THE ROLE OF ARGUMENT IN SCIENCE EDUCATION

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ABSTRACT

This paper makes the case for argument in science education drawing on a range of research efforts in the field. The specific research reported here took place over two years between 1999 and 2001 in junior high schools in the greater London area. The research was conducted in two phases. In phase 1, working with a group of 12 science teachers, the main emphasis was to develop sets of materials and strategies to support argumentation in the classroom, and to support and assess teachers' development with teaching argumentation. In phase 2 of the project, the focus of this paper, teachers taught the experimental groups a minimum of nine lessons that involved socio-scientific or scientific argumentation. In addition, these teachers taught similar lessons to a comparison group at the beginning and end of the year. The focus of this research was to assess the progression in student capabilities with argumentation. For this purpose, data were collected from 33 lessons by videotaping two groups of four students in each class engaging in argumentation. Using a framework for evaluating the nature of the discourse and its quality developed from Toulmin's argument pattern, the findings show that there was an improvement in the quality of students' argumentation.

1. INTRODUCTION

This paper, a summary of the ideas presented in a keynote address at the ESERA conference[1], addresses three questions:

- Why does argument matter in science education?
- What do we know about how it can be taught?
- How can we assist teachers to develop their practice?

2. WHY DOES ARGUMENT MATTER IN SCIENCE EDUCATION?

In answering the first of these questions, I and my co-workers, Shirley Simon of the Institute of Education and Sibel Erduran from King's College, have a particular conception of scientific literacy which is associated with two particular features that we believe to be missing from the landscape of contemporary science education. These are (a) opportunities to inspect, and engage with, the arguments that lead to the construction of scientific explanations, and (b) opportunities to evaluate

[1] To capture some of the essence of the talk, the style is, therefore, somewhat colloquial.

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critically plural alternatives. In short, what we subscribe to is a critical notion of scientific literacy. Embedded in that view is a premise that:

> …'to know science' is a statement that one knows not only *what* a phenomenon is, but also *how* it relates to other events, *why* it is important and *how* this particular view of the world came to be (Osborne, 2000).

Put simply, too much of science education presents a set of disembodied information masquerading as knowledge. Information is characterised by the fact that it is second hand consisting of other people's interpretation of experience. It may be about people, events, objects, and may deal with the abstract and theoretical concepts in science (Wells, 1999). Whether it can be remembered depends on the extent to which it can be infused by the receiver with meaning and assimilated into the individual's existing body of knowledge. Addicted, as many are, to simplistic conceptions in which education is seen as a process of information transmission (Reddy, 1979), my view is that that we are failing to offer students the opportunity to truly know science. Rather, it is as if the grand picture of science education were presented as a 1000 piece jigsaw, forgetting that its complexity ensures that most do not stay the course to ever see the whole picture.

Knowledge, in contrast, is something which is constructed through a process of justifying beliefs through reasoning, conjecturing, evaluating evidence, and considering counter-arguments. It is these processes, as Wells (1999) would argue, that 'constitute the activity of knowing'. That science teachers may lack aspects of such knowledge is evidenced by the difficulty they have when confronted with instances of the epistemic question – how do you know, for instance, that the following fundamental tenets and beliefs developed by school science are true?

- Day and Night are caused by a spinning Earth
- We live at the bottom of a sea of air
- We look like our parents because every cell carries a coded chemical blueprint of ourselves
- Plants take in carbon dioxide from the air
- All matter is made of atoms

My informal research would suggest that less than 10% of teachers of science are able to provide one of the two crucial pieces of evidence that demonstrate that the Earth spins. This is not so much a failure on the part of these teachers, but a failure on the part of their own education. Yet appreciation of the strange vision that science offers of the material world is not self-evident; science requires that what we offer students, at least some of the time, is the opportunity to engage in the process of scientific argument – to consider evidence, to appreciate that not all evidence is equally significant, and to evaluate arguments and propose counter-arguments.

Lest we forget, there are four potential learning goals to any science lesson (Duschl & Erduran, 1996). Goals may be conceptual in nature in an attempt to