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The influence of computer-assisted instruction on students' conceptual understanding of chemical bonding and attitude toward chemistry: A case for Turkey

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Abstract

In this study, the effect of computer-assisted instruction on conceptual understanding of chemical bonding and attitude toward chemistry was investigated. The study employed a quasi-experimental design involving 11 grade students; 25 in an experimental and 25 in a control group. The *Chemical Bonding Achievement Test* (CBAT) consisting of 15 two-tier questions and the *Chemistry Attitude Scale* (CAS) consisting of 25 item were the principal data collection tools used. The CBAT and CAS instruments were administered in the form of a pre-test and post-test. Analyses of scores of the two groups in the post-test were compared and a statistically significant difference was found between groups in favor of experimental group. It also seems students from the experimental group were more successful than the control group students in remediation of alternative conceptions. The results of this study suggest that teaching–learning of topics in chemistry related to chemical bonding can be improved by the use of computer-assisted teaching materials.

Keywords: Computer-assisted instruction; Chemical bonding; Attitude; Alternative conception

1. Introduction

Meaningful learning theory suggests that the learning process consists of an interaction between preexisting knowledge and new knowledge and as a consequence students' own knowledge is central for further learning (Ausubel, 1968; Mintzes, Wandersee, & Novak, 1998). The literature suggests that students often develop ideas that are different from those accepted by scientific community and intended by their teachers (BouJaoude, 1992; Ebenezer & Fraser, 2001; Peterson & Treagust, 1989; Treagust, 1988; Zoller, 1990). Students' ideas that are different to scientific ideas are variously called misconceptions, alternative conceptions, and alternative frameworks (Özmen, 2004); the most being misconceptions and alternative conceptions. Students' alternative conceptions is the term we use here, because it recognizes that to the students' such ideas make sense

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and fit in with their everyday experiences. The conceptions are often highly resistant to change, and according to Niaz (2001a), such ideas should be considered as part of their 'hard-core' beliefs.

Many studies all levels of schooling to determine students' ideas about basic chemistry concepts suggest that students who did not acquire a satisfactory understanding of scientific conceptions occurred as a result of traditional teaching methods such as simple lecturing. Such teaching requires students to sit passively and does not much engage students actively in learning (Morgil, Oskay, Yavuz, & Arda, 2003). In such a traditional teacher-centered classroom, the students thus become listeners, and the teacher gives out the facts and defines important ideas. Students' participation is often limited to listening to the teacher and perhaps raising their hand to answer questions (Muir-Herzig, 2004). It is reported that traditional teaching methods when used in teaching science means students may understand the subject – but only at a 'knowledge level' that involves them memorizing concepts without achieving in-depth understanding. Similarly, highly teacher-centered teaching methods may negatively affect the learners' beliefs about science, leading them to see science learning as a simple accumulation of facts, and science as uninteresting (Kiboss, 2002; Kiboss, Ndirangu, & Wekesa, 2004). These pedagogical approaches may then influence students' attitudes, cognitive development and achievement in science education (Çepni, Taş, & Köse, 2006). Because of this, science and chemistry teachers may need to consider alternative teaching approaches – particularly for difficult and abstract science concepts. Some authors suggest this might be achieved by using more learner-centered approaches and particularly those that employ modern information and communication technologies. These technologies can help facilitate knowledge-construction in the classroom and guide student activities, leaving teachers the opportunity to interact with small groups and to diagnose difficulties (Williams, Linn, Ammon, & Gearhart, 2004). Whitworth and Berson (2003) claim that technology-based learning can help develop students' decision-making and problem-solving skills, data processing skills and communication skills. In student-centered classrooms with the aid of computers, students are able to collaborate, to use critical thinking and to find alternatives solutions to problems (Jaber, 1997). Recently there has been interest expressed in science education reform which emphasizes the need for integrating computer technologies into learning and teaching (Herman, 1996).

The literature notes that computer-assisted instruction (CAI) is one such area recently lauded for its capacity to improve the teaching of difficult and abstract science concepts and to simulate dangerous experiments and to stimulate interest in science learning (Allessi & Trollip, 1991). Computer also may be effective in other areas as a general pedagogical aid that complements regular teaching methods (Kiboss et al., 2004). The term computer-assisted instruction (CAI) is used here to mean an approach where information is delivered by the computer in a manner similar to programmed learning, and that is aimed at student achievement of specific educational goals through step-by-step instruction (Simonson & Thompson, 1994). At this time computer-based technology is (and will likely become more) a component of school and university classrooms. Several capabilities of computers, such as providing individualized instruction, practice, revision, teaching and problem-solving, simulations during the applications and immediate feedback, make computers useful instructional devices for developing desired learning outcomes (Ertepınar, 1995). An additional advantage is that the teacher can use computers at different times and places according to the characteristics of the subject matter, the students, and available software and hardware (Morgil, Yavuz, Oskay, & Arda, 2005). In summary, although authors' views about contribution of computer based learning environments can make to student achievement vary, the utilization of computers in learning points to positive contributions of computer based learning environments to student learning.

2. Technology and schooling: Turkish scene

Turkey is a candidate for membership of the European Union (EU), and is a developing country with a population of about 70 million. The Turkish Educational System comprises four components: (i) pre-school, which is optional; (ii) basic education, which is 8 years in duration, compulsory, and free in public schools; (iii) secondary education, which is 3 years in duration, is not compulsory and is free in public schools; (iv) higher education including universities, which is generally 4 years, and is not compulsory. Science is a compulsory subject in the Turkish Educational System. Science courses begin at the age of 9–10 (grade 4) and go on until the age of 14–15 (grade 8). In another words, science is a compulsory subject between grades