Some critical reflections on the teaching of controversial issues in science education

Justin Dillon, Marcus Grace and Chris Oulton discuss controversial aspects of ‘scientific literacy’ and describe a way of teaching controversial issues in science which they believe would increase the relevance of science education and provide a training in how decisions could and should be made.

Science and the public – unease, mistrust and hostility

How do you decide? Take, for example, the issue of genetically modified (GM) crops. Should we encourage their production in order to increase the amount of food available to the world’s population or should we ban them as potentially dangerous? Although many people have strong opinions about this issue, few know all the facts nor understand all the issues involved. We are very good at being able to form an opinion with very little information. But if we only had opinions when we knew all the facts we wouldn’t have many opinions. In the case of GM crops it seems that many people form their opinions by choosing from a range of views put forward by other people who appear to know more or to be more experienced. This would seem to be pragmatic but begs several questions such as ‘How do we decide whom to listen to?’, ‘How do we make a sound judgement?’ and ‘Who do we trust to make a decision when we are confused?’

Living in what is ostensibly a participative democracy we might expect that schools would teach people how and when to make effective decisions. Citizenship, the new English National Curriculum subject, offers opportunities for people to learn about arguments, evidence, decisions and the nature of controversy. Other subjects such as Science or English, with higher status and more curriculum time, offer further opportunities for students to develop an understanding of these issues.

Forming an opinion about GM crop production without any knowledge of the science involved would be foolhardy. One might expect that students would be taught about genetic modification in school science – but where should they learn about the controversial aspects of GM crop production? Much of the content of the science curriculum is relatively uncontroversial: geography and history appear to offer much more scope for discussion and debate. Indeed, most of the scientific knowledge taught in schools has been known for a hundred years and is unlikely to change – mirrors, magnets and metals will almost certainly look and behave the same in another hundred years’ time. But a relevant science education, an understanding of how science makes knowledge and of its limitations – what some might call ‘scientific literacy’ – cannot be developed without an appreciation of the nature of science. A science education that shied away from teaching about the controversial nature of several key issues in contemporary society would be ethically bankrupt.

Scientific knowledge and the making of scientific knowledge are not the same thing. Cross and Price (1996: 23) draw distinctions between ‘the nature of Science as a process leading to the production of scientific theory and ... [science] as an institution [that is] the organisations of Scientists and the major places where science is done’. Although we trust a lot of scientific knowledge a lot of the time, we don’t necessarily trust all scientists all the time – particularly those charged with advising the government of the day. Only a few years ago the House of Lords Select Committee on Science and Technology commented that:

Society’s relationship with science is in a critical phase ... On the one hand, there has never been a time when the issues involving science were more exciting, the public more interested, or the opportunities more apparent. On the other hand, public confidence in scientific advice to Government has been rocked by a series of events, culminating in the BSE [Bovine Spongiform Encephalopathy] fiasco; and many people are deeply uneasy about the huge opportunities presented by areas of science including biotechnology and information technology, which seem to be advancing far ahead of their awareness and assent. In turn, public unease, mistrust and occasional outright hostility are breeding a climate of deep anxiety among scientists themselves. (Select Committee 2000: 11)

So, how do we encourage students to engage with science and scientists? Can science education help society adopt a realistically critical stance to scientific knowledge and to the ways that it is portrayed in the media?

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Teaching about controversial issues in science education
The values underpinning current practice
The evidence from analyses of textbooks and inspectors’ reports chimes with our own experience that science teaching has tended to be dominated by a philosophy that science is neutral, objective and dispassionate. However, the plethora of popular books on science and technology show that scientific discovery is often far from being cold, soulless and uncontroversial. Scientists have values and those values impinge on their choice of research topics and on the way that they carry out their research. Scientists, contrary to popular belief, act as any other humans. Science and controversy go hand in hand as one glance at a newspaper all too clearly shows. However, encouraging science teachers to teach about the controversial nature of science is not easy.

This is not to say that teachers don’t teach anything controversial. What we are saying is that little consideration has been given to the problems with the way that controversial issues are taught in science. Recent research in England (Oulton et al., 2001, 2004, in press) showed that teachers frequently adopt a particular set of strategies when they teach about controversial issues:

• the focus should be on rationality, reasoning and sticking to the facts;
• a balanced view on the issue must be presented;
• the teacher should remain neutral.

