Chapter 13: Teaching controversial issues in science

Chapter aims

By the end of this chapter it is hoped that you will;

- Understand why some issues are controversial in science teaching and how controversial issues present opportunities for teaching and learning.
- Have some ideas around the approaches that you might adopt in dealing with some of these issues.
- Have the confidence to deal with issues that may be culturally sensitive.
- Appreciate broader learning that can take place through the study of controversial issues in science.
- Consider your own influence and position relative to some issues and strategies around 'teacher views'

Introduction

To an extent there will always be something of a contradiction in teaching, primarily because we are often ridiculously busy. From the day-to-day running around, preparing classes, sorting out the children to the administration preparation for inspections and reviews. Time is not exactly at a premium. With this in mind, it is understandable that we sometimes concentrate on the 'immediate' and perhaps overlook the long-term and deeper aspects of some of our teaching.

The organisation of a trip to a zoo or to an aquarium normally means that just seeing the animals or the fish is probably enough. Such visits certainly provide a great deal of material for science teaching before, during and after the event, as well as plenty of

cross over into other areas of the curriculum. Possibly it's too much for us to consider the ethics of keeping wild animals in captivity, or perhaps the validity of conservation claims, or whether perhaps you could achieve the same learning outcomes on a school-grounds bug safari hunt.

If you do find the time to sit down and consider the more controversial areas of present day science you may well come up with something of a media-driven list. That list will of course be contextualised by both time and location. For example, in the 1970s research into assisted fertilisation led to the development of in-vitro fertilisation (IVF) techniques and these were seen as highly controversial. Press reports of 'test tube babies', giving an entirely false image of the process did not help to placate concerns and in 1985 there was a Parliamentary Bill that prosed to ban the procedure. Yet today IVF is an available assisted fertility method that over 48,000 women went through in 2011 in the UK and although it is still opposed by the Catholic Church it is perhaps not seen as controversial as it once was. That is not to say that this is the case elsewhere and this is an important part of teaching certain areas of science. What may seem uncontroversial in one place would be prohibitively so elsewhere. Furthermore, as the research into fertility treatments has developed, new techniques and new research avenues have opened up. Recently the UK government gave support to a procedure known as 'mitochondrial transfer' where the mitochondria from a healthy female donor is combined with the nucleus of the mother and sperm of the father to prevent genetic diseases being passed with the result that the embryo (and eventually the child) will contain genetic from three people. Some see this as a major step forward in the eradication of certain genetic diseases, others may see it as a step nearer to so-called 'designer babies'. The point for us to consider

here is that new technologies and techniques provide new and very often complex ethical dilemmas and challenges for established value systems.

This is not new of course, in science we have a long history of controversy, from suggesting that the Earth was not at the centre of the universe, to suggesting that the diversity of life on Earth was driven by natural selection. The latter example remains controversial in many parts of the world today, including in some communities in the UK. This poses the question as to what actually constitutes a controversial issue?

This is one of the problems with this area is simply how do we identify them? One way was the 2011, NESTA survey of teachers in the US. The survey provided a list of 18 science topic areas and the teachers were requested to specify if they had experienced any pressure from the wider community to not teach about any of the prescribed areas. Of the 275 respondents, nearly half had experienced resistance to teaching about the age of the Earth. Even more, nearly two thirds, had suffered opposition to teaching evolution. These intriguing results underline some of the primary issues relating to the teaching of science. It may be that the theory of evolution appears equivocal in detail to many, as there are different views and perspectives within evolutionary biology that to scientists make it an interesting a fertile area of discussion. Techniques used in dating the age of the Earth on the other hand, use a suite of refined laboratory methodologies that allow replication and verification. It is difficult to be critical of the results of these methods. Although error is always present, it is difficult to see how these highly refined protocols and endless replication could be so inaccurate that one could scientifically accept that the Earth

was only 6000 years old. Yet it would appear that stating that, based on the results, could be seen as controversial.

This then is the difficult issue. Controversy is contextualised by social and cultural considerations, the stronger the opposition to an idea within a community the more controversial that idea will become and eventually coming to be seen as offensive, seditious and even threatening.

