Science and religion: implications for science educators

Michael J. Reiss

Abstract A religious perspective on life shapes how and what those with such a perspective learn in science; for some students a religious perspective can hinder learning in science. For such reasons Staver's article is to be welcomed as it proposes a new way of resolving the widely perceived discord between science and religion. Staver notes that Western thinking has traditionally postulated the existence and comprehensibility of a world that is external to and independent of human consciousness. This has led to a conception of truth, truth as correspondence, in which our knowledge corresponds to the facts in this external world. Staver rejects such a conception, preferring the conception of truth as coherence in which the links are between and among independent knowledge claims themselves rather than between a knowledge claim and reality. Staver then proposes constructivism as a vehicle potentially capable of resolving the tension between religion and science. My contention is that the resolution between science and religion that Staver proposes comes at too great a cost – both to science and to religion. Instead I defend a different version of constructivism where humans are seen as capable of generating models of reality that do provide richer and more meaningful understandings of reality, over time and with respect both to science and to religion. I argue that scientific knowledge is a subset of religious knowledge and explore the implications of this for science education in general and when teaching about evolution in particular.

Keywords Epistemology • Science & religion • Constructivism • Creationism

> Certain people, whose minds are prone to mystery, like to believe that objects retain something of the eyes which have looked at them, that old buildings and pictures appear to us not as they originally were but beneath a perceptible veil woven for them over the centuries by the love and contemplation of millions of admirers. (Proust 2000, p. 241)

It might be thought by some to be surprising that science educators need to give serious consideration to the relationship between science and religion and the implications of this for science education. However, there are a number of reasons why such consideration is needed. For a start, and from a rather negative perspective, there is growing acknowledgement that for some students a religious perspective can hinder the sort of science learning that most science educators would like to see. The most well known instance of this is learning about the topic of origins, whether of the universe, of life, or of humans. Indeed, many students never even get the opportunity to learn about evolution in any depth as curricula / textbooks in a number of countries avoid or minimise the time spent on evolution. More generally, it is increasingly clear that a religious perspective on life shapes how and what is learnt in science and in other domains of knowledge. Given all this, John Staver's article in this issue is to be welcomed. It proposes a new way of resolving the widely perceived discord between science and religion. In this commentary, I first examine describe Staver's core argument, and discuss the attractiveness of it, then suggest some problems with it, before proposing a different view of the relationship between science and religion and discussing the implications of this for science education.

Staver's argument

Staver begins by noting that while theology (which I take to be the academic study of religion) may have a cousinly relationship with science, in that they both search for truth, "even though the dimensions of reality upon which they focus are different," the interface between science and religion has been understood in a wide range of ways. Haught's (1995) four-fold typology of conflict, contrast, contact, and confirmation is cited and then Staver gets to the heart of his argument, namely that "Western conceptions of truth and knowledge are the taproots of the discord between science and religion." (I too am content to focus on the Abrahamic faiths, agreeing with Staver that the relationship between science and Eastern religions is more straightforward and less conflictual.)

Staver then goes on to note that Western thinking has traditionally postulated the existence and comprehensibility of a world that is external to and independent of human consciousness. This has led to a conception of truth, known as truth as *correspondence*, in which our knowledge corresponds to the facts in this external world. Members of religious and scientific communities each assert that they represent the correct way to establish valid explanations of these facts. Thus, concludes Staver, the competition between religion and science as social institutions continues, each attempting to legitimize its explanations of reality.

Staver then argues for the notion of epistemological scepticism. A moderate, rather than extreme (solipsistic) form is adopted and truth as *coherence*, rather than correspondence, is introduced. Whereas in truth as correspondence one attempts to make connecting links between what is known and the actual states of affairs in the external world, in truth as coherence "the links are between and among independent knowledge claims themselves rather than between a knowledge claim and reality. Moreover, the purpose in making such connections is to organize our experiences."

