Implementation and Evaluation of Web-Based Learning Activities on Bonding and the Structure of Matter for 10-th Grade Chemistry

Abstract

This study deals with the development, implementation, and evaluation of web-based activities associated with the topic of *chemical bonding*, as taught in 10th grade chemistry. A website was developed entitled: *"Chemistry and the Chemical Industry in the Service of Mankind"*, its URL is: http://stwww.weizmann.ac.il/g-chem/learnchem (Kesner, Frailich, & Hofstein, 2003).

The main goal of this study was to assess the educational effectiveness of website activities dealing with the *chemical bonding* concept. These activities include visualization tools, as well as topics relevant to daily life and industrial applications. The study investigated the effectiveness of a web-based learning environment regarding the understanding of *chemical bonding* concepts, students' perceptions of the classroom learning environment, their attitudes regarding the relevance of learning chemistry to everyday life, and their interest in chemistry studies.

Two groups participated in this study: an experimental and a comparison group. The experimental group integrated various activities from the website, while a comparison group studied the *chemical bonding* topic without the web-based activities. More specifically, the research questions are as follows:

1. a. Is there a difference between the two groups in understanding the topic of *chemical bonding*?
   b. How did the web-based activities influence students' understanding regarding the structure of matter and the *chemical bonding* concept?
2. How did the web-based activities influence the teaching of the *chemical bonding* concept?
3. Is there a difference between the groups in students' perceptions regarding the chemistry classroom learning environments?
4. Is there a difference between the groups in students' interest and attitudes regarding learning chemistry?
5. Is there a difference between the groups regarding students' awareness of the ways in which chemistry is relevant to their lives?

As mentioned before, in the present study we focused on activities (from the website), all of which deal with *chemical bonding* concept. The following are the reasons for the decision to focus on this topic: (1) *Chemical bonding* is a key concept that is taught in 10^{th} grade chemistry in high school. It provides the basis for many other chemistry topics that are taught later, and (2) *Chemical bonding* is a difficult for students using existing tools (e. g., static models in books, ball-and-stick models), which are insufficient to demonstrate the abstract nature phenomena associated with this topic.

The four activities developed for this study are (1) models of the atomic structure, (2) metals – structure and properties, (3) ionic substances in everyday life and in industry, and (4) molecular substances – structure, properties, and uses.

The study was conducted during the academic years 2003 – 2005. The schools from which the samples (both experimental and comparison groups) were drawn could be characterized as urban and suburban high schools academic in nature and consisted of students from a modest socioeconomic background. In addition, all these schools had a tradition of scoring above average in the final examinations ("Bagrut"). All the chemistry teachers of the experimental and comparison classes had at least 5 years of experience in teaching chemistry. It should be noted that the two groups followed the same basic syllabus and also the same time length. Forty class period were devoted to the teaching the concept of *chemical bonding*. The only difference between the two groups was that the experimental group students were exposed to the website and conducted the above mentioned four activities.

The study analyzed both quantitative and qualitative research. The quantitative tools of the study included: A *Semantic Differential* questionnaire and *a Chemistry Classroom Web-Based Learning Environment Inventory* to assess students' perceptions regarding the relevance of chemistry to their life and attitude towards chemistry studies, a *Feedback questionnaire* that examined the students' response after performing the website activities, and *an achievement test* that assessed their knowledge and understanding of the concept of *chemical bonding*.

The qualitative research included observations and interviews of both students and teachers. About twenty eight observations were made while the

students preformed the Internet activities. Eighteen students and seven teachers from the experimental group, and two teachers from the comparison group were interviewed.

The quantitative research reveals that the experimental group outperformed the comparison group significantly, in the achievement post-test, which examines students' understanding of *chemical bonding* concept. We also found from the attitude questionnaires that in most of the categories, the experimental group demonstrated more positive attitudes compared to comparison group. Those results are in alignment with interviews that were analyzed in which teachers and students in the experimental group suggested that the visualization tools helped students to better understand the *chemical bonding* concept. In addition, we found that web-based learning was a significant addition to the teacher's explanations in class, since it provided scaffolding and supported the students' learning process, and indeed promoted cooperative and active learning within a community of learners using a constructivist approach. Furthermore, the students were satisfied with the activities conducted on the website and enjoyed their chemistry learning Also, they showed significant higher awareness to the relevance of chemistry to daily life. The teachers were also satisfied with the web-based activities because they were more aware to students' difficulties in understanding the *chemical bonding* concept, and the visual tools help them to demonstrate abstract phenomena to their students. Moreover, the website activities caused teachers to make reflection on their instruction strategies and improve them.

The main value of this study is the development and formulation of an instructional approach for effective use of web-based learning in science in general and in chemistry in particular.