The effect of conceptual change based instruction on students’ attitudes toward chemistry

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Abstract

This study aims to explore the effect of conceptual change based instruction accompanied with demonstrations (CCBIAD) on 11th grade students’ attitudes toward chemistry. The sample consists of sixty-nine 11th grade students in two classes in a high school. In the experimental group, CCBIAD was used, whereas in the control group, traditionally designed chemistry instruction was used. The students’ attitudes were measured by Attitude Scale toward Chemistry. The results of ANOVA show that there was a significant mean difference between post-test scores of two groups in favor of the experimental group. As a conclusion, CCBIAD has a key role in forcing students’ attitudes toward chemistry.

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Keywords: Conceptual change based instruction, attitudes toward chemistry

1. Introduction

In science education, attitude toward science is an important factor affecting students’ science achievement as well as students’ alternative conceptions or misconceptions. Attitude is an affective concept influencing one’s construction of knowledge and action to something (Shrigley, Koballa & Simpson, 1988). An important reason for examining attitudinal constructs in science education is to be able to understand the ways in which they affect student learning in the cognitive field. Students’ interest is likely to be positively correlated with their achievement in science understanding (Simpson, Koballa, Oliver, & Crawley, 1994). The development of scientific literacy among students requires their positive attitudes toward science (Linn, 1992). There are some research findings showing evidence for the relationship between students’ attitudes towards school science and their achievement in science (e.g., Neathery, 1997; Simpson & Oliver, 1990; Osborne & Collins, 2000). These studies show that the students who have more positive attitudes towards science would be more successful in science classrooms. The relationship between attitude and achievement is influenced by contextual factors, including classroom organization, teacher authority, the nature of classroom academic tasks, and evaluation structure. These contextual factors may serve to strengthen the relations between attitudinal constructs and science learning as well as to weaken them (Pintrich, Marx, & Boyle, 1993).

According to Koballa and Glynn (2007), students’ science learning experiences affect their attitudes positively, increase their motivation for science learning, and as a result, lead to higher achievement in science. Indeed, they

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(Koballa & Glynn, 2007) point out that “approaches to positively affecting student attitudes include instruction that emphasizes active learning and the relevance of science to daily life” (p. 95). Instructional method in science classroom is one of the variables with respect to students’ perceptions in science courses (Ebenezer & Zoller, 1993). Science teacher has also effect on students’ attitudes toward science (Cavallo & Laubach, 2001; Myers & Fouts, 1992). Since many activities such as instructional activities, interactions among students, students’ participation are guided by teachers in science classroom; science teachers play a key role in promoting positive attitudes towards science in students. Myers and Fouts (1992) found that more positive attitudes of students were related to involvement, personal support, relationships with classmates, and various teaching strategies and unusual learning activities.

Students also have different attitudes toward different domains of science: physics, chemistry, and biology (Osborne & Collins, 2001). There has been substantial research related to attitudes toward science. However, only some research has focused on a particular field of science such as chemistry (Hill, Pettus, & Hedin, 1990; Menis, 1983, 1989). Attitude toward chemistry refers to “a person’s liking or disliking of chemistry” (Nieswandt, 2007, p. 912) or to having a “positive or negative feeling” (Koballa & Crawley, 1985, p. 223) with respect to chemistry. The quality of science teaching is an important factor affecting students’ attitudes toward school science (Ebenezer & Zoller, 1993; Osborne, Simon, & Collins, 2003). Using laboratories in science or chemistry lessons positively affects students’ attitudes toward that lesson (Adesoji & Raimi, 2004). In the literature, there have been many research studies on the effect of different instructional strategies on students’ attitudes (Gibson & Chase, 2002; Wong, Young, & Fraser, 1997).

Understanding many concepts in chemistry is difficult for most students because of the abstract nature of chemistry (Ben-Zvi, Eylon, & Silverstein, 1986; BouJaoude, 1991). Therefore, students have many misconceptions in chemistry. Reaction rate is an abstract chemical topic, which is also important in learning other fundamental chemical concepts such as chemical equilibrium. Students have misconceptions, thus learning difficulties, in the subject of reaction rate. Therefore, research needs to be conducted to investigate how students change their misconceptions about rate of reaction. The conceptual change model is one of the effective methods for coping with misconceptions and for understanding concepts. The conceptual change model which is based on constructivist notion claims that learning is a process of knowledge construction (Cobern, 1996). Posner, Strike, Hewson, and Gertzog (1982) proposed this model with four conditions for the accommodation phase to occur: Intelligibility, plausibility, fruitfulness, and dissatisfaction with the existing concepts. If a student is presented a more intelligible, plausible, and fruitful concept, s/he can change his/her previous concept (Posner et al., 1982).

Many studies show results related to the effect of conceptual change based instruction on students’ attitudes towards chemistry (Uzuntiryaki, 1998; Azizoglu, 2004). In some of these studies (e.g. Bozkoyun, 2004; Cam, 2009), the positive effect of conceptual change based instruction was presented whereas in some (e.g. Azizoglu, 2004) it was reported that this instruction had no effect on students’ attitudes toward chemistry as a school subject. Therefore, the present study investigates the effect of conceptual change based instruction accompanied with demonstrations on students’ attitudes toward chemistry as a school.

