Teaching evolution in a creationist environment: an approach based on worldviews, not misconceptions

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ABSTRACT Belief in creationism and intelligent design is becoming more widespread. This article examines the characteristics of religions and the possible relationship between science and religion before going on to consider how science teachers might deal with creationism in their classrooms when teaching evolution. The central argument is that creationism is best seen not as a misconception but as a worldview. The most that a science teacher can normally aspire to is to ensure that students with creationist beliefs understand the scientific position. In the short term, the scientific worldview is unlikely to supplant a creationist one. We can help students to find their science lessons interesting and intellectually challenging, without them seeming threatening. Effective teaching in this area can not only help students learn about the theory of evolution, but to appreciate better the way science is done, the procedures by which scientific knowledge accumulates, the limitations of science and the ways in which scientific knowledge differs from other forms of knowledge.

The rise of creationism

To some people's surprise and consternation – and to others' delight – belief in creationism is growing in extent and influence, both in the UK and elsewhere. Definitions of creationism vary, but about 40% of adults in the USA and perhaps over 10% in the UK believe that the Earth is only some 10 000 years old, that it came into existence as described in the early parts of the Bible or the *Qur'an*, and that the most that evolution has done is to change species into closely related species (Jones and Reiss, 2007). For a creationist it is possible that the various species of zebra had a common ancestor, but this is not the case for zebras, bears and antelopes – still less for monkeys and humans, for birds and molluscs or for palm trees and flesh-eating bacteria.

At the same time, of course, the overwhelming majority of biologists consider evolution to be the central concept in biological sciences, providing a conceptual framework that unifies every disparate aspect of the life sciences into a single coherent discipline (National Academy of Sciences and Institute of Medicine, 2008). Equally, the overwhelming majority of scientists believe that the universe is of the order of about 13–14 billion years old. Even though evolution and cosmology are well-established scientific theories, they are at the centre of a prolonged, possibly deepening, religious controversy.

Evolution and cosmology are understood by many to be a religious issue because they can be seen to contradict the accounts of origins (inorganic, organic and human) described in the Jewish, Christian and Muslim Scriptures. The issue seems like an ongoing dispute that has science and religion actively battling to support the credibility of their explanations for origins. If, like me (and Rowan Williams, the Archbishop of Canterbury), you like *The Simpsons*, have a look at http://religiousfreaks.com/UserFiles/Media/simpsons.creationism.mov (last accessed 12 January 2008) for one such treatment of the evolution / creationism issue in school science lessons.

The public presentation of the controversy often gives the impression that biblical

creationism and biological evolution refer to two mutually exclusive explanatory systems. The lower visibility of presentations of moderate views creates the impression in many people's minds that a clear delineation exists between those who support scientific theories and those who adhere to scriptural teachings.

This highly publicised schism between a number of religious worldviews, particularly Judaeo–Christian views based on *Genesis* and mainstream Islamic readings of the *Qur'an*, and modern scientific explanations derived from the theory of evolution is exacerbated by the way people are often asked in surveys or interviews about their views on human origin. There is a tendency to polarise religion and science in questionnaires that focus on the notion that either God created everything or God had nothing at all to do with it. The choices used in many public polls erroneously imply that scientific evolution is necessarily atheistic, coupling complete acceptance of evolution with explicit exclusion of any religious premise. Most surveys contain only a small number of options, making analysis easy, 'clean' and strictly numeric. The limited number of categories forces people to codify their views to fit into, at best, three or four predetermined categories, and misses more nuanced information about what they are actually thinking.

In fact, people have personal beliefs about religion and science that cover a wide range of possibilities. Eugenie Scott (1999) and others have proposed that individuals hold a spectrum of views, ranging from young-Earth creationists to those for whom the scientific and religious worldviews are integrated into one. Therefore, before going on to consider how science teachers might deal with creationism in their classrooms when teaching evolution, I want briefly to examine the characteristics of religions and the possible relationships between science and religion. The central argument of this article is that creationism is best seen by a science teacher not as a misconception but as a worldview. The implication of this is that the most a science teacher can normally aspire to is to ensure that students with creationist beliefs understand the scientific position. In the short term, this scientific worldview is unlikely to supplant a creationist one.

