

Chapter 3

The Relationship Between Science and Religion: A Contentious and Complex Issue Facing Science Education

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3.1 Introduction

Traditionally, at least in many national contexts, science and religion have been seen as quite distinct and largely unrelated school and college subjects and indeed as generally nonoverlapping activities in society in general. However, this is both an oversimplification that ignores the complex and sometimes nuanced interactions between science and religion and a misleadingly comfortable position that is being challenged in many parts of the world.

Consequently, there has recently been increased attention to the relationship between science and religion and how this might impact on teaching and learning science. A particular area of contention is the teaching of scientific theories and models related to origins, including ideas about the origins of the universe and evolutionary ideas about human origins. (The particular issues surrounding the challenges of teaching evolution are discussed in more detail in Chap. 4). However, there is no room for complacency for those not teaching such potentially controversial topics, as the difficulties being faced by those charged with teaching natural selection in some national contexts are a symptom of a deeper underlying tension between understandings of the nature of science and the worldview commitments of many of those holding religious faiths. This chapter offers an introduction to key features of this issue and explains why this is an important topic that all working in science education need to take seriously.

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3.2 Symptoms of a Problem in Science Education

It is clear that in some national contexts, there is an active focus on the ‘science and religion issue’, which is causing concern for science educators. This has perhaps had the highest profile in the USA where there have been a series of legal battles focused on the teaching of evolutionary theory in school and where a new perspective (‘intelligent design’, ID), claiming scientific credibility, has been presented as an ‘alternative’ to widely accepted evolutionary theory (see Chap. 4). At one level science and science education have held firm in the USA, in the sense that the judiciary has tended to support the teaching of evolutionary theory in US schools, whilst denying requests to also impose teaching (in science lessons) of alternative ‘theories’ of human origins. However, although the science/science education community in the USA may be winning what we might think of as the ‘battle for minds’, there is much evidence that the ‘battle for hearts’ often proceeds rather differently, with individual teachers and students often ignoring legal decisions to choose for themselves which topics they will teach, or study, according to conscience (Long 2011).

This is not an issue for the USA alone. Controversy around teaching of evolution has arisen in various other national contexts where previously science and religion have long coexisted largely independently within mainstream education (Billingsley et al. 2014). As in the USA, the focus of debate is often on the teaching of evolution, and/or more specifically natural selection, as evolution has become something of an intellectual battleground for those adopting different worldview commitments. Moreover, as this chapter will illustrate, it would be a mistake to see the conflict as purely the result of some people of particular religious persuasions objecting to the teaching of some scientific content. That is certainly an important aspect, but increasingly the controversy has also been encouraged by some scientists who are in principle opposed to religion and its influence in society.

Symptomatic of the tensions in science education concerning the relationship between science and religion was an incident in 2008 when a well-respected science educator, and a strong advocate of evolution, Professor Michael Reiss, was pressured to step down from his role as education director in a learned scientific society. In the UK, the Royal Society (RS) – one of the most esteemed scientific societies in the world – was embarrassed by the advice Reiss (also a professor of science education at a prestigious university) offered on how teachers should deal with student responses to the teaching of evolution in classrooms and required his resignation. In effect, Reiss recommended that teachers should engage with students’ questions and objections when teaching about evolution. That of course is the approach generally taken when teaching challenging science topics and can be seen as a key strategy in constructivist approaches to science education (Taber 2009) – if not indeed just good sense.

Reiss’s comments were reported (and indeed misreported) in the media. From an educational perspective, Reiss was only making a common-sense point, that learners’ ‘worldview’ commitments (such as religious convictions) need to be consid-

ered when we teach them, but *the impression given* by the RS's response was that any suggestion that teachers should enter into dialogue about learners' grounds for rejecting or questioning evolution was unacceptable.

At first sight, this seems a very strange position for the RS to adopt, when its very motto (*'nullius in verba'*) emphasises the importance of questioning authority rather than simply relying on the word of an authority figure (such as a science teacher). Not only did the decision to dismiss Reiss look illogical to many outsiders, but it provided propaganda fodder for those who campaign against the teaching of evolution. Antievolutionists were able to interpret and present the RS's actions as evidence that scientists hold evolution as above question and wish to avoid debate about the issue. So, for example, one website set up by a group rejecting evolution reported:

This week, in Britain, we have had the highest profile proof that even a hint that your views on evolution might differ from those of the scientific establishment is enough to force you out. Prof. Michael Reiss, an evolutionist and the Royal Society's director of education, resigned under pressure (given the push) within a couple of days of merely suggesting that creationism and ID could be discussed in classrooms—even if it was in order to explain why they were, in his view, wrong.

