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Promoting Conceptual Change in Science
Which is More Effective: Conceptual Change Text or Analogy?

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ABSTRACT

This research is planned to examine the efficiency of conceptual change text and analogy consisting of science students' alternative concepts within basic concepts of Chemical Bonds. The sample of this study is composed of the selected 46 students who attend science classes at Çukurca Mehmetcik Private Courses. The students were graduated from high school and were continuing their education in the institute to prepare for the university exams. The quasi-experimental research design was used in this study. Two classes were randomly selected as experimental groups from four classes. In the study, data was collected by using "Chemical Bonds Concept Achievement Test" (CBCAT). The CBCAT was used as the pre-test to detect students' levels at the beginning of the study, and the post-test to find out the students' new levels of achievement. In the analysis of the data, an independent sample test design was performed, in which dependent variables were the pre-test and post-test scores.

Key Words: Conceptual Change; Conceptual Change Text; Analogy.

INTRODUCTION

The main aim of science education is to help students to develop meaningful understanding of science concepts and to use these concepts for intended purposes. For a meaningful learning, conceptual understanding needs to be supported by problem solving. To do so, science teaching has to develop conceptual understanding in students' minds rather than rote memorization of the concept.

Many researchers and educators have accepted that the most important things that students bring to their classes are; their background, attitudes, abilities, and experiences. These characteristics make students active during the learning process. According to cognitive theory, students construct sensible and coherent understanding of events and phenomena in their world from their point of view. Learners base their understanding on their previous knowledge. Therefore, during instruction, learners generate their own understandings based

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on their previous concepts. As a result of that, learners may build concepts which are different from those accepted by scientific community even after formal instruction (Janiuk, 1993; Schmidt, 1997; Treagust, 1988; Clement, 1982; Driver & Ericson, 1983; Helm & Novak, 1983; Anderson & Smith, 1987; Bishop & Anderson, 1990; Hırça, Çalık, Seven, 2011). These alternative views have been given several names including alternative frameworks (Driver & Easly, 1978; Driver & Ericson, 1983), naive beliefs (Caramazza, McCloskey & Green, 1981), preconceptions (Anderson & Smith, 1983; Hashweh, 1988), children's science (Gilbert, Osborne & Fensham, 1982), and misconceptions (Cho, Kahle & Norldland, 1985; Griffiths & Grant, 1985; Griffiths & Preston, 1992).

For better understanding and meaningful learning, misconceptions which are affecting students' learning of subsequent concepts negatively have to be remediated. According to Posner et al. (1982), learning is best viewed as a process of conceptual change. There are two different conceptual changes; these are assimilation and accommodations in students' mind. Assimilation is the integration of new phenomena with the existing cognitive structure and accommodations are the replacement or reorganization of the central concept. They proposed four conditions for conceptual change to occur:

1. There must be a dissatisfaction with the existing concept
2. New concept must be intelligible
3. New concept must be initially plausible
4. New concept must be fruitful

Many instructional strategies based on conceptual change approach, help students change their misconceptions. One of the instructional strategies to dispel students' misconceptions is the use of refutational or conceptual change texts (Guzzetti, et al, 1992; Hynd, et al, 1994; Maria & MacGinite, 1987; Chambers & Andre, 1997; Hynd, Alvermann,& Qian, 1997; Palmer, 2003). Reputational and conceptual change texts are the texts that refute commonly held misconceptions. The major difference between reputational text and the conceptual change text occurs when the students were asked explicitly to make predictions about a situation. In the conceptual change text model, students were asked explicitly to predict what would happen in a situation before provided with information that demonstrates the inconsistency between common misconceptions and the scientific conceptions.

Many researchers (Hynd, 1994; Chambers & Andre, 1997; Hynd, Alvermann & Qian, 1997; Palmer, 2003) showed that refutational texts help students change their misconceptions. Refutational text explicitly contrasts a correct scientific theory with common misconceptions. Alverman and Hague (1989) demonstrated that under appropriate instructional conditions both activating prior knowledge and explicitly refuting misconceptions led to enhance the achievement test performance. Guzzetti et al. (1993) meta-analyzed the literature on refutational text and conceptual change approach and concluded that they facilitate learning of science concepts.

