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The effect of students' perceptions of nature of matter on their laboratory attitudes and their achievement in chemical equilibrium

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Abstract

One of the basic subjects that chemistry students have difficulty is chemical equilibrium. Learning of the particulate nature of matter can increase students' achievement in this subject. In addition to this, students' interest, belief and attitude towards chemistry or the nature of matter are factors effecting achievement. In this study the effects of understanding nature of matter and attitudes on university students' achievement in chemical equilibrium subject were investigated. Moreover the effects of gender and department on students' achievement were also examined. It was found that students' attitudes effected their achievement in chemical equilibrium; on the other hand attitudes affected students' comprehension of nature of matter.

Keywords: science education; nature of matter; chemical equilibrium; misconception; attitude; gender.

1. Introduction

Studies on chemistry education designate that students have a lot of misconceptions that are inappropriate to scientific view about basic terms of chemistry. These misconceptions hinder learning other subject matters. As a result students become unsuccessful in chemistry although they work hard (Nakhleh, 1992). Students often have misconceptions on particulate nature of matter and chemical equilibrium.

Students have difficulty in learning these topics which have a critical role in perceiving chemistry, physics, biology and fundamental sciences and they also have a lot of misconceptions on these topics because the topic can be learned with abstract concepts due to the concepts it includes (Griffits & Preston, 1992; Nakhleh, 1992; Nakhleh, 1993; Yezierski & James, 2006).

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For example although students know the concepts of atom, molecule and ion that are particles of the matter, when they hear these concepts no image comes into being in their minds. Students try to unify the particulate nature of the matter at submicroscopic level with the macroscopic nature to solve this problem.

When students' misconceptions on chemistry topics are researched, it is seen that one of the main reasons of the misconceptions is that scientific language is different from the daily language. The chemical equilibrium can be given as an example of this. Studies have shown that a lot of students including university students have problems in chemical equilibrium because the chemical equilibrium is a dynamic balance state and it is very different from the balance that students encounter in their daily lives.

Students think that the equilibrium concept is the static balance which is equal to the balance that they encounter in physics and in their daily lives (Wheeler & Kass, 1978; Allsop & George, 1984; Hackling & Garnett, 1985; Banarjee, 1991; Pardo & Portoles, 1995; Akkuş et al., 2003).

There are a lot of misconceptions on chemical equilibrium because students can not perceive particulate nature of matter which is the basic subject matter of chemistry. Therefore planning a teaching method based on teaching the particulate structure of the elements better in chemistry classes will be very effective in increasing the level of course success and in removing the misconceptions.

A lot of studies which aim at researching the factors that affect student success in science education have been conducted. According to the results of these studies the attitudes of students, also, affect their success (Duit, 1991; as cited by: Azizoğlu, 2004). Therefore, during the curriculum studies of several countries, educators focus on activities that will develop students' attitudes (Aiken & Aiken, 1969; Koballa, 1988; As cited by: Salta & Tzougrakı, 2004).

A lot of studies in which education activities have been strengthened with different methods and techniques to develop students' attitudes on science have been conducted and in some of these studies it has been researched that whether the attitudes of female and male are different (Francis & Greer, 1999).

Although studies show that generally the success of the male students is meaningfully higher than the success of the female students, there are, also, studies in which there is not a meaningful difference between genders (Greenfield, 1996; Tina & Pell, 2002).

The purpose of this study is to research whether university students' perceptions of the particulate nature of matter have an effect on their success in chemical equilibrium. Also the effects of students' departments, attitudes and gender on their perceptions of the particulate nature of matter and on their success in chemical equilibrium have been considered.

2. Method

The study has been conducted during 14 weeks in Fall Semester of 2005- 2006 Academic Year with 169 students who take the course of 'Basic/General Chemistry Laboratories' in Gazi University Gazi Education Faculty Chemistry Education Laboratories. These students are composed of Mathematics Education group (First and Second Training) (91), Science Education group (First and Second training) (42) and Chemistry Education group (36).

At the beginning of the term Particulate Nature of Matter Test (α = 0, 84), and The Attitude Test (α=0, 77) were applied as a pre-test and students' misconceptions, deficiencies and levels of achievement were determined according to the test results.