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Time for reflection 13.1

Harwood and Hahn (1990) have suggested that a controversial issues are those that "deeply divide a society, that generate conflicting explanations and solutions based on alternative value systems"

Think carefully about this statement in relation to science. Now consider the following questions:

- Does a 'society' have to be divided for there to be a controversy over a scientific finding or stance? Can such divisions occur at finer levels of definition, say at community level? If so, what is the most important influence?
- Is science a 'value system'? When they talk of 'alternative value systems' what do they mean?

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This is a problem for teachers because, depending on the context, nearly any subject or topic could be seen as controversial or offensive, but as a result we are simply careful as to which books we read or resources that we use. However, in science that is considerably more difficult. Science is a method of examining the world that is evidence-based. Challenging that evidence is part of the scientific process, which is why we publish our methods (so others may replicate the work) and encourage critical engagement with our results.

In fact, criticality is a key aspect of science. In science, theories and laws are based on evidence, observed, produced or calculated. We interrogate the methods we've used and are always critical of our findings, but eventually the evidence will become quite irrefutable at which point you may have to accept that the world is round. People are of course free to continue to believe that the Earth is flat, few scientific principles are enforced legally (unlike some religious ones) however, to do so is to simply ignore the overwhelming evidence, rather than to challenge it. One may simply not believe in gravity rather thinking that the surface of the Earth is just slightly sticky, in the same way you may believe that the world is only 6000 years old and that natural selection is not the explanation for the diversity of life on the planet. When people say they don't believe in evolution they do so by ignoring the prodigious evidence.

Science is often at a disadvantage in that it is often mistakenly perceived as dealing in absolutes and irrefutable facts. Of course science does not. It is quite the opposite, for as we discussed earlier it is more likely to deal in probability. One of the great problems that science faces is its strength. As science is not about certainty, it

constantly doubts itself. That's a good thing. The assuredness of certainty is actually intellectually rigid and infertile, doubt on the other hand, is much more fertile and nutritious in terms of ideas and challenges. It seems to curious perhaps to talk of doubt as a real strength, but until you understand how doubt is a core principle of science and see that as its strength, you haven't really 'got' science yet.

One of the key questions then is how do we teach about controversial issues without causing controversy. Is such an approach feasible?

Most strategies need to be fair to science. Too often perhaps we let evolution be described as "just a theory and there are other explanations". This is entirely incorrect. We need to remind ourselves here that there are no other overarching scientific explanations for the origin of species beyond natural selection. That is not to say that other explanations cannot be considered, nor are necessarily wrong, but rather every alternative explanation beyond evolution has little or no basis in science and needs to be considered outside of science lessons.

The importance of this has recently been heightened by the inclusion of evolution in the 2014 National Curriculum (DfE, 2013). This document is a tacit example of how evidence supports a theory. Children in Year 6 will learn about the form and formation of fossils, later they can use these to look at how the form of animals and plants has changed over time. The fossil record of course is one of the sources of evidence for evolution, having recognised change, the next step is to think about how this changes occur. It is not really possible to adequately explain such variation without some consideration of natural selection. Children are to be encouraged to

think about how animals have become adapted over time to suit their environments (the example given is an investigation into how the giraffes' neck got longer). It also suggests that children could find out about the work of palaeontologists such as Mary Anning and how Wallace and Darwin developed their ideas on evolution. Furthermore, all schools in England must teach evolution as a "comprehensive and coherent scientific theory".

State funded faith schools in England will also have to deliver this component of the primary curriculum so a consideration on how to go about this is timely and apposite.

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Time for reflection 13.2

Consider the following points:

- Has science and the science that you have studied ever really undermined your beliefs, or reinforced them?

- Do you think that your own values may influence your teaching in science?

- Would it be acceptable for a child to leave your class on geology and rocks, despite evidence to the contrary, believing that the Earth is 6000 years old and that people co-existed with dinosaurs? If not, would you try to persuade them otherwise?

[End Box]

Seeing controversial issues in science as an opportunity

Teaching about certain topics can be a source of concern and anxiety and it is entirely understandable to think about simply circumnavigating controversial issues and teaching science as a process using ‘safer’ topics. However, the National Curriculum in England includes a number of controversial issues (such as evolution and sex education) that need to be taught, so avoidance now may be impossible. It is something as teachers that we have to get used to.

In fact some would argue that science teaching is actually enhanced by using such issues as it can promote dialogue between the teacher and children and between the children themselves that if handled appropriately, can be an interesting way of introducing the uncertainties of the scientific process. Not only that, but a range of other skills relevant to science may also be encouraged.