Another instructional strategy to dispel students' misconceptions is the use of analogies. Throughout the history of science, scientists and science educators have used analogies to explain fundamentally important concepts (Brown, 1992; Clement, 1993; Gentner, 1989; Hesse, 1966; Lawson, 1993; Thagard, 1992; Venville & Treagust, 1997). The analogies serve as initial models for the concepts. It is not surprising, therefore, that textbook authors use analogies to explain science concepts to students (Iding, 1997). Many research show that; If an analogy is not used carefully, it can be counterproductive, by causing students to form misconceptions (Duit, 1991; Glynn et al., 1995; Thiele & Treagust, 1994).

It is frequently mentioned in the literature that to make concept teaching more effective, teachers should design and apply the education process by considering the appropriate circumstances for students' individual differences (Doran 1972, Schoon & Boone 1998;

Ülgen, 2001). For this reason, it is crucial to do researches about the reasons of these alternative conceptions and how to correct them, and to take the data obtained into consideration. In related literature many researches have been done to solve these problems in this field, and materials that can be used in class environment to teach related concepts were developed. Some of those materials are; conceptual change texts, analogies, and conceptual caricatures, etc.. Although there are a number of studies that examine the effectiveness of Conceptual Change Text or Analogy, to compare traditional instruction (Brown, 1992; Clement, 1993; Gentner, 1989; Hynd, 1994; Chambers & Andre, 1997; Hynd, Alvermann & Qian, 1997; Duit, 1991; Glynn et al., 1995; Thiele & Treagust, 1994; Coll & Treagust, 2001; Bilgin & Geban, 2001), specifically there are no studies on comparing Analogy and conceptual change text. This is the reason why it is needed to do comparative researches. Besides, researches on that field indicate that among the units about which students have alternative conceptions, Chemical Bonds and Intermolecular Forces Unit is the most common one (Ebenezer & Gaskell, 1995; Taber, 1997; Coll & Treagust, 2001; Prieto, Ebenezer & Fraser, 2001; Ünal, 2003; Sevim, 2007; Taber, 2011). Researches that have been done about these subjects indicate that students have alternative conceptions related to these concepts and even after the education, they still carry some of these alternative conceptions. Therefore, aim of this study is to determine the alternative conceptions of students on Chemical Bonds and Intermolecular Forces, and the effectiveness of conceptual change texts and analogies which are prepared according to conceptual change strategy on students' conceptual change processes.

This research was planned for two general purposes: To determine students' alternative conceptions about basic concepts of chemical bonds and Intermolecular Forces, and to determine the effectiveness of the conceptual change texts and Analogies on students' conceptual changes.

Because it is a requirement to select pre-constructed classes as random experiment groups, sample of the study is composed of the students of Çukurca Mehmetçik Private Course. For this reason, the method of the study is determined as quasi-experimental. The experimental pattern used in the study is shown in Table 1.

Table 1. *Research pattern of the study*

Groups	Pre-Test	Application	Post-Test
1. Experiment Group	CBIFCT	Use of Conceptual Change Texts During Learning Process.	CBIFCT
2. Experiment Group	CBIFCT	Use of analogy During Teaching Process	CBIFCT

CBIFCT: Chemical Bonds and Intermolecular Forces Concept Test

METHODOLOGY

a) Sample of the study

Sample of the study is composed of selected students who had been attending science classes of Çukurca Mehmetcik Private Courses. In the institute, there were two weekend and two weekday classes. The students of all classes were graduated from high school and were continuing their education in the institute to prepare for the university exams. The weekday class was selected as the 1st experiment group, and the weekend class was selected as the 2nd experiment group, randomly. In both classes, chemistry lessons were held by the same teacher. Teacher is also a researcher at the same time, and at that time, he was an assistant professor and while he was doing his national service, he was also teaching chemistry at

Çukurca Mehmetcik Private Courses. Students in this research, first taught about Chemical Bonds and Intermolecular Forces at 9th grade and then at 11th grade in detail and last, at the Institute.

b) Test used in the study

"Chemical Bonds and Intermolecular Forces" Concept Test was applied first before teaching the subject being studied, in order to determine students' alternative conceptions about the concepts of this subject, and was applied as the last test to determine developments in students' conceptions after teaching. The test used in the study was adapted from CBIFCT which Sevim (2007) used in his PhD thesis and is composed of 16 questions. Questions in test are analyzed in two groups; passive knowledge (conceptual change accomplished. Individual can solve a problem by putting the change into practice. On the other hand, s/he cannot use the concept while solving a problem and cannot create a problem by using the concept.) and active knowledge (conceptual change occurred. Individual can solve a problem by putting this change into practice, create problems and draw conclusions. The potential information at the passive level became active).