The final chain of Staver's argument, and one that is likely to be attractive to many science educators, especially those comfortable with cultural studies of science education, is to propose constructivism as a vehicle potentially capable of resolving the tension

between religion and science. Staver maintains that "Constructivists understand the attraction of seeking reality, but we also grasp the fruitless nature of this task." Abandoning such an attraction, constructivists with a religious faith can appreciate that "Knowing reality as it is, therefore, is something we never had, and to think that it has been revealed in God's word is an illusion." Staver concludes that "the empirical truth of science is compatible with the revealed truth of God's word in a constructivist perspective, because describing reality as it exists separate from, external to, and independent of humans is not the goal for either science or religion."

An evaluation of Staver's argument

To someone, such as myself, with a religious faith and a commitment to science, there is much in Staver's argument that is attractive. It proposes a way of understanding the relationship between science and religion that is respectful of both traditions and grounded in the theory of knowledge. Furthermore, his argument has major implications that Staver hints at in his final thought – "Will the resolution proposed herein gain any traction across the scholarly communities and among the public at large?" – indicating that the argument is potentially a fruitful one.

However, I shall argue in this section that the resolution between science and religion that Staver proposes comes at too great a cost – both to science and to religion. Let me begin with science.

Although I have argued on a number of occasions that reality and science as an account of reality should be distinguished (e.g. Reiss 1993), I am reluctant to concede that scientific truth should be seen as coherence rather than correspondence. I do not intend to accuse Staver of radical scepticism, which he is careful to disavow, but his portrayal of truth as coherence – for all that it fits with our understanding of science as a community of practice, where coherence (though peer review) is central – concedes too

much.

As is well known, a standard epistemological problem with coherence is that "it is not clear how the problem concerning alternative coherent belief systems is avoided" (O'Brien 2006, p. 83). For science, the point is that such alternative coherent belief systems are very rare in established science – i.e. normal, paradigmatic science *sensu* Thomas Kuhn or core science *sensu* Imre Lakatos. While the following has always been one of my favorite passages in Kuhn's (1970) *The Structure of Scientific Revolutions*:

> Let us then assume that crises are a necessary precondition for the emergence of novel theories and ask next how scientists respond to their existence. Part of the answer, as obvious as it is important, can be discovered by noting first what scientists never do when confronted by even severe and prolonged anomalies. Though they may begin to lose faith and then to consider alternatives, the do not renounce the paradigm that has led them into crisis. They do not, that is, treat anomalies as counter-instances, though in the vocabulary of philosophy of science that is what they are. In part this generalization is simply a statement from historical fact, based upon examples like those given above and, more extensively, below. These hint what out later examination of paradigm rejection will disclose more fully: once it has achieved the status of paradigm, a scientific theory is declared invalid only if an alternate candidate is available to take its place. No process yet disclosed by the historical study of scientific development at all resembles the methodological stereotype of falsification by direct comparison with nature. That remark does not mean that scientists do not reject scientific theories, or that experience and experiment are not essential to the process in which they do so. But is does mean – what will ultimately be a central point – that the act of judgement that leads scientists to reject a

> previously accepted theory is always based upon more than a comparison of that theory with the world. The decision to reject one paradigm is always simultaneously the decision to accept another, and the judgement leading to that decision involves the comparison of both paradigms with nature *and* with each other. (p. 77)

it is worth citing here in two respects. First, Kuhn maintains that alternative paradigms *are* compared with nature, not only with each other; and for those of a still more radical disposition, Paul Feyerabend, for all his anarchism/dadaism, never rejects comparisons with nature – indeed, his careful historical work relied on this. Secondly, the scientific community is rarely truly divided in this way ("rarely" here refers not, of course, to the subject matter on which scientists are actually working at any one time for that is frontier science which is precisely where a whole swirl of competing theories, albeit not paradigms, may co-exist, but to the mass of normal science which is solidly consensual and quite firmly established); Kuhn here is writing explicitly about the response to crisis – for an individual scientist, generally a most rare event.