Before we look at the science skills that may be developed it is important to remember that more direct teaching styles are not particularly appropriate when it comes to examining topics that may be deemed as controversial. Direct instruction on how and what to think has little to do with good science or good education. The teaching approach therefore must be very carefully considered.

For your children to really gain from looking at controversial issues there must be a type of teaching approach that encourages discussion and expression. However, children will need to build the confidence to express their views openly and to be able to do so with security and assuredness that such opinions are part of a wider discussion and that others may not agree. Indeed, using some of the creative

approaches discussed in the second half of this book could be instrumental to this. Role-play, drama or pictorial art may have much to offer here through role play in debates, or small dramas based around historical controversy or by using visual representations of different ideas and views on the classroom wall.

In a process that is well described (Oxfam – Teaching Controversial Issues) each stage of any science investigation has different learning outcomes, however, the study of more contentious issues, such as evolution and natural selection, may provide additional opportunities. The following is not a definitive list of outcomes, but is certainly teaching around these issues should allow

- Creative thinking relating to experimental designs to demonstrate adaptation – such a process introduces to the children simple means of reducing error and thinking through how other variables may influence the results.

- Careful observation and noting can be especially important here. Looking carefully at the changes in fossils over time.

- Asking questions and that originate from observation and data

- Children then require reasoning to develop justifications for explanations based on their own evidence and from making inferences from their data.

- Contradictory views allow for an interrogation of the veracity of methods used and the way data was collected

- Seeing their work in context and in relation to the work of others, such as Darwin or Wallace.

- Finally, it is through the expression of their ideas, in whatever form that may take, verbal, pictorial or diagrammatic that they learn to discuss and exchange views.

Some of the above are not unique to the teaching of controversial issues and can be achieved through the creative delivery of any part of the curriculum. However, using these issues does provide an opportunity to allow for intriguing discussion and a sense of personal expression that others areas would perhaps struggle to provide.

Points for practice

There are a range of approaches open to teaching and exploring contentious issues in science and these methods should also help children develop a range of other relevant and requisite skills. Different topics may require different approaches, some may be best suited for pictorial or diagrammatic work, and others may be better suited for discussion. However, when you are thinking about the method to adopt you will also need to consider the broader skills and values that you wish the children to learn or consider. For example you may consider the following:

Group work: The children work in 'research' teams, each child with a specialist role. The teams can even be working on different parts of the same problem and then report

back at the conclusion of the session. This allows the children the opportunity of working together, but also evaluating their own results in relation to that of others. They can also see the importance of looking at different types of evidence and how this builds to present a coherent theory. Of course it also allows them to see that not evidence may be valid, thereby promoting questioning skills.

Visual media: Making a 'research' documentary: Using mobile media to record events and views as a means of looking at different ideas through simulated interviews. The interviews could also be with adults beyond the classroom. Again, the children are thinking about questions and becoming familiar with and confident in questioning.

The Important role of discussion

Reporting findings is an important part of science practice but when it comes to discussing suggestions and inferences around potentially controversial issues the teacher's role becomes vital.

Here a common criteria of any approach is one that promotes balanced views and this is no doubt important and originates from the liberal view that children make their own decisions and that the teacher, given their position of authority in the classroom, could easily influence the children's view. One discussion that invariably takes place is how the teacher's own personal views, values and belief should be placed in this type of teaching, and there are a variety of positions that you might want to consider taking in any discussion. Any of these approaches can be useful, but with any

teaching style, their effectiveness depends on the topic, the context of the work and the age of the children. Something that is often overlooked, but is probably the most important consideration here is the teacher's discretion and working knowledge of the group's dynamics. Every group is different in a variety of subtle (and not so subtle ways). The complexity of personalities, friendships, confidence, ability and maturity will often mean that the teacher needs to rely on their own evaluation of what the group can reasonably be expected to cope with. This is a decision, as in all teaching situations, that need not be made in isolation. The guidance and advice of colleagues should always be sought if there are doubts, but the teacher will ultimately need to take the decision.

In terms of the approaches that may be considered, Harwood (2006) has identified six possible standpoints.

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Activity 13.1

Read through the following approaches. We have provided an advantage and disadvantage to each. Think about these carefully, can you add more?

The approaches that may be adopted are:

● Committed

The teacher will clearly state his or her own views to the children.

