td>0.929</td>
<td>3</td>
<td>104</td>
<td>0.430</td>
</tr>
<tr>
<td>SECT</td>
<td>0.362</td>
<td>3</td>
<td>104</td>
<td>0.780</td>
</tr>
</tbody>
</table>

Homogeneity of slopes was also controlled for conducting MANCOVA. By controlling this assumption it’s been controlled if the slopes of the covariate to the dependent variable are equal. Table 5.5 shows that mutual effect between 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 Homogeneity of Slopes Assumption

<table>
<thead>
<tr>
<th>Source</th>
<th>Dependent Variable</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta Squared</th>
<th>Noncent. Parameter</th>
<th>Observed Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>ASTC</td>
<td>551,992</td>
<td>3</td>
<td>183,997</td>
<td>1,023</td>
<td>.386</td>
<td>.029</td>
<td>3.069</td>
<td>.271</td>
</tr>
<tr>
<td></td>
<td>SECT</td>
<td>17,575</td>
<td>3</td>
<td>5,858</td>
<td>1,298</td>
<td>.279</td>
<td>.036</td>
<td>3.895</td>
<td>.338</td>
</tr>
<tr>
<td>Intercept</td>
<td>ASTC</td>
<td>245912,676</td>
<td>1</td>
<td>245912,676</td>
<td>1,367E3</td>
<td>.000</td>
<td>.929</td>
<td>1367,136</td>
<td>1,000</td>
</tr>
<tr>
<td></td>
<td>SECT</td>
<td>29510,223</td>
<td>1</td>
<td>29510,223</td>
<td>6,540E3</td>
<td>.000</td>
<td>.984</td>
<td>6539,980</td>
<td>1,000</td>
</tr>
<tr>
<td>Gender</td>
<td>ASTC</td>
<td>397,193</td>
<td>1</td>
<td>397,193</td>
<td>2,208</td>
<td>.220</td>
<td>.021</td>
<td>2,208</td>
<td>.313</td>
</tr>
<tr>
<td></td>
<td>SECT</td>
<td>17,349</td>
<td>1</td>
<td>17,349</td>
<td>3,845</td>
<td>.053</td>
<td>.036</td>
<td>3,845</td>
<td>.493</td>
</tr>
<tr>
<td>Treatment</td>
<td>ASTC</td>
<td>145,621</td>
<td>1</td>
<td>145,621</td>
<td>.810</td>
<td>.037</td>
<td>.008</td>
<td>.810</td>
<td>.145</td>
</tr>
<tr>
<td></td>
<td>SECT</td>
<td>.003</td>
<td>1</td>
<td>.003</td>
<td>.001</td>
<td>.981</td>
<td>.001</td>
<td>.001</td>
<td>.050</td>
</tr>
<tr>
<td>Gender * Treatment</td>
<td>ASTC</td>
<td>.648</td>
<td>1</td>
<td>.648</td>
<td>.004</td>
<td>.952</td>
<td>.000</td>
<td>.004</td>
<td>.050</td>
</tr>
<tr>
<td></td>
<td>SECT</td>
<td>.217</td>
<td>1</td>
<td>.217</td>
<td>.048</td>
<td>.827</td>
<td>.000</td>
<td>.048</td>
<td>.055</td>
</tr>
<tr>
<td>Error</td>
<td>ASTC</td>
<td>18706,924</td>
<td>104</td>
<td>179,874</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SECT</td>
<td>469,277</td>
<td>104</td>
<td>4,512</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>ASTC</td>
<td>264933,000</td>
<td>108</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SECT</td>
<td>30022,000</td>
<td>108</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>ASTC</td>
<td>19258,917</td>
<td>107</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SECT</td>
<td>486,852</td>
<td>107</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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), attitudes 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 oriented instruction with respect to achievement related to solubility equilibrium concept and attitudes toward chemistry as a school subject was tested by using MANCOVA by controlling the effect of students’ science process skills. Results of the study were given in Table 5.6.

Table 5.6 MANCOVA Results

<table>
<thead>
<tr>
<th>Effect</th>
<th>Value</th>
<th>F</th>
<th>Hypothesis df</th>
<th>Error df</th>
<th>Sig.</th>
<th>Partial Eta Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>Wilks' Lambda</td>
<td>.329</td>
<td>1.042E2</td>
<td>2,000</td>
<td>102,000</td>
<td>.000</td>
</tr>
<tr>
<td>SPST</td>
<td>Wilks' Lambda</td>
<td>.940</td>
<td>3.299</td>
<td>2,000</td>
<td>102,000</td>
<td>.042</td>
</tr>
<tr>
<td>Gender</td>
<td>Wilks' Lambda</td>
<td>.963</td>
<td>1.978</td>
<td>2,000</td>
<td>102,000</td>
<td>.144</td>
</tr>
<tr>
<td>Treatment</td>
<td>Wilks' Lambda</td>
<td>.483</td>
<td>54.612</td>
<td>2,000</td>
<td>102,000</td>
<td>.000</td>
</tr>
<tr>
<td>Gender * Treatment</td>
<td>Wilks' Lambda</td>
<td>.980</td>
<td>1.030</td>
<td>2,000</td>
<td>102,000</td>
<td>.361</td>
</tr>
</tbody>
</table>

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’$\lambda$=.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 concept and 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’\(\lambda\)=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 important effect of interaction between gender and treatment on students' understanding of solubility equilibrium concepts concept (Wilks’\(\lambda\)=0.980, F: 1.030- p: 0.361).