(Halloway 2008)

The action of the RS not only gave the impression that Fellows of the organisation were ignorant of fundamental pedagogic principles but inadvertently lent support to those like Halloway who wished to suggest that evolution is an irrational commitment of the scientific community that needs to be protected by a kind of 'thought-police' mentality. For those working in science education, the RS's action seemed doubly counterproductive: it was unhelpful to those who (like Reiss) are strongly committed to scholarly debate that can contribute to effective teaching of evolution, and it undermined the public understanding of science by appearing to present science as an authoritarian endeavour that requires scientists to follow an official party line, rather than being open to freethinkers and diverse views. However, the RS's decision can be understood better when recognised as informed by discourse among scientists about the very nature of science itself. In considering the nature of the relationship between science and religion, it is important to realise that just as there are many religions, and diverse traditions within major world religions such as Christianity and Islam, there are also different ways of understanding the nature of science. The particular conceptualisations of religion and science being adopted *both* need to be taken into account when considering how science and religion can be related.

This chapter will explain why there can be no consensus on an issue such as 'the' relationship between science and religion. Two important themes that will be drawn upon in this account are those of *worldview* and of the *metaphysical commitments* of science. Before considering these notions, it is useful to consider some of the common stances that can be adopted regarding the relationship between science and religion.

3.3 ‘The’ Relationship(s) Between Science and Religion

It is inappropriate to think of ‘the’ relationship between science and religion. For one thing there are many different religions, which hold different things to be true. Even within what might seem to be a single religion such as Christianity, there are quite diverse traditions. This explains why the Anglican and Roman Catholic churches, for example, do not teach against scientific theories such as cosmological and evolutionary ideas about origins, and yet some other Christian churches (such as some Baptist traditions originating in parts of the USA) consider their Christian tenets to completely exclude the possibility that evolution (in the sense of ‘macro’ evolution – that leads to completely new forms of living thing) occurs, leading some Christians to reject key scientific ideas from biology, geology, astronomy and cosmology.

Moreover, just as there is not one form of religion, neither is there a single understanding of the nature of science, and different views of what science is, and what its limits might be, can lead to very different views about how science might be understood to relate to religion. Given these complications – that there is more than one religion, and there is more than one way of understanding the nature of science – it is not surprising that very different notions of how science stands in relation to religion have been suggested.

3.3.1 *Different General Stances to the Relationship Between Science and Religion*

One suggestion is that there are four broad approaches that can be taken to understanding the relationship between science and religion (Barbour 2002), along the following lines:

Independence: that science and religion are actually quite independent of each other and therefore being religious has no bearing on scientific work, and being a scientist has no bearing on religious commitment. This perspective may be adopted by those who see religion as about morality and the purpose and meaning of human lives (areas outside science) but having no authority in accounts of the material world. The evolutionist and essayist Stephen Jay Gould (2001) adopted a version of this perspective suggesting that science and religion were nonoverlapping magisteria.

Integration: that it is quite possible to see science and religion as totally consistent with each other and in agreement about any areas where they might overlap (Moreland and Reynolds 1999).

Dialogue: that science and religion do sometimes have the same concerns but are not obviously in agreement. However, in these cases it is possible to explore how they could be understood as consistent by engaging in a dialogue (Fulljames and Stolberg 2000) between the two starting points (religion and science).

Conflict: that science and religion do sometimes have overlapping concerns, and in at least some of these areas of overlap, they offer totally inconsistent and opposing conclusions (Dawkins 1995/2001). In effect, in these matters, accepting science requires rejecting religion, and accepting religious teaching requires rejecting aspects of science.

Moreover, there is increasingly a version of the ‘conflict’ stance which is not linked to particular issues (such as evolution by natural selection) but is understood to suggest that science and religion are by their very natures exclusive ways of understanding the world: from this perspective one cannot be both devoutly religious and a fundamentally sound scientist. To adapt a saying from Christianity, no person can have two intellectual masters. This position is often based on a view that religious conviction requires the adoption of metaphysical commitments that are inconsistent with a scientific perspective.