2. Method

2.1 Sample

The sample of this study consisted of sixty-nine 11th grade students from two chemistry classes taught by a same teacher in a public high school. Two teaching methods were randomly assigned to the groups. The experimental group instructed by conceptual change based instruction accompanied by demonstrations was consisted of 34 students while the control group instructed by traditionally designed chemistry instruction was consisted of 35 students. The ages of the students in both groups ranged from 16 to 17 years.
2.2 Attitude toward Chemistry Scale

This test was used to measure students’ attitudes toward chemistry as a school subject. It was developed by Geban, Ertepinar, Yilmaz, Altin, and Şahbaz (1994). The test included 15 items in 5-point Likert-type scale. The points were “fully agree”, “agree”, “undecided”, “disagree”, “fully disagree”. The reliability of the test was found to be 0.83. This test was administered to the students in both experimental and control group before the treatment as a pretest in order to assess their attitudes toward chemistry and after the treatment as a posttest in order to determine the effect of conceptual change based instruction on students’ attitudes toward chemistry as a school subject. In Attitude Scale toward Chemistry (ASTC), there were both positive and negative items. Firstly, the data of negative items were recoded from “1” to “5”, “2” to “4”, “4” to “2”, and “5” to “1”. Then a total score of each student in both groups was calculated. Higher scores in ASTC mean more positive attitudes toward chemistry.

2.3 Treatment

At the beginning of the treatment, the students in both groups were administered Attitude Scale toward Chemistry in order to assess students’ attitudes toward chemistry as a school subject as pretests. During the treatment, rate of reaction topics were covered as part of the regular classroom curriculum in the chemistry course in the both experimental and control group. In the experimental group, conceptual change based instruction accompanied by demonstrations (CCBIAD) was used. This instruction was designed to address students’ misconceptions related rate of reaction concepts and to eliminate them by considering four conditions for conceptual change (Posner et. al, 1982), which were dissatisfaction, intelligibility, plausibility, and fruitfulness. While starting to the lesson, the teacher asked some questions related to the topic to the students in order to make students aware of their misconceptions and dissatisfied with their existing conceptions (dissatisfaction). Then, the concepts were explained through the use of a demonstration related to the concept. Since the students observe sample events related to the concepts during their scientific explanation by the teacher, these concepts were aimed to be more intelligible to the students (intelligibility). After that, new examples, especially daily life examples, related to this topic were given to students to enhance their understanding the rate of reaction concepts deeply (plausibility). Finally, the students were asked to use new concept in explaining a new situation (fruitfulness).

In the control group, traditionally designed chemistry instruction was applied. During the instruction, the teacher used lecturing and discussion methods in the classroom. The sessions in this group were mainly based on teacher’s presentation of the topics. The lessons began with the teacher introducing the topic to the class. When the students did not understand the subject, they asked questions and the teacher made extra explanations by giving daily life examples. However, the teacher taught the subjects without considering students’ misconceptions and previous knowledge. After teacher’s solving an exercise related to that topic, the students were asked to solve some exercises from either textbook or other supplementary books. The teacher asked mostly quantitative questions to students. During these practices, students sometimes discussed the key points related the topic. At the end of the lesson, the teacher made a summary of the topic to clear up it for the students. Finally, some homework was assigned to the students.

3. Results

The hypothesis stating that there is no significant mean difference between post-test mean scores of the students taught with conceptual change based instruction accompanied with demonstrations and the students taught with traditionally designed chemistry instruction with respect to their attitudes towards chemistry as a school subject was tested by using two-way Analysis of Variance (ANOVA). The results show that there was a significant mean difference between post test mean scores of the students taught with conceptual change based instruction accompanied with demonstrations (CCBIAD) and the students taught with traditionally designed chemistry instruction (TDCI) in favor of the experimental group with respect to their attitudes towards chemistry as a school
subject, F (1, 65) = 11.093, p < .05. The experimental group students scored significantly higher than the control group students in Attitude Scale toward Chemistry ($\bar{X}_{CCBIAD} = 63.17$, $\bar{X}_{TDCI} = 55.51$).

4. Conclusions and Implications

In this study, the effect of conceptual change based instruction on students’ attitudes toward chemistry as a school subject was investigated. The results show that there was a significant effect of conceptual change based instruction accompanied by demonstrations on students’ attitudes toward chemistry. Classroom observations performed during the study also support this finding. The reason of the significant mean difference might be using demonstrations during conceptual change based instruction in the experimental group even the treatment lasted just four weeks not a long term. Demonstrations not only make students to be aware of their misconceptions (Chi & Roscoe, 2002) but also increase their motivation and interest to learn chemical concepts. Furthermore, in the experimental group, students were encouraged to share their ideas and participate in classroom discourse. The teacher tried to know students’ misconceptions and to remedy them by promoting them to be active participant in classroom. These might be other reasons of more positive attitudes in experimental group students.

One of the aims of science education is to develop positive attitudes toward science in students because there is significant relationship between students’ achievement in science and their positive attitudes toward science. Therefore, teachers should aim to develop students’ attitudes toward science besides their understanding of scientific concepts in science classroom and consider the factors affecting students’ attitudes toward science. Conceptual change based instruction not only enhance meaningful concept understanding but also encourage students to participate in classroom discourse through the tools used based on conceptual change method. Using demonstrations in chemistry classroom make a contribution to students’ conceptual understanding since students have a chance to observe the chemical events regarding the subject. Demonstrations are also effective for taking students’ attention to lesson and motivating them to participate in the lesson. Therefore, teachers should use appropriate demonstrations during their chemistry instruction.

References


