FACILITATING CONCEPTUAL CHANGE IN ATOM, MOLECULE, ION AND MATTER COCEPTS[1]

Atom, İyon, Molekül ve Madde Kavramlarının Öğrenilmesinde Kavramsal Değişim Metinlerinin Etkisi

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Abstract

The main purpose of the study was to investigate the effects of conceptual change texts oriented instruction accompanied with analogies on seven grade students' understanding of atom, molecule, ion and matter concepts. In addition, the effect of instruction on students' attitudes toward science as a school subject and the *effect of gender difference on understanding of atom, molecule, ion and matter concepts were investigated.. In this study, 70 students at seventh grade from two classes were participated and they were instructed by the same teacher. The study was conducted during 2004-2005 first semester. Two groups were selected randomly throughout five classes. One of the group was defined as control group and other group defined as experimental group. Students in control group were instructed traditional method and students experimental group were instructed by conceptual change text oriented instruction accompanied with analogies. Attitude Toward Science and Atom, Molecule, Ion, Matter Test were administered to both groups as a pre-test and post-test. ANOVA model was used to test hypothesis. The results showed that experimental group significantly better acquisition of the scientific conceptions related to atom, molecule, ion and matter concepts than the traditional group. On the other*

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hand, no significant effect of gender difference on understanding of atom, molecule, ion and matter concepts and students' attitudes toward science as a school subject was found.

Key Words: *Conceptual Change Text, Analogy, Misconception, Attitude Toward Science*

Öz

Bu çalışmanın amacı analojilerle desteklenmiş olarak hazırlanan kavramsal değişim yaklaşımına dayalı öğretimin 7. sınıf öğrencilerinin atom, molekül, iyon ve madde konusu ile ilgili kavramları anlamalarına etkisini incelemektir. Aynı zamanda, öğretim yönteminin öğrencilerin Fen Bilgisi dersine yönelik tutumlarına etkisi ve cinsiyet farkının öğrencilerin atom, molekül, iyon ve madde kavramlarını anlamalarına etkisini incelemektir. Çalışmada, aynı fen öğretmeninin eğitim verdiği 70 yedinci sınıf öğrencisi yer almıştır. Çalışma, 2004-2005 eğitim öğretim yılı birinci dönemde yürütülmüştür. Çalışmada iki grup, beş grup arasından rastgele seçilmiştir. Gruplardan biri kontrol grubu olarak adlandırılmış diğeri deney grubu olarak adlandırılmıştır. Kontrol grubundaki öğrenciler geleneksel yöntem ile öğrenim görmüş ve deney grubundaki öğrenciler analojilerle desteklenen kavramsal değişim metinleri ile öğrenim görmüşlerdir. Çalışmada, Fen Bilgisi Dersi Tutum Ölçeği ve Atom, Molekül, Iyon ve Madde Kavram Testi her iki gruba da ön test ve son test olarak uygulanmıştır. Çalışmanın hipotezlerini desteklemek için ANOVA istatistiksel analiz yöntemleri kullanılmıştır. Analiz sonuçları deney grubundaki öğrencilerin atom, molekül, iyon ve madde konularındaki başarılarının, kontrol grubundaki öğrencilere göre daha yüksek olduğunu göstermiştir. Ancak, cinsiyet farkının atom, molekül, iyon ve madde kavramlarını anlama ve Fen bilgisi dersine olan tutumlarına bir etkisi olmadığı saptanmıştır.

Anahtar Kavramlar: *Kavramsal Değişim Metinleri, Analoji, Kavram Yanıgıları, Fen Bilgisi Dersi Tutum Ölçeği*

INTRODUCTION

In Science education students have most of ideas while the learning occurs or after the end of learning. Students construct their ideas through their experiences with their social environment. Although students have instructed with scientific knowledge, they hold their pre-knowledge. Students' pre-knowledge conflict with new knowledge and they may not construct a relation between the scientific knowledge and new knowledge. By this way, the conceptions may be misunderstood by the students. These alternative students' views have been characterized as preconceptions (Anderson and Smith, 1983), intuitive beliefs (McCloskey, 1983), children's science (Osborne, Bell, & Gilbert, 1983), naive beliefs (Caramazza, McCloskey, & Green, 1981). These terms describe an idea that a student holds before general chemistry instruction (Bodner, 1986). Students' ideas may be change quite different from expected.