5.2.4 Hypothesis 4

According to Hypothesis 4 there is no significant contribution 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’\(\lambda\)=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

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

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.
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 among boys and girls regarding their acquisition of concepts of solubility equilibrium, (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- η²:0.004).

5.2.9 Hypothesis 9

Hypothesis 9 stated that there is no significant difference 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 that the posttest mean scores of 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: 0.166- p:0.144- η²:0.021).

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- η²:0.000).

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 skills is an important forecaster 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 efficiency 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’ attitudes 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 also cause misconceptions 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 solubility equilibrium 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 be effective for 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 caused a higher acquisition 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, without 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 it with 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 acquisition 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 approach 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 acquisition. Also, Çakır and his colleagues 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 attitudes toward chemistry 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 included to the study in terms of science 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 science processes 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 conducted investigations showing the positive contribution of conceptual change 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 their attitudes towards chemistry as a school subject. Results of the investigation revealed that teaching methodology has positive contribution to both understanding concepts and attitudes of the students (2010). Gender also has no significantly important effect on their attitude toward chemistry 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 based lecturing, improved comprehension 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 learning 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 similar studies and benefit from their experiences could be useful. 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 greater study 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 other distinctive 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


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


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Teacher College Press.


**APPENDIX A**

**ÇÖZELTİLERDE DENGİ TESTİ**

**Yönerge:** Bu test sizin çözeltilerde denge konusundaki kavramlarınızı 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 
\[ \text{Cu}_3(\text{PO}_4)_2 \] in çözünürlük çarpımı (\( K_C \)) için aşağıdaki kilerden hangisi doğrudur?

- A) \( K_C = \left[ \frac{[\text{Cu}^{+2}][\text{PO}^{-3}_4]}{[\text{Cu}_3(\text{PO}_4)_2]} \right]^2 \)
- B) \( K_C = \left[ \frac{[\text{Cu}^{+2}][\text{PO}^{-3}_4]}{[\text{Cu}_3(\text{PO}_4)_2]} \right]^2 \)
- C) \( K_C = \left[ \frac{[\text{Cu}^{+2}][\text{PO}^{-3}_4]}{[\text{Cu}_3(\text{PO}_4)_2]} \right]^3 \)
- D) \( K_C = \left[ \frac{[\text{Cu}^{+2}][\text{PO}^{-3}_4]}{[\text{Cu}_3(\text{PO}_4)_2]} \right]^2 \)
- E) \( K_C = \left[ \frac{[\text{Cu}^{+2}][\text{PO}^{-3}_4]}{[\text{Cu}_3(\text{PO}_4)_2]} \right]^2 \)

\[ \text{Cu}_3(\text{PO}_4)_2 \Leftrightarrow 3 \text{Cu}^{+2} (\text{suda}) + 2\text{PO}^-_4 (\text{suda}) \]

2) Belirli bir sıcaklıkta AgI çözeltisi katısı ile dengededir.

\[ \text{AgI} (k) \Leftrightarrow \text{Ag}^{+} (\text{suda}) + \text{I}^- (\text{suda}) \]
Bu çözeltiye aynı sıcaklıkta bir miktar NaI eklendiğinde \( Ag^+ \) ve \( I^- \) iyonları derişimi nasıl değişir? İfadelerinden hangileri hesaplanabilir?

\[
\left[ Ag^+ \right] \frac{[I^-]}{K_{\text{çç}}}
\]

A) Yalnız II B)III ve IV C) I ve III

A) Azalır Artar
Değişmez

B) Değişmez Artar
Artar

C) Azalır Artar
Artar

D) Artar Azalır
Değişmez

E) Azalır Azalır
Azalır

3) 25°C'de 9.09 gram PbSO\(_4\) kantisı 300 L suda çözünerek doygun olmayan PbSO\(_4\) çözeltisi hazırlanıyor. Buna göre,

- I. PbSO\(_4\) kantisının mol sayısı
- II. \( K_{\text{çç}} \)
- III. \( [Pb^{2+}] \)
- IV. SO\(_4^{2-}\) iyonlarının mol sayısı

(PbSO\(_4\)=303)

4) Sudaki çözünmeyi veren \( 5.10^{-3} \) M olan XY\(_2\) tuzunun aynı sıcaklıktaki çözünürlük çarpımı kaçtır?