Truth as coherence as a way of understanding religious truth can be defended. But it is a defence that is unlikely to find favour for many with a religious outlook, aside, perhaps from the large number of Jewish secularists/atheists from Spinoza to the present day, for whom, within whichever strand of Judaism they reside, it is Jewish practice rather than metaphysical belief that is of central importance.

For the great majority of religious believers to admit to truth solely as coherence is surely to paint oneself into a corner, to abandon the attempt meaningfully to connect the religious view of life with reality, to restrict oneself to an isolated enclosure of religious understanding, distinct not only from science but from anything of much significance, and to lay oneself open to the accusation not so much of wishful thinking but of limited thinking and little wishfulness.

As will be apparent, with respect both to science and to religion, I favour a different version of constructivism in which the standard objections to naïve realism described by Staver are accepted but humans are seen as capable of generating models of reality that, over time, and subject to occasional reversals of fortune, do provide richer and more meaningful understandings of reality.

Such a view of science sits squarely within mainstream history and philosophy of science including its modern developments such as critical scientific realism and inference to the best explanation. Within religion there is, I admit, more diversity but I would still hold that mainstream theology occupies a realist position). I also feel that Staver has too narrow a conceptualisation of religion when he writes that the legitimizing force of religion is 'God's revealed truth in how humans are to live'. This is to focus only on the *ethical and legal dimension* of religion how – so Sunni Islam has its Five Pillars, *Shahada* (testimony of faith), *Salat* (prayer), *Zakat* (alms-giving), *Sawm* (fasting) and *Hajj* (pilgrimage to Mecca), while Judaism has the Ten Commandments and other regulations in the Torah and Buddhism its Five Precepts. A more typical view, derived from Smart (1989) and Hinnells (1991), sees the following dimensions as also being generally characteristic of most religions:

- the *practical and ritual dimension* that encompasses such elements as worship, preaching, prayer, yoga, meditation and other approaches to stilling the self;
- the *experiential and emotional dimension* of religions that has both the rare visions given to some of the crucial figures in a religion's history, such as that of Arjuna in the *Bhagavad Gita* and the revelation to Moses at the burning bush in *Exodus*, and 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;
- vital stories that comprise the *narrative or mythic dimension*, for example the story of the six day creation in the Judaeo-Christian scriptures;

- the *doctrinal and philosophical dimension* that arises, in part, as theologians within a religion struggle to integrate the narrative/mythic dimension into a more general view of the world; so, for example, 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;
- the *social and institutional dimension* of a religion that relates to its corporate manifestation, for example the Sangha – the order of monks and nuns founded by the Buddha to carry on the teaching of the Dharma – in Buddhism, the umma' – the whole Muslim community – in Islam, and the Church – the communion of believers comprising the body of Christ – in Christianity;
- the *material dimension*, namely the fruits of religious belief as shown by places of worship (e.g. synagogues, temples and churches), religious artefacts (e.g. Eastern Orthodox icons and Hindu statues) and sites of special meaning (e.g. the river Ganges, Mount Fuji and Uluru (Ayers Rock)).

A different view of the relationship between science and religion

As Staver indicates, there are a wide range of ways of seeing the relationship between science and religion, Barbour's (1990) earlier one of conflict, independence, dialogue and integration is also widely used in the science and religion literature). Understandings of the relationship(s) between science and religion vary greatly, at least in part because of considerable variation in how people conceptualise both science and religion, especially religion.

One approach that I have found to be of worth in science classes with undergraduates training to be science teachers is, when teaching about the nature of science, to get them to think about the relationship between scientific knowledge and religious knowledge

(Reiss 2008). What seems to work well is to ask students, either on their own or in pairs, to indicate this relationship by means of a drawing, and then for all of us in the class to discuss the various drawings that result. See, for example, the hypothetical representation in Figure 1. A person producing the representation in Figure 1 sees both religious and scientific knowledge as existing but envisages the scope of religious knowledge as being smaller than that of scientific knowledge and of there being no overlap between the two.

