Chemical Literacy: Defining it with teachers and assessing its expression at the high-school level

By Yael Shwartz

Department of Science Teaching

Ph.D. THESIS

Submitted to

The Feinberg Graduate School

The Weizmann Institute of Science

Supervisors:

Prof. Avi Hofstein & Dr. Ruth Ben-Zvi

Department of Science Teaching

May 2004

Abstract

The ongoing reform in science education, in the USA, England, as well as in Israel, set the attaining of scientific literacy for all students as its main goal. Like all other scientific disciplines, chemistry teaching in high school should address this goal. Therefore, the main goal in this research was to define chemical literacy. The process of defining it involved the collaborative work of science education researchers and high-school teachers. In order to facilitate this collaboration, a long-term workshop was designed, in the format of a study group, in which theoretical as well as practical issues were discussed. The workshop revealed teachers' perceptions regarding chemical literacy, and chemistry teaching goals. As a result of the workshop, it was suggested that the definition should include a general framework for defining chemical literacy, as well as specific content requirements for achieving the basic level of chemical literacy, the level every high-school graduate should achieve. The agreement of a wider group of scientists and teachers was provided by interviews & questionnaires. As a result, the definition of chemical literacy, suggested within this study consists of four dimensions: content, context, skills, and affective aspects.

Based on the definition of chemical literacy that was obtained, we developed assessment tools, in order to evaluate the expression of chemical literacy among high-school students. The tools assess different levels of literacy: nominal, functional, and structural.

The main research findings were as follows:

- The basic chemistry course (10th grade) significantly improved students' acquaintance with chemical concepts (nominal level); however, it had a limited contribution to their ability to explain concepts (functional literacy), and no significant contribution to their ability to refer to the correctness of chemical explanations, regarding everyday phenomena (structural literacy). No improvement in their attitudes toward chemistry was observed; in fact, their interest in chemistry concepts decreased significantly. Significant differences were revealed in most of the assessed parameters, between students who opted to study science in future studies and those who opted to study other subjects. The findings imply that the basic course was designed as a preparatory course and thus addresses the needs of the first group only. For both groups, it can be concluded that the basic course fails to establish a sufficient level of chemical literacy.
- The achievements of students at the end of the advanced course were significantly higher than those of students at the end of the basic course, in most of the assessed variables. This finding demonstrates students' ability to use and apply chemical knowledge that is being taught in chemistry classroom. However, since the advance chemistry course does not address all aspects of chemical literacy, the over-all achievements were not high.
- Teachers expressed the existence of a conflict between teaching chemistry with the goal of 'chemical literacy' for all students, on the one hand, and providing more advanced content knowledge to those who chose to study science at higher levels, toward a final examination in chemistry (Bagrut), on the other hand. This conflict influences teachers' practice and prevent them from fully addressing the needs of all students enrolling the basic chemistry course. This topic should be addressed in pre and in-service programs for chemistry teachers.

The overall picture that was obtained suggests that a change in high-school chemistry teaching is necessary in order to achieve chemical literacy. Some content components of the advanced course should be introduced already in the basic course, and a more general but comprehensive presentation of chemistry concepts should be implemented. Also, teaching chemical concepts in relevant contexts, addressing leaning skills, and marinating interest and motivation of all students, would result in attaining higher levels of chemical literacy.