

Special editorial:

Teaching about ideas and evidence in science – towards a genuinely broad and balanced ‘science for all’

This issue of *School Science Review* has the theme of teaching about ‘ideas and evidence in science’. This characterisation derives from terminology used in the English National Curriculum, but the importance of teaching about the *nature of science* alongside teaching about the ‘products’ of science, that is scientific knowledge, is increasingly recognised internationally.

In the UK there has been some concern that teaching about the nature of science is relatively weak in some schools, and there is recognition that many teachers would welcome more support in this area, and in particular guidance on suitable approaches and resources. The articles in this theme issue offer some ideas about useful approaches and report on the development of resources that are available to support teachers – whether working to the English National Curriculum or in another context.

Identifying the problem

Although teaching about the nature of science was always *intended* to be an intrinsic aspect of the English National Curriculum, it was originally present in the form of preambles introducing the specified content. A revision to make ‘ideas and evidence’ clearly a statutory part of ‘content’, and the decision to make formal assessment of this part of the curriculum a focus of national testing, raised the status of teaching the nature of science. This has also led to concerns that many teachers are not sufficiently prepared to deliver this aspect of the curriculum. Several factors are likely to contribute to this problem:

- Most teachers learnt relatively little about the nature of science in their own schooling, or in their own degree studies.

- This is an area that has not been widely emphasised in initial teacher education in the past.
- It is expected that the nature of science will be taught through the context of existing curriculum topics, when simply teaching the curriculum models of biology, chemistry and physics has often made enough demands of the teacher, without considering how those ideas came about, or the extent to which they can be considered ‘reliable knowledge’.
- Many teachers feel that the secondary science curriculum is content-heavy, so that time is limited and has to be carefully apportioned.
- The aspect of ‘scientific enquiry’ that has previously seemed to be the priority in teaching about the nature of science, and so been the focus of much teacher effort and angst, has been ‘scientific investigations’.

So, many science teachers have limited explicit preparation for teaching about ideas and evidence in science. Although the English school curriculum defines ‘science’ as the school subject, most science teachers have degrees in chemistry, mineralogy, genetics, electrical engineering or some other specific scientific discipline. A ‘science’ degree seldom involves any substantive, explicit, consideration of the nature of science. While there are clearly exceptions, most undergraduate education provides a detailed background in the currently accepted theories and procedures of a single scientific discipline and limited explicit preparation for teaching about the nature of science.

This is clearly a shortfall that could be addressed in initial teacher education. Yet the existing demands on such courses, such as the one-year Post-Graduate Certificate of Education, are

already very heavy, and such courses rely on trainees being inducted into good practice during the two-thirds of the training year spent working in schools. Trainees are undergoing a major change of professional identity from 'chemist', for example, to 'science teacher', and for many trainees the expectation that they can teach outside of their specialism and across the science curriculum seems a more pressing challenge. It is also likely that most new teachers trained during the National Curriculum era have had little modelling of good practice during school placements. Clearly there is the potential for a vicious circle, with trainees learning to play down and marginalise this aspect of teaching science. A number of the articles in this issue derive from an initiative designed to break into that vicious circle, by aiming to make 'ideas and evidence' a focus of the training experience for student teachers.

The KS3 project on teaching ideas and evidence in science

The Secondary National Strategy (formerly the Key Stage 3 National Strategy) is an immense initiative funded by the UK government in order to raise standards through improving teaching and learning in secondary schools. The Strategy has strands in major curriculum areas, such as science, as well as in whole-school initiatives, cross-curricular themes and a focus on initial teacher education. As one small aspect of the Strategy, an initiative was developed in the context of science initial teacher education to respond to the recognition that 'ideas and evidence' is 'currently underdeveloped in many schools' and is an aspect of science teaching where there is 'room for improvement'.

Jan Peckett, the Secondary National Strategy's Regional Director with responsibility for initial teacher education in science, invited universities to participate in an initiative to enrich the quality and quantity of engagement with the 'ideas and evidence in science' aspect of *Scientific enquiry* (Sc1) at key stage 3. The initiative was designed to help focus the minds of the teacher educators, trainee teachers, and their school-based mentors, and to lead to case studies that might augment the teaching repertoires of those directly involved, as well as affording the potential for wider dissemination. It was hoped that this work

might also have the potential to contribute to the professional development of more experienced teachers of science.

