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## The place of socio-scientific issues in citizenship education

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This key note presentation addressed four questions: What are socio-scientific issues? Why is consideration of socio-scientific issues an important part of citizenship education? What are the implications for teaching? Where should consideration of socio-scientific issues sit in the curriculum? I posed these questions not as an authority on citizenship education, but as an experienced science educator. I draw on research experience of examining how teachers and pupils deal with socio-scientific issues in 'normal' science classrooms, and, to a limited extent, across the curriculum.

### What are socio-scientific issues?

Socio-scientific issues feature strongly in everyday experience – whether through media reports or individual and societal decision-making. For example, of particular interest in the media, as I write this, is: whether pupils should be admitted to primary school only if parents can show that they have had MMR vaccination; the potential of increased risk to health to young people of particulates in city air; the nature of a swine 'flu pandemic.

In a co-authored book (Ratcliffe and Grace, 2003) I have argued that socio-scientific issues have the following characteristics. They

- Have a basis in science, often at frontiers of knowledge;
- Involve forming opinions;
- Are frequently those which are media-reported;
- May have an incomplete evidence base;
- Can address local, national & global dimensions;
- Involve values and ethical reasoning;
- May require understanding of probability and risk.

### Why is consideration of socio-scientific issues an important part of citizenship education?

When pupils consider socio-scientific issues, they are inevitably examining their own and others' values; societal decision-making; ethical concepts of rights and responsibilities. These three areas, I would argue, are important features of citizenship education. In England the formalisation of citizenship education was triggered by the Crick report (DFEE/QCA, 1998). Since 2002 statutory citizenship education in England has focused on strands of social and moral responsibility, community involvement and political literacy. The consequence of implementation of a statutory citizenship curriculum has been that citizenship education is now embedded in schools, but principally in the hands of humanities (history, geography, religious education) teachers. As Davies (2004) discusses, science contexts have potential for supporting the strands of formal citizenship education if approached through the eyes of experienced citizenship educators. The lack of use of socio-scientific issues in citizenship education is thus a paradox. Here are some of the most important issues facing society at a local, national and global level. Yet they can be sidelined as potential contexts in the 'citizenship curriculum'. I could postulate a number of reasons for their omission – humanities teachers veering away from science contexts because of the level of their own knowledge of the underlying science; science teachers not being keen to engage in discussions about values and ethics because they see these as not part of science; the cross-curricular nature of socio-scientific issues preventing their effective engagement anywhere in the curriculum.

To some extent, the lack of discussion of socio-scientific issues within citizenship education may be because the expectations of pupils' learning are not clearly defined. What do we want to achieve in using socio-scientific issues? That pupils are:

- Able to make *informed* decisions about issues with a scientific base? – focus on the scientific content
- Can contribute to democratic processes from an *informed* perspective? – focus on the interaction between science and society in terms of processes of decision-making
- Able to deal with controversy – using evidence and value judgements? – focus on clarification of values and interaction with evidence.

Each of these is a different goal, highlighting the complexity of socio-scientific issues, yet, perversely, their strengths as contexts for citizenship education. I have argued (Ratcliffe and Grace, 2003) that consideration of socio-scientific issues in science classrooms involves:

- Conceptual understanding (e.g. concepts of genetics, ethics)
- Procedural understanding (e.g. how scientific evidence is generated; how decisions might be made)
- Recognition of personal and societal values

All of these are in the context of incomplete information and filtered through media reporting. A further issue for teachers is the topical and transient nature of particular socio-scientific issues. I am reminded of a comment relayed to me by a science education researcher who was working with both history and science teachers on a curriculum development project. This was during a period of alert about BSE (Bovine Spongiform Encephalopathy) in beef in England. A history teacher was enthusing about how the different media reporting of BSE was allowing him to show features of evidence and opinion and relate these to the types of evidence used in analysis and understanding of an important event in history. The science teacher, in response, had no recognition that he could have used the BSE crisis in science teaching. This exchange reflected the dominance of two different curriculum imperatives operating at the time – History focusing on the principles of evidence, at the expense, to some, of learning of historical ‘facts’; science focusing on understanding of science concepts, at the expense of learning about the nature and role of scientific evidence. The science teacher clearly did not see the media-reporting of BSE as an opportunity for his pupils’ learning of science – a sad state of affairs. This anecdote may suggest that humanities teachers are more open to examining socio-scientific issues than science teachers, but research evidence is needed to help explore the place of socio-scientific issues in the curriculum.