Particulate Nature of Matter Test has been prepared by benefiting from the misconceptions identified in the literature. The Particulate Nature of Matter Test consists of 24 multiple choice questions. In this test the concepts like atom, molecule, ion, particle, particulate structure, compound and mole which are key points in perceiving the particulate nature of the matter.

The validity of the test is determined as internal validity and after controlling the test experts in science education have decided that the test is appropriate for the purpose of the study. The reliability of the test has been determined as α = 0, 84 after it was applied to 534 high school and university students.

The Attitude Test is a five likert scale prepared with the aim of determining students' attitudes towards laboratory practices. Items have been determined as absolutely agree 5 and absolutely disagree 1; the items have been graded as absolutely agree 1; absolutely disagree 5. In attitude scale cronbach alpha reliability coefficient has been measured as α=0, 77 for a sampling of 166 individuals.

After the test an education that will remove the identified misconceptions was planned. The laboratory experiments have been planned by considering particulate nature of matter and theoretical knowledge instruction of every experiment has been conducted by considering particulate nature of matter. Four weeks after the application of Particulate Nature of Matter Test chemical equilibrium topic was taught. After teaching chemical equilibrium, laboratory experiments continued during 6 weeks and the Chemical Equilibrium Test, Particulate Nature of Matter Test and the Attitude Test were applied as the post-test; then the tests were analyzed. The Chemical Equilibrium Test was prepared by benefiting from the misconceptions in the literature.

3. Findings

The first question of the study researches whether university students' perceptions of particulate nature of matter have an effect on their success in chemical equilibrium. With this aim, after descriptive statistics of The Chemical Equilibrium Test, Particulate Nature of Matter Test were prepared, Pearson correlation was used to determine whether there is a meaningful relation between students' success scores of chemical equilibrium and scores of the particulate nature of the matter. It was found that there is an incoherent relation at a low level (r= 0,104 p=0,188).

The comparison of the scores of the Chemical Equilibrium Test (pre/post), and the scores of Particulate Nature of the Matter Test according to gender was made by using t-test to research the meaningful difference between genders on the topic of students' success of chemical equilibrium and the particulate nature of the element.

According to the t-test results, there is not a meaningful difference between the average scores of Particulate Nature of the Matter pre-Test (t_{167}= -1,535 p=0,127) and Particulate Nature of the Matter post-Test (t_{164}=3,617 p=0,727) of male and female.

However according to independent samples t-test results, there is a meaningful difference between the average scores of The Chemical Equilibrium test of female and male (t_{153}= -0,350 p=0,000). The female's average scores of The Chemical Equilibrium Test (67, 04) are meaningfully different from the male's average scores of The Chemical Equilibrium Test (57, 60). One way ANOVA was applied to determine in which parts the means of female and male are different.

According to the results of Scheffe test in the girls' average scores there is a meaningful difference (p<0, 05) between the departments of Mathematics (60, 24) – Chemistry (76, 26), Mathematics – Mathematics (second training) (70, 14), Science (62, 84) – Chemistry (76, 2). Also, in the boys' average scores there is a meaningful difference (p<0, 05) between the departments of Mathematics (48, 27) - Mathematics (second training) (69, 88); Science (47, 11) – Mathematics.

ANOVA test with a single factor was used to research the change of average test scores between departments. According to the test results there is not a meaningful different between departments in terms of the Particulate Nature of the Matter pre-Test scores (p=0,311), however there is a statistically meaningful difference between departments in terms of the Particulate Nature of the Matter post-Test scores (p=0,000) and the Chemical Equilibrium Test scores (p=0,000).

According to Scheffe test when we compare the Particulate Nature of the Matter post-Test scores there is a difference between Mathematics(86,82) – Science (79,07); Mathematics –Science (88,57) and Chemistry students; and when we compare the Chemical Equilibrium Test scores there is a statistically meaningful difference between Mathematics (55,23)- Chemistry (71,41) and Mathematics (second training) (70,04); Science (56,04)- Chemistry and Mathematics (second training) (70,04) groups.