\[
\text{A) } 5.10^{-5} \quad \text{B) } 5.10^{-6} \quad \text{C) } 5.10^{-7} \quad \text{D) } 5.10^{-9} \quad \text{E) } 5.10^{-12}
\]

5) Suda çözünme tepkimesi

\[
PbI_{2(k)} \rightleftharpoons Pb^{2+}_{(suda)} + 2I^-_{(suda)}
\]

olarak verilen CaF\(_2\) tuzunun, kantisı ile dengede olan sulu çözeltisi ile ilgili,
I. Çökme hızı çözünme hızına eşittir.  
II. \( K_{cc} = \left[ Pb^{2+} \right] \left[ I^- \right]^2 \) dir.  
III. \( \left[ Pb^{2+} \right] = s \) molar ise  
\( K_{cc} = 4s^3 \) 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?

\[ \text{HClO}_4 + \text{H}_2\text{O} \Leftrightarrow \text{ClO}_4^- + \text{H}_3\text{O}^+ \]

1  2  3  4
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 aşağıdaki ifadelerden 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) I ve II  D) III ve IV  E) I, II ve III

11) NH₃, CH₃COOH, H₂O maddeleriyle ilgili olarak aşağıdaki ifadelerden hangisi veya hangileri doğrudur?

I. NH₃ yapısında H bulundurduğu için asittir.
II. CH₃COOH yapısında OH bulundurduğu için bazdır.
III. H₂O hem asit hem de baz olarak davranabilir.
IV. Eşit derişimli çözeltilerinde NH₃'ün pH değeri CH₃COOH'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 Kₛₚ = 4 x 10⁻⁸)
A) $2 \times 10^{-4}$  B) $2 \times 10^{-7}$  C) $1 \times 10^{-8}$

D) $1 \times 10^{-7}$  E) $4 \times 10^{-8}$

13) 0.2 M HX çözeltisinin pH değeri 2 dir.
HX in aynı sıcaklıkta iyonlaşma yüzdesi kaçtır?

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

14) Aşağıda bazı çözeltilerin derişimleri ve pH değerleri verilmiştir.

<table>
<thead>
<tr>
<th>Derişim(M)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. 0.1</td>
<td>13</td>
</tr>
<tr>
<td>II. 0.1</td>
<td>5</td>
</tr>
<tr>
<td>III. 0.001</td>
<td>3</td>
</tr>
<tr>
<td>IV. 0.01</td>
<td>2</td>
</tr>
<tr>
<td>V. 0.1</td>
<td>1</td>
</tr>
</tbody>
</table>

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)
16) HNO₂nin t°C deki asitlik sabiti 

\[ K_a = 1.10^{-5} \] 

tür.

Aynı sıcaklıkta 0.1 M HNO₂ çözeltisinin pH değeri kaçtır?

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

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

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

18) **Durum Açıklama**

I. \(Q < K_{fC}\) Aşırı doymuş çözelti

II. \(Q = K_{fC}\) Sistem dengededir

III. \(Q > K_{fC}\) 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) \(6.9 \times 10^{-4}\)

II. Amonyak (NH₃) \(1.8 \times 10^{-5}\)

III. Anilin(C₅H₅NH₂) \(7.4 \times 10^{-10}\)
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) pH 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 doğrudur?

I. $K_c$ 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) \( \text{CH}_3\text{COOH} \) NaOH

C) HCl NH\(_3\)

D) HNO\(_3\) KOH

E) HBr NH\(_3\)
**APPENDIX B**

**KIMYA DERSİ TUTUM ÖLÇEĞİ**

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

Her cümleyi dikkatle okuduktan sonra kendinize uygun seçeneği işaretleyiniz.

<table>
<thead>
<tr>
<th>AD:</th>
<th>SOYAD:</th>
<th>SINIF:</th>
<th>TAMAMEN KATILMIYORUM</th>
<th>KATILMIYORUM</th>
<th>KARARSIZM</th>
<th>HIC KATILMIYORUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Kimya çok sevdiğim bir alandır.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Kimya ile ilgili kitapları okumaktan hoşlanıyorum.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>5. Kimya konularıyla ilgili daha çok şey öğrenmek isterim.</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>7. Kimya dersine zevkle çalışırım.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Kimya dersine ayrılan ders saatinin daha fazla olması istersen.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>10. Kimya konularını ilgilendiren günlük olaylar hakkında daha fazla bilgi edinmek isterim.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>11. Düşünce sistemimizi geliştirmede kimya öğrenimi önemlidir.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>15. Çalışma zamanının önemli bir kısmını kimya dersine ayırmak isterim.</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**APPENDIX C**

**BİLİMSEL İŞLEM BECERİ TESTİ**

**AÇIKLAMA:** Bu test, özellikle Fen ve Matematik derslerinize 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, işlemel açıklamalar getirebilme, problemin çözümü için gerekli incelemelerin tasarlanması, grafik çizme ve verileri yorumlayabilme kabiliyetlerini ölçebilen sorular bulunmaktadır. Her soruyu okuduktan sonra kendinize uygun seçeneği yalnızca cevap kağıdına işaretleyiniz.

