

TEACHING ABOUT THE EPISTEMOLOGY OF SCIENCE IN SCHOOL SCIENCE CLASSROOMS: CASE STUDIES OF TEACHERS' EXPERIENCES

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ABSTRACT

There is evidence that many science teachers have limited expertise in teaching the epistemology of science (the ways in which knowledge claims in science are developed and justified). We examine the classroom talk of seven teachers as they use published lesson resources to teach about the development of scientific models in two concept areas (cell membrane structure and electromagnetism). Our aim is to provide recommendations for the content and form of professional development activities likely to support teachers' effective uptake of these, and similar, teaching resources. We first provide a characterisation of the content of science-related classroom talk. Two distinctive lines of talk related to conceptual development can be identified in each of the Cell Membranes lessons, and an additional line of talk in each of the lessons focuses on the epistemology of science. Handling these distinctive classroom conversations was a new pedagogical challenge for these teachers. We then identify features of classroom talk likely to constrain or promote student learning about the epistemology of science. Several teachers supported student learning by making explicit statements about what students were intended to learn about the epistemology of science. Teachers also made links to other lessons to exemplify epistemic issues in a variety of science concept areas. The paper ends with a discussion of the design of continuing professional development activities to support teachers in introducing epistemic ideas in the science curriculum.

1. INTRODUCTION

Teaching about the epistemology of science is gaining an increasing emphasis within many school science curricula (AAAS, 1995; Matthews, 1994). However, classroom-based studies have shown that there is currently no broadly established body of professional knowledge and expertise within the teaching community related to teaching about the epistemology of science (Lederman et al., 2003; Roth & Lucas, 1997). It is likely that science teachers responding to the increasing emphasis on epistemic issues within curricula will rely heavily on published resources, at least initially. We examine how a small group of teachers used published lesson resources for teaching about a single aspect of the epistemology of science: the development of theoretical models in the context of cell membrane structure and electromagnetism. Our analysis addresses two research issues. We first provide a characterisation of the content of science-related classroom talk. Given the

epistemic focus of the lessons, we were particularly interested in the balance between talk about science concepts and talk about the epistemology of science. We then identify features of classroom talk likely to constrain or promote student learning about the epistemology of science. Our findings lead to recommendations for the content and form of professional development activities likely to support teachers' effective uptake of these teaching resources.

Our approach reflects the view that there is much that the teacher must do in order to take published teaching resources and enact them in the classroom, i.e. teaching is a *situated* practice (Lave & Wenger, 1991). As a result, rather than examining teachers' espoused knowledge about the epistemology of science, or statements about what they wanted students to learn from the lessons, we focus on teachers' classroom talk. We recognise that, whilst teacher action is influenced by personal knowledge and intentions, factors specific to the school and classroom context also have a significant impact on the 'craft' of teaching. Brown and McIntyre (1993) refer to such factors as *classroom conditions* that guide teacher action, e.g. pupil attitudes and abilities, time available in class, issues raised by pupils and teacher fatigue. The study reported here is part of a larger study in which six different teaching activities were designed and evaluated in the classroom (Hind, 2002; Leach, Hind, & Ryder, 2003).

2. STUDY DESIGN

The teachers whose lessons we examine in this paper volunteered to be involved in the project, and were already known to the authors as experienced and effective high school science teachers. Seven teachers were involved (four Cell Membranes lessons; three Electromagnetism lessons). Teachers are referred to in this paper using pseudonyms. None of the teachers had previously undertaken professional development activities associated with teaching about the nature of theoretical models in science. By focusing on teachers' first time use of published teaching resources we hope to identify development needs that are most critical for these teachers. Examining the use of each of these teaching resources in 3-4 different classroom contexts, allows for a range of contingent factors to come into play, reflecting our view of teaching as a situated practice.

The lessons involve students aged 16-18 following specialist Advanced level science courses in the UK. These are academic courses focusing primarily on subject matter knowledge within a specific science discipline. Whilst aspects of the epistemology of science are identified as general learning aims for these courses, such issues are not emphasised in the 'knowledge to be taught' within the curriculum.

Each class was attended by 10-20 students, the teacher, and at least one of the authors. Whole class teacher/student talk was audio recorded. We also recorded some student group discussions (typically 2-4 students) to examine the impact of whole class talk on a sample of students; the student groups were randomly selected. In addition we draw upon statements during post-lesson interviews with two of the