Conceptions that are inconsistent with the accepted scientific conceptions defined as misconceptions. Researchers have used various terms for misconceptions, such as alternative conceptions, alternative frameworks, and preconceptions (Novick & Nussbaum, 1982; Nakleh, 1992). Misconceptions integrated into a student's cognitive structure and interfered with subsequent learning. When the student don't make connection new knowledge into a cognitive structure, they already keep their inappropriate knowledge in their mind. Thus, the new information cannot be connected appropriately to their cognitive structure, and weak understanding or misunderstandings of the concepts will occur (Nakhleh, 1992).

Misconceptions and pre-existing knowledge that students have cannot be eliminated by simply presenting new information. Students are resistant to change their existing knowledge when they are instructed by traditional method (Wong & Pungh, 2001). If the students actively engaged the learning process, their misconceptions and existing knowledge may be changed. So, students must become motivated to participate actively the lesson.

In science education, students have a lot of misconceptions at science concepts. So, many researchers have focused on students' misconceptions at science concepts like dissolution (Blanco, 1997), chemical bonding (Coll and Taylor, 2001), chemical reaction (Ayas and Ozmen, 2002). Studies focusing on students' understanding of atom, molecule, ion and matter indicated that students have a considerable degree of misconceptions in several grade levels. Particulate nature of the matter is fundamental to subsequent learning of various topics in chemistry education. (Novick and Nussbaum, 1978). For example, it is the basic of chemical bond, chemical equilibrium, and chemical reactions. There have been various research studies done in order to determine students' understanding and misconceptions about atom, molecule, ion and matter concepts (Osborne and Cosgrove , 1983; Lee at al., 1993; Harrison and Treagust, 1996; Harrison and Treagust, 2000).

Consequently, many researchers explored misconceptions and instructional approaches for to prevent them. Constructivism is one of the most effective theory among the learning theories. (Hynd, McWhorter, Phares, and Suttles, 1994). According to this philosophy, learners construct knowledge themselves. Students construct their own knowledge by experiencing their own ideas which are based on their previous knowledge. They apply these to new situations and integrate the previous knowledge with the new knowledge (Hein, 1991; Taber and Watts, 1997). How students come to understand scientific knowledge is very important problem. Researchers designed models to provide this understanding. One of the models in constructivism theory is conceptual change model. In this model; teacher asks to students to predict what would happen in a given situations related to science concepts. Then the teacher demonstrates the inconsistency between common misconceptions and scientific conceptions and he/she gives the presentations of information (Chamber and Andre, 1997). According to conceptual change model when students have existing knowledge before the instruction they cannot link easily the new knowledge with their own meanings (Hynd et.al.1994). If the teacher transformed the symbols, theories and terminologies to appropriate instructional materials, students can understand the new conceptions easily (Chiu, 2005). Many science researchers stated that conceptual change approach provides meaningful understanding in students' mind and it helps to remove the students' alternative conceptions (Hynd at al, 1994; Tekkaya, 2003; Pabuççu and Geban 2006). A conceptual change text is one of the techniques that identifies and analayses students' misconceptions and it removes them from students' mind. Inconcistencies between the misconceptions and the scientific knowledge is illustruated in conceptuai change texts. By this way cognitive conflict occurs andvnew conception is constructed in students' mind (Hynd at al. 1994). Also, using analogies is another way to prevent misconceptions. Analogies are important things in learning difficult scientific science concepts. There are comparisons of structures between two domains in analogies. These are useful tools in education. Many researchers investigated effects of analogies in science and they stated that analogies are explanotory and useful devices in science (Heywood 2002; Rule & Afurletti 2004; Yanowitz, 2001). Duit (1991) stated that analogies may enhance the learning and it may make easier understanding of abstract issues.

Students have a lot of misconceptions on atom, molecule, ion and the matter concepts. These concepts are the central of the chemistry concepts. There is a need for effective instructional strategy to prevent students' misconceptions. Because of this reason, the purpose of the study was to explore the effects of conceptual chance texts oriented instruction accompanied with analogies over traditionally designed science instruction on 7th grade students' understanding of atom, molecule, ion and matter concepts and their attitudes toward science as a school subject. The second purpose of this study is to identify the role of gender, treatment and the interaction between gender and treatment.