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

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

   a. Her oyuncunun almış olduğu günlük vitamin miktarını.

   b. Günlük ağırlık kaldırma çalışmalarının miktarını.

   c. Günlük antreman süresini.
d. Yukarıdakilerin hepsini.


a. Arabaların benzinleri bitinceye kadar geçen süre ile.

b. Her arabanın gittiği mesafe ile.

c. Kullanılan benzin miktarı ile.

d. Kullanılan katkı maddesinin miktarı ile.

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

a. Arabanın ağırlığı.

b. Motorun hacmi.

c. Arabanın rengi.

d. a ve b.

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

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

b. Evde ne kadar çok pencere ve kapı varsa, isınma 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:

<table>
<thead>
<tr>
<th>Deney odasının sıcaklığı (°C)</th>
<th>Bakteri kolonilerinin sayısı</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>15</td>
<td>6</td>
</tr>
</tbody>
</table>

Aşağıdaki grafiklerden hangisi bu verileri doğru olarak göstermektedir?
6. Bir polis şefi, arabaların hızının azaltılması ile uğraşmaktadır. Arabaların hızını etkileyebilecek bazı faktörleri olduğunu düşünmektedir. Sürücülerin ne kadar hızlı araba kullandıklarını aşağıdaki hipotezlerin hangisiyle sınayabilir?

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

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

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

d. Arabalar eskidikçe kaza yapma olasılıkları artar.

a. Her deneyde arabanın gittiği toplam mesafe ölçülür.
b. Rampanın (eğik düzlem) eğim açısı ölçülür.
c. Her iki deneyde kullanılan tekerlek tiplerinin yüzey genişlikleri ölçülür.
d. Her iki deneyin sonunda arabanın ağırlıkları ölçülür.

8. Bir çiftçi daha çok mısır üretemenin yollarını aramaktadır. Mısır miktarını etkileyen faktörleri araştırmayı tasarlar. Bu amaçla aşağıdaki hipotezlerden hangisini sırayabilir?

a. Tarlaya ne kadar çok gübre atılırsa, o kadar çok mısır elde edilir.
b. Ne kadar çok mısır elde edirse, kar o kadar fazla olur.
c. Yağmur ne kadar çok yağarsa, gübrenin etkisi o kadar çok olur.
d. Mısırl üretimi arttıkça, üretim maliyeti de artar.

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

b. Yükseklik arttıkça sıcaklık artar.

c. Sıcaklık arttıkça yükseklik azalır.

d. Yükseklik ile sıcaklık artışı arasında bir ilşki yoktur.

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

a. Topları aynı yükseklikten fakat değişik hızlarla yere vurur.

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

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

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

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 cevaplayıniz.

**Açıklama:** Bir araştırmada, bağımlı değişken birtakım faktörlere bağlı olarak gelişim gösteren değişkendir. Bağımsız değişkenler ise bağımlı değişkene etki eden faktörlerdir. Örneğin, araştırmmanın 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 ıssısı...
alacak şekilde bir yere koyar. 8.00 - 18.00 saatleri arasında, her saat başı sıcaklıklarını ölçer.

12. Araştırma'da aşağıdaki hipotezlerden hangisi sınanmıştır?

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

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

c. Güneş farklı maddeleri farklı derecelerde ıstır.
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. Her bir 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. Her bir 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. Bu araştırmada sınanan hipotez hangisidir?

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

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

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

d. Kullanılan suyun miktarı arttıkça sıcaklığı da artar.

18. Bu araştırmada kontrol edilebilen değişken hangisidir?

a. Her bardakta çözünen şeker miktarı.

b. Her bardağa konulan su miktarı.

c. Bardakların sayısı.

d. Suyun sıcaklığı.

19. Araştırmanın bağlı 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.

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.


a. Kullanılan toz ya da spreynin miktarı ölçülen.

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

c. Her fidede oluşan kabağın ağırlığı ölçülen.

d. Bitkilerin üzerinde kalan bitler sayılır.

23. Ebru, bir alevin belli bir zaman süresi içinde meydana getireceği ısı enerjisi miktarını ölçmek ister. Bir kabin içine bir liter soğuk su koyar ve 10 dakika süreyle ısıtır.Ebru, alevin meydana getirdiği ısı enerjisini nasıl ölçer?
a. 10 dakika sonra suyun sıcaklığında meydana gelen değişimeyi kaydeder.

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

c. 10 dakika sonra alevin sıcaklığını ölçer.

d. Bir litre suyun kaynaması için geçen zamanı ölçer.


Buz parçacıklarının büyüklüğü, odanın sıcaklığı ve buz parçacıklarının şekli gibi faktörlerin erime süresini etkileyeboleceğini düşünür. Daha sonra şu hipotezi sindamaya karar verir: Buz parçacıklarının şekli erime süresini etkiler. Ahmet bu hipotezi sindamak için aşağıdaki deney tasarmlarının hangisini uygulamalıdır?


