Dealing With Scientific Controversy

The nature of controversial issues

Controversy about contemporary science and its uses can arise in at least two ways. In both cases, an understanding of the nature of probability and risk is helpful.

a) The social application of well-established science, for example, the use of genetic engineering; the use of renewable and non-renewable energy sources.

In cases like these, the main issues for discussion are to do with the interaction of other dimensions, such as ethics, politics, economics etc., with the existing *scientific evidence* – i.e. issues are discussed and opinions formed in terms of competing values, impact on people etc.

Some teachers may thus consider that discussion of socio-scientific issues is not the business of science lessons. Others may consider the applications of science as of prime importance in helping pupils put their experience of school science in context. Research evidence (for example, Solomon, 1993) suggests that pupils are interested in socio-scientific issues and these have the potential to put the science in context and increase motivation.

In many cases (e.g. the methods and management of waste, the potential uses of cloning), analysis of the issue is by examining risks and benefits, weighing up alternatives, considering different factors and points of view. The focus is not mainly on the nature of the scientific evidence but on its implications.

b) Societal discussion of the implications of 'science-in-the-making', for example, the nature of global warming.

In cases like these, the issues discussed in a) apply but, in addition, there is the controversy over the nature of the scientific evidence. To allow pupils to engage in effective consideration of such cases, they need to have some understanding of the ways in which scientific evidence is generated and used. The processes and practices of science are implicit in most science classrooms. Pupils develop an awareness of the nature of science through the activities in which they are engaged. Unfortunately, these experiences can sometimes reinforce some common myths about the nature of science (see below). For example, most scientists wear white coats and do experiments, often involving Bunsen burners and other specialist apparatus. In order to be able to deal with scientific controversy, it helps to make the processes and practices of science more explicit – this is the essence of the 'Ideas and Evidence' strand of Scientific Enquiry in the Science National Curriculum.

This discussion could suggest that socio-scientific issues where the science is well established can be considered effectively in lessons other than science. However, the distinction between case of type a) and type b) is not clear cut. There are limits to existing scientific evidence. These may feature in discussions about resolving societal problems.

The processes and practices of science

Most science and citizenship teachers will not have had a formal, explicit education in the nature of science. We may each have a different conception of the purpose and nature of science and the ways in which it advances. In turn, these views may influence the way in which we deal with controversy in the classroom.

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McComas and colleagues (1998, p6) recognise that 'at the level of fine detail there will always be active debate regarding the ultimate level of science'. However, from examining science education documents around the world, they propose that there is a consensus about the view of science which can be presented to pupils (Table 1). Recent empirical research of what experts consider should be taught *about* science supports most of this consensus and adds further detail (Osborne et al, 2001).

You might like to use Table 1 as a checklist to see whether you agree with these views about the nature of science.

Table 1

A consensus view of the nature of science objectives extracted from eight international science standards documents (McComas, 1998, p6).

Scientific knowledge while durable, has a tentative character.
Scientific knowledge relies heavily, but not entirely, on observation, experimental evidence, rational arguments and scepticism.
There is no one way to do science (therefore, there is no universal step-by-step scientific method).
Science is an attempt to explain natural phenomena.
Laws and theories serve different roles in science, therefore students should note that theories do not become laws even with additional evidence.
People from all cultures contribute to science.
New knowledge must be reported clearly and openly.
Scientists require accurate record keeping, peer review and replicability.
Observations are theory-laden.
Scientists are creative.
The history of science reveals both an evolutionary and revolutionary character.
Science is part of social and cultural traditions.
Science and technology impact on each other.
Scientific ideas are affected by their social and historical milieu.

You may find that students believe one or more of the common myths about science (Table 2), because of the way scientific endeavour is presented. Just as ideas about electricity, photosynthesis etc need clear explanations to aid understanding, the main ideas and terminology of the nature of science need highlighting and explaining.

How many of these myths do you expose and challenge in your teaching?

Table 2
Common myths about the nature of science (after McComas, 1998)

Myth	Correction
Hypotheses become theories which in turn become laws.	Laws are generalisations or patterns. Theories are explanations of those generalisations.
Scientific laws and other such ideas are absolute.	Scientific laws have limitations and can be subject to revision.
A hypothesis is an educated guess.	Hypothesis could mean a 'generalising' hypothesis (which might become a law); an 'explanatory' hypothesis (which might become a theory); a prediction.
A general and universal scientific method exists.	No research method is applied universally. Scientists approach and solve problems with imagination, creativity, prior knowledge and perseverance.
Evidence accumulated carefully will result in sure knowledge.	It is impossible to make all possible observations and to secure facts for all time.
Science and its methods provide absolute proof.	Accumulated evidence can provide support for a law or theory but never prove them to be true.
Science is procedural more than creative.	It is the creativity of individual scientists which allows them to go beyond the evidence and develop laws and theories.
Science and its methods can answer all questions.	Science cannot answer moral, ethical, social, aesthetic questions.

Scientists are particularly objective.	Scientists are no different in their objectivity than other professionals. They do try to be careful in analysis of evidence.
Experiments are the principal route to scientific knowledge.	Scientific knowledge is gained in many ways including observation, analysis, speculation, library investigation and experimentation.
Scientific conclusions are reviewed for accuracy.	The number of findings from one laboratory checked by others is small.
Acceptance of new scientific knowledge is straightforward.	If an idea is a significant breakthrough or change, its acceptance is by no means quick or easy.
Scientific models represent reality.	Scientific models are created to describe aspects of the natural world and are useful in giving predictions and explanations.
Science and technology are identical.	Pure science is the pursuit of knowledge for its own sake. Technology, or applied science, is exploitation of science.
Science is a solitary pursuit.	Scientists work in teams.

Value judgements

Discussion of socio-scientific issues involves making value judgements. *Values* are 'principles, fundamental convictions, ideals, standards or life stances which act as general guides to behaviour or as reference points in decision-making or the evaluation of beliefs or action….' (Halstead, 1996, p5). Thus our values are influenced by our upbringing, societal norms, religious beliefs etc. We cannot avoid discussing values when we consider socio-scientific issues. Indeed helping pupils to be aware of their own and others' values may be an important purpose of the discussion. In the suggested activities, value judgement and opinion are definitions which are avoided for pupils as the nuances are subtle. Rather, the emphasis is on appreciating the nature of values and the way in which they impact on judgement and opinion forming. The activities allow exposure and discussion of values in a structured way.

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Recommendations:

To have effective discussion of socio-scientific issues, bear the following in mind:

Be aware of your own and your pupils' understanding of the nature of science.

Be aware of your own and your pupils' value system.

Be clear about the purpose of the activity and share this with the pupils.

The purpose of most of the suggested activities is not to resolve the issue – a near impossible task – but to clarify how we can reason using scientific evidence and values, and form justified opinions.

References and Further reading:

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