The characteristics of religions

Although it is difficult to summarise the nature of religion in a way that satisfies the members of all religions, several of the characteristics of most religions (Smart, 1998) contribute to debate over origins. First, religions have a practical and ritual dimension that encompasses such elements as worship, preaching, prayer, yoga, meditation and other approaches to stilling the self. By the time students enter secondary school, many have learned to find a comfort from this dimension that can be disrupted by scientific explanations that are so different from their existing beliefs.

Abrupt exposure to science can also disrupt the security of the experiential and emotional dimension of religions. At one pole are the rare visions given to some of the crucial figures in a religion's history, such as that of Arjuna in the *Bhagavadgita* and the revelation to Moses at the burning bush in *Exodus*. At the other pole are the experiences and emotions of many religious adherents, whether a once-in-a-lifetime apprehension of the transcendent, or a more frequent feeling of the presence of God either in corporate worship or in the stillness of one's heart. Science, particularly evolution's connection to human origins, can seem dismissive of this dimension and may be rejected for that reason.

All religions hand down, whether orally or in writing, vital stories comprising the narrative or mythic dimension of their tradition. For some religious adherents, such stories are believed literally; for others, they are understood symbolically. In the case of the six-day creation account in the Judaeo–Christian Scriptures, scientific ideas are incongruent enough to pose cognitive challenges that teachers need to help students negotiate. Furthermore, creationist critiques of school science teaching receive wide circulation, and some students may think that science teachers will try to convince them that God was not ultimately responsible for human and cosmic origins.

The doctrinal and philosophical dimension of religion arises in part from the narrative/mythic dimension, as theologians within a religion struggle to integrate these stories into a more general view of the world. Thus, the early Christian church came to its understanding of the doctrine of the Trinity by combining the central truth of the Jewish religion – that there

is but one God – with its understanding of the life and teaching of Jesus Christ and the working of the Holy Spirit. Contemporary theologians face the challenge of helping citizens integrate doctrinal and philosophical teachings of religion into worldviews that are compatible with the understandings that are the product of scientific progress.

While doctrine attempts to define the acceptable beliefs of a community of believers, the ethical and legal dimension regulates how believers act. So, Islam has its five Pillars – *Shahada* (profession of faith), *Salat* (worship), *Zakat* (almsgiving), *Saum* (fasting) and *Hajj* (pilgrimage) – while Judaism has the Ten Commandments and other regulations in the *Torah*, and Buddhism has its five precepts. Part of the creationist movement's objection to the theory of evolution is the perceived threat of modernism (or post-modernism) and associated immorality (or amorality). Aversion to evolution can also be based on the assumption that acceptance of the theory of evolution requires atheism.

The social and institutional dimension of a religion relates to its corporate manifestation – for example, in Buddhism, the order of monks and nuns, the Sangha, founded by the Buddha to carry on the teaching of Dharma; the whole Muslim community, the Umma, in Islam; and the communion of believers comprising the body of Christ, the Church, in Christianity. Science provides only a weaker version of this dimension through the community of peer-validated scientists. The associated loci of control involve different values than those of religion, which again demand an intellectual shift that individuals with a strong religious faith may not be eager to make.

Finally, there is the material dimension to each religion, namely the fruits of religious belief as shown by places of worship (e.g. synagogues, temples and churches), religious artifacts (e.g. Eastern Orthodox icons and Hindu statues) and sites of special meaning (e.g. the river Ganges, Mount Fuji and Uluru (a.k.a. Eyre's Rock)). When evolution is regarded as a contradiction to religious tradition, there is the threat of the loss of connection to these valued sites. Thus, for some believers, embracing the explanatory value of evolutionary science means sacrificing too much in terms of the loss of the religious dimensions of their lives.