Advantages: It is an open and honest statement and could led to interesting wider discussions as to why they hold that view.

Disadvantages: Bias and possible promotion through predisposition to certain ideas and beliefs.

● Objective or Academic

The teacher provides, as best as possible, an account of as many different perspectives as is reasonably possible, but remains neutral themselves.

Advantages: All things considered and potentially no overt bias.

Disadvantages: Is it possible to consider all views, indeed, are all equally worthy of consideration? Covert bias is possible through the selection of accounts and emphasis placed on them.

● Devil's Advocate

The teacher deliberately adopts contrary views for the sake of debate and discussion.

Advantages: It allows all views to be thoroughly tested and interrogated.

Disadvantages: Is any true consensus reached? There is a danger of simply promoting children to respond along the lines of "So what is the answer then?"

● Advocate

The teacher adapts the Devil's Advocate approach. Once the different views have been discussed they state their own position.

Advantages: How the teacher has come to that decision in itself is an interesting way of introducing to children how methods of evaluation may be influenced by personal beliefs.

Disadvantages: May provide disproportionate validation of the teachers views as opposed to others, so possible bias again.

● Impartial Chairperson

Here the pupils provide their own views and the teacher may facilitate a discussion, however the teacher only facilitates the events and does not offer their own views.

Advantages: The group develops skills in articulating their views and presenting an evidence-based argument.

Disadvantages: Takes considerable skill to allow those less eloquent to express their views with confidence. Debates can often be won by personality and performance rather than careful consideration.

● Declared Interest

The teacher states their own view and then all other possible views and interpretations attempting an unbiased presentation.

Advantages: The pupils may be able to interpret and evaluate ideas, knowing that there are different interpretations that may be equally valid.

Disadvantages: Again, care needs to be taken so that the teachers view is given greater credence than the alternatives.

This is not a definitive list of approaches and we could perhaps add:

● Adoptive position

The teacher places himself or herself beyond the dialogue by using prefixes to identify different positions and views, such as “If I were a scientist I might say…” or, “People who disagree with the scientists might think that…”

Advantages: Objective delivery of varied viewpoints and interpretations

Disadvantages: It is still the teacher that selects the views and as such still may afford bias.

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Of course it is not only the teacher that may adopt contrary positions when it comes to interpretations and issues. Creative pedagogies discussed elsewhere in this book such as role-play and drama would be ideally suited.

Presenting a ‘balanced’ argument is often seen as a reasonable approach, but the trouble is that those with different perspectives will interpret balance differently. Ultimately, bias is very difficult to eradicate and whether it is possible, or even desirable, particularly in a contemporary multi-ethnic society is worth questioning. All of these approaches are good ways for children to really gain from looking at controversial issues and they are all based on a type of teaching approach that encourages discussion and expression. However, children will need to build the confidence to express their views openly and to be able to do so with security and

assuredness that such opinions are part of a wider discussion and that others may not agree.

Of course the issue with science is that evidence can be interpreted in different ways. It is easy to misunderstand a science principle, such as the erroneous idea that a vacuum cleaner 'sucks' up a piece of paper, especially if the initial evidence might suggest that it does just that! It is not too difficult to demonstrate that the paper gets pushed into the vacuum (demonstrate the principle using water rather than air) it is much more difficult to demonstrate evolutionary change over time based on observation. Sometimes the changes in the form of a fossil may be due to stages in a creature's life cycle, rather than to any evolutionary process, in that juveniles may look very different to adults. All of these ideas are open for discussion and as such mirror the scientific world. Scientists of course have the chance to put their ideas forward for discussion and often an academic debate or discourse ensues. Of course during these debates it is the work that is criticised, not the person or team (that is why science papers are written in the third person if you've ever wondered) and it is vitally important that that mutual respect and the ground rules of debate are strictly followed. Appropriate group behaviour is an important consideration here, as everyone needs to be sufficiently confident to give his or her ideas. Responses to misbehavior are as important as to let a disparaging remark go unchallenged could be seen as condoning the sentiment.