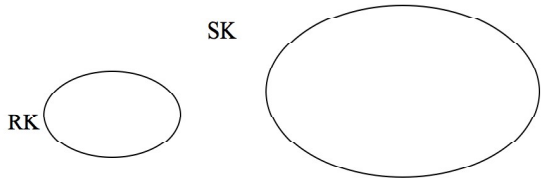

Figure 1 Hypothetical representation of how someone who sees both religious and scientific knowledge as existing but envisages the scope of religious knowledge as being smaller than that of scientific knowledge and of there being no overlap between the two might draw the relationship between religious knowledge (RK, left) and scientific knowledge (SK, right).

A number of science educators favour such a clear-cut distinction between religious and scientific knowledge, along the lines of that defended by Gould (1999). There are a number of advantages to such a position. For example, it allows a person with a strong religious belief who might otherwise be troubled by certain aspects of science to avoid possible conflict (and vice versa) and it provides an epistemological justification for why religious matters should not be examined in science classes, which is useful in a country such as the USA that prohibits the teaching of religion in public schools. However, there are many for whom scientific knowledge and religious knowledge are not distinct. At one end are those who draw religious knowledge as being much smaller than scientific knowledge and wholly or partly contained within it (Figure 2); at the other are those whose worldview is predominantly religious (Figure 3). My own position is close to that shown in Figure 3, the one difference being that I would increase the size of the ellipse representing scientific knowledge (perhaps by about 50% along each of its two

dimensions) but still enclose it fully within the ellipse representing religious knowledge. Let me know explain what I consider such a representation to mean.

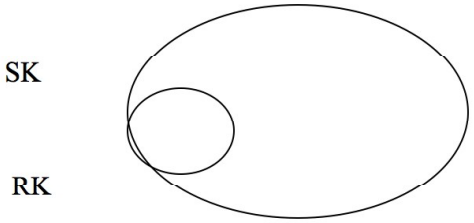

Figure 2 Hypothetical representation of how someone who sees religious knowledge as being much smaller than scientific knowledge and almost entirely contained within it might draw the relationship between religious knowledge (RK) and scientific knowledge (SK).

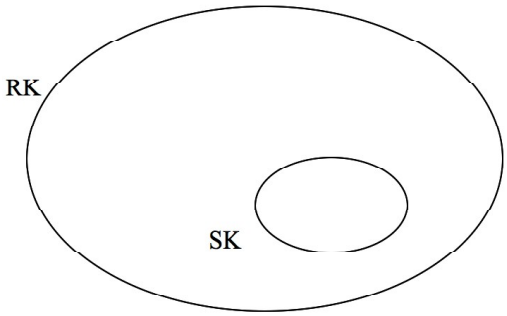

Figure 3 Hypothetical representation of how someone whose worldview is predominantly religious might draw the relationship between religious knowledge (RK) and scientific knowledge (SK).

First, although I embed scientific knowledge entirely within religious knowledge, this does not mean that I hold that scientific knowledge can be obtained from religious sources. If there is any conflict about scientific knowledge between the teachings of science and those of religion (whether from the readings of the scriptures, from revelation or from the teachings of individuals held to have a particular authority within the religion) I am nearly always on the side of science. (I saw “nearly always” not as a cop out but because, as we know, science is fallible and it is not inconceivable, though most unlikely nowadays, that a particular instance of scientific conflict between science and religion might subsequently, and scientifically, be resolved in favour of the religious

reading.) This, of course, distinguishes my position (and that of many other religious believers) from the many Christians, Hindus, Muslims and others who believe that religion (usually in the scriptures) provides a source (usually a divine revelation) of reliable scientific knowledge. (At the risk of labouring the point, I am perfectly content with the idea that the scriptures may contain reliable scientific knowledge but this is simply a reflection of their incorporation of aspects of widely known science, e.g. traditional ecological knowledge, at the time they were authored.)