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

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

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

Tablodaki verilerin grafiği aşağıdakilerden hangisidir?

Tablo:

<table>
<thead>
<tr>
<th>Gübre miktarı (kg)</th>
<th>Çimenlerin ortalama boyu (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>50</td>
<td>12</td>
</tr>
<tr>
<td>80</td>
<td>14</td>
</tr>
<tr>
<td>100</td>
<td>12</td>
</tr>
</tbody>
</table>
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, şekeri suda çözünme süresini etkileyebilecek değişkenleri düşünmektedirler. Suyun sıcaklığını, şekeri ve suyun miktarlarını değişken olarak saptarlar. Öğrenciler, şekeri suda çözünme süresini aşağıdaki hipotezlerden hangisiyle sınayabilir?

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

b. Su soğudukça, şekeri çözülmemek 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 araştırma grubu, değişik hacimli motorları olan arabaların randımanlarını ölçer. Elde edilen sonuçların garfiği aşağıdaki gibidir:
Aşağıdakilerden hangisi değişkenler arasındaki iliškiiyi 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 küçüldüğçe, 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 paragrafi okuyarak cevaplayıniz.


29. Bu araştırmada sınanan hipotez hangisidir?

a. Bitkiler güneşten ne kadar çok ışık alırsalar, o kadar fazla domates verirler.
b. Saksılar ne kadar büyük olursa, karıştırılan yaprak miktarı o kadar fazla olur.
c. Saksılar ne kadar çok sularırsa, içlerindeki yapraklar o kadar çabuk çürür.
d. Toprağa ne kadar çok çürük yapak karıştırılırsa, o kadar fazla domates elde edilir.

30. Bu araştırmada kontrol edilen değişken hangisidir?

a. Her saksidan elde edilen domates miktarı
b. Saksılarca karıştırılan yaprak miktarı.
c. Saksılardaki torak miktarı.
d. Çürümüş yapak karıştırılan saksi sayısı.

31. Araştırmadaki bağımlı değişken hangisidir?

a. Her saksıdan elde edilen domates miktarı
b. Saksılarca karıştırılan yaprak miktarı.
c. Saksılardaki torak miktarı.
d. Çürümüş yapak karıştırılan saksi 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 saksi sayısı.

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

a. Kullanılan mıknatısın büyüklüğü ile.

b. Demir tozlarını çeken mıknatısın ağırlığı ile.

c. Kullanılan mıknatısın şekli ile.

d. Çekilen demir tozlarının ağırlığı ile.


<table>
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<tr>
<th>Mesafe(m)</th>
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<tbody>
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<td>50</td>
<td>5</td>
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<td>100</td>
<td>2</td>
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</tbody>
</table>
Aşağıdaki grafiklerden hangisi verilen bu verileri en iyi şekilde yansıtır?

35. Sibel, akvaryumdaki balıkların bazen çok haraketli bazen ise durgun oldularını gözler. Balıkların hareketlilğini etkileyen faktörleri merak eder. Balıkların hareketlilğini 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.

a. TV’nin açık kaldığı süre.

b. Elektrik sayacının yeri.

c. Çamaşır makinesinin kullanma sıklığı.

d. a ve c.
AKTİVİTE 1

Katısı ile dengede olan Ag₂SO₄ çözeltisi için Kₐ₇ üretiminin X cinsinden ifadesini nedir?

\[ \text{Ag}_2\text{SO}_4 (\text{kat}) \rightleftharpoons 2\text{Ag}^+ (\text{suda}) + \text{SO}_4^{2-} (\text{suda}) \quad K_{\text{a7}} = 1.6 \times 10^{-5} \]

Not: SO₄²⁻(suda) iyonunun derişimini X kabul ederek çözünüz

I. \[ K_{\text{a7}} = (2X)^2 \cdot X \]
II. \[ K_{\text{a7}} = X^2 \cdot X \]
III. \[ K_{\text{a7}} = 2X \cdot X \]

Yazılarınızı okumadan önce aşağıdaki boş bırakılan kısıma cevabını ve nedenini yazınız.
Bazı öğrenci arkadaşlar Ag⁺ iyon derişimini SO₄²⁻ iyon derişiminin iki katı olarak düşünürler. Nitkeim aranızda II denklemi seçen varsa bu kavram yanlıştır onlarda sahip olabilirler. II. denklemi seçenekler eşitliği yanlış kurmuştur çünkü her bir mol SO₄²⁻ iyonu oluşumu için iki mol Ag⁺ iyonu oluşmaktadır. Dolayısı ile Ag⁺ iyonu derişimi SO₄²⁻ iyon derişiminin iki katıdır ve aşağıdaki gibi bir eşitlikle ifade edilir.

\[
[\text{Ag}^+] = 2[\text{SO}_4^{2-}]
\]