Finally, it is important to remember the limitations of science. Science is one way of trying to understand the world around us and however powerful its methodology, it is only one way of trying to understand. One of the key aspects of science (as we saw in

Chapter 2) is that we set hypotheses that are clear testable statements, normally taking the form of a prediction, for example “The water level will rise if we put in some pebbles into the beaker” or “The water level will rise if we put some sugar cubes in.” From such statements a definitive answer may be derived. These are very simple examples but the principal for all scientific hypotheses remains the same. Questions such as “Do rocks have emotions?” or “Does water like salt?” cannot be definitively answered. They can certainly be asked, but they would need to be rewritten for a scientific methodology to be designed to attempt any kind of response. This of course means that science can only answer the right type of question. This is often seen as a problem for science and it is certainly a limiting factor in its application. For some, the answers to the types of questions that science cannot answer may be found elsewhere, sometimes through simple belief.

Considering wider values in controversial issues in science

A final characteristic of teaching around controversial issues in science is the opportunity that it affords to promote not only academic skills in articulating ideas and building confidence, but that it also allows us the chance to also promote certain values that are important in the practice of science.

Science is often said to aspire to be value-free in that it deals objectively with results and evidence. Of course that is not necessarily the case. Science as a methodology values certain characteristics of practice such as accuracy and precision and inversely ‘de’-values unsubstantiated claims or exaggeration. We also have certain values that influence our ethical practice and those in turn may be shaped by cultural and societal

influences. Of course other values in science are the ones placed on it by society and these at times may be contradictory. For example as of June 2013 the Large Hadron Collider at Cern has cost £2.6 billion. If we are concerned with values in science there is probably not a great deal to discuss relating to the research at Cern, but what of the wider ethical considerations of this research? Given the context of the unlikely achievement of the 8 UN Millennium Development goals (including the eradication of extreme poverty and hunger) by 2015, what and who's 'values' does the LHC project actually present and represent? When we talk about values in science we need to think about whose values. Contemporary governments will fashionably say they value science, increasingly because of its potential contribution to the economy, others may value it for perceived wider intellectual and academic benefits. The vitally important value relating to science of course is the value that you put on it as a teacher.

Teaching controversial science topics is also an effective way of promoting values with children. Respecting other people's views yet learning how to question them in ways that are productive to both parties is one. In multi-ethnic and multi-faith societies where there are so many different belief and value systems such an approach is vital. Learning how to take turns in presenting ideas and how to carefully listen to others are not skills exclusive to science, but are part of the critical nature of it. In the same way that teamwork, sharing results and being self-critical and self-doubting are also features of modern science practice.

Conclusion

Progress in modern science has been astounding. Progress in biomedical science in particular has been nothing short of revolutionary, for in a little over a hundred years life expectancies in high-income countries such as the UK have all but doubled. In fact science has effectively provided us with amounts to a second life. However these new advances not only change our behaviour, but they have challenged the way we see the world. To end as we began, there is nothing new in this. Science has always challenged our worldviews. Sometimes this has been painful in the extreme when it has challenged belief, tradition and convention. Yet this is the nature of science, to question the expected, to defy orthodoxy and to be the instigator of change, however imperceptible that change may be. It is inevitable that at times it will promote controversy, but to avoid this and take the uncontested route in teaching means that whatever it is you teach, it is not science.

Further Reading

Troyna, B. & Carrington, B. (1988) (Eds) Children and Controversial Issues: Strategies for the Early and Middle Years. Falmer Press Ltd

Rather dated now, but still a good resource for ideas and approaches.

Oxfam (2006) Teaching Controversial Issues. Global Citizenship Guide. [On-line] Available from: https://www.oxfam.org.uk/~/media/Files/Education/Teacher%20Support/Free%20Guides/teaching_controversial_issues.ashx.

Referenced below as well, this short document is an excellent introduction to the topic and provides good links to other on-line resources.

Oulton, C., Dillon, J. & Grace, M. M. (2004) Reconceptualizing the teaching of controversial issues. *International Journal of Science Education*, 26 (4) pp411-423

For an overview of science and its contribution to teaching controversial issues.

Wooley, R. (2010) Tackling Controversial Issues in the Primary School: Facing Life's Challenges with Your Learners. Routledge.

Most resources look at teaching controversial issues in secondary school settings, this is an interesting look at the topic with specific reference to primary education.

References

Harwood, D. (2006) cited in Oxfam (2006) Teaching Controversial Issues. Global Citizenship Guide. [On-line] Available from https://www.oxfam.org.uk/~/media/Files/Education/Teacher%20Support/Free%20Guides/teaching_controversial_issues.ashx. Accessed 19.07.13

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