9. HISTORY OF SCIENCE AND ARGUMENTATION IN SCIENCE EDUCATION

Joining Forces?

1. THE ROOM FOR STUDYING ARGUMENTATION IN CURRICULA

These instructions are intended to provide guidance to authors. Although national variations are significant, there appears to be a general trend in most national and international curricula to stress Nature of Science (NOS) elements increasingly in science education as well as to incorporate more and more consciously Critical Thinking (CT) skills, and the understanding of socio-scientific issues (SSI) in the advanced primary and the secondary school education. For all of these aims an adequate image of science and the pivotal role argumentation plays needs to be realised (Driver, Newton et al., 2000). For approaches with deductive orientation, it is crucial that students acquire the ability to:

determine which of two or more proposed alternative explanations (claim) for a puzzling observation is correct and which of the alternatives are incorrect (Lawson, 2003, p. 1389).

Whatever view one holds about the type of argumentation, it clearly has a role in epistemological questions concerning science education. Theory choice is but one of the important aspects of argumentation in science education, others include the means to generate products or answers, a useful tool to teach students to back their claims or choices with evidence. As Sandoval and Millwood stress:

argumentation is a central practice of science and thus should be at the core of science education. ... understanding the norms of scientific argumentation can lead students to understand the epistemological bases of scientific practice (Sandoval & Millwood, 2008, p. 71).

Argumentation also has “social functions”. After a successful science education (by the end of high school) students are expected to be able to use criteria to distinguish well from poor arguments. Most national curricula expect students to talk science and write science, and even further to acquire general argumentative skills that can be used outside the science class or even school; the ability to persuade others or to reach an agreement with peers (Jiménez-Aleixandre, 2008, p. 97).

2. THE ROOM HISTORY OF SCIENCE AND ARGUMENTATION HAS IN CURRENT CURRICULA

Argumentation appears to be a crucial aspect of science, and, as such, also for approaches incorporating history of science in curricula. In spite of this, at the
moment mostly desiderata are set in course and curriculum objectives, without providing the necessary time for both history of science and argumentation in science classes. As a recent study concludes:

Despite such efforts at the level of international policies about the science curriculum, the systematic uptake of argumentation work in everyday science classrooms remains minimal (Jiménez-Aleixandre & Erduran, 2008, p. 20).

This is true even of the courses that aim explicitly to develop critical thinking skills and to teach NOS elements to students. I analysed in detail one such school-system, the International Baccalaureate Organization (IBO), and the new compulsory Theory of Knowledge course, launched in 1999 (Zemplén, 2007). Yet the IBO is still way ahead of most national curricula, and most countries lag behind implementing the NOS and SSI elements into school-science.

It would be unjust to blame only the slow implementation of the specific goals. There might be other reasons for the generally dismal results of students in comparison to the aims set. These aims might simply be overambitious, as

Only a minority of people progress to the final, evaluative epistemology, in which all opinions are not equal and knowing is understood as a process that entails judgment, evaluation and argument (Zohar, 2008, p. 256).

A large percentage of students never reach many of the curricular requirements concerning the epistemological understanding of science, even if they received instruction concerning NOS. In my view this problem is still underestimated by curriculum-developers, often only paying lip-service to certain goals, the teach-ability of which has only been demonstrated to be successful for high-ability students (Zemplén, 2007, p. 170–174).

Decades of research on the cognitive development of students suggests that this is not by chance. The desiderata most curricula set are not reachable to the large majority of students in either the later years of primary school or in high schools. In fact, for many, these skills only develop in the undergraduate or even post-graduate years – if at all (King & Kitchener, 1994). Without explicit instruction the success-rate is even smaller. Another factor affecting the success of curricular development is the difficulty of designing learning environments and content. As the causes of unsuccessful teaching interventions are underdetermined, but the successful ones are ascribed to the curricular (often modular) development, a bias is inherently built into any such procedure. As such, cognitive developmental differences are not addressed in most developmental projects. From this follows that partial success – generally meaning success with high ability students – is used as positive feedback in the course-development, thereby masking the results of lower-ability students. The result is that most aims are set with high-ability students in focus (Voss, et al., 1991).

Apart from the differences in the individual cognitive capabilities of students, a number of limiting factors also influence the efficacy of teaching, so a cursory overview of the most important ones is in order before one can proceed.