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Challenges in wide scale implementation efforts to foster higher order thinking (HOT) in science education across a whole school system

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ABSTRACT

This study explores the challenges involved in scaling up projects and in implementing policies across the whole school system in the area of teaching higher order thinking (HOT) in Israeli science classrooms. Eight semi-structured individual interviews were conducted with science education experts who hold leading positions pertaining to learning and instruction on the state level of the following school subjects: elementary and junior- high school science and technology; high-school physics; high school chemistry; and high school biology. Some of the challenges that the interviews revealed are common to many types of educational change processes. The interviews also revealed several challenges which are more specific to the educational endeavor of teaching HOT according to the infusion approach across large numbers of classrooms: challenges involved in weaving HOT into multiple, varied, specific science contents; challenges involved in planning a reasonable and coherent developmental sequence of thinking goals; the fact that content goals tend to have priority over thinking goals and thus to disperse of the latter in policy documents and in implementation processes; and finally, the considerable challenges (pedagogical and organizational) involved in developing educators' sound and deep professional knowledge in the area of teaching HOT and metacognition on a large, nation-wide scale. The data shows that wide-scale implementation of thinking in Israeli science classrooms often develops as an evolutionary rather than as a revolutionary process. The implications for designing large scale implementation programs aimed at fostering students' reasoning are discussed.

1. Introduction

1.1. Issues involved in teaching HOT on a large scale

> So teaching for thinking and understanding [across the whole school system]. . . We have not yet entirely deciphered the code of how to do it [L2]

As the introductory citation indicates, the challenge of teaching thinking on a large, national scale is a huge one. There is nothing new in acknowledging that a large gap often exists between educational policy and the way it is implemented. This gap is especially large in the context of policies that address changes in the core of education, i.e., changes in learning and instruction, such as the change involved in teaching thinking. Unfortunately, it is very difficult to change the core of

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education on a large, system-wide scale. Large scale efforts to improve teaching and learning focus more on structural and administrative characteristics of reform than they do on fundamental changes in the instructional core. Innovations that require significant changes in the core of educational practice are usually not only limited in their effects to a small scale, but also do not usually last very long.

Innovations addressing the teaching of thinking are definitely at the very core of learning and instruction. Without delving into the challenges involved in defining higher order thinking (e.g., Resnick, 1987; Schraw, McCrudden, Lehman, & Hoffman, 2011), I refer here to the latter concept in its widest sense encompassing issues such as thinking skills/strategies, critical thinking, argumentation, use of evidence, scientific reasoning, scientific literacy, inquiry, problem-based learning and problem solving. During the past 30 years there have been a substantial, and rapidly growing number of empirical studies supporting models and theories that address teaching thinking in science classrooms. Consequently, educators are currently familiar with many good models that work quite well for teaching science by emphasizing students' higher order thinking rather than merely memorization of facts.

Most of the models for teaching thinking in science education classrooms were studied within small scale projects. In addition, there have been some pioneering attempts to scale up such projects to scores of teachers and classrooms (e.g., Adey & Shayer, 1993; Adey & Shayer, 1994; Blumenfeld, fishman, Krajcik, Marx, & Soloway, 2000; Osborne, Erduran, & Simon, 2004; White & Frederiksen, 1998; Zohar, 2004). However, at the turn of the 21st century, successful teaching of thinking on the level of small or even large-scale projects is no longer sufficient. Policy documents from all over the world highlight the need to teach 21st century skills. HOT is an important component of any list of 21st century skills (Partnership for 21st Century Skills, retrieved July, PCS, 2011; Pellegrino & Hilton, 2012). Resnick (2010) argues that scaling up the "thinking curriculum" in a way that will foster proficiency for ALL students is currently a major educational challenge:

> Today we are aiming for something new in the world: *An elite standard for everyone*. . . That is what the term *21st-century skills* really means. The skills are not new (*some* students have been successfully learning them in *some* schools from the beginning of civilization). But the aspiration to successfully teach knowledge-grounded reasoning competencies to everyone is still just that—an aspiration. . .. But the transformation of the *institution* of schooling that will be needed to come close to making the aspirational goal a real achievement is huge (p. 184)

The goal of this paper is to examine the challenges involved in scaling up instruction of higher order thinking. The meaning of scaling up in this context is to take ideas and practices educators are familiar with on the level of projects and to implement them on a national level, i.e., across the state's whole school system. The paper examines these challenges by studying the views of leaders who had been involved in various large scale efforts to implement HOT in science instruction. Naturally, some of the pertinent challenges are common to gaps between policy and practice in general, or to scaling-up innovative, reform pedagogies in other areas (e.g., Blumenfeld et al., 2000; Dede, Honan, & Peters, 2005; Elmore, 2004; Fullan, 2007; Levin, 2008; Levin & Fullan, 2008; Lee & Krajcik, 2012). Yet, because of the unique features of teaching higher order thinking, some of these challenges are unique to efforts aiming at fostering students' thinking across hundreds or even thousands of classrooms.

Since many of the challenges that will be described in the findings section pertain to the development of teachers' knowledge, the next section will discuss relevant prior studies addressing teachers' knowledge in the context of teaching HOT. This will be followed by a section that will describe the educational context within which the present study took place.

1.2. Teachers' knowledge in the context of teaching HOT

Instruction of HOT requires much more than adopting a new curriculum because it requires a deep change in teaching practices. Like the teaching of other issues that pertain to current educational reforms, it stretches and challenges teachers' capabilities. In order to be able to respond to the unexpected events characterizing "thinking rich classrooms", teachers must be able to teach in an intelligent, flexible and resourceful way that cannot be scripted into a fixed set of technical instructional routines and skills (Carpenter et al., 2004; Loef-Frank, Carpenter, Fennema, Ansel, & Behrend, 1998). In order to teach thinking successfully teachers need to replace the traditional view of teaching as transmission of information and learning as passive absorption with more active, constructivist views of learning and an intricate set of specific beliefs and knowledge about teaching. Let us take a closer look at this knowledge.

1.2.1. Subject matter knowledge and pedagogical content knowledge (PCK) in the context of teaching HOT

As many studies show, familiarity with whatever it is that one is supposed to teach is a necessary condition for instruction. Another necessary condition for sound instruction is familiarity with appropriate teaching methods. There is a large body of literature that, following Lee Shulman's work, addressed various components of teachers' knowledge and distinguished (among other things) between subject matter knowledge, general pedagogical knowledge and pedagogical content knowledge (PCK). However, since the classic discourse in this area usually applies to teaching concepts rather than to teaching thinking, the meaning of these components of teachers' knowledge is not straight forward when we try to apply it to the context of teaching HOT. It therefore, requires further clarification.

The term used in the literature for whatever it is that one is supposed to teach is subject-matter knowledge (e.g., Cocharn & Jones, 1998; Shulman, 1986, 1987; Wilson, Shulman, & Richert, 1987). But because of the unique nature of thinking strategies this concept is confusing when the focus of our attention is on teaching thinking rather than on teaching facts and concepts.