In this study the relation among students' success scores of the particulate nature of the matter, chemical equilibrium and attitude has been researched by using Pearson correlation analysis. There is a positive, meaningful relation at a medium level among the scores of the Chemical Equilibrium Test, the Particulate Nature of the Matter post-Test and The Attitude pre-Test (for the Particulate Nature of the Matter post-Test r=0,213 p=0,009 and for the Attitude pre-Test r=0,291 p=0,002).

According to this, as the Chemical Equilibrium Test score increases the Particulate Nature of the Matter post-Test score, also, increases and as the Attitude pre-Test score increases, the Chemical Equilibrium Test score, also, increases. There is a positive, meaningful relation at a high level between the Particulate Nature of the Matter pre-Test and the Particulate Nature of the Matter post-Test (r= 0,589 p=0,000).

The relation among the Attitude pre-Test, the Chemical Equilibrium Test, the Particulate Nature of the Matter pre-Test and the Particulate Nature of the Matter post-Test is, also, positive and meaningful (for the Attitude test

r=0,631 p=0,000). This means that as students' scores of pre-attitude increase, students' scores of the Chemical Equilibrium Test, the Particulate Nature of the Matter post-Test and the post-attitude, also, increase.

4. Conclusion

In science education a concept is not used in teaching only a single topic; it can, also, be used in other topics. Every concept that is learned has strong relations with a lot of topics and concepts and it forms a root to learn them. One of the factors that hinder teaching a topic is concepts and conceptual framework are formed in an inappropriate way. It is impossible for a student that can perceive the concepts and the conceptual framework clearly and can construct them in his/her mind in an appropriate way for scientific view not to learn a topic. This situation is valid in lesson topics as well as concepts.

If lesson topics are learned in a meaningful and coherent way, other topics related to those topics are, also, learned in the same way. The subject matter of 'the particulate nature of the matter' provides a root to learn other topics. Teaching this topic should be given importance and a teaching plan should be made by forming relations with this topic while teaching other topics, therefore the misconceptions encountered in chemistry education can be removed.

In this study it has been tried to determine whether the perception of the particulate nature of the matter has an effect on the success in the chemical equilibrium. With this aim, the Particulate Nature of the Matter Test and the Chemical Equilibrium Test are applied to students and it has been determined that there is not a meaningful difference between these two tests. It is not an expected result because, as it is stated in literary studies, the particulate nature of the matter provides a root for teaching chemical topics. It is a fact that removing the misconceptions in this topic will decrease the problems in other topics.

After the instruction the Particulate Nature of the Matter Test was applied and it was determined that there is a meaningful difference between the Particulate Nature of the Matter pre-Test and post-Test. The reasons of this difference are preparations and experiments made during the whole semester. These studies include the teaching process based on the particulate nature of the matter. As a result, we can conclude that most of the student 's misconceptions are removed.

Also, in the study it was also researched that whether the gender factor has an effect on the success in the particulate nature of the matter and the chemical equilibrium. There is not a meaningful difference among the scores of the Particulate Nature of the Matter pre-Test and post-Test in terms of gender. However in the Chemical Equilibrium Test female are more successful than male. According to this result female have perceived the chemical equilibrium better.

The chemical equilibrium is a topic in which all students, including chemistry students, have problems. However the perception of this topic is necessary to perceive some topics such as acid-base reactions, elevation-reduction and resolution. Therefore, it is an obligation that we should teach these topics meaningfully and remove students' misconceptions.

The particulate nature of the matter has a special place among the chemistry topics and solving the problems in this topic facilitates learning all other topics. A teaching based on the particulate nature of the matter provides to solve a lot of problems in chemical equilibrium.

One of the purposes of this study is to research whether students' attitudes have an effect on their achievement in chemical equilibrium. Studies have shown that science attitudes affect the success. Also, in this study it has been found that the laboratory attitudes affect the success in the chemical equilibrium. There is a positive relation at a high level between the results of the attitude test and the scores of the chemical equilibrium test.

According to this study we should give importance to the particulate nature of the matter and benefit from conceptual changes that provide opportunity of removing students' misconceptions and we should, also, develop students' attitudes to increase the achievement in chemical equilibrium.

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