Table 2. *Analysis of questions*

QUESTION NUMBER	CONTENT	LEVEL
1st , 11th and 13th questions	Covalent Bond	Passive Knowledge
5th and 8th questions	Covalent Bond	Active Knowledge
2nd and 9th questions	Ionic Bond	Passive Knowledge
4th and 15th questions	Ionic Bond	Active Knowledge
3rd 7th 10th 12th 14th questions	Intermolecular Forces	Passive Knowledge
6th and 16th questions	Intermolecular Forces	Active Knowledge

c) Data Analysis

To analyze data, SPSS 17,0 package program is used. While analyzing the scale, data are explained trough average ($\overline{X}$), standard deviation (S), frequency (f) and percentage (%) values in tables. In statistical analysis are based on 0,05 significance level.

To detect whether data show normal distribution or not, Kolmogov-Smimov test results are analyzed and it is proven that data show normal distribution. According to Kolomogov-Smimov test results, it is detected that ranks of students from scale show normal distribution on the 0,05 significance level. As a result, analysis will be based on parametric tests. Independent Sample Test was applied on the results of Test.

While distributing the points for the test, each question is given equal points, and marks of students before and after the classes were analyzed. Also, because every question has one scientifically correct answer and three choices that have misconceptions, which are also available in literature, changes in each choice were analyzed qualitatively.

d) Preparation of Analogies and Conceptual Change Texts (CCT)

Conceptual change texts and analogies used in this study are defined as preparation for the reorganization by Posner -(Posner, Strike, Hewson, & Gertzog, 1982), based on the views of Piaget and Thomas Kuhn's "Conceptual Change Approach". The CCTs which were used in this study were selected from texts that used in Sevim's study in 2007.

Preparation of analogies is benefited from the books, literature, and the data obtained from the test of the concept which applied the students. At the end of these researches, the

analogies which intended the students prepared as a draft before pilot studies that also benefited from analogies which Kılıç used in his studies in 2007. Together with the some of the faculties who are experts in the field the prepared analogies were analyzed. Some changes occurred according to our opinions in analogies. Especially, the lack of given scientific information is resolved and added new information depends on scientific development in this field in recent years. As a result of these studies, pilot study was finalized before the analogies. It is obtained from texts and analogies, after CCT was developed and texts were applied to 25 students from 10^{th} and 11^{th} grade at Çukurca High School for the pilot study. The texts and analogies are formed based on the data that were obtained and used in our studies.

FINDINGS and DISCUSSIONS

a) General Findings of CBIFCT

In this study, concept test is composed of 16 questions and applied as pre-test and post-test. Findings are presented under separate titles.

Table 3. *Group statistics*

	Group	N	Mean	St. Deviation	St. Error Mean
Pre-Test	1. Experiment Group	24	44,7916	12,3175	2,5143
	2. Experiment Group	22	43,4659	11,4884	2,4493
Post-Test	1. Experiment Group	24	59,1146	10,7333	2,1930
	2. Experiment Group	22	74,7159	12,5708	2,6801

Table 4. *Results of independent sample test of experiment groups' pre-test and post-test scores*

Test	Group	Mean	N	sd	t	P*
Pre-Test	1. Experiment Group	44,7916	24	44	.377	0.708
	2. Experiment Group	43,4659	22			
Post-Test	1. Experiment Group	59,1146	24	44	-4.537	0.000
	2. Experiment Group	74,7159	22			

* p>0,05

As seen in Table 4, there is no meaningful difference between the groups' success before application when their pre-test results are compared according to t-test. ($t_{(44)}$: .377; p>0,05). The arithmetic mean of first group marks was; $\overline{X}$ =44,79/24, the second group's arithmetic mean was; $\overline{X}$ =43,47/22. When their arithmetic means are compared, it is seen that the difference between the two is not significant.

Results of the t-test that was done after the application indicate that 2^{nd} experiment group (analogies were used) is more successful than the 1^{st} experiment group (Conceptual Change Texts were used),($X_{Analogy}$: 74,72; X_{CCT}: 59,12) and there is a significant difference between these two groups.

