THE ROLE OF ARGUMENTATION IN DEVELOPING SCIENTIFIC LITERACY

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ABSTRACT

Recent approaches in educational research frame science learning in terms of the appropriation of discourse practices where argumentation plays a central role in the development of explanations and theories. The main objectives of the research reported in this paper were to (1) investigate the pedagogical strategies necessary to promote argumentation skills in students; (2) determine the extent to which the implementation of such strategies enhances teachers' pedagogical practices with argumentation; and (3) examine the extent to which lessons which follow these pedagogical strategies lead to enhanced quality in students' argumentation. Data collected from a set of lessons on scientific and socioscientific topics from twelve, year 8 schools in London are reported and discussed. These lessons were analysed using a framework based on Toulmin's Argument Pattern. There were statistically significant differences in the quality of arguments generated in the classrooms of the project teachers who had participated in the training workshops. The strategies that we have adopted for working with teachers, and the frameworks to support argumentation will be discussed.

1. INTRODUCTION

Decades after Joseph Schwab's argument that science should be taught as an 'enquiry into enquiry' and almost a century since John Dewey advocated classroom learning as a student-centred process of enquiry, school science is still struggling to achieve such aspects of scientific literacy in the classroom. Take, for instance, the publication of the AAAS edited volume on inquiry (Minstrell & Van Zee, 2000), the recent release of *Inquiry and the National Science Education Standards* (National Research Council, 2000), and the inclusion of 'scientific enquiry' as a separate strand in the English and Welsh science national curriculum (Department for Education and Employment, 1999). These three works serve as signposts to an ideological commitment that teaching science needs to accomplish much more than simply detailing what we know. Of growing importance is the need to educate our pupils and citizens about how we know and why we believe, for example, science as a way of knowing (Driver, Leach, Millar & Scott, 1996; Erduran, 2001; Erduran & Osborne, in press). The shift requires a focus on (1) how evidence is used in science for the construction of explanations – that is, on the arguments that form the links between data and the theories that science has constructed; and (2), the development

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of criteria used in science to evaluate the selection of evidence and the construction of explanations.

While consideration of the important roles language, conversation, and discussion have in science learning can be traced back several decades (Bruner, 1964; Lansdown, Blackwood & Brandwein, 1971), it was not until the 1980s that serious discussion of the role of language in science learning began (Gee, 1996; Lemke, 1990). More recently, the field has turned its attention to that discourse which addresses argumentation (Driver, Newton & Osborne, 2000). The case made here is that argumentation, i.e., the coordination of evidence and theory to support or refute an explanatory conclusion, model, or prediction (Suppe, 1998), is a critically important epistemic task and discourse process in science. Situating argumentation as a central element in the learning of sciences has two functions: one is as a heuristic to engage learners in the coordination of conceptual and epistemic goals, and the other is to make students' scientific thinking and reasoning visible to enable formative assessment by teachers. From this perspective, epistemic goals are not additional extraneous aspects of science to be marginalized to single lessons or the periphery of the curriculum. Rather, striving for epistemic goals like developing, evaluating, and revising scientific arguments represents an essential element of any contemporary science education process. An important task for science education, therefore, is to develop children's ability to understand and practice scientifically valid ways of arguing, and enable them to recognise not only the strengths of scientific argument, but also its limitations. Hence, the research presented in this paper, seeks to study how the teaching and learning of argumentation about scientific issues can be enhanced in science lessons. In so doing, our work builds on previous research into young people's epistemologies of science (Driver et al, 1996) and the conduct of group discussion in science lessons (Alexopoulou & Driver, 1997; Newton, Driver & Osborne, 1999).

2. THEORETICAL BACKGROUND ON ARGUMENTATION

Over the past few decades certain influential educational projects have all laid foundations for the work on argumentation in science lessons. These projects have promoted independent thinking, the importance of discourse in education and the significance of cooperative and collaborative group work (e.g., Cowie & Rudduck, 1990). In addition to these projects, a body of relatively unintegrated research concerning argumentative discourse in science education has begun to emerge (e.g., Boulter & Gilbert, 1995; Means & Voss, 1996; Mason, 1996; Herrenkohl & Guerra, 1998). Perhaps the most significant contribution to this literature has come from Kuhn (e.g., Kuhn, 1991) who explored the basic capacity of individuals to use reasoned argument. Kuhn investigated the responses of children and adults to questions concerning problematic social issues. She concluded that many children and adults (especially the less well educated) are very poor at the coordination of evidence (data) and theory (claim) that is essential to a valid argument. More recent work by Hogan and Maglienti (2001) exploring the differences between the reasoning ability of scientists, students, and non-scientists found, likewise, that the performance of the latter two groups were significantly limited.