### **What are the implications for teaching?**

There have been a number of research projects, mainly by science education researchers, which have examined the actions of pupils and teachers in their consideration of socio-scientific issues (e.g. Zeidler, 2003; Lee and Witz, 2009). In terms of conceptual frameworks the following are ones which have been used by researchers as the basis for exploration of pupils’ learning:

**Decision-making theories** normative and descriptive – an emphasis on rationality and evidence in examining pupils’ thinking (e.g. Baron and Brown, 1991)

**Argumentation** Claims supported by warrants, rebuttals – examination of pupils’ discourse (e.g. Erduran *et al*, 2004)

**Epistemological model of controversy** – A theoretical framework for consideration of socio-scientific issues. Reasonable disagreement (role of evidence); communicative virtues (tolerance, openness); modes of thought (narrative, logico-scientific) (Levinson, 2006)

**Value based reasoning** Moral development, Ethical reasoning – a focus on goals, rights, responsibilities, values clarification (e.g. Layton, 1986)

To illustrate the nature of such research and outcomes for teaching, I briefly examine a cross-curricular project. The project arose from a proposal that pupils may gain a more holistic view of a specific socio-scientific issue by science and humanities teachers working together and that teachers of different disciplines might benefit by sharing teaching strategies. A cross-curricular team of researchers worked with a small number of secondary schools to develop, implement and evaluate a cross-curricular day for 15 year-old pupils on genetic engineering (Harris and Ratcliffe, 2005; Ratcliffe, Harris and McWhirter, 2004). The framework for the day had: a stimulus (for most schools in the form of an external speaker); sessions on the science of genetics and genetic engineering; sessions on social aspects and ethics; and a final synthesis session – Can we? Should we? The final session took the form of a debate or an opportunity for pupils to synthesise their views in different forms such as powerpoint presentations, radio discussion clips or posters.

The outcomes of the evaluation showed a number of features relevant to the consideration of socio-scientific issues as contexts for citizenship education. From the pupils’ perspective, there were a number

of characteristics of the day about which they were very positive and for which there was evidence of good pupil engagement:

- The study of one topical issue in depth.
- A novel stimulus raising questions
- External speakers, providing novelty and expertise
- The opportunity to share views, with a structure supporting critical discussion.
- A focus on the ethics of real problems
- An activity centred on the construction of a tangible product, allowing all pupils to synthesise their views actively and creatively.
- The opportunity to work in teams, reinforcing active learning and critical discussion

While teachers were positive about the event, and were likely to repeat the activity in future, there were a number of issues regarding the support of pupils' learning. Teams of science and humanities teachers engaged in cross-curricular planning prior to the day. In most schools, however, science teachers led the science session and humanities / RE teachers led the ethical discussion. There was limited sharing of different teaching approaches within the planning and delivery. It was rare to see well-supported discussions and reflections on the process of discussion and decision-making. Humanities teachers were not necessarily better at generating high level discussion than science teachers, for whom open discussion, particularly that involving value judgements, is not a normal feature of science classes. If consideration of socio-scientific issues is multi-faceted, then teachers need to have good pedagogical content knowledge of: concepts of science and of scientific evidence – the nature of science; values and ethical reasoning; methods of supporting pupils' discussions. Evidence from the cross-curricular project suggested that there are significant professional development needs for many teachers.

