Hacettepe Üniversitesi Eğitim Fakültesi Dergisi 19 : 79-84 [2000]

EFFECT OF CONCEPTUAL CHANGE APPROACH ON STUDENTS' UNDERSTANDING OF CHEMICAL CHANGE AND CONSERVATION OF MATTER

KAVRAMSAL DEĞİŞİM YAKLAŞIMININ ÖĞRENCİLERİN KİMYASAL DEĞİŞİM VE MADDENİN KORUNUMU KONULARINI ANLAMALARINA ETKİSİ

Ömer GEBAN* Gülsüm BAYIR**

ABSTRACT: The research reported in this study was designed to identify and characterize students' conceptions about chemical change and to investigate the effectiveness of conceptual change text instruction over traditionally designed chemistry instruction on 9thgrade students understanding of chemical change. In this study 10 tenth grade students were interviewed to expiore the students' concepts of chemical change. There were two groups in the study. The experimental group was instructed by conceptual change texts through teacher lecture while the control group was instructed by traditionally designed chemistry instruction. Both groups took 20 multiple choice items achievement test at the end of the treatment. Independent t-test statistics was used to detect the differences between the groups on achievement in chemistry. The results show that the experimental group had a significantly higher scores with respect to achievement than the control group.

KEY WORDS: *Chemical Change, Conceptual Change Text, Misconceptions.*

ÖZET: Bu araştımada öğrencilerin kimyasal değişim konusundaki anlam yanılgıları belirlenmiş ve kavramsal değişim metinlerinin kullanıldığı öğretim metodunun lisel öğrencilerinin başarılarılarına etkisi incelenmiştir. Öğrencilerin kimyasal değişim ve maddenin korunumu konusundaki kavram yanılgılarını bulmak amacıyla 10 lise II öğrencisi ile görüşme yapılmıştır. Daha sonra iki grup oluşturulmuştur. Kimyasal değişim konusu işlenirken deney grubunda kavramsal değişim metinlerini kullanıldığı bir öğretim, kontrol grubunda ise geleneksel öğretim metodları kullanılmıştır. Bu uygulamadan sonra her iki grup ta 20 çoktan seçmeli soru içeren bir başarı testi almıştır. İki grup arasındaki kimyasal değişim ve maddenin korunumu ile ilgili başarı farkını gözlemek için t-testi analizi kullanılmıştır. Sonuçlar kavramsal değişim metinlerinden faydalanan grubun başarısının istatistiksel olarak daha fazla olduğunu göstermiştir.

ANAHTAR SÖZCÜKLER: *Kimyasal Değişim, Kavramsal Değişim Metinleri, Anlam yanılgıları.*

1. INTRODUCTION

Science education is becoming increasingly popular and important as it seen as a mean of improving the method of scientific thinking, providing students with more experiences of making explanation and interpretation about their environment and capability of finding solution of problem. In recent years research has focused on identifying and characterizing students understanding and difficulties about many science topics in science education.

Research has consistently shown that students do not come to classroom with blank slates, rather they come with well-established understanding about how and why everyday things behave as they do [1]. During instruction learners generate their own meaning based on their backgrounds, attitudes, abilities and experience. According to cognitive model, students built sensible and coherent understandings of the events and phenomena in their word from their own point of view [2]. Furthermore, resent research has revealed that these understandings whether correct or incorrect, influence how students learn new scientific knowledge. These different concepts have been variously described by different researchers as preconceptions, misconceptions, alternative frameworks, children's science, students' descriptive and explanatory system[3].

Research done to identify the sources of students' incorrect scientific understanding and to evaluate instructional technique to change

* Assoc. Prof.Dr., METU, Faculty of Education, Department of Secondary Science and Mathematics Education, 06531-Ankara.
**Graduate Student, METU, Faculty of Education, Department of Secondary Science and Mathematics Education, 06531-Ankara.

these incorrect understandings have been more popular in science education research literature.