METHODOLOGY

Sample

This study consisted of seventy students at 7th grade from two classes of a General Science Courses. They were taught by the same teacher. Two instruction methods of the study were randomly assigned to the groups. Data for this research was obtained from 35 students participating in conceptual change text oriented instruction accompanied with analogies and 35 students participating in traditionally designed science classroom instruction.

Instrument

In this study, two written test were used. These tests were Atom, Molecule, Ion, Matter Conceptions Test and Attitude Scale Toward Science as a school subject. During the development stage of the test, the alternative conceptions of the students about atom, molecule, ion and matter concepts were determined from the related literature atom, molecule, ion and matter. Therefore it could be expected to be determined misconceptions about atom, molecule, ion and matter concepts for the students who give the wrong answer. The tests were administered to students under standard condition.

Atom, Molecule, Ion, Matter Concept Test

This test was developed by the researcher and for the content validity the test was examined by a group of expert in science education for appropriateness of the items. The test consists 19 multiple choice items. Each question had one correct answer and the other choices are distracters. Questions were asked to students make a conceptual prediction about a situation. Distracters of items involve the misconceptions and it is possibly to choose the distracters in the test.

Attitude Scale Toward Science

This scale was developed by Geban and Ertepınar (Geban et al., 1994) to measure students' attitudes toward science as a school subject. This instrument contains 15 items in a point likert type scale (fully agree, agree, undecided, partially agree, and fully disagree) in Turkish. The scale is 5 point and there are positive and negative statements. It was given to the all students in this study.

Procedure

This study was conducted over 4 weeks. A total of 70 students in a elementary school were participated in two science classes of the same teacher. Two different treatments were used in this study. Traditionally designed science instruction was utilized to the students in control group and conceptual change text oriented instruction accompanied with analogies was utilized in experimental group. During the treatment the topics related to atom, molecule, ion and matter were covered as a part of the regular classroom curriculum in the science course. The course of the regular schedules is three 40 minutes periods per a week. Lecture and discussion methods were used in the traditionally designed science instruction courses. Teaching methods was based on explanations, textbooks and questioning. Hence, the misconceptions that students had been not took into account. Definition, explanation and concepts were presented on the blackboard. However, the conceptual change texts and texts accompanied with analogies were given to 35 students in experimental group. Texts were prepared by the researcher by searching for the related literature. Conceptual change texts identified the misconceptions about atom, molecule, ion and matter concepts and corrected them by giving analogies, examples, figures and scientific explanation. Scientific knowledge and explanation in the texts are intelligible and plausible. Thus, students were expected to be dissatisfied with their previous knowledge, and then they were corrected by using analogies, examples, figures and scientific explanation. Students activated to make a prediction about the situation. It was given some evidence that the misconceptions are incorrect. Thus, it was provided that to reach the scientifically correct explanation. The teacher started the lecture with an inquiry questions to activate students' existing knowledge and misconceptions. Teacher attempted to provide a discussion environment and also she tried to find out students misconceptions about atom, molecule, ion and matter concepts. During the treatment, each conceptual change text was given to the students by using overhead-projector. Teacher acted as a guide in the discussion. Conceptual change text was given in the class hour. Also, analogies were used in some conceptual change texts.

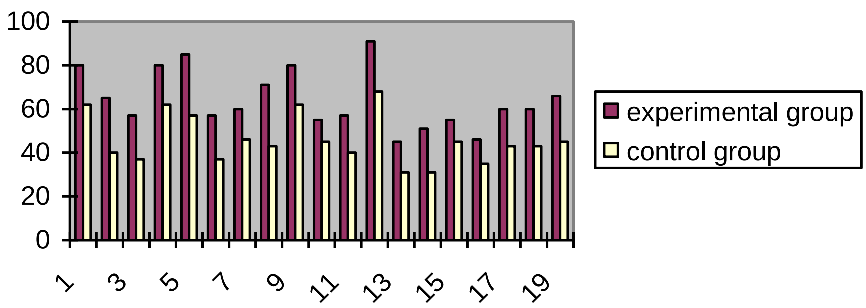
Data Analyses

ANOVA was used to determine the effectiveness of the two different instructional methods and gender differences in students' achievement related to atom, molecule, ion and the matter concepts. In addition, it was used to determine the differences between the post test mean scores of the students in conceptual change text instruction group and traditionally science instruction group with respect to their attitudes toward science as school subject.

Results

Figure 1 shows the correct responses to the questions in the posttest.