The relationship between science and religion

These aspects of religion also provide a number of other axes on which the relationship of science and religion can be examined. For example, the effects of the practical and ritual dimension are being investigated by scientific studies that examine such things as the efficacy of prayer and the neurological consequences of meditation. There have been a number of scientific attempts to 'explain' religious feelings. The narrative/mythic dimension of religion clearly connects with scientific accounts of such matters as the origins of the cosmos and the evolution of life. The doctrinal and philosophical dimensions can lead to understandings that may agree or disagree with standard scientific ones (e.g. about the status of the human embryo); and the ethical and legal dimension can lead to firm views about such matters as euthanasia.

There is now a very large literature on the relationship between science and religion. Indeed, the journal *Zygon* specialises in this area. A frequent criticism by those who write in this area (e.g. Roszak, 1994) is of what they see as simplistic analyses of the area by individuals, often well-known scientists, who occasionally write about it. Indeed, it is frequently argued that the clergy, both in the past and nowadays, are often far more sympathetic to a standard scientific view on such matters as evolution than might be supposed (e.g. Colburn and Henriques, 2006).

A thorough historical study of the relationship between science and religion is provided by John Hedley Brooke (1991). Brooke's particular aim is '*to reveal something of the complexity of the relationship between science and religion as they have interacted in the past*' (p. 321), and it is worth quoting from his postscript at some length:

Popular generalizations about that relationship, whether couched in terms of war or peace, simply do not stand up to serious investigation. There is no such thing as the relationship between science and religion. It is what different individuals and communities have made of it in a plethora of different contexts. Not only has the problematic interface between them shifted over time, but there is also a high degree of artificiality in abstracting the science and the religion of earlier centuries to see how they were related. (Brooke, 1991: 321)

Brooke's work sits alongside that of Barbour (1990), a classic text in the science–religion field. Barbour, in a classification that continues to prove fruitful, identified four ways in which science and religion could be seen to relate: conflict, independence, dialogue, and integration.

The *conflict* model of the relationship between science and religion exists most straightforwardly when science is seen as swallowing religion. As Barbour puts it '*In a fight between a boa constrictor and a warthog, the victor, whichever it is, swallows the vanquished*' (p. 4). In the UK and a number of other countries, the conflict model has recently been associated particularly with some of the writings of Richard Dawkins. A rather large literature is beginning to develop around Dawkins's writings on religion (McGrath, 2005), but Dawkins's argument, and the responses to it, can be summarised fairly straightforwardly. Dawkins holds that the arguments in favour of religious faith (which he equates to a belief in God) are invalid. In particular, the argument from biological design fails because Darwinian evolution can explain even the most apparently convincing cases of design (Dawkins, 2006). Dawkins also considers that religious faith is itself best seen as a sort of viral infection. The more informed theological responses to Dawkins have claimed that he either misunderstands theology or intentionally chooses not to attempt to understand it; in other words, that Dawkins is attacking a straw man.

The *independence* understanding of the relationship between science and religion sees each enterprise as having its particular worth and existing distinct from the other. This is comparable to the relationship between engineering and aesthetics: both might examine a building but the questions they could, respectively, answer about it – '*Is it constructed safely?*' and '*Is it beautiful?*' – do not overlap (much). In Barbour's view, independence might occur because science and religion use contrasting methods or employ different languages.

When science and religion are seen in *dialogue*, there may be questions about the boundaries between them or the methods of the two fields. For example, there is considerable literature available about the extent to which certain religions facilitate or hinder the rise of science. One line of argument within the Judaeo–Christian tradition has been that the orderliness of the universe is contingent, rather than necessary. In other words, God could have made the universe unintelligible, thus precluding science. The fact that the universe is ordered has encouraged many scientists to feel that in studying 'the book of nature' they are attempting to understand something of the mind (or at least the workings) of God.

