"SCIENTIFIC COMMUNICATION": AN INSTRUCTIONAL PROGRAM FOR HIGH-ORDER LEARNING SKILLS AND ITS IMPACT ON STUDENTS' PERFORMANCE

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ABSTRACT

In this paper we describe an instructional model for the acquisition of high order learning skills (HOLS) and the program "Scientific Communication", which supports its application in a junior high school (JHS) science and technology curriculum. The model emphasizes explicit and spiral instruction of learning skills, and a continuous demand for their implementation in various contexts and tasks. We describe a study that assessed the impact of our instructional model on students' performances. Students (N=447) from five different JHSs participated in the study: One group (N=334) studied the program "Scientific Communication", and the other (N=113) did not study learning skills through any formal program. The results show superior performance of the first group over the second in the following ways: the ability to describe and explicate the practice of learning skills; three aspects of the actual performances of a complex task: knowledge, learning skills, and the quality of products; and reports by students on the skills that they had acquired. The results also indicate that high and average achieving students gained the most from the program. We concluded that the contribution of the program "Scientific Communication" to students' performances of learning skills indicates the potential of its underlying instructional model in achieving its goals.

1. INTRODUCTION

Nowadays science teachers have to face an endless struggle between the vast number of topics that must be taught and the need to develop independent learners who master a variety of high order skills, namely, learning skills, thinking skills, and inquiry and problem solving skills. A major goal of science instruction in school is to prepare all students for life in a world of rapid scientific and technological change, rather than to prepare a small number of students for a highly specialized scientific career. The shift is toward placing curriculum content in more ecologically valid contexts by making it more inquiry-based (Linn, Songer & Eylon, 1996; Bybee, 1997) and by urging the adoption of measures to assess students in ways which tap their ability to engage in inquiry activities rather than memorization of content knowledge *per se* (Bol & Strage, 1996). This shift in goals, has led to reforms in science and technology education in many countries (National Science

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Education Standards, 1996; The National Curriculum of England – Science, 1999; DeBoer, 2000). These reforms reflect the overall tendency to encourage students to integrate into their lives what they learn in the science classroom and to replace traditional frontal instruction with instruction that is more student-centered and active (Linn, Songer & Eylon, 1996; Bybee, 1997).

In order for students to learn independently, they must be able to implement high order skills successfully (Berliner, 1992; Campbell et al., 2000). However, some researchers and educators claim that students' capabilities and skills develop spontaneously throughout various learning experiences in the course of their studies. Others claim that skill development can be achieved only through explicit, guided, and well-planned learning opportunities. Most studies do not support the first approach of spontaneous acquisition of skills; in fact, such studies show that students find it difficult to acquire skills by themselves and thus need supervision and direct instruction (Shamos, 1995; Castello, & Monereo, 1999). Thus, it is necessary to equip teachers with instructional methods and materials that foster adequate skills development.

In this article we focus mainly on high-order *learning* skills (HOLS): any HOLS is composed of skills and sub-skills. The performance of each of these skills and sub-skills and the ability to integrate them in complex learning tasks determine the level of one's learning capabilities. For example, oral presentation is a HOLS that requires the implementation of various skills and sub-skills, like gathering information from different sources, information organization, and summarizing. Integrating well all these skills into a final product of oral presentation constitutes evidence of high order learning skills.

In this article we refer to the following high order learning skills: information retrieval, scientific reading, scientific writing, listening and observing, information representation, and knowledge presentation. We designed a model for HOLS instruction, and developed learning materials, the program "Scientific Communication", for the junior high school (JHS) level (grades 7-9).

In this article we also present a study of the effect of our instructional model on the performances and achievements of students in learning tasks.

2. THE "SCIENTIFIC COMMUNICATION" PROGRAM

In 1993 a new reform took place in Israeli Junior High Schools (JHS): a new subject was introduced, "Science and Technology" (S&T), that was followed by a new syllabus which emphasized skills learning. In accordance with that reform, we developed a new program: "Scientific communication", for teaching HOLS. Each of these skills (HOLS) can be further divided into sub-skills; for example, scientific writing may refer to knowing how to write a scientific essay, how to write a scientific report, how to compose an abstract, and so on (Figure 1).