3.4 The Significance of Metaphysical Commitments

Metaphysics is a branch of philosophy, and when scientists class a question as metaphysical, they tend to imply it is a philosophical question that is not open to empirical investigation and so not able to be answered by scientific enquiry. The prefix ‘meta’ is a little misleading, because metaphysics does not *go beyond* physics but rather if anything precedes physics or any other empirical science. Metaphysics concerns that which is a priori, that which is determined independent of experience, whereas scientific enquiry is concerned with developing knowledge a posteriori, that is, empirically, from experience. The term metaphysics is thought to derive from the way an early editor of Aristotle’s works decided that the set of Aristotle’s books, now called the ‘Metaphysics’ concerned with more philosophical and theological questions, were best tackled after reading Aristotle’s writings on physics.

Metaphysical commitments are those things a person believes firmly but which cannot be tested empirically. This can be illustrated with an example of two contrary assumptions one might make:

- (a) The experienced world is a material world that has existence independent of the observer.
- (b) The experienced world is an illusion that is no more than a dream in the mind of the person who thinks they are observing the world.

At first sight many readers may think that option (a) is clearly more sensible and perhaps even that option (b) is a rather fanciful, if not silly, suggestion. Yet most of us have experienced dreams that *at the time* we considered to be real experiences, and many well-respected thinkers have given serious consideration to alternatives to (a) such as (b). Plato considered this world not to represent ultimate reality but to be an imperfect image of a more perfect reality beyond. That is perhaps not so different from the position taken in those religions that consider this world as a temporary staging post ahead of potential admission to a more perfect and less corruptible reality.

A belief that this physical world is all that exists is a metaphysical commitment, as is the belief that we human beings are spirits that have existence prior to and beyond this material life. Neither idea can be proven or falsified in any strict sense – although at one time scientists seriously tested the notion that the body lost weight at the moment of death as the person’s soul left the body (Fisher 2004). Similarly, belief that the world has some kind of purpose, being part of the operation of some cosmic plan, is a metaphysical commitment, as is a commitment to the alternative idea that there is no meaning or purpose to the world or to life, beyond the meanings and purposes that we as human beings create for ourselves.

As such metaphysical commitments are ‘a priori’, and seem to those that are strongly committed to them to be obviously the way things just are, they provide interpretive frameworks through which experience is filtered. Someone who considers that the physical world is all there is will interpret their experiences differently from someone who thinks that clearly this world must have been created by a superior intelligence with an important purpose in mind. In both cases the interpretations will not only inevitably be consistent with their prior assumptions but will also tend to reinforce those commitment by seeming to provide further supportive evidence of the sense of that position (Taber 2013a).

That is not to say that all people have strong commitments on such issues, as it is certainly possible to remain open minded about such questions. Yet where people do hold strong commitments, they can be highly influential in their thinking. A genuine belief that a person who dies in a holy war will be well rewarded in another life, or that the destitute or disabled are simply reaping the punishment due to them because of their wrongdoing in a previous life, makes certain behaviours rational that can seem bizarre, foolhardy or cruel to those who do not share those beliefs.

3.4.1 The Adoption of a Worldview

An increasingly important idea in science education is the notion of a worldview, a ‘way people have of looking at reality, the basic assumptions and images that provide a more or less coherent way of thinking about the world, the cognitive structure into which an individual fits new information’ (Allen and Crawley 1998, p. 113). Cobern (1994, p. 6) describes a worldview as ‘the set of fundamental non rational presuppositions on which ... conceptions of reality are grounded’, that is, a worldview comprises a coherent set of metaphysical commitments that a person holds. Worldview is often at least in part derived from, and reinforced by, the beliefs of the wider community. This is particularly so in traditional or relatively closed societies where youngsters are surrounded by others who all take certain metaphysical commitments for granted and where those commitments infuse all aspects of behaviour and language.

Worldview has become an important consideration in science education because it has increasingly been recognised that some learners’ worldviews may include commitments at odds with what is to be taught in science (Hewitt 2000). If science

teachers present ideas in lessons that seem obviously false, or simply nonsense, to learners (because they are inconsistent with their worldviews), then such ideas are likely to be rejected rather than taken as deserving serious consideration by the students. Worldview often acts tacitly, so learners will not necessarily identify a clear contradiction between teaching and some personal commitment: that can happen, but it is also possible that teaching may be misinterpreted or just not seem to make any sense from within the learner's worldview.