Finally, science and religion may be seen to be capable of *integration*. There are a number of models of integration, one of which sees science and religion contributing as partners to a comprehensive metaphysical worldview. There is, for example, a huge academic literature on process theology, an intellectual discipline that attempts to do just this. More mundanely, and somewhat closer to home for most people, many devout religious believers also accept the teachings of science and attempt, for example, to see their physical health, their feelings, and the success (or otherwise) of their personal relationships as being inextricably the result both of the laws of science ('*If you don't eat enough vitamins, you will become unwell*') and of God's laws ('*For the Lord loves justice; he will not forsake his saints. The righteous shall be preserved for ever, but the children of the wicked shall be cut off*' – *Psalm* 37: 28).

The significance of origins

With regard to the issue of origins, which of these four understandings of the relationship between science and religion is best depends on the precise questions being asked. If one is asking about whether dinosaurs and humans coexisted (Figure 1), that is manifestly a scientific question (to which the correct and scientific answer is 'no'), and any religious attempt to answer the question differently is bound to lead to conflict (Figure 2). If, though, one is asking about why the universe has precisely the values of the various physical constants that it does (values which, if only minutely different, would preclude the evolution of any life, let alone life sufficiently intelligent to be asking this question), then this is perhaps less of a scientific question, so that conflict is less likely to be seen as inevitable. Most of the literature on creationism (and/or intelligent design) and evolutionary theory puts them in stark opposition (Reiss, in press). Evolution is

Figure 1 There are an increasing number of creationist museums. (The Creation Museum, Petersburg, KY, USA. Photo: Jonathan M. Gitlin)

consistently presented in creationist books and articles as:

- *illogical* – e.g. natural selection cannot, on account of the second law of thermodynamics, create order out of disorder; mutations are always deleterious and so cannot lead to improvements;
- *contradicted by the scientific evidence* – e.g. the fossil record shows human footprints alongside animals supposed by evolutionists to be long extinct; the fossil record does not provide evidence for transitional forms;
- *the product of non-scientific reasoning* – e.g. the early history of life would require life to arise from inorganic matter – a form of spontaneous generation rejected by science in the 19th century; radioactive dating makes assumptions about the constancy of natural processes over aeons of time, whereas we increasingly know of natural processes that affect the rate of radioactive decay;
- *the product of those who ridicule the word of God*, and a cause of a whole range of social evils (from eugenics, Marxism, Nazism and racism to juvenile delinquency – see Figure 3).

By and large, creationism has received similarly short shrift from those who accept the theory of evolution. In a fairly early study the philosopher of science Philip Kitcher argued that *'in attacking the methods of evolutionary biology, Creationists are actually criticizing methods that are used throughout science*' (Kitcher, 1982: 4–5). Kitcher concluded that the flat-Earth theory, the chemistry of the four elements, and mediaeval astrology '*have just as much claim to rival current scientific views as Creationism does to challenge evolutionary biology*' (Kitcher, 1982: 5). Many scientists have defended evolutionary biology from creationism. The main points that are frequently made are that:

- evolutionary biology is good science since not all science consists of controlled experiments where the results can be collected within a short period of time;

Figure 2 Some cartoonists pillory creationism. (Cartoon: David Horsey)

Figure 3 An anti-Darwin poster.

- creationism (including 'scientific creationism') isn't really a science in that its ultimate authority is scriptural and theological rather than the evidence obtained from the natural world;
- an acceptance of evolution is fully compatible with a religious faith.

The relationship between science and religion has changed over the years. Nevertheless, there are two key issues fuelling the evolution/creationism controversy: one is to do with understandings of reality, and the other to do with evidence and authority. Although it is always desperately difficult to generalise, most religions hold that reality consists of more than the observable world, and many religions give weight to institutional authority in a way that science generally strives not to. For example, there is a very large religious and theological literature on the world to come. However, to labour the point, science, strictly speaking, has little or nothing to say about this question, while religious believers within a particular religion are likely to find the pronouncements on the question of even the most intelligent and spiritual of their present leaders to be of less significance than the few recorded words of their religion's founder(s).