Bazı öğrenci arkadaşlar tarafından yapılan diğer yanlıştık çözünürlük çarpımı (Kₐₚ) yazarken Ag⁺ derişimini SO₄²⁻ derişiminin iki katı olarak aldık, neden tekrar karesini alıyoruz diye düşünürler. Bu düşüncein kaynağı denklemi denkleştirirken zaten derişimleride ayarlıyoruz yanlıştırıdan kaynaklanmaktadır Aranızda III denklemi seçen varsa bu kavram yanlıştır onlarda sahip olabilirler.. Kₐₚ bağıntısı yazılırken Ag⁺ iyonu derişiminin karesini almamızın nedeni ise Kₐₚ bağıntısının tanımandan gelmektedir. Yani çözünürlük çarpımı Kₐₚ çözünürlük dengesinde yer alan iyonların molar derişimlerinin katsayıları üstel olarak yazıldiktan sonraki çarpımıdır.

DOĞRUSU nedir? Kₐₚ bağıntısı nasıl yazılır?

Yukarıda katsışı ile dengede çözelti için Kₐₚ ifadesi
K_{cc} = \left[ Ag^{+} \right]^{3}\left[ SO^{2-4} \right] \) şeklinde olur. \( K_{cc} = (2X)^2 \cdot X \)
AKTİVİTE 2

Belirli bir sıcaklıkta katısı ile dengede olan PbCl\textsubscript{2} çözeltisinin çözürülük çarpımı $K_{\text{çç}}$ ifadesi aşağıdakilerden hangisi gibi olur?

$$\text{PbCl}_2 \rightleftharpoons \text{Pb}^{2+}(\text{suda}) + 2\text{Cl}^-(\text{suda})$$

I. $K_{\text{çç}} = \frac{[\text{Pb}^{2+}][\text{Cl}^-]}{[\text{PbCl}_2]}$

II. $K_{\text{çç}} = \frac{[\text{Pb}^{2+}][\text{Cl}^-]^2}{[\text{PbCl}_2]}$

III. $K_{\text{çç}} = [\text{Pb}^{2+}][\text{Cl}^-]^2$

IV. $K_{\text{çç}} = [\text{Pb}^{2+}] 2[\text{Cl}^-]$

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

I ve II denklemi seçen varsa kimyasal reaksiyonlarda denge bağıntısını yazarken, ürünlerin derişiminin girenlerin derişimine bölerek yazıldığını anımsamalarından

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dolaydırlar. Fakat genelde öğretmenler ve kitaplar örneklerini gaz tepkimelerinden oluşturduğu için öğrencileri arkadaşlarınız k_{CC} denkleme katıları da yazma yanlıştırmasına düşmektedir. Oysa denge bağıntısı yazılırken katıların derişimi ALINMAZ. Çünkü katıların miktarındaki azalma hacmindeki azalma ile doğru orantılı olduğu için katıların derişimi değişmeyecektir.

**DOĞRUSU nedir?** \(k_{CC} \) bağıntısı nasıl yazılır?

\[
PbCl_2 \leftrightarrow Pb^{+2} \text{(suda)} + 2Cl^{-} \text{(suda)}
\]

Bu denge tepkimesinin denge sabiti

\[
K_c = \frac{[Pb^{+2}][Cl^{-}]}{[PbCl_2]}
\]

şeklinde yazılır. Bu denge ifadesinden \(K_c[PbCl_2] = [Pb^{+2}][Cl^{-}] \) bulunur. Hem \(K_c \) hem de PbCl₂ kâtısının derişimi sabit olduğundan, iki sabit sayının çarpımı yine sabit bir sayı olacaktır. Dolayısı ile yeni ifade, \(K_c[PbCl_2] = k_{CC} = [Pb^{+2}][Cl^{-}] \) şeklinde yazılar ve BELİRLİ bir SİCAKLıKTA böyle hesaplanır. Kimyasal reaksiyonlarda çözünürlik çarpımı sabiti yazılıırken KÂTILAR DAHİL EDİLMEZ. Çözünürlik çarpımı (\(k_{CC} \)) çözünürlik dengesinde yer alan ıyonların molar derişimlerinin katsayıları üstel olarak yazıldığtan sonraki çarpımdır. PbCl₂ kâtısının çözünmesine ilişkin çözünürlik sabiti \(K_{CC} = [Pb^{+2}][Cl^{-}] \) ile bulunur.
AKTİVİTE 3

\[
\text{NaOH}_{(\text{suda})} + \text{HCl}_{(\text{suda})} \rightarrow \text{NaCl}_{(\text{suda})} + \text{H}_2\text{O}_{(\text{s})}
\]

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

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

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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.

\[
2\text{NaOH}_{(\text{suda})} + \text{H}_2\text{SO}_4_{(\text{suda})} \leftrightarrow \text{Na}_2\text{SO}_4_{(\text{suda})} + \text{H}_2\text{O}
\]

Peki reaksiyonunda olduğu gibi kuvvetli bir baz olan NaOH ile kuvvetli bir asit olan H₂SO₄ çözeltilerinde eşit mol sayılarında karıştırıldığımızda notr çözelti elde edilir mi?
NaOH çözeltisinde 1 mol OH⁻ iyonu H₂SO₄ 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 değeri de önemlidir. Nötrleşme tepkimeleri için

\[ M_A \cdot V_A \cdot T_A = M_B \cdot V_B \cdot T_B \]

\( M_A \): Asidin molaritesi, \( V_A \): Asidin hacmi, \( T_A \): Asidin tesir değeri

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 daha 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 CH₃COOH 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 NH₃ karışımda pH 7 den küçük olur.