Ben-Zvi, Eylon and Silberstain [4] studied students' understanding of chemical reactions. They found that students have great difficulty in changing their thinking when they are asked to jump from observable changes in substances to the observable changes in terms of the interactions between individual atoms and molecules.

In another study Abraham, Gryzbowski, Renner and Marek [5] found similar results for the chemical change concept with eight grade students. Five chemistry concepts were used in the study (chemical change, dissolution, conservation of atoms, periodicity and phase change). They note that students confuse physical change with chemical change. Results of this study show that students conserve atoms but try to do this by changing the formula of the compounds. The authors indicated that most of the students sampled showed no understanding or had developed various misconceptions of these concepts.

Hesse and Anderson [6] also studied the chemical change concept. Results revealed that students commonly experience difficulties at three different epistemological levels: chemical knowledge (most students fail to invoked atoms and molecules as explanatory constructs), conservation reasoning (many students can not predict or explain mass changes in the chemical reactions), explanatory ideas (many students' explanations are based on analogies with everyday events).

Most conceptual change approaches to instruction focus on using in-class teacher-student and student-student interaction to promote conceptual change. Such methods are very appropriate for smaller-sized classrooms. They are more difficult to accomplish in large classes. In such large-class situations, text-based conceptual change features to promote conceptual change are more appropriate. Even in small class situations, text designed to promote conceptual change may reinforce in-class instruction and may help teachers teach in a way that promotes conceptual change [7]. One of the most successful techniques is the conceptual change texts or refutational texts [8]. These texts are those that refute commonly held naive concepts and designed to make readers aware of the inadequacy of their intuitive ideas, directly stating that commonly held intuitive ideas do not explain certain phenomena through the use of explanations and examples.

Beeth [9] argued for a different approach to a conceptual change instruction. In this study students who selected from elementary school classrooms learned to speak about their conceptions in powerful ways (ie. to be a metacognive). The researcher found that conceptual change instruction supports change in students from passively receiving information to actively examining their own conceptions.

Markow and Lonning [10] also studied the conceptual change instruction. They tried to find out whether the construction of prelab and postlab concept map help students' understand the concept involved in the experiment they performed or not. They note that students responded very positively toward the use of concept maps in laboratories. According to the authors' research, students feel strongly that constructing prelab and postlab concept maps help them understand the conceptual chemistry of the experiments.

In another study Chambers and Andre [7] found that students used conceptual change text demonstrate better conceptual understanding of electric circuits than the students used the traditionally text. They also investigated that the relationship between gender, interest and experience in electricity.

The review undertaken here showed that students have conceptions that are significantly different from the scientific one, these conceptions have serious effects for subsequent learning and traditional instruction methods have little or no effect on changing these misconceptions.

2. PURPOSE

In this research the following questions were tried to be answered:

What are the specific misconceptions ninth grade students have about chemical change and conservation of matter concepts?

Does conceptual change instruction be effective over traditionally designed chemistry instruction on 9^{th} grade students' understanding of chemical change and conservation of matter concepts?

3. METHOD

3. 1. Subjects

In the first stage of the study, 10 tenth grade students were chosen for clinical interviews. Selection was done by considering their willingness to talk freely about their responses. The subject of the second stage of the study was 50 ninth grade students from two classes of a Chemisrtry Course instructed by the same teacher from a specific high school. Two instruction methods used in this study were randomly assigned to each group. The experimental group who took conceptual change text instruction consisted of 25 students. The control group who took traditionally chemistry instruction consisted of 25 students.

3. 2. Instrument

Chemical Change Concepts Test was developed to measure the students' understanding of chemical change concepts. This test consisted of 20 multiple choice questions. These questions required students to make a conceptual prediction about a situation in which there is a possibility of make wrong response caused by the misconceptions of students. There were four alternatives for each questions. The distractors reflected misconceptions.

During the development stage of the test review of related literature, results of interviews and suggestions of teachers were utilized. The reliability of this test was found to be 0.78.