Worldview conflicts with science education may occur at the level of ontology (the kinds of things that exist) or epistemology (how we come to obtain reliable knowledge). There may also seem to be clashes in terms of axiology or the values that people take for granted in living their lives. If a student is brought up in a society that includes evil spirits as a core part of its worldview, and considers them responsible for disease or misfortune (Morris 2006), then scientific models of disease may seem both incoherent and irrelevant (Thagard 2008). Similarly, in many tribal societies, traditional ecological knowledge (TEK) is understood and communicated in a holistic manner that does not separate out the analytical reductive approach of ('Western') science from other – metaphorical, spiritual, poetic, etc. – ways of knowing (Berkes 1993). Such societies have often developed effective TEK that allows them to manage environmental resources in sustainable ways (Freeman 1992), but formal science education with its abstract concepts and deductive logic-dominated forms of argument may make little sense in terms of those traditional ways of knowing. For these societies, TEK is not a discrete aspect of culture (as science may appear in many 'developed' nations) but is closely integrated with a worldview that posits a particular relationship between the people, the biota and the environment (Inglis 1993). So, for example, students from some cultures may object to the use of animals for display or dissection in school science (Allen and Crawley 1998).

Religious beliefs are often key components of worldviews. So in many religions, there is a belief in an active non-human, immaterial, being of great intelligence able to act directly in the world through supernatural means. For those who strongly believe that God created the world; and did so for a purpose; and that people are an integral part of that purpose, such commitments may colour all aspects of their thinking about the world. Many of those who believe (e.g. as in Christianity) that God has a personal relationship with them, is interested in them as people, offers them eternal life and guides (and judges) their behaviour, are likely to consider that such a God is relevant to *all* aspects of their lives.

3.5 Metaphysical Commitments in Religious Worldviews

It is an oversimplification to equate religion with worldview, as central tenets of particular religions often blend with other cultural traditions in particular locations to inform the worldview of a society. In particular national contexts, religious beliefs and practice may be syncretic, that is, they may reflect previously distinct traditions

that have become blended. There are many examples of this where people have converted to major world religions in ways which adopt and reflect pre-existing local beliefs and rituals (Morris 2006).

So, for example, in Sudan, adherents to Zar cults recognise the existence of three types of jinn, designated as white (generally benign), black (malevolent) and red jinn – the latter being associated with various forms of minor illness or distress. Now the existence of jinn is an accepted part of Islam, where it is considered that God created men from clay and jinn from fire. Jinn, like men, may do either good or bad deeds. So Islam includes an ontological commitment to the existence of a class of beings (jinn) that although invisible to humans are real components of the world and as integral to God's creation as humanity. However, the red jinn are not a conventional feature of Islamic belief and represent aspects of more traditional African beliefs that have been grafted onto Islam in that part of Africa.

Another example would be Vodou (or Voodoo), the traditional folk religion in Haiti. Vodou is a tradition that is often misunderstood (perhaps due to rather misleading sensationalist accounts) but is actually a local adaption of Roman Catholicism incorporating rituals and beliefs not considered part of Catholicism elsewhere. Similarly, there is a religious cult in Brazil, Candomblé, which encompasses a whole range of spirit beings – including some of African derivation, some from Native American traditions and Catholic Saints.

Religion can be understood to draw upon, as well as inform, a group's worldview, as for a new religion to be successfully established, it must seem sensible from the existing worldviews of potential adherents. For some scholars this is quite relevant to important aspects of the science and religion debate and how scriptures and traditions need to be interpreted. So, for example, it has been suggested that the accounts of the creation in the Jewish and Christian scriptures were intended to convey an important spiritual truth (and in particular the notion of a single God, who was the creator) in a form that the tribe with their existing worldview could understand and relate to and learn to accommodate within their incumbent model of the world (Habgood 2002).

3.5.1 Examples of Ontological Commitments in Religious Worldviews

There are many examples of beliefs about the nature of what exists and the nature of existence that are incorporated into religious worldviews. The aim within this chapter is not to survey all the potential commitments of different religious traditions that might be seen relevant from a scientific perspective (which would be a massive task) but simply to offer sufficient examples for the reader to appreciate the range of potential points of contact between science and religion.