When the data which were obtained from the post-test after application are evaluated, the arithmetic mean of the first group ($\overline{X}$ =59,12/24) increased approximately 16 points, and the arithmetic mean of the second group($\overline{X}$ =74,72/22) increased approximately 31 points. This result indicates conceptual change tests and analogies have a great effect on students' conceptual change about alternative concepts. This result is congruent with the results of the studies carried by Wang and Andre (1991), Hydn et.al. (1994), Hynd et.al. (1997), Guzzetti

et.al. (1997), Ocak (2000), Yürük (2000), Sungur (2000), Bayır (2000), Ünlü (2000), Diakidoy et.al. (2003), Chambers and Andre (1997), Sevim (2007). However, when groups are evaluated individually, the result is that the conceptual change was less successful in the first group which the conceptual change texts were applied, than the second group which the analogies were applied.

b) Arguments Toward the Alternative Concepts About Covalent Bond and Conceptual Change

On the 1st , 5th , 8th, 11th and 13th questions of the test the aim is to ascertain the understandings of covalent bonds. First question of the test is aimed to ascertain students' understandings of how the covalent bond occurs and how the atoms react while valance electrons are conjoining each other. The answers which contain alternative concepts and accepted to be correct by students are; "*Electrons disappeared between two atoms.''* 30%, "*Electrons separated between two atoms*.'' 20% and ''*Electrons were transferred from one atom to another''* 30%.On the eleventh question the aim is to make the students determine the element groups a covalent bond formed between. In both groups more than 50% of the students confused the formation of covalent bond and other bonds and they claimed that covalent bond would be formed *''Between metal atoms*''(22%), *''Between metal atoms and nonmetal atoms*''(19%), and *''between noble gasses and metal or nonmetal atoms*''. When the answers given to these questions are analyzed, it is seen that these students confused covalent bonds with ionic bonds. Especially to the question *"How a covalent bond is formed?*", students answered: '*electrons were transferred from one atom to another''* and to the question ''*on periodical table, between which groups of elements is covalent bond formed*?'', they answered ''*Between Metal and Nonmetal atoms*.'' When the literature analyzed, student's confusion about these two concepts is also seen in the studies carried by Nicoll (2001), Tan ve Treagust (1999), Taber (1997) ve Ünal (2003). Also, students confused metallic bond with covalent bond and they claimed that covalent bond is formed *''between metal atoms''*. This result is in accordance with the results of Ünal(2003) and Sevim(2007). The other false answers which students accepted as correct were: ''*Electrons disappeared between two atoms'', ''Electrons separated between two atoms*.''. These alternative concepts which are common student errors were also ascertained by Boo (1998), Eshach and Garik (2001) and Sevim (2007).

In the thirteenth question of the test the aim is to make the students determine the molecule between the atoms that contains polar covalent bond. In this question students confused the concepts 'non-polar covalent bond' with 'polar covalent bond', and great majority of them (79% of the sample group) selected the compounds which have non-polar covalent bonds between their atoms by assuming that compounds have polar covalent bond patterns. The confusion of the students about 'polar' and 'non-polar' concepts also the result of the studies carried by Nicoll (2001) and Ünal (2003). This situation can be described as a sign to the confusion of students about these two concepts.

These questions are the ones that require passive knowledge level. Percentages of the alternative concepts which students have in these questions in 1st group 58%-70%, in 2nd group 64%-73%. These percentages are between 66%-70,2% in the 1st sample group, between 18%-23% in the 2nd group for the post-test. When the data are analyzed, it is obvious that conceptual change in 1st group was more than the 2nd sample group. This data is parallel with Mikkila-Erdmann (2001)'s study which indicates that alternative concepts in memorization questions undergo a significant conceptual change

In the 5th question of the test, the aim is to ascertain student understandings about the difference between conductivities of a diamond which has double covalent bonds, and

graphite. To these questions, majority of the students marked the answers which had errors as correct. The alternative concepts of students were: *''Because carbon atoms are not bonded tightly in graphite, some of the atoms do not form bonds and move individually.''* 26%, *''Graphite conducts electricity because in Graphite, some of the carbon atoms are delocalized and these conduct electricity*.'' 26%, and *''Graphite conducts electricity because they contain the layers of carbon atoms which can slide on each other.*'' 29%. When these alternative concepts are analyzed it is seen that the students did not know much about the composition of Graphite, and with interpreting superficial information they already had, they determined the reason of graphite's electrical conductivity. These three alternative concepts students had are parallel with the errors which are also emphasized on Tan and Treagust (1999)'s study. In addition to that, naive views and conceptual errors of students about covalent bonds, is also shown in the study of Peterson, Treagust and Garnett(1989).