CorrectProportion



Number of Items Proportion

As seen in figure 1 there is a difference between experimental group and control group achievement. The average percentage of correct responses of experimental group was %67 while that of control group was %47. The differences was easily seen questions 3, 5, 8, 12 .As it was examined the proportion of misconceptions of two groups, it was seen that some of the misconceptions were used much than the others. It was given proportion of misconceptions in some question; For the first question students had to distinguish examples of matter (door, human body, cloud) and non matter (heat). Most of the students responded this question correctly (%80 of students in experimental and %62 of students in control group). However in both groups, %50 of the students thought that ‘cloud’ is not a matter and %15 of them thought ‘door’; %35 of them taught the ‘human body’ is non matter.

The students were asked about structure and shape of the atoms in question 2. %65 of the students in experimental group and %40 of the student in control group responded this question correctly. However in both groups, %20 of the students defined that an atom resembles a solid sphere with components; %50 of them thought that an atom look like several dots around nucleus.

Feature of fourth question was that it addressed a misconception which was related particulate nature of matter. Students distinguished heat, light and perfume according to their particulate nature. %66 of the students in experimental group and %43 of the student in control group responded this question correctly. However in both groups, %50 of the students responded the question wrongly and %21 of them choose perfume and heat; %29 of them choose light.

It was asked to identify the correct size of an oxygen molecule in question 5. %85 of the students in experimental group and %57 of the student in control group responded this question correctly. However in both groups, %43 of the students thought that the molecule is as big as a speck of dust; %33 of them thought that the molecule is as big as a germ; %24 of them thought that it is as big as the size the point on pencil. Feature of the sixth question was that it asked to students the correct statement about the variation of water molecules during the evaporation process. %57 of the students in experimental group and %37 of the student in control group responded this question correctly. However in both groups, %41 of the students thought that when the water evaporate, it is separated to oxygen and hydrogen .%35 of them thought that a new matter occurs. %24 of them is thought that atoms in the water molecules change.

The students were asked what happens to atoms in a flower when squashed by a car in question12. %91 of the students in experimental group and %68 of the student in control group responded this question correctly. However in both groups, %50 of the students thought that atoms in the flower change to another atoms. %35 of them thought that shape of the atoms will change; %15 of them thought that atoms will disappear.

The analyses result showed that the post test mean scores of control group and experimental group with respect to understanding of atom, molecule, ion and matter were significantly different ($F=10.49$, $p<0.05$) experimental group scored significantly higher than the control group (X(experimental) = 10.78; X(control) = 8.72).

Table 1. *ANOVA Summary (Understanding)*

Source	Sum of square	DF	Mean Square	F	Sig.
Corrected Model	82,346 [a]	3	27,446	3,637	0,017
Intercept	6617,053	1	6617,053	876,851	0,000
Group	79,230	1	79,230	10,499	0,002
Gender	4,053	1	4,053	0,537	0,466
Interaction	2,170	1	2,170	0,288	0,594
Error	513,154	68	7,546		

The results are shown in the table 1. Gender didn't make a significant contribution to the variation in understanding (F=0.534, p>0.05). There was no statistically significant difference between boys and girls with respect to understanding of atom, molecule, ion and matter concepts.

Interaction between gender and treatment in students' understanding of atom, molecule, ion and matter concepts, analysis of variance was used. The results are shown in the table 1. Interaction between gender and treatment didn't make significant contribution to the variation in understanding (F=0.288, p>0.05).

Also,the analyses result showed that the post test mean scores of experimental group and control group with respect to attitudes towards science as a school subject were not significantly different (F=0,008 p>0.05). The analyses result showed that the post test mean scores of experimental group and control group with respect to attitudes towards science as a school subject were not significantly different (F=0,008 p>0.05). The analysises of data is summarized in Table 2.

Table 2. *ANOVA Summary (Attitude)*

Source	Sum of square	DF	Mean Square	F	Sig.
Corrected Model	105,483 [a]	3	35,161	0,514	0,674
Intercept	6617,053	1	257053,776	3756,326	0,000
Group	79,230	1	0,557	0,008	0,927
Gender	4,053	1	13,337	0,195	0,660
Interaction	2,170	1	89,786	1,312	0,256
Error	513,154	68	68,432		

The results are shown in the table 2. Gender didn't make a significant contribution to the variation in understanding (F=0.195, p>0.05). There was no statistically significant difference between boys and girls with respect to attitudes towards science as a school subject. Also, interaction between gender and treatment didn't make significant contribution to the variation on students' attitudes towards science as a school subject (F=1.312, p>0.05).