Second, the reason why my SK ellipse is quite small compared to my RK ellipse is simply that there are a non-inconsiderable number of elements in my RK view of the world that sit outside of science. (In the same way, my visual representation of physics knowledge would be smaller than one for biology knowledge as all of physics sits within biology whereas there is much biology that is not explicable by physics, for all that biology is consistent with the laws of physics.) For example, I have spent some time thinking about such matters as the virgin birth, the resurrection and whether there is a world to come but all these matters sit outwith science – as do many non-religious issues, such as whether there is an infinity of primes (mathematics – there are), whether actions can always be judged ethically in terms of their consequences alone (moral philosophy – I am not sure), whether Jackson Pollock is as great an artist as Claude Lorrain (aesthetics – probably, in my view) and so on.

General implications for science education

It is difficult to provide generalised suggestions as to how science educators might deal with the interface between science and religion as context is so important; indeed there are, of course, countries (e.g. France, Turkey, USA) where a separation between religion and the state there are legal restrictions in force in respect of what can be taught. In general, the principal reason for science educators dealing with the interface between

science and religion is to help students (whatever their age and whether their science education is formal or informal) better to learn science.

Teaching about aspects of religion in science classes could potentially help students better understand the strengths and limitations of the ways in which science is undertaken, the nature of truth claims in science, and the importance of social contexts for science. In that sense, considering religion within science education places the issue squarely within the consideration of mainstream socio-scientific issues.

However, there are also reasons to be cautious before teaching about aspects of religion in science classes (Reiss 1992). For example, a science teacher might feel that they simply do not have the expertise to teach effectively about such matters (though my experience and that of others is that initial teacher education and continuing professional development can help address this need), that these matters are better dealt with elsewhere in the curriculum (in some cases co-operation with other subject departments can be fruitful), or that it is impossible to teach objectively about such matters so that one risks indoctrinating one's students either into or away from a religious faith. More mundanely, there are frequently the constraints of curriculum time.

Implications when teaching about evolution

To some people's alarm, and others' delight, creationism is growing in extent and influence, in a number of countries. Definitions of creationism vary but about 40% of adults in the USA and probably over 10% in all other countries surveyed (Miller et al. 2006) believe that the Earth is only some ten thousand or so 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, for example, lemmings had a common ancestor but this is not the case for lemmings, rabbits and beavers – still

less for lemmings and humans, for lemmings and trilobites or for lemmings and edible mushrooms.

At the same time, of course, the overwhelming majority of biologists consider evolution to be the central concept in the biological sciences and to be as well established as any unifying scientific theory, providing a conceptual framework that brings together every aspect of the life sciences into a single coherent discipline. Equally, the overwhelming majority of scientists believe that the universe is of the order of about 13–14 billion years old.

The public presentation of the controversy in the media and elsewhere often gives the impression that biblical creationism and biological evolution refer to two mutually exclusive explanatory systems. The lower visibility of presentations of alternative 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 publicized 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 origins. There is a tendency to polarize 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 public polls may 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 that makes 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, even conflictual, 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 religions worldviews are integrated into one. When faced with individuals who hold creationist views, science educators might be best advised to see creationism not as a naïve misconception but as a worldview, in other words as a fairly robust (durable) and well established (well defended) mental structuring of reality. 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, this scientific worldview is unlikely to supplant a creationist one.

Most of the literature on creationism (and/or intelligent design) and evolutionary theory puts them in stark opposition (Reiss, in press). Evolution is 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 (eugenics, Marxism, Nazism, racism, juvenile delinquency).