Five universities responding to the invitation were selected to set up individual projects within the overall umbrella of the initiative: Cambridge (project leader Keith Taber), Keele (Rob Tweats), King's College London (Sibel Erduran – now at Bristol), the London Institute of Education (Shirley Simon) and York (Martin Braund). The Key Stage 3 Strategy supported the five individual projects with modest funding. The universities involved reported their work as case studies made available through the Strategy website (www.standards.dfes.gov.uk/keystage3).

The SEP publication – a resource for teachers

The Gatsby Science Enhancement Programme (SEP) was keen to collaborate in the initiative and approached the Strategy through Jan Peckett, offering support by matching the Strategy's funding and enabling the original plans to be developed further. SEP is part of Gatsby Technical Education Projects, which provides support for various aspects of scientific and technical education. SEP offers an open invitation for all UK science teachers to sign-up as 'Associates' through its website (<http://www.sep.org.uk/index.html>), and so to have access to a wide range of information and resources. Sally Johnson, the SEP project manager, organised further dissemination of the outcomes of the initiative through the production of a CD-ROM, made available to teachers at the 2005 ASE annual conference, and distributed to Strategy consultants. This resource contains a set of materials providing teachers with a range of ideas, activities and approaches to explore and develop pupils' understanding of ideas and evidence in science. The material is designed to be adopted or adapted by teachers, or simply be used as inspiration.

The developing curriculum context

In the short period of time since the Key Stage 3 Strategy initiative, the focus of most secondary teachers in England has switched to key stage 4 (14–16 year olds), where a major revision

of the National Curriculum is about to take effect. This revision responds to teachers' (and pupils') perceptions of a 'crammed' curriculum, where the type of science education experienced by most secondary pupils provides a fleeting familiarity with a broad range of the 'products' of science, rather than developing the type of scientific literacy that will support all young people as they become consumers, citizens and voters. The new curriculum is less prescriptive, providing opportunities for the development of courses (and the examination specifications which constrain and channel them) that can meet the needs of different groups of young science learners in schools.

Only time will tell whether good intentions lead to desirable outcomes. Many aspects of the existing National Curriculum, which has been rightly criticised, developed in response to pressure from the science education community for a *broad and balanced science education for all* to age 16. One desired outcome was that youngsters should not opt out of science subjects so early, and we no longer have the situation previously common in many schools where most girls stopped studying physics topics at age 14.

However, this gain was at the cost of the loss of many innovative courses designed to cater to the learning needs of different groups of pupils. In my own first teaching appointment we offered physics (and other traditional science options) to the more 'academic', mode 3 CSE courses in branches of engineering science to those felt to be better suited to less theory and more applications, and a very practical 'science at work' course for those who found science most demanding. Other schools offered options such as agricultural science. However, these 'alternative' courses did not provide the required full coverage of the National Curriculum.

It has taken almost two decades for official policy to acknowledge that broad and balanced science does not have to mean all pupils should be expected to learn about *all* the major traditional school topics from the different science disciplines. The new key stage 4 curriculum specifies less core content and puts more emphasis on the intellectual and social skills that are essential for both science careers and wider scientific literacy.

An invitation to teach about science

As well as the articles deriving from the initial teacher education key stage 3 projects, this issue also includes articles discussing a number of other developments in examining and pedagogy, relating to teaching about ideas and evidence in science. I am grateful to the authors of the articles, the referees, and *SSR* editorial and production staff for helping to bring about this theme issue.

The following articles, then, discuss various approaches to teaching about the nature of science. New or more experienced teachers, whether confident or apprehensive about teaching 'ideas and evidence in science', should find these articles informative, and thought-provoking, offering as they do ideas and perspectives for enriching teaching. The ideas discussed in these articles offer support for teaching *about* science, whilst teaching science, and that is what has often been missing from the learning experience of secondary pupils.

The introduction of the National Curriculum in England brought about a science that was 'broad and balanced', but only in terms of the coverage of the traditional topics of biology, chemistry and physics, and some earth and space science. Now the refocusing of the key stage 3 curriculum through the Key Stage 3 National Strategy, the significantly revised key stage 4 curriculum, and the further review of key stage 3 that will necessarily follow, offer the science education community an opportunity to rethink what 'broad and balanced' should really mean. Perhaps by the twentieth anniversary of the English National Curriculum we can offer breadth in terms of meeting the needs of future scientists and all other citizens, and balance between learning some important science and learning something important *about* science.

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