We think that there are major problems with all these strategies. Few people, if any, appear to make decisions simply on ‘the facts’. Indeed deciding what are ‘the facts’ faced with conflicting expert opinions (such as the Measles, Mumps and Rubella (MMR) debate) is extremely difficult. For example, logically, one could argue that the best solution for an individual to minimize the risk to their child would be not to have them take the MMR vaccine but for everyone else’s child to take it. Making policy on a national scale can often involve balancing individual needs against those of society as a whole. Such decision-making policies involve ethical, social and political issues that go beyond a simplistic rational analysis of ‘the facts’.

Secondly, the issue of ‘balance’, while on the surface an attractive proposition, is contentious. Take the case of race—a concept that has been shown to be biologically flawed. Nevertheless the issue is still contentious. The notion that we would present a balanced view of race to children and let them make up their own minds might appeal to extreme libertarians but might result in students rehearsing racist views in classrooms. ‘Race’ is one of many controversial issues where science provides adequate facts, with sufficient certainty, to say ‘this is how the world is’.

Finally, a short critique of the related issue of neutrality. It would be unusual if teachers were neutral about the issues they present as controversial. We imagine that few science teachers have no opinion about the MMR vaccine or about the safety of GM food. We believe that it is unethical to pretend to pupils that teachers have no opinion. One reason is that it will often be a lie and the second reason is that the teacher’s choice of resources and approaches will almost certainly be biased to a greater or lesser extent. The position that we have argued for elsewhere is that ‘teachers should make their position explicit at the start of the exercise so that pupils are aware of potential bias in the way the teacher has arranged the experience and in what they say and do’ (Oulton et al., 2004). We also argued that ‘if we really expect pupils to be open about what they feel and think is it appropriate that teachers never give their opinion and share the basis for their thinking?’ This is not to say that teachers and students should be forced to give their opinions about every issue. Rather, we are saying that openness and transparency are more likely to encourage trust and debate.

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Problems with current teaching approaches
A list of approaches that teachers use often includes role-play. However, although it is often used there is little evidence that it helps students to form their attitudes. Given the time constraints, the lack of training that teachers have in using role-plays and the lack of adequate resource material, we argued that although role-play might be useful ‘the focus should be on pupils’ understanding of the event as a process not simply as a way to develop their understanding of the issue’ (Oulton et al., 2004). That is, the main purpose of role-play should be to look at how people make decisions rather than to rehearse a range of arguments.

Another approach that teachers report using is the debate. We argued that debate ‘can be problematic if it encourages pupils to form opinions too soon. In such cases, pupils’ opinions may simply be based on the personality or the ability of one of those presenting an issue and it is unfair to ask pupils to make their mind up on something that adults continue to argue about.’ (Oulton et al., 2004). We would agree with Joan Solomon, (2001) who suggested that teachers should put more emphasis on discussion as opposed to argument and debate because discussion is more likely to lead to self-reflection and a clarification of values.

Towards an alternative model of teaching about controversial issues
Much of the following discussion is based on an article that we wrote for the International Journal of Science Education (Oulton et al. 2004). Humanities teachers tend to use ‘stimulus activities’ more than science teachers to initiate class discussion. For example, Leat (2000) describes ‘mind movies’ based on materials produced for geography teachers. These are essentially stories, but pupils are asked to turn the story into a ‘movie’ in their minds, by imagining certain ‘shots’. Like stories, they draw on and develop visual
memory skills. The teacher reads a carefully selected passage to the students (taken from a newspaper, magazine, Internet article, etc.) and asks them to imagine the situation. This provides the basis for a class discussion that begins with a deeper feeling for the issue.

We think society would benefit if science education encouraged pupils, who are both today’s and tomorrow’s citizens, to:

1. Adopt a more positive and realistic view of science and its potential for resolving conflicts than is currently common;
2. Develop critical skills in relation to reflection upon and critiquing argumentation;
3. Less automatically accept received views;
4. Recognise the tentative nature of scientific knowledge and be willing to develop their thinking over time;
5. Develop their willingness and ability to find more information;
6. Offer better argumentation in support of the stance that they currently hold including as appropriate philosophical and ethical aspects.

