Abstract: In this research study, two groups of chemistry students were compared: A group of students who participated in an inquiry-type laboratory program implemented in the context of high school chemistry, with a group of students who were involved in a more traditional-type laboratory method. Three subjects were assessed: (1) the students’ abilities to ask questions while conducting a chemistry experiment, (2) the students’ perception of their classroom laboratory learning environment, and (3) the students’ attitude toward the chemistry laboratory. In order to assess the development of inquiry skills, a practical test was administered. For the purpose of assessing the students’ perceptions of the chemistry laboratory learning environment and attitude towards laboratory work, the Hebrew version of the Science Laboratory Environment Inventory (SLEI) and, the ‘Attitude towards Science Laboratory’ questionnaires were administered respectively. In general, it was found that the inquiry group outperformed the control in these variables. In addition it was found that the students who conduct inquiry-type activities in the chemistry laboratory developed the ability to ask more and better inquiry-type questions.

Keywords: Attitude towards science laboratory, Inquiry questions, Inquiry skills, Inquiry-type laboratory, Laboratory learning environment

1. INTRODUCTION

As the beginning of the twenty-first century, we are entering a new era of reform in science education. Both the content and pedagogy of science learning and teaching are being scrutinized, and new standards intended to shape and rejuvenate science education are emerging (National Research Council, 1996). Inquiry in the science laboratory is one of the important components of this reform (Bybee, 2000; Hofstein & Lunetta, 2004; Lunetta, 1998;). It should be mentioned that the issue regarding the teaching and learning in science laboratories was the focus of several surveys and studies that were conducted in recent years in Europe (e.g. Sere, 2002; Tiberghien et al., 2001). In the context of the science laboratory, inquiry includes the following components: asking relevant questions, hypothesizing, choosing a research question for further investigation, planning an experiment, conducting the experiment, and finally analyzing the findings and arriving at conclusions. 

Laboratory activities have long had a distinctive and central role in the science curriculum, and science educators have suggested that many benefits accrue from...
engaging students in science laboratory activities (Hofstein & Lunetta, 1982; Tobin, 1990; Hodson, 1990; Lazarowitz & Tamir, 1994; Garnett et al., 1995; Lunetta, 1998; Hofstein & Lunetta, 2004). More specifically, they suggest that, when properly developed, inquiry-centered laboratories have the potential to enhance students’ meaningful learning, conceptual understanding, and their understanding of the nature of science. Hofstein and Walberg (1995) suggested that inquiry-type laboratories are central to learning science, since students are involved in the process of conceiving problems and scientific questions, formulating hypotheses, designing experiments, gathering and analyzing data, and drawing conclusions about scientific problems or phenomena.

The National Science Education Standards in the USA (National Research Council [NRC], 1996) use the term inquiry in two ways (Bybee, 2000; Lunetta, 1998): (a) inquiry as content understanding, in which students have opportunities to construct concepts and patterns, and to create meaning about an idea to explain what they experience; and (b) inquiry in terms of skills and abilities. Under the category of abilities or skills, Bybee included; identifying and posing scientifically oriented questions, forming hypotheses, designing and conducting scientific investigations, formulating and revising scientific explanations, and communicating and defending scientific arguments. It is suggested, that many of these abilities and skills are in alignment with those that characterize inquiry-type laboratory work, an activity that puts the student in the center of the learning process.

The main goal of this paper is to describe (and demonstrate) how providing chemistry students with opportunities to be involved in inquiry-type activities in the chemistry laboratory resulted a change in the students’ questioning behavior, enhanced the students’ attitude to and interest in chemistry laboratory, and improved their perceptions regarding the classroom laboratory learning environment.

2. THE INQUIRY LABORATORY PROGRAM

About 100 inquiry-type experiments were developed and implemented in 11th and 12th grade chemistry classes in Israel (for more details about the development procedure, assessment of students’ achievement and progress, and the professional development of the chemistry teachers, see Hofstein et al., 2004). Almost all the experiments were integrated into the framework of the key concepts taught in high-school chemistry, namely: acids-bases, stoichiometry, oxidation-reduction, bonding, energy, chemical-equilibrium, and the rate of reactions. These experiments have been implemented in the school chemistry laboratory in Israel for the last five years (about 125 teachers in about 82 schools, and about 3500 students). Only teachers who underwent an intensive professional development were involved in teaching the inquiry laboratory program. In these professional development initiatives the teachers were given the opportunity to conduct all the stages of the inquiry experiments as will eventually be done by their own students.

Typically in the chemistry laboratory, the students perform the experiments in small groups (3–4), by following the instructions in the laboratory manual. Table 1 presents the various stages that each of the groups undergo in order to accomplish