In the 8th question of the test, the aim is to ascertain student understandings of the reactions of the electrons in polar covalent bond. In this question, most of the students selected "*Electrons have equal distances to both of the atoms*.'' as the correct answer. The misconception of electrons localization on the center between two atoms in all covalent bonds also determined in studies carried by Peterson, Treagust, and Garnett (1989), Ünal (2003) and Peterson and Treagust (1989). The reason for student's misconception can be their knowledge about the common use of electrons in the covalent bonds, and because of this information, they may think that sharing must be equal. This thought may be the result of student's misunderstanding of the concept 'sharing'. Also in the 8th question of the test, the aim is to ascertain student understandings of positions of bond electrons in HF molecule and the reason for that position. In this question as in the other, most of the students selected the alternative concepts which are defined as common errors of students in literature. Errors of these choices were: *'' Because hydrogen and fluorine form a covalent bond, electron pair must place at the center''* 22%, *'' electrons which are not joining the bonding, effects the positions of the bonding or shared electrons.''* 28%, and '*Because fluorine electron is bigger than hydrogen electron, it has a stronger effect on bond electrons.*''23%.Students who have these misconceptions can be interpreted as they do not have adequate knowledge about electronegativity and the role of this concept during covalent bonding. Students who have this misconception could associate the electron sharing with covalent bond correctly but they could not think of the effects of the effect of electronegativity and as a result, the effect of sharing unequal electron pairs in bond polarity. The misunderstanding of students about the concept of electronegativity is also shown in the studies carried by Nicoll (2001), Peterson, Treagust and Garnett (1989) and Peterson and Treagust (1989).

c) Arguments Toward the Alternative Concepts About Ionic Bond and Conceptual Change

The aim of the 2nd and the 9th questions in the test is to ascertain the student understandings about ionic bonds. The purpose of the 2nd question is to ascertain student understandings about how an ionic bond is formed and the reactions of valance electrons in atoms while forming an ionic bond. Incorrect answers were chosen equally by the students in both groups are: "electrons completely disappeared" 26%, "electrons separated between two atoms" 26% and "electrons are shared between two atoms" 20%. In the 9th question of the test, the aim is to observe student's detection of which group elements on the periodic table form ionic bond. More than 50% of the students in both groups selected these choices about ionic bond formation: "*between metal atoms*" 37%, "*Between nonmetal atoms*." 13%,"Between noble gases and metal atoms or nonmetal atoms." 28%. When answers given

to these questions are analyzed, it is found that students confused ionic bond with covalent bond and metallic bond with ionic bond. The result which indicates students' confusion about these concepts, is similar to the studies carried by Nicoll (2001), Tan and Treagust (1999), Taber (1997), Ünal (2003) and Boo (1998).

Also these questions require passive knowledge level, and in both groups, the conceptual change of students is observed. The aim of the questions is to ascertain student understandings about how ionic bond is formed and how do the electrons of atoms that form the bond react during the formation. The mean rank of results were calculated and it is seen that on the pre-test, while students in the 1st group had 71%, and the students in the 2nd group had 73% alternative concepts, these rates increased to 25% in the 1st group, and 14% in the 2nd group after the post-test. As indicated at the alternative concepts that students have, the most wide alternative concept about Chemical bonds is the confusion of covalent bond with ionic bond. First of all, because analogies about covalent bonds provide them to realize and remember their alternative concepts, it is acceptable that they achieved conceptual change about ionic bond. Second, it is considered that students got the chance to realize these errors one by one with the help of Conceptual Change Text.

The 15th question of the test requires active knowledge level about ionic bond. In this question the rate of having alternative concepts in the 1st group is 75%, and the students in the 2nd group had 82% alternative concepts in the pre-test. In the post-test however, these rates are: 37% for the first group, and 27% for the 2nd group.

