15. HIGH QUALITY INTERACTION IN SCIENCE AND TECHNOLOGY EDUCATION

How teachers link cognitive and linguistic development

INTRODUCTION

This chapter describes the approach of incorporating high quality interaction in science and technology education, employing interaction as indispensable tool and strategic purpose simultaneously.

First we argue why high quality interaction is vital in science and technology education (S & T education). We describe the concrete features that mark high quality and demonstrate why high quality interaction needs to be incorporated in teacher professionalization. Next we focus on research findings that show how teachers are actually able to learn to realise the desired interaction in S & T education. The findings result from small scale quantitative studies and from a qualitative description of an S & T lesson.

INTERACTION IN SCIENCE AND TECHNOLOGY: HANDS ON, MINDS ON, TALK IT OVER

In science and technology education the popular adagio is hands on, minds on (introduced by Driver 1983). We will argue here, that this adagio lacks a third component. Although ‘minds on’ implies to ‘think aloud together’, our work with practitioners has made clear the need for an explicit statement. Children need ample and high quality opportunities to talk to others, i.e. peers and teachers, about discoveries, ideas and solutions. Without such opportunities science and technology education will not reach its goals. So we propose an extended adagio: hands on, minds on, talk it over. This adagio could also help to avoid the trap of the so called ‘pseudo-inquiry’ (see Harlen & Léna, chapter 1): plenty of practical activity, but a lack of involvement of the children in making sense of phenomena or events in the natural world (italics by the authors). The proposed extension is grounded in two major theories: socio cultural learning theory and language acquisition. These can be fruitfully linked: “the very same conversations that provide the opportunity for the child to learn language also provide the opportunity to learn through language.” (Wells, 1999, p.51). Interaction in S & T education needs to be thought- and talk-provoking.
Indispensible tool: active learning

Here we probe learning theories of science & technology education for the role they assign to dialogue\textsuperscript{w}. The kind of science and technology that children are to learn does not merely consist of a wide array of facts that can be transmitted to the children by a teacher or a textbook. The main objectives of S & T-education in primary school are (Van Graft & Kemmers 2007):

- children get familiar with the process of ‘doing science’
- children acquire knowledge: not mere facts, but concepts in their context
- children develop an inquisitive attitude

These aims can only be reached fully, if interaction plays a prominent role. This role is eminent for three reasons:

1. learning originates from language in dialogue
2. reasoning processes are acquired through dialogue
3. learning to engage in dialogue creates an open mind for new ideas

Each of these reasons is explained here.

1. learning originates from language in dialogue. When learners are engaged in problem-solving activities with peers and teacher, they learn through language. The aims of S & T education are in accordance with the current view on learning as a socio cultural process (Vygotsky, 1978; Leontiev, 1981). Learning is not a matter of transmission from an expert (teacher) to novices (the pupils), but consists essentially of transformation or co-construction by active learners (the pupils) with the support of a facilitator (teacher). In the social exchange children make meaning of the world surrounding them. In such transactions classroom discourse functions as a thinking device (Wertsch & Toma 1995). “… language is the essential condition of knowing, the process by which experience becomes knowledge” (Halliday 1993, p.94). In interaction children acquire new concepts and interconnect concepts. Moreover, it is oral interaction that permits them to function at their highest cognitive level. The abstractions needed to cope with written language restrict the level of cognitive operations a child can manage with as much as three years (Hammond 1990, cf Halliday 1993, p.110; Snow & Kurland 1996; Dickinson & Tabors, 2001)

2. reasoning processes are acquired through dialogue. Learning through dialogue is expanded in approaches such as dialogic inquiry (Wells 1999), inquiry learning (van der Linden & Renshaw 2004; Flick & Lederman 2006), inquiry-based science education (Harlen & Allende 2009), and dialogic teaching (Alexander, 2004; Mercer & Littleton 2007). Dialogue is also part in the Dutch version of the content-based approach: ‘Taalgericht vakonderwijs’ (Content based language education) (Hajer & Meestringa 2009). Through interaction children think things through, construct representations, and reflect on solutions and explanations. For instance, when making a prediction before executing an experiment “one is involved in a form of theorizing, as one examines one’s beliefs about the phenomenon in question and relates them to any other knowledge one has that is relevant to the possible outcomes of the experiment. As important as the actual predictions that students make, therefore, are the reasoning processes that