DISCUSSION

Most of the studies in science education show that students are unable to understand some basic science issues. Students can interpret the concepts, incorrectly and then they may not make interaction the new knowledge with their existing knowledge (Gilbert, Osborne and Fenshman 1982). Students use their existing knowledge to interpret new information in ways which make sense to them. They build their own conceptual structure by restructuring of their existing knowledge (Posner at al. 1982). Students' interaction with their friends, parents affects the learning by this way; they have made meaning of their everyday experiences. And, they construct new knowledge on their existing knowledge. As accepted by many scientists, misconceptions are defined as conceptions which are inconsistent with the scientific knowledge. It must be eliminate or prevent the misconceptions in order to enhance students' meaningful learning. Most of the researchers investigated how can be changed the pupils' existing knowledge and they proposed instructional strategies for it. One of them is conceptual change approach. It is developed by Posner et al.(1982). There are four conditions for changing students' misconception. In this model learners must become dissatisfied with their existing conceptions as well as find new concepts intelligible, plausible, and fruitful, before conceptual restructuring will occur. However, it was found in this study that some student misconceptions are very resistant to instructional change. Also it was found that some students insist their misconceptions even after instruction.

As it was compared the posttest mean scores of experimental group and control group, it was found that there were significant difference between the two groups. The results showed that students' understandings of scientific conceptions in experimental group are better than the students in control group. In traditionally science instruction, the conceptions were instructed to the students traditionally as seen in science textbooks. However, in conceptual change text instruction the conceptions were instructed to the students in different ways. By using prior knowledge of the students in conceptual change text instruction, special learning statements were constructed. Students' alternative ideas and scientific explanation were given in qualitative examples, and the students activated to find out the descriptive evidence in the text. It was provided by asking questions about the examples consisting misconceptions. Then, students will be aware of the inconsistency between their intuitive ideas and scientific explanation. Therefore, students realize that their intuitive ideas are inadequate to explain the descriptive events. The study showed that activating students' prior knowledge and refuting their misconceptions led to enhance students' understanding of the conceptions and their achievement. Paralleling the findings of previous studies in the literature (Nakleh, 1992; Harrison and Treagust, 1996; Haidar, 1996), it was found in the present study that there were a number of misconceptions among the students concerning the subject of atom, molecule, ion and matter which can be summarized as follows:

Table 3. *Misconceptions among the students concerning the subject atom, molecule, ion and matter*

Atoms are large enough to be seen under microscope.
Atom can be squashed.
When the atom was squashed, its shape can be changed or it can be transform another atom.
Atoms in molecules of water are liquid.
Electron doesn't play any role in chemical reaction
Heat is matter.
Molecules change in evaporation.

The attitude scale toward science as a school subject was administered to all students in two groups. When the results of the study analyzed it was found that there was no significant difference between the test scores of the conceptual change text instruction group and traditionally science instruction group in terms of attitudes toward science as a school subject. The results indicated that statistically development of experimental group and control group are similar. Students' attitudes toward science have been constructed from first science course in their education life. Conceptual change text instruction was administered to students a 4 week period. This is short time to change students' attitude toward science. In order to have more positive attitude, the new method may need to be used for more length time period.

On the other hand, the results showed that there is no significant difference between girl and boy with respect to achievement related to atom, molecule, ion and the matter concepts. Achievement of the boys and girls both experimental group and control group are not different.

CONCLUSION

In summary, this study showed that conceptual change text instruction caused significantly better acquisition of scientific conceptions and elimination of misconceptions related to atom, molecule, ion and matter concepts than the traditionally designed instruction. Gender was not a strong predictor for the understanding of related concepts and for the attitudes towards science as a school subject. Both group caused statistically the similar attitudes towards science as a school subject. Also, it was found that students have difficulties in understanding of atom, molecule, ion and matter concepts, and students' misconceptions related these concepts are resistance to change. If these misconceptions could not be eliminated, they affect further learning negatively.

Therefore, researchers, instructors, textbook writers and curriculum developers must be aware of students' misconceptions in atom, molecule, ion and matter concepts and try to prevent them from occurring.

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