The other finding of the study is that Analogy or Conceptual Change Text, the conceptual change happened 37% on the 1st group (the group which analogies were used), 27% on the 2nd group. These data indicates that Analogies more effective.

d) Arguments Toward Alternative Concepts About Intermolecular Forces and Conceptual Change

The 3rd, 6th, 7th, 10th, 12th, 14th, 16th questions of the test are about student understandings of Intermolecular Forces. In the 13th question of the test the aim is to ascertain student understandings about the formation of Van Der Waals forces and the features of the concept. Most of the students selected the wrong answers equally such as: ‘‘*Van der Waals forces are the bonds between atoms in non polar molecules i.e.: H_2, O_2, CI_2,’’*, ‘‘*Strength of Van der Waals forces depends on size of the molecule, but does not depend on the form of the molecule*.’’, ‘‘*Van der Valls forces exists only between noble gases such as: He Ar Ne.’’*. The reason for students misconception of ‘‘*Van der Waals forces are the bonds between nonpolar molecules such as: H_2, O_2, CI_2’’* can be interpreted as students' confusion of intermolecular bonds with chemical bonds. When the literature is analyzed about this subject, this alternative concept was particularly studied by Ünal(2003). On the other hand, the results that shows students confusion of Intermolecular Forces with Chemical Bonds also found in the studies carried by Treagust(1988), Peterson, Treagust and Garnett(1989), Peterson and Treagust(1999). Similarly, they limited the subject with Noble Gas Atoms. That is another evidence of the poor understanding students have. The other misconception about this subject is: ‘‘*force of Van der Waals Forces depend on molecule size but do not depend on the form of the molecule.’’*. The same results are only available in Unal(2003)’s reports.

In the seventh question of the test, the aim is to ascertain student’s understandings about Dipol-Dipol Forces. As answer of this question more than 50% of the students chose these answers which contain common alternative concepts: ‘*The melting and boiling points of the molecules, which contain Dipol Dipol interaction, are generally low*.’’, and *‘‘Dipol-Dipol Forces are weaker than Van der Waals Forces.’’ “These are the weak forces between*

molecules as a result of the atoms affected by the momentary disruption of symmetries of the nobel gas atoms which generally have symmetrical distribution of electrons.'', ''noble gas atoms such as He, Ar,, Ne, have symmetrical electron distributions. An instant break of symmetry causes polarity. And these are the weak attraction forces caused by the effect of this symmetrical break on the atoms around polarity.'' In this question, students confused the most important alternative concepts with Dipol-Dipol Forces and Van der Waals Forces. Also some students thought that Dipol-Dipol Forces are weaker than Van der Vaal Forces. These results show the weak views that students had about Intermolecular Forces. In literature, students weak understandings about the molecular attractive forces were also mentioned in the studies carried by Treagust(1988) Peterson, Treagust and Garret(1989) Peterson and Treagust(1989), Tan and Treagust(1999) and Ünal (1999).

In the 10th question of the test, the aim is to determine student understandings about the formation of Intermolecular Forces and the features of these forces. To this question, more than 50% of the students gave these wrong answers: "*The force that keeps hydrogen and oxygen together in a water molecule is the hydrogen bond.*'' And ''*hydrogen bond is an attraction force formed between hydrogen of a water molecule and hydrogen in another water molecule*.''. Students partially accept ''*Intermolecular forces are the forces in molecules*'' as the correct answer. When answers given to these questions are analyzed, it was found that students confuse Intermolecular Forces with Chemical bonds. Especially they use covalent bonds and hydrogen bonds on wrong places. Misconception students had about connections Hydrogen bond with Covalent bond and consider it a molecular bond was also emphasized on the studies carried by Peterson, Treagust and Garnett(1989), Peterson and Treagust(1989), Tan and Treagust(1999). The most important result of this question is that these students' marked the statement indicating that hydrogen bond was formed between hydrogen in one molecule and hydrogen in other molecule as the correct answer.

The 12th question of the test is a passive knowledge requiring question about hydrogen bonds. After the pre-test 79% of the first group members and 77% of the 2nd group members had alternative concepts, after the post-test, these rates decreased to 33% in for the 1st group, and 23% for the 2nd group. Similar to the other concepts, in the group which were taught with Analogy, there had been a significant conceptual change on passive knowledge level.