*1. Teachers' Knowledge and Understanding of the Nature of Science*

Teacher is anxious about his/her understanding      ←————— Confident that they have a sufficient understanding

*2. Teachers' Conception of Their Own Role*

Dispenser of knowledge      ←————— Facilitator of learning

*3. Teachers' Use of Discourse*

Closed and authoritative      ←————— Open and dialogic

*4. Teachers' Conception of Learning goals*

Limited to knowledge gains      ←————— Includes the development of reasoning skills

*5. The Nature of Classroom Activities*

Student activities are Contrived & inauthentic      ←————— Activities are owned by students and authentic

**Figure 1      Dimensions of practice in teaching ideas-about-science**  
(from Bartholomew, Osborne, & Ratcliffe, 2004)

A separate research project (Bartholomew, Osborne and Ratcliffe, 2004) followed science teachers as they aimed to teach aspects of the nature of science, including discussion of socio-scientific issues. Five dimensions of practice were identified (Figure 1). In classrooms where pupils were fully engaged in active learning, teachers tended to act according to the right hand end of the dimensions. Whether these dimensions of practice are applicable to all aspects of citizenship education remains to be seen (with concepts of citizenship substituted for nature of science). However, their relevance to discussion of socio-scientific issues in science classrooms appears to be established.

Evidence from research projects suggests that there is some way to go before teachers – science and humanities – are skilled and willing to support discussion of socio-scientific issues as part of citizenship education. There is a need for effective professional development to assist teachers in adapting to new curricula, which, in England now, have greater expectations of handling ethical reasoning alongside understanding concepts of science and the nature of science. The UK is fortunate in having a National Network of Science Learning Centres which provides access to very high quality professional development to support science and other teachers at various stages of their career ([www.slcs.ac.uk](http://www.slcs.ac.uk)). The National Centre, based in York, offers residential programmes for teachers across the UK. The Regional Centres, one in each of the nine government regions of England, support professional development through short courses available across the region. The professional development across the network is based on a set of principles based on research evidence of effectiveness of supporting changes in practice (Joyce and Showers, 1988; Loucks-Horsley *et al*, 1998; Darling-Hammond and Youngs, 2002; Adey, 2004). In particular, the planning involves needs analysis by teachers and developers, with the implementation featuring identification of learning outcomes linked to effective practice, collaborative sessions between teachers and experts, support over a period of time to assist with change. Innovative programmes have been developed which show high impact on teachers' practice. For example, from feedback from a sample of participants (484) on regional centre programmes for 2008-09, 91% reported an impact on practice, with 45% expressing this as improved confidence in teaching aspects of science. Teachers also reported impact on pupils, with 82% indicating pupils had access to new and different classroom activities; 73% stating pupil motivation had improved and 56% noting improvements in pupils' learning

Although many of the programmes run by the National Network focus on improvement of science teaching as a whole, some have a specific emphasis on citizenship and socio-scientific issues.

### **Where should consideration of socio-scientific issues sit in the curriculum?**

There are a number of unresolved issues in supporting teachers in dealing with socio-scientific issues. Some relate to the available research evidence to support effective learning and others to curriculum policy. While there may be good knowledge of pupils' progression in moral development and their understanding of specific science concepts, we have limited understanding of progression in learning about socio-scientific issues and about the nature of science. With one notable exception (Driver *et al*, 1996), there has been limited research into understanding how learners of different ages deal with concepts underlying socio-scientific issues. Driver's cross-age study explored pupils' conceptions of aspects of the nature of science and showed how pupils might refine their ideas with age and experience. Studies such as this are important and provide much-needed evidence for curriculum design. In the absence of good research, and the compartmentalisation of the secondary curriculum into tightly defined subject areas, it is debatable where the best place for consideration of socio-scientific issues is. Placing them in the humanities curriculum may allow an effective context for consideration of key citizenship concepts, such as human rights. However, if socio-scientific issues do not feature in the science curriculum, pupils can be left with the impression that school science has no relation to everyday life, nor raises ethical and social issues. It is perhaps understandable that, from my background, I view discussion of socio-scientific issues as important in science classrooms. Whether that is the most effective place to allow pupils access to high quality citizenship education remains to be discussed and researched further.

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