A key feature considered common to religions is the belief in a spiritual world that in some sense goes beyond what is recognised in the natural world reported in

scientific ontologies. This has been referred to as ‘intuitive certainty of another world’ (Morris 2006, p. 18). The existence of God (of gods) is common to most religions, and there may be beliefs in various other types of entity that are not recorded in scientific accounts of what exists. Some examples have already been met in the jinn and spirits associated with various natural phenomena in cults such as Candomblé. Other examples would be angels, the Devil, another place beyond the physical universe where spirits might reside (Heaven), etc. The difficulty with making such generalisations is that many of these entities may be understood in ontologically different ways in different religions or even within distinct traditions within a religion.

So, for example, the Devil (also known as Satan, Lucifer, Beelzebub, etc.) is important in Christian traditions but may be seen from different traditions within the religion as personifying evil in a metaphorical sense or actually being a person-like creature, either corporeal, or at least able to take the appearance of human form. Clearly belief in the devil as a notion reflecting temptation to do evil things is rather different from believing in an actual individual being who is engaged in a real battle with the (equally real) forces of good. This kind of distinction is very important for teachers to bear in mind, as knowing that a student in a class believes, for example, that *God sends angels to look after or communicate with people* could refer to a specific type of non-human being, or could alternatively be a reference to how God is considered to work through people (who become his angels in particular circumstances by virtue of their actions).

Interpreting just what people mean by their beliefs is important as some particular religious ontologies are more likely to be seen as contrary to scientific perspectives or principles than others. Shamanistic religions, for example, hold to a two-world system, where an alternative reality (experienced in a trance state) is just as real as the everyday reality experienced in the normal waking state (Morris 2006). This contrasts with common Western views (drawing on the naturalistic explanations typical of science) that would see the alternative reality as an illusionary experience, for example, triggered by psychoactive drugs, fatigue and immersion in repetitive rhythmic rituals. The shaman would recognise the same triggers but see them as facilitating entry into another reality, not offering imaginary delusions. To the naturalist, however, these are real experiences, but they are not experiences of something real.

The Buddhist worldview is built around metaphysical commitments to suffering being an intrinsic feature of existence, impermanence and decay as inherent qualities of the world, and the experience of self as an illusion (Morris 2006). A modern scientific perspective might well consider the self as an emergent property, or even an epiphenomenon, if not actually an illusion, and the notion of a fixed self that passes through life is certainly open to critical consideration. (In this matter the Buddhist view might have more in common with scientific accounts than everyday Western ‘common-sense’ notions!) Some interpretations of evolutionary theory would also see suffering as necessary in the living world, but as a contingent feature of any individual’s experiences rather than an inherent feature of existence (Dawkins 1995/2001). Modern theories of matter would consider the world observed in flux to be constructed from a more stable and permanent substrate (at least on timescales

that are short compared with the history of the universe). Arguably, each of these three themes is open to dialogue between the Buddhist commitment and scientific understandings. Indeed, there is something of a tradition of looking for parallels between Eastern philosophies and modern interpretations of physics (Capra 1975).

Among those that believe in a creator God, there can be different views about the nature of God and of his actions. A deist would consider that a creator God would set up the universe ready to play out and then observe without taking any further action. Isaac Newton's theological views seemed to approximate to this position, although he thought God needed to occasionally fine-tune His creation (Cooper 1984). Theists may see the nature of creation rather differently. For many theists, the universe was not only initially created by God at some point in the past, but its continued existence depends upon God. From this perspective 'the creation' *was* not an event, but *is* an ongoing process (Alexander 2009).

Some theists may distinguish two kinds of action in the world by God – those things which are a kind of playing out of an original plan or programme and those which involve God acting directly in the world to intervene in the usual cause of events, such as during various events in the Old Testament or Jewish Torah that are considered miraculous. One example is an event during the Exodus story where the Israelites having escaped from slavery in Egypt needed to cross the River Jordan to finally enter their promised land. The waters stopped flowing from upstream as soon as the priests walked into the river.