The 6th and the 16th questions of the test is about creating a general understanding about Intermolecular Forces and is requiring active knowledge. In 6th question, students were asked to find the molecules which had the highest and the lowest boiling points. For this question while students who had alternative concepts were 79% in the first group and 77% in the second group for the pre-test, after the post-test this rate decreased to 50% in the first group, and to 32% in the second group. In the 16th question of the test, students were asked to explain the the reason why water is in liquid form while hydrogen sulfur is in gas form at room temperature. For this question, while students who had alternative concepts were 91% in the first group and 87% in the second group for the pre-test, after the post-test this rate decreased to 42% in the first group, and 28% in the second group. Similar to the other results, using analogy was also effective in this question. On the other hand, it was also seen that the great majority of the students could not change the alternative concepts they had. Despite the fact that the change on the alternative concepts about Intermolecular Forces was enough, the reason for the decrease of this rate in the questions designed for practicing these concepts, could be accepted as a sign of insufficiency of the Conceptual Change Texts in creating a conceptual change at active knowledge level. While these data is parallel with the results of Sevim(2007), they are in contradiction with the results of Mikkila-Erdmann(2001) which indicates that Conceptual Change Text is effective on conceptual change in the critical distinction and producing.

RESULTS and SUGGESTIONS

Data obtained toward the aim of this study are presented below:

- Based on the results of the t-test which was done after the application related to the subject of Chemical Bonds and Intermolecular Forces, it is concluded that 2nd experiment group(where analogies were used) is more successful compared to the 1st experiment group (where Conceptual Change Texts were applied) ($X_{Analogy}$: 74,72; X_{CCT}: 59,12), and there is a significant difference ($t_{(66)}$: 0.000; $p<0.05$) between these two groups. For this reason, it is concluded that a method supported by analogies is more effective on conceptual change than a method supported by Conceptual Change Texts.
- When data obtained from the pre-test are analysed, it is detected that from both groups ¾ of the students in passive knowledge level, and 4/5 of the students in active knowledge level, have alternative concepts in Chemical Bonds and Intermolecular Forces. Based on this information, it is concluded that students develop more alternative concepts related to the concepts that hey don't use in daily life, when compared to the other concepts. This result is in accordance with the results of Ebenezer and Gaskell (1995), Taber (1997), Coll and Treagust (2001), Prieto, Ebenezer and Fraser (2001), Ünal (2003); Sevim (2007)'s studies.
- On the questions which require passive knowledge level, conceptual change rate was high in both group. On these questions rates of students, who had alternative concepts at the post-test results, vary between 12% and 24%. Based on these results, it can be inferred that a method which is supported by Analogy and/or Conceptual Change Texts are both effective on achieving conceptual change in passive knowledge level. This result is in accordance with the study of Mikkila-Erdmann (2001) which indicates that preconceptions on the memorization questions of CCTs were significantly changed, and the results of Guzzetti et al., (1997), Hynd et al., (1997), Thiel and Treagust (1995), Venville and Treagust (1997)'s studies that indicate CCT and Analogies are effective on students' conceptual change.
- On the questions that require active knowledge level, conceptual change occurred in the group on which the method that was supported with Conceptual Change Texts are applied lower than the other group. On the post-test, rates of having an alternative conception was above 30%. Based on this, it can be inferred that CCTs are not effective enough to provide conceptual change in active knowledge level. This result is in contradiction with the result of Mikkila-Erdmann (2001)'s result which indicates that preconceptions in the questions of critical distinction and making conceptual connections in CCT change significantly. As can be inferred from the results of the study; Despite CCT is effective enough on conceptual change in passive knowledge level, it is not effective enough on the situations that require making connections between concepts and finding possible solutions to the problems. In other words, it is not suitable for imagining the micro phenomenons in macro level. For this reason, CCT should be supported with demonstration, and computer simulations etc.

On the questions which require active knowledge level, conceptual change occurred at a very high level. At the post-test, alternative concept rate was below 27%. Based on this, it can be inferred that Analogies are effective enough to achieve conceptual change. This result is in accordance with the results of Bilgin and Geban (2001), Thiel and Treagust (1995), Venville and Treagust (1997), Özkan et al., (2001; 2004)'s studies which indicate that Analogy is effective on conceptual change.

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