The University of Cambridge

Teaching Ideas and Evidence in Science: Case studies of Classroom practice

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Introduction

The trainee teachers involved in the Cambridge project were asked to think about the teaching of ideas and evidence in science during their work on professional placement, and were invited to apply their understanding of this area of teaching. Five of the trainee teachers made presentations on aspects of their work, sharing their experiences, to audiences of experienced teachers.

The materials on the CD-ROM are not presented as exemplars to be followed, but rather they are designed to show how new teachers (with appropriate support from more experienced colleagues in their schools) were able to incorporate teaching about ideas and evidence in science into their classroom work.

Experienced teachers, with strengths in teaching about ideas and evidence, may find little that is new or innovative in these cases. However, they do demonstrate that:

- teaching about ideas and evidence in science need not be the preserve of the most experienced, accomplished science teachers;
- teaching about aspects of ideas and evidence in science does not mean moving outside the normal curriculum, but can be incorporated in existing schemes of work.

These cases show what able and enthusiastic, although very inexperienced, trainee teachers were able to achieve within the constraints of a professional teaching placement

Contributors to the project

Name	Contribution
Vicky Asbury	Project team – Cambridge based project
Cathy Auffret	Science teacher and mentor – Chesterton Community College, Cambridge
Susie Bentley	Project team – Cambridge based project
Gareth Burley	Science teacher - Deacon's School, Peterborough
Linsey Cushion	Mentor - Fearnhill School, Letchworth
Ann D'Souza	Project team – Cambridge based project
Tom De Trafford	Project team – Cambridge based project. Author of one of the project reports.
Stephen Diston	Project team – Cambridge based project
Jon Dunning	Mentor - Fearnhill School, Letchworth
Linda Hague	Director of Studies – St. John's College School Cambridge

Emily Harris	Project team – Cambridge based project
Scott Horsley	Project team – Cambridge based project
Stuart Kilby	Mentor - Jack Hunt School, Peterborough
Martin Koch	Project team – Cambridge based project. Author of project report.
Tamsin Lowe	Project team – Cambridge based project. Author project report.
Steve Mason	Project team – Cambridge based project
Susan Millins	Project team – Cambridge based project. Author of project report.
Hannah Perry	Science teacher - Jack Hunt School, Peterborough
Ann Peters-Wotherspoon	Science teacher – St. John's College School Cambridge
Teresa Quail	Project team – Cambridge based project. Author of project report.
John Raffan	Science education tutor – University of Cambridge
Greg Reid	Science teacher - King Edward VII School, King's Lynn
Alan Roberts	Mentor - College Heath Middle School, Mildenhall
Zulfikar Sayeed	Gifted & Talented Coordinator - Deacon's School, Peterborough
Philip Stephenson	Science education tutor – University of Cambridge
Keith Taber	Project leader – Cambridge based project. Author of project materials.
Stephen Tomkins	Science education tutor – University of Cambridge
Cliff Webb	Project team – Cambridge based project
Stephanie Wells	Mentor - King Edward VII School, King's Lynn
Gordon West	Project team – Cambridge based project
Elaine Wilson	Science education tutor – University of Cambridge
Mark Winterbottom	Science education tutor – University of Cambridge
Richard Worsey	Mentor - Deacon's School, Peterborough

Overview of activities

Activity P: Teaching Electricity at Y7

Developed by Tom de Trafford, Fearnhill School in Letchworth

This project examined how practical work and the use of models and analogies influenced the way pupils construct their own understanding of the concepts that they are studying. He looked at how the use of physical evidence is combined with external ideas to give the pupils the basis to form their own personal models of science.

Activity Q: Teaching the Solar System at Y7

Developed by Tamsin Lowe, at King Edward VII School, King's Lynn

Tamsin used 2 lessons to teach about models in science, in the context of the topic of the solar system. She used the first lesson to consolidate learning for weaker pupils,

and to apply teaching about scientific models to concepts with which most of the pupils were confident. A key aspect of Tamsin's work was that she made the nature of model and modelling explicit in her teaching:

Activity R: Teaching Forces at Y8

Developed by Martin Koch, Deacon's School, Peterborough

Martin focussed on tasks designed to develop 'higher level' thinking skills, including modified CASE (*Cognitive Acceleration through Science Education* – Adey & Shayer, 1994) tasks. The topics were related to 'forces' – i.e. moments and pressure.

His aim was to engage more able pupils in challenging thinking, e.g. by letting them apply previous knowledge in a different context. Two tasks involved the introduction of new topics (moments, pressure), and an investigation based around the practical application of a principle (moments). Instead of presenting the pupils with facts (rote learning), they had to develop their own ideas and find laws. Daily life experience had to be related to the new science concepts, and formulating their findings mathematically provided an extra step of abstraction. Martin was guided by the notions of higher level thinking skills in terms of 'Bloom's taxonomy' (Anderson & Krathwohl, 2001).

A key feature of Martin's approach was the use of pupil predictions that could then be tested out. The well-known POE (predict-observe-explain) teaching approach is a useful way to get pupils to think about ideas and evidence in science. Asking pupils to make predictions can be a very valuable starting point, especially with less able or younger pupils. Most pupils are able to make predictions that can be tested, *even when they are unable to verbalise their thinking* (which may often be tacit). This is especially useful when predictions are found to be incorrect, as this often acts as additional motivation to make sense of phenomena. By asking pupils to predict answers before carrying out activities, Martin provided pupils with a personal interest in the evidence to be collected, and a strong impetus to explain any aberrant findings.

Activity S: Teaching Light at Y8

Developed by Susan Millins, College Heath Middle School, Mildenhall

Susan worked with a Y8 group, and was supported by Alan Roberts (Head of Science). She focused on *extension work* for a small group of more able pupils in the mixed ability group.

Susan set the group a task to identify which fast food outlet were diluting drinks – requiring the pupils to apply the conceptual knowledge they had been taught in an unfamiliar practical context. She aimed to give these pupils more autonomy (something recommended in providing provision for the more able in science) and asked them to design, carry out, and develop, an appropriate practical way of comparing different strengths of drinks using colorimetric analysis (incorporating the use of ICT in the form of a datalogger). This was an activity that Susan felt required

pupils to extend their thinking beyond the QCA scheme of work and allowed them to apply and further the knowledge they should already have acquired.

This type of investigation is familiar from the assessed practical work undertaken for Sc1. In this case, Susan wanted pupils to have the opportunity to use data logging with the colorimeter, and so directed them to predict how colour would be influenced by dilution:

Activity T: Teaching Electricity at Y9

Developed by Teresa Quail, Jack Hunt School, Peterborough

Teresa's project considered three aspects of the nature of science – empirical work and the use of models and analogies. She considered how teaching strategies (practical work, the use of models and analogies) could help identify and correct pupils' misconceptions (analogous to the way science develops through the interplay of experimental and theoretical work).

In particular, Teresa asked pupils to imagine electrical phenomena from the perspective on an electron. Asking pupils to transform material presented in class through creative writing makes them actively think about the ideas, especially if they are asked to work key points into their stories. Imaginative writing tasks also provide a way for the teacher to see how pupils are conceptualising key ideas, and so diagnose misconceptions.