Bazı bitkiler toprağın pH ina göre farklı renkte çiçek verir. Örneğin asitli topraklarda sadece mavi çiçekli ortanca yetiştirken nötr veya bazik topraklarda pembe çiçekli ortanca yetiştir. Asitli topraklarda yetiştiren mavi çiçekli ortancanın pembe çiçekli olmasını isteyen çiftçi toprağa bazı olan kireç tozu serperek toprağın asitliğini azaltır.
AKTİVİTE 4

CH₃COOH, HCOOH, NH₃, PH₃ gibi maddelerin hangileri asit, hangileri bazdır? Yapılarında H⁺ iyonu bulunduran her maddeyi asit, OH⁻ bulunduran her maddeyi baz diye tanımlamak doğrudur? H₂O sadece çözücüdür? Hem asit hem baz gibi davranabilir mi?

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

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

I. CH₃COOHₜ(suda) + H₂O(s) ⇌ CH₃COO⁻ₜ(suda) + H₃O⁺(suda)

ASİT1 BAZ2 BAZ1 ASİT2

II. NH₃(suda) + H₂O(s) ⇌ NH₄⁺ₕ(suda) + OH⁻ₜ(suda)

BAZ1 ASİT2 ASİT1 BAZ2
Bronsted-Lowry asit-baz tanımini göre proton veren (H⁺) madde asit, proton alan madde bazdır.

I. reaksiyonda ileri yönde CH₃COOH proton verdiği için asit, H₂O ise proton aldığı için bazdır. Geri yönde CH₃COO⁻ proton aldığı için baz, H₃O⁺ proton verdiği için asittir.

II. reaksiyonda ileri yönde NH₃ proton aldığı için baz, H₂O proton verdiği için bazdır. Geri yönde ise NH₄⁺ proton verdiği için baz, OH⁻ proton aldığı için bazdır.

Dikkat ederseniz H₂O. tepkimde baz, II.tepkimede ise asittir. Yani

**H₂O** osadece çözücü olmakla kalmayıp tepkimelerde asit ve baz gibi davranabilmektedir.

Bronsted-Lowry tanıminına göre CH₃COOH/CH₃COO⁻ ve H₂O/H₃O⁺ gibi çiftlere eşlenik (konjuge) asit-baz çifti denir.
AKTİVİTE 5

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

Yazınları okumadan önce aşağıdaki boş bırakılan kısmına cevabınızı ve nedenini yazınız.

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Zayıf bir asit olan HCN ise suda tam olarak iyonlarına ayrışmaz.HCN’nin ne kadarının iyonlaştığını gösteren asitlik sabiti \(K_a = 4.9 \times 10^{-10}\) dur.

\[
\begin{align*}
\text{HCN} (\text{suda}) & \leftrightarrow \text{H}^+ (\text{suda}) + \text{CN}^- (\text{suda}) \\
\text{Başlangıç (M)} : & 0,1 \quad 0 \quad 0 \\
\text{Değişme (M)} : & -x \quad +x \quad +x \\
\text{Dengede (M)} : & 0,1-x \quad x \quad x
\end{align*}
\]

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

HCN çok az iyonlaştığı göre \(x\), 0.1’den çok küçük bir değer olmalıdır ve 0.1’in yaninda ihmal edilir.0.1-x ≈ 0.1 alınır.
\[ K_a = \frac{(x)(x)}{0.1 - x}, \quad 4.9 \times 10^{-10} = \frac{x^2}{0.1}, \quad x = 7 \times 10^{-6}, \quad \text{pH} = -\log(7 \times 10^{-6}), \quad \text{pH}_1 = 5.15 \]

0.1M HCN’den 7.10⁻⁶ iyonlaştı ise

100M \[ X \]

\[ X = \%0.007 \text{ iyonlaşır.} \]

Aynı hesaplamaları 10⁻³ M HCN için tekrar edersek x=7.10⁻⁷ çıkar, pH₂=6.15

0.001M HCN’den 7.10⁻⁷ iyonlaştı ise

100M \[ X \]

\[ X = \%0.07 \text{ iyonlaşır.} \]

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 \((\text{C}_2\text{H}_5)\text{NH}\) (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 arttıkça asidin şiddetı azalır mı, artar mı? 0.1 M CH₃COOH mı daha asidiktir, 0.1 M HCN mı? (K_{CH₃COOH}=1.8.10^{-5}, K_{HCN}=4.9.10^{-10})

Yazılıları okumadan önce aşağıda boş bırakılan kısıma cevabını ve nedenini yazınız.