3. 3. Procedure

The second stage of the study was conducted over 3 weeks. Conceptual change text was distributed to students and students were instructed to read texts carefully. After they read texts, teacher explained students' misconceptions, why these misconceptions were incorrect and give the scientifically correct situations.

There was a discussion between the students and the teacher. During the treatment the chemical change concepts topics were covered as a part of the regular classroom curriculum in the chemistry course.

After the treatment Chemical Change Concepts Test was given to each group.

4. RESULTS

Misconceptions were found through interviews and the percentages of misconceptions that students responded in achievement test after treatment are stated in Table 1. The table shows that the students from each group have difficulty in changing their thinking from observable changes in substances to the observable changes in terms of the interactions between individual atoms and molecules. In addition %90 of students in control group think that chemical changes are always irreversible. Although the students took conceptual change texts, in the experimental group %45 of the students have uncertainty about invisible reactants and products in the reactions. Results show that the percentages of misconceptions that were held by the students in control group are higher than that of experimental group.

With respect to achievement related to chemical change and conservation of matter concepts there is a significant difference was found between students who took conceptual

Table1. Percentages of misconceptions that students responded for each group

Misconceptions	E.G.	C.G.
Have an additive view of chemical reaction rather than interactive one.	%10	%20
Difficulty in changing their thinking from observable changes to observable changes in terms of the interaction between atoms.	%6	%9
In a chemical change the substance modifies its appearance but it continues to be the same.	%5	%9
In a chemical change displacement from one physical location to another occur.	%2	%7
In a chemical change the reactants are destroyed.	%0	%5
Chemical change is a transmutation of a substance into a new one.	%3	%9
In a physical change no chemicals are involved.	%5	%20
Only physical changes are reversible.	%30	%55
Chemical changes are always irreversible.	%45	%90
In a physical change only one substance changes.	%5	%10
In a chemical change one substance changes in the presence of another substance.	%5	%15
Uncertainty about invisible reactants and products in the reactions.	%45	%80
Ignorance of the significance of the oxygen and carbondioxide in burning.	%10	%15
Burning involves only fire or flame.	%15	%50
Burning is a destructive process.	%5	%10
Heat is the only source of black film which is formed when metal wire is heated.	%0	%5
In a chemical change the substance continues to be the same but the amount is different.	%15	%20
Things get lighter when they are burned.	%5	%30
Molten or dissolved material weight less than the same material in its solid form.	%20	%30
In a chemical change number of molecules and the number of moles are conserved.	%0	%10

change text instruction and those who took traditionally designed chemistry instruction ($t=3.654$, $df=48$, $p<0.05$). The students using the conceptual change instruction had significantly higher scores than the students using traditionally designed instruction.

5. DISCUSSION AND IMPLICATIONS

Chemistry is a science whose primary purpose is the description and explanation of

chemical changes[6]. Thus it is not suprising that most chemistry textbooks consists of equation that represents various types of chemical reaction and explanation of how and why those reaction occur. Since the concept of chemical reactions is considered to be an important objective of chemistry teaching, teachers should be made aware of students' difficulties in this area.

Chemical reaction can be stated in a single sentence like that chemical reaction involves the breaking apart and recombination of molecules. In addition the rules for writing and balancing chemical equations are relatively simple. However, learning about chemical change is not as simple and straightforward as it seems. Students confused about chemical changes especially about chemical changes occurred in our real word.

The students have their own beliefs about the nature of matter. These beliefs may lead them to understand and explain chemical change in quite different ways. Thus learning about chemical change is not just the learning of facts and rules.

The other scientific concept understanding and applying of which is problematical for many students is the law of conservation of mass. Mass conservation is often problem even for simple physical change. Conservation of substance is a central idea in chemistry necessary for the differentiation between chemical and physical changes.

The increasing use of natural resources and the large quantities of disposed waste require a strong emphasis on this concept [11]. We should teach in a way that helps students appreciate the power of such chemistry concepts in understanding the word.