Given the unsuccessful history of scientists' participation in educational battles over evolution, it seems hopeful that a pluralistic position, promoting cultural tolerance and individual autonomy, has a better chance of ensuring that students at the very least learn what evolution is. In the past, science has all too often exacerbated this evolution/creation conflict by appearing to dismiss the legitimacy of religious ideas and the validity of personal beliefs (cf. Cobern, 1996).

Classroom specifics

So how might one teach evolution in science lessons, say to 14–16 year-olds? The first thing to note is that there is scope for young people to discuss beliefs about the origins of the Earth and living things in other subjects, notably religious education (RE). In England, the DCSF (Department for Children, Schools and Families) and QCA (Qualifications and Curriculum Authority) have published a non-statutory national framework for RE and teaching units which include a unit asking '*How can we answer questions about creation and origins?*' The unit focuses on creation and the origins of the universe and human life, as well as the relationships between religion and science. It can be downloaded from http://www.qca.org.uk.

In the summer of 2007, after months of behind-the-scenes meetings and discussions, the DCSF *Guidance on creationism and intelligent design* received Ministerial approval and was published (DCSF, 2007). As one of those who helped put the *Guidance* together I am relieved it seems to have been broadly welcomed. Even the discussions on the RichardDawkins.net forum have been pretty positive, while *The Freethinker*, '*The Voice of Atheism since 1881*', described it as '*a welcome breath of fresh air*' and '*a model of clarity and reason*'.

The *Guidance* points out that the use of the word 'theory' in science (as in 'the theory of evolution') can mislead those not familiar with science as a subject discipline because it is different from the everyday meaning (i.e. of a theory being little more than an idea). In science, of course, the word indicates that there is a substantial amount of supporting evidence, underpinned by principles and explanations accepted by the international scientific community. The *Guidance* goes on to point out:

Creationism and intelligent design are sometimes claimed to be scientific theories. This is not the

case as they have no underpinning scientific principles, or explanations, and are not accepted by the science community as a whole. Creationism and intelligent design therefore do not form part of the science National Curriculum programmes of study. (DCSF, 2007)

The *Guidance* points out that the nature of, and evidence for, evolution must be taught at key stage 4 (ages 14–16) as these are part of the programme of study for science, while key stages 1, 2 and 3 (ages 5–14) include topics such as variation, classification and inheritance which lay the foundations for developing an understanding of evolution at key stage 4 and post-16. It then goes on to say:

Creationism and intelligent design are not part of the science National Curriculum programmes of study and should not be taught as science. However, there is a real difference between teaching 'x' and teaching **about** *'x'. Any questions about creationism and intelligent design which arise in science lessons, for example as a result of media coverage, could provide the opportunity to explain or explore why they are not considered to be scientific theories and, in the right context, why evolution is considered to be a scientific theory.* (DCSF, 2007).

This seems to me a key point. Many scientists, and some science educators, fear that consideration of creationism or intelligent design in a science classroom legitimises them. For example, the excellent book *Science, evolution, and creationism*, published by the US National Academy of Sciences and Institute of Medicine asserts:

The ideas offered by intelligent design creationists are not the products of scientific reasoning. Discussing these ideas in science classes would not be appropriate given their lack of scientific support. (National Academy of Sciences and Institute of Medicine, 2008: 52).

I agree with the first sentence but disagree with the second. Just because something lacks scientific support doesn't seem to me a sufficient reason to omit it from a science lesson. When I was taught physics at school, and taught it extremely well in my view, what I remember finding so exciting was that we could discuss almost anything providing we were prepared to defend our thinking in a way that admitted objective evidence and logical argument.

In an interesting exception that proves the rule, I recall one of our advanced level chemistry teachers scoffing at a fellow student who sat with a spoon in front of her while Uri Geller (if you don't know who I mean, search *You Tube*, including some of the clips that claim to expose him) maintained he could bend viewers' spoons. I was all for this approach. After all, I reasoned, surely the first thing was to establish whether the spoon bent (it didn't for her) and, if it did, then start working out how.