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CH₃COOH'ın pH'ını hesaplayalım.

CH₃COOH (suda) ⇌ H⁺ (suda) + CN⁻ (suda)

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

CH₃COOH çok az iyonlaştığı göre x, 0.1'den çok küçük bir değer olmalıdır ve 0.1'in yanında ihmal edilir. 0.1-x ≈ 0.1 alınır.

K_a = \frac{(x)(x)}{0.1-x}, \quad 1.8.10^{-5} = \frac{x^2}{0.1}, \quad x=1.3.10^{-3}, \quad pH=-log(1.3.10^{-3}), \quad pH=2.89

HCN'nin pH'ını hesaplayalım.

HCN (suda) ⇌ H⁺ (suda) + CN⁻ (suda)
Başlangıç (M) : 0,1 0 0
Değişme (M): -x +x +x
Dengede (M): 0,1-x x x

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

\[ K_a = \frac{(x)(x)}{0.1-x} \]

\[ 4.9 \times 10^{-10} = \frac{x^2}{0.1}, \quad x=7 \times 10^{-6}, \quad \text{pH}= -\log(7 \times 10^{-6}), \quad \text{pH}= 5.15 \]

0.1 M CH₃COOH, 0.1M HCN’ye göre daha asidiktir. Asitlik sabiti arttıkça, asit daha çok iyonaşacağından ortamındaki H⁺ iyonu derişimi artacaktır. Ortamındaki H⁺ iyonu derişimi arttığında zaman pH daha küçük bir değer alır, dolayısıyla daha asidik olur.

**Kₐ değeri ne kadar küçükse asit o kadar zayıftır.**

Benzer durumu bazlara uyarlarsak Kₐ değeri arttıkça, baz daha çok iyonaşacağından ortamındaki OH⁻ iyonu derişimi artacaktır. Ortamındaki OH⁻ iyonu derişimi arttığında zaman, p OH daha küçük bir değer alır, dolayısı ile daha az bazik olur.

**Kₐ değeri ne kadar küçükse baz o kadar kuvvetlidir.**
AKTİVİTE 7

Doymamış çözeltilerde $K_{c^+}$'den bahsedilebilir mi?

Yazılarınızı okumadan önce aşağıda boş bırakılan kısıma cevabını ve nedenini yazınız.

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$K_{c^+}$ dengede olan bir çözeltinin iyon derişimlerinin katsayısı üstel olarak yazıldıktan sonraki çarpımıdır. Doymamış bir çözeltide denge durumdan bahsedemeyiz. Bu nedenle $K_{c^+}$ hesaplaması yapamayız. Kimya test kitaplarında sorular genelde belirli bir sıcaklıklı doymuş çözelti için sorulduğundan dolayı, bazı öğrenciler doymamış çözelti de $K_{c^+}$ değerinin hesaplanabileceği kavram yanılışına düşmektedirler.

O zaman biz doymamış çözelti de iyon derişimi çarpımı ile neyi hesaplıyoruz? Iyon çarpımı(Q) ile $K_{c^+}'yi karşılaştırarak, denge reaksiyonun hangi yöne yürüyeceğini tayin edeceğimiz değeri hesaplanmış oluyoruz. Q değeri çözelti reaksiyonunun kalıtılmaması altında çökecek iyonların derişimlerini $K_{c^+}$ bağıntısında yerine konarak hesaplanır.

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

İyon denklemi:

\[
Pb^{+2}(\text{suda}) + 2NO_3^-(\text{suda}) + 2K^+(\text{suda}) + CrO_4^{2-}(\text{suda}) \rightarrow PbCrO_4(k) + 2K^+(\text{suda}) + 2NO_3^-(\text{suda})
\]

\[
\downarrow
\]

çöker

Net tepkime ise,

\[
Pb^{+2}(\text{suda}) + CrO_4^{2-}(\text{suda}) \rightleftharpoons PbCrO_4(k)
\]

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


3. Durum \((Q > K_{sp})\): Bu çözelti aşırı doymuştur. Sistem dengede değildir. \(Q\) değerinin küçülmesi gerekir. Bunun içinde iyonların bir kısmı \(Q = K_{sp}\) 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 queries aiming 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 numerous 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

<table>
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<tr>
<th>Degree</th>
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<tr>
<td>MS</td>
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<td>2006</td>
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<tr>
<td>BS</td>
<td>METU Geological Engineering</td>
<td>2002</td>
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<tr>
<td>High School</td>
<td>Arı Science High School, Ankara</td>
<td>1996</td>
</tr>
</tbody>
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FOREIGN LANGUAGES

Advanced English

HOBBIES

Reading, history, movies, swimming