Science education researchers indicate that many novice learners in chemistry are able to apply algorithms without significant conceptual understanding [12]. Therefore, they can solve numerical problems, but fail to answer conceptual questions. What essentially distinguishes conceptual learners from algorithmic ones is that the former are more advanced and less dualistic in their thinking, more experienced in problem solving, more situational in their knowledge orientation and more verbal in their reasoning [13]. Gil-Perez and Carrascosa [14] stated that one of the most important outcomes of research on science misconceptions has been, undoubtedly, a better understanding of science learning difficulties and the awareness of the necessity for profound changes in the teaching learning process, to improve meaningful learning.

Misconception or preconception has serious effects for subsequent learning. Therefore it is important to find out students' earlier conceptions in order to plan future activities.

During the treatment, there is an interaction between the teacher and the students. The teacher asked questions to students, answered the questions of students and explained the students' difficulties. This provided feedback to the teacher and the students. Conceptual change text helped students to consider their prior knowledge and see the difference between their intuitive ideas and scientific ones. The conceptual change approach provided special learning environments such as identifying common misconceptions, presenting descriptive evidence in the text that the typical misconceptions are incorrect, providing scientific explanation of the concepts and enabling students the opportunity to practice the correct explanation by utulizing questions. This type of progress in the experimental group may have caused better understanding in chemical change and conservation of matter concepts.

REFERENCES

[1] Posner, G. J., Strike, K. A., Hewson, P. W. and Gertzag, W. A. "Accommodation of Scientific Conception: Toward a Theory of Conceptual Change". **Science Education**, 66(2), 211-227, (1982).

[2] Osborne, R. J. and Wittrock, M. C. "Learning Science: A Generative Process". **Science Education**, 67(4), 489-508 (1983).

[3] Nakhleh, M. B. "Why some students don't learn chemistry". **Journal of Chemical Education**, 69, 191-196 (1992).

[4] Ben-Zvi, R., Eylon, B. S. and Silberstain, J. "Students visualisation of a chemical reaction". **Education in Chemistry**, 24(4), 117-120 (1987)

[5] Abraham, M. R., Grzybowski, E. B., Renner, J. W. and Marek, E. A. "Understanding and Misunderstandings of Eighth Graders of Five Chemistry Concepts Found in Textbooks". **Journal of Researh in Science Teaching**, 29(2), 105-120 (1992).

[6] Hesse, J. J. and Anderson, C. W. "Conceptions of Chemical Change". **Journal of Research in Science Teaching**, 29(3),277-299 (1992).

[7] Chambers, S. K. and Andre, T. "Gender, prior knowledge, interest and experience in electricity and conceptual change text manipulation in learning about direct current". **Journal of Research in Science Teaching**, 34(2), 107-123 (1997).

[8] Alvermann, D. E. and Hague, S. A. "Comprehension of Counterintuitive Science Text: Effects of Prior Knowledge and Text Structure". **Journal of Educational Research**, 82,197-202 (1989).

[9] Beeth, M. E. "Teaching Science in Fifth Grade: Instructional Goals That Support Conceptual Change". **Journal of Research in Science Teaching**, 35(10),1091-1101 (1998).

[10] Markow, P. G. and Lonning, R. A. "Usefulness of Concept Maps in Collge Chemistry Laboratories: Students Perceptions and Effects on Achievement". **Journal of Research in Science Teaching**, 35(9),1015-1029 (1998).

[11] Chambers, S. K. and Andre, T. "Gender, prior knowledge, interest and experience in electricity and conceptual change text manipulation in learning about direct current". **Journal of Research in Science Teaching**, 34(2), 107-123 (1997).

[12] Haidar, A. H. "Prospective Chemistry Teachers Conceptions of the Conservation of Matter and Related Concepts". **Journal of Research in Science Teaching**, 34(2),181-197 (1997).

[13] Nakhleh, M. B. "Why Some Students Don't Learn Chemistry". **Journal of Chemical Education**, 69(3), 191-196 (1992).

[14] Gil-Perez, D. and Carrascosa, J. "What Do About Science Misconceptions". **Science Education**, 79(1) ,77-93 (1990).