So when teaching evolution, there is much to be said for allowing students to raise any doubts they have (hardly a revolutionary idea in science teaching) and doing one's best to have a genuine discussion. The word 'genuine' doesn't mean that creationism or intelligent design deserve equal time. However, in certain classes, depending on the comfort of the teacher in dealing with such issues and the make up of the student body, it can be appropriate to deal with the issue. If questions or issues about creationism and intelligent design arise during science lessons they can be used to illustrate a number of aspects of how science works, such as: '*how interpretation of data, using creative thought, provides evidence to test ideas and develop theories*'; '*that there are some questions that science cannot currently answer, and some that science cannot address*'; '*how uncertainties in scientific knowledge and scientific ideas change over time and about the role of the scientific community in validating these changes*'.

Having said that, I don't believe that such teaching is easy. Some students get very heated; others remain silent even if they disagree profoundly with what is said. The DCSF *Guidance* suggests:

Some students do hold creationist beliefs or believe in the arguments of the intelligent design movement and/or have parents/carers who accept such views. If either is brought up in a science lesson it should be handled in a way that is respectful of students' views, religious and otherwise, whilst clearly giving the message that the theory of evolution and the notion of an old Earth/universe are supported by a mass of evidence and fully accepted by the scientific community.

I do believe in taking seriously and respectfully the concerns of students who do not accept the theory of evolution, while still introducing them to it. While it is unlikely that this will help students who have a conflict between science and their religious beliefs to resolve the conflict, good science teaching can help students to manage it – and to learn more science. Creationism can profitably be seen not as a simple misconception that careful science teaching can correct, as careful science teaching might hope to persuade a student that an object continues at uniform velocity unless acted on by a net force, or that most of the mass of a plant comes from air. Rather, a student who believes in creationism can be seen as inhabiting a non-scientific worldview, that is a very different way of seeing the world. One very rarely changes one's worldview as a result of a 50-minute lesson, however well taught.

My hope, rather, is simply to enable students to understand the scientific worldview with respect to origins, not necessarily to accept it. We can help students to find their science lessons interesting and intellectually challenging without them being threatening. Effective teaching in this area can not only help students learn about the theory of evolution but to appreciate better the way science is done, the procedures by which scientific knowledge accumulates, the limitations of science and the ways in which scientific knowledge differs from other forms of knowledge.

References

Barbour, I. G. (1990) *Religion in an age of science: The Gifford Lectures 1989–1991*. Vol. 1. London: SCM.

Brooke, J. H. (1991) *Science and religion: some historical perspectives*. Cambridge: Cambridge University Press.

Cobern, W. W. (1996) Worldview theory and conceptual change in science education. *Science Education*, **80**, 579–610.

Colburn, A. and Henriques, L. (2006) Clergy views on evolution, creationism, science, and religion. *Journal of Research in Science Teaching*, **43**, 419–442.

Dawkins, R. (2006) *The God delusion*. London: Bantam Press.

DCSF (2007) *Guidance on creationism and intelligent design*. Available at www.teachernet.gov.uk/docbank/index.cfm?id=11890) (last accessed 12 January 2008).

Jones, L. and Reiss, M. J. ed (2007) *Teaching about scientific origins: taking account of creationism*. New York: Peter Lang.

Kitcher, P. (1982) *Abusing science: the case against creationism.* Milton Keynes: Open University Press.

McGrath, A. (2005) *Dawkins' God: genes, memes, and the meaning of life*. Oxford: Blackwell.

National Academy of Sciences and Institute of Medicine (2008) *Science, evolution, and creationism.* Washington DC: National Academies Press.

Reiss, M. J. (in press) Imagining the world: the significance of religious worldviews for science education. *Science & Education*.

Roszak, T. (1994) God and the final frontier. *New Scientist*, 28 March, 40–41.

Scott, E. (1999) The creation/evolution continuum. *Reports of the National Center for Science Education*, **19**, 16–23.

Smart, N. (1998) *The world's religions*. 2nd edn. Cambridge: Cambridge University Press.

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