A Comparison of 10th Grade Students’ Theoretical and Applied Knowledge about the Concepts of Physical and Chemical Change

Hülya DEMİRCİÖĞLU1, Gökhan DEMİRCİÖĞLU2, Alipaşa AYAS3, Selda KONGUR4

1 Assist.Prof.Dr., Karadeniz Technical University, Fatih Faculty of Education, Trabzon-TURKEY
2 Assoc.Prof.Dr. Karadeniz Technical University, Fatih Faculty of Education, Trabzon-TURKEY
3 Prof.Dr., Bilkent University, Faculty of Education, Ankara-TURKEY
4 Chemistry Teacher, Ümraniye High School, Istanbul-TURKEY

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SYNOPSIS

INTRODUCTION

It was known that chemistry is a difficult field for students to learn and for teachers to teach. The most important reason of this is shown as chemistry embraces many abstract concepts and includes a large number of the basic concepts that requires more mental thinking (Reid, 2000). Chemistry requires students to make descriptions about what is happening both at the molecular level and macroscopic level (Novick & Nussbaum, 1981), and to associate their theoretical knowledge with daily life and to produce solutions to problems encountered. These skills are very difficult for students to achieve. Research has showed that students could not explain chemical changes happening on the molecular level (Abraham et al, 1992; Abraham et al., 1994).

After a careful examination of the available science education literature, it was found a lot study showing that students in different grade levels held the various alternative concepts about physical and chemical changes (e.g. Eilks et al., 2007; Johnson, 2000; Demircioğlu et al., 2006). In the literature, common alternative conceptions about physical and chemical changes were grouped into the following themes (DeBoer et al., 2009): (1) a chemical reaction occurs during a change of state (Ahtee & Varjola, 1998), (2) a chemical reaction occurs when a substance dissolves (Abraham et al., 1994). (3) a chemical change is irreversible (Cavallo et al., 2003). (4) Changes on the particulate level occur in the same fashion as those on the macroscopic level (Lee et al. 1993, Andersson, 1990), (5) Chemical reactions require two reactants (Cavallo et al., 2003; Eilks et al., 2007), (6) The atoms and molecules of the reactants of a chemical reaction are transformed into other atoms and molecules (Andersson, 1986), (7) The products of a chemical reaction, though unseen, must
have somehow existed from the start in another location, like the air or inside the starting materials (Andersson, 1986), (8) Matter is not conserved during a change of state (Lee et al., 1993), (9) Mass is not conserved during processes in which gases take part (Hesse & Anderson, 1992), (10) When a chemical reaction occurs, atoms just disappear. For example, the atoms burn up (Andersson, 1986), or the number of atoms decreases when wood burns in a closed system (Mitchell & Gunstone, 1984). In addition to the grouping, it was emphasized that students don’t tend to make clear distinctions between physical and chemical changes (BouJaoude, 1991) and attempt to explain most phenomena on the macroscopic level without considering the microscopic level (Stavridou & Solomonidou, 1998).

PURPOSE OF THE STUDY

The aim of this study is to compare 10th grade students’ applied knowledge with their theoretical knowledge and to identify their alternative concepts about concepts of the physical and chemical changes.

METHODOLOGY

The present study used the case study approach which enables in-depth examination of the subject and generally answers questions which begin with “how” or “why”. This research was administered on 128 grade 10 students at Ümraniye High School in Istanbul. A twenty two-item test (11 theoretical questions and 11 applied questions) was constructed for the purpose of identifying the students’ understandings concerning the concepts of the physical and chemical change. To confirm content validity, the test was examined by a group of experts comprised of four university chemistry educators and five high school chemistry teachers who have been teaching for over ten years at the central high school in the city of Trabzon. Its alpha reliability coefficient (KR20) for the pilot study was found to be 0.84. Also, semi-structured interviews were conducted individually with 12 students randomly selected from the sample.

Instrument and Analysis of Data

The students’ performance on the theoretical and applied questions in the test was compared using independent samples t test. The distribution of students' choices for the answers of multiple choice questions are given as frequency and percentage. The open-ended test items and interviews were analyzed under the following categories and headings; understanding, partial understanding, alternative conception and no understanding, suggested by Marek, 1986; Demircioğlu, 2008.

FINDINGS

At the end of the research, it was found that the students participating in the present study had a lot of alternative concepts about physical and chemical changes and not sufficient understanding related to the concepts under investigation. Also, the results showed that the students were more successful in the theoretical questions than the applied questions in the test ($t_{(254)}=4.113$, $p<0.05$). However, theoretical knowledge of them is lower than expected. This supported the findings of Haidar and Abraham (1991)’ study.

DISCUSSION and SUGGESTIONS

Although the concepts studied here have been taught by starting from fourth and fifth grades and by enhancing their contents in almost all teaching grades, it was remarkable that
students still held alternative conceptions of them. The reason of this may be that teachers ignored or superficially taught the concepts because of the intensity of the curriculum. As known, incomplete or erroneous ideas may hinder subsequent learning (Anderson, 1986), cause more alternative conceptions (Demircioğlu, 2002).

CONCLUSIONS and SUGGESTIONS

Chemistry is an important field because a lot of events in daily life are related to the chemistry. Although students live and operate in the macroscopic world of matter, they do not perceive chemistry as related to their surroundings. Moreover, they cannot explain relationships between the macroscopic and microscopic levels. Chemical concepts are very abstract and students find it difficult to explain chemical phenomena by using these concepts. To promote the students’ understandings about the basic chemistry concepts, it is very important to determine students’ preconceptions and alternative concepts before the new concepts are introduced. Students’ applied knowledge and skills should be paralleled to their theoretical knowledge for meaningful learning.

REFERENCES