To achieve these outcomes we need to rethink our approach to teaching about controversial issues.

We suggest that approaches are needed that:

1. Focus on the nature of controversy and controversial issues, ie. that help learners to appreciate how and why people disagree; that show the full range of worldviews held by individuals and cultural groups; that show the value and limitations of science and scientific knowledge and that help students to develop greater political understanding in terms of access to, and the use of, power.
2. Motivate pupils to recognise the notion that a person’s stance on an issue will be affected by their worldview;
3. Emphasize the importance of teachers and learners reflecting critically on their own stance and recognise the need to avoid the prejudice that comes from a lack of critical reflection.
4. Give pupils the skills and abilities to identify bias for themselves encouraging them to take a critical stance towards claims of neutrality, a lack of bias and claims to offer a balanced view.
5. Promote open mindedness, a thirst for more information and more sources of information and a willingness to change one’s view as appropriate, and avoid strategies that encourage pupils to actually make up their minds on an issue too hastily.
6. Motivate teachers, as much as possible, to share their views with pupils and make explicit the way in which they arrive at their own stance on an issue.

Take, for example, the issue of Foot and Mouth Disease (FMD) to illustrate what teaching approaches based on this model might look like. We begin by suggesting how a teacher working with pupils in the 14-19 age-range might currently approach the topic (see Wellington 1986a, 1986b). Using an article in a newspaper as a starting point, the teacher would ask the pupils what they know about FMD. These ideas would be collected on the board and the teacher would fill in any obvious gaps. The class would then be encouraged to discuss in small groups the pros and cons of vaccination as a way of controlling the disease. They would then have a whole class debate and vote for or against the use of vaccination. For homework they would have to write a short piece arguing for or against vaccination. The teacher would mark the homework on the basis of the accuracy of its scientific content.

In our alternative model, the teacher would again start with the newspaper article, or a stimulus activity of the kind described above, question the pupils about their ideas about the disease and fill in some of the gaps. The class would then be provided with five position statements on how the outbreak should be handled, each from a particular group (UK Government, National Farmers’ Union, an organic farming organization, an animal welfare group and the Dutch government). The teacher would explain the purpose of the exercise and why particular groups have been chosen to represent a (not the) range of opinions on the issue. The teacher would divide the class into groups and each group would use the documents and the Internet in order to answer the following questions.

1. Who is in the group?
2. How are they funded?
3. Who do they represent?
4. What are they trying to achieve as an organization?
5. What key values/philosophy or ethical position is explicit in the organization’s publicity materials?
6. What evidence are they using in the FMD debate?
7. Do they indicate the limits to their evidence?
8. What is the source of their evidence?
9. Do they present contrary arguments?
10. How strong do you think their argument is?
11. What do they want us to believe?
12. What are the consequences of their argument?

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Each group would present its findings as a poster, handout or short presentation. The teacher would lead a group discussion, reflecting on the strengths and weakness of the various presentations and the arguments from the five groups. The focus would be on the quality and effectiveness of the argument and presentations rather than on a resolution of the issue. For homework, pupils would be asked to compose a critical question that they would like to ask a representative of each organization if they were interviewing them. In each case, the pupil would have to state (for the teacher) why they were asking the question. The teacher would mark the sophistication of each question in terms of the pupil’s ability to analyze weakness in arguments and their ability to pose questions that could effectively elicit answers.

We believe that the approach that we have outlined above addresses some of the problems inherent in the existing teaching of controversial issues in science lessons. We believe that adopting such approaches would increase the relevance of the science education that students receive as well as providing a training in how decisions could and should be made.

References

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Science: The Global Dimension
Science is a global activity with global consequences for all our lives. It is also a human activity with ethical, social and political dimensions. Science education provides opportunities to relate technological change to changes in a wider context, such as effects on the environment and our quality of life. The impact of science is not confined to scientists but affects all people everywhere.

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* exploring and debating the role of science and scientists in a global context
* incorporating concepts of global citizenship and sustainable development
* ensuring respect for human rights
* raising awareness of poverty and injustice and the structures that cause them
* communicating the idea of mutual interdependence.

The booklet aims to show how the global dimension in science can contribute to a broad, balanced and enriched curriculum through examples of activities, case studies and resources. It also provides details of how to access further resources, guidance and support to develop classroom practice.

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