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 (1983) argues that “in attacking the methods of evolutionary biology, Creationists are actually criticizing methods that are used throughout science” (pp. 4–5). Kitcher

concludes 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" (p. 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; that creationism (including "scientific creationism") is not really a science in that its ultimate authority is scriptural and theological rather than the evidence obtained from the natural world; and that 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 fueling the evolution/creationism controversy: one is to do with understandings of reality, the other to do with evidence and authority. Although it is always desperately difficult to generalize, 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.

Given the often 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.

Classroom specifics

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 U.S. 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, p. 52).

I agree with the first sentence but disagree with the second. Just because something lacks scientific support does not 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. (I should add that my teacher, Colin Harris, was excellent at ensuring after such discussions that we still covered the intended, core physics; a discussion about the meaning of gravity was no substitute from understanding how to calculate G, the gravitational constant, and then use the value in calculations of gravitational attraction.)

In an interesting exception that proves the rule, I recall one of our advanced level chemistry teachers scoffing at a fellow student who had sat the previous evening with a spoon in front of her while Uri Geller maintained on national television he could bend viewers’ spoons. I was all for this approach. After all, I reasoned, surely the first thing was to establish if the spoon bent (it did not 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” does not 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, any school or other regulations / accepted practice 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" (these phrases are taken from the current National Curriculum for science in England [QCA 2009], but have wider currency).

Having said that, I do not believe that such teaching is easy. Some students get very heated; others remain silent even if they disagree profoundly with what is said. The current official Guidance in England from the Department for Children, Schools and Families 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" (DCSF 2007, p. ???).

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 in the same way 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 their being threatening. Effective teaching in this area can not only help students learn about the theory of evolution but better to appreciate 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, volume 1*. London: SCM.

DCSF (2007). Guidance on creationism and intelligent design. Accessed 1 January 2009 at www.teachernet.gov.uk/docbank/index.cfm?id=11890.

Gould, S. J. (1999). *Rocks of ages: Science and religion in the fullness of life*. New York: Ballantin.

Haught, J. F. (1995). *Science & religion: From conflict to conversation*. Mahwah, NJ: Paulist Press.

Hinnells, J. R. (1991). *A handbook of living religions*. London: Penguin Books.

Jones, L., & Reiss, M. J. (Eds.). (2007). *Teaching about scientific origins: Taking account of creationism*. New York: Peter Lang.

Kitcher, P. (1983). *Abusing science: The case against creationism*. Milton Keynes: Open University Press.

Kuhn, T. S. (1970). *The structure of scientific revolutions* (2nd ed.). Chicago: University of Chicago Press.

Miller, J. D., Scott, E. C., & Okamoto, S. (2006). Public acceptance of evolution. *Science, 313*, 765-766.

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

O'Brien, D. (2006). *An introduction to the theory of knowledge*. Cambridge: Polity Press.

Proust, M. (2000). *In search of lost time, volume VI: Time regained*, translated by C. K. Scott Moncrieff & Terence Kilmartin, revised by D. J. Enright. London: Vintage.

QCA (2009). National Curriculum: Science Key Stage 4 – How science works. Available at http://curriculum.qca.org.uk/key-stages-3-and-4/subjects/science/keystage4/index.aspx (last accessed 1 January 2009).

Reiss, M. J. (1992). How should science teachers teach the relationship between science and religion? *School Science Review*, *74*, 126-130.

Reiss, M. J. (1993). *Science education for a pluralist society*. Milton Keynes: Open University Press.

Reiss, M. J. (2008). Should science educators deal with the science/religion issue? *Studies in Science Education, 44*, 157-186.

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

Smart, N. (1989). *The world's religions: Old traditions and modern transformations*. Cambridge: Cambridge University Press.

Michael J. Reiss is Professor of Science Education and Assistant Director at the Institute of Education, University of London, Chief Executive of Science Learning Centre London, Honorary Visiting Professor at the University of York, Docent at the University of Helsinki, Director of the Salters-Nuffield Advanced Biology Project, a member of the Farm Animal Welfare Council, editor of the journal *Sex Education* and a priest in the Church of England. For further information see www.reiss.tc.