Traditionally such miracles have been seen as God intervening in the normal natural course of events to interrupt nature (Moreland and Reynolds 1999). From this perspective a supernatural force stopped the waters for long enough for the Israelites to cross. However, other theistic interpretations consider that these events are not supernatural, but rather due to an unusual confluence of particular natural circumstance (e.g. recent rainfall levels, unusual wind direction, mudslides upstream diverting flow, etc.). This interpretation is not intended to make the event a mere coincidence or 'lucky break', but rather represents *a miracle of timing* where God (having omniscience) has set up the natural world in such a way that the improbable circumstances occurred at just the right moment in history (Humphreys 2004).

This raises complications for a common notion that science enquires into nature but has no jurisdiction over a supernatural world should one exist. That position would suggest that the existence of supernatural beings and powers is outside the range of application of science, which only concerns itself with the natural. Yet for many modern-day theists, a simple distinction between the natural and the supernatural is not meaningful as God may be seen as immanent in nature and sustaining it, not through supernatural means, but by being the very basis of nature itself (Alexander 2009).

3.5.2 *Examples of Epistemological Commitments in Religious Worldviews*

As suggested earlier, science is based on empirical enquiry, and as the RS suggests, a premise of the scientific revolution was the notion that scientists should seek to find out for themselves and ‘take no one’s word for it’. That said, it is now widely recognised that even science is based upon some a priori commitments (as discussed below) that must be adopted prior to empirical enquiry. Also, in practice, the modern scientist inevitably has to assume a good deal of what is already accepted, as science is iterative and progress is only possible because each generation of scientists comes to take for granted what are considered secure findings produced by their predecessors. However, it is still assumed that any scientist has a right to question any scientific principle or result and – indeed – a responsibility to make reasonable efforts to bring significant counter-evidence apparently falsifying accepted ideas to the notice of the scientific community. *In principle*, then, scepticism is encouraged, and interpretation of empirical evidence is considered the basis of scientific authority.

Religious traditions, however, are often quite different. In Islam, for instance, the Qur’an (or Koran) is considered to record the actual word of God as dictated directly to the Prophet (Muhammad). The Qur’an therefore represents absolute authority and is not open to revision or modification (although of course – as with any text, sacred or otherwise – it must be interpreted). In a similar way, the Ten Commandments recorded in the Torah are considered to have been given directly to Moses by God (inscribed on tablets of stone, giving little scope for misreporting of them in scripture). Scripture is therefore seen in some religions as a direct source of knowledge.

Another major source of authority in some religious traditions is the priest, or similar person, who is considered to be able to act as an intermediary between God and other people. Within Christianity, for example, some traditions consider that the interpretation of scripture, and so pronouncements on what is right or wrong, is a responsibility of the church hierarchy – an issue that Galileo Galilei faced when teaching about the heliocentric system (that he was allowed to discuss as a hypothesis or heuristic, but something he was forbidden from presenting as factual).

The Roman Catholic church has changed its view on that particular point, but today has official positions on matters such as abortion and the use of contraceptive technology, that are supposed to be binding on all members of the Church. In some circumstances the Pope as supreme pontiff of the Universal Church (considered to have authority handed down through each Pope since the Apostle Peter) with his advisors is considered to be infallible on matters of religious teaching. By contrast, in some protestant traditions (where there are no formal priests), much more emphasis is given to individual Christians following their own conscience in matters of morality (following advice offered by the Apostle Paul).

Another epistemological commitment in some religions (e.g. Islam and commonly in Christianity) is that humans are able to understand nature in a meaningful way – as it is God’s intention that his people should appreciate his creation (Moreland

and Reynolds 1999). Yet in some Eastern religions (Hinduism, Buddhism, Sikhism), there is a strong emphasis on *Māyā*, that is, on aspects of the perceived world being illusory.

3.5.3 *Examples of Axiological Commitments in Religious Worldviews*

Religions often offer moral guidance on the right way to live and what comprises good rather than bad or evil. Such guidance may relate to social relations (respect, compassion, forgiveness) or particular practices and rites, for example, certain foods that are prescribed or excluded either on particular occasions or generally. So, in religions such as Judaism and Islam, there are strict dietary codes of this type, both relating to what can be eaten and how the food is sourced and prepared. This means that, for instance, advances in slaughterhouse techniques that might be considered to cause less suffering to the animals being killed would not be acceptable if they were seen as inconsistent with the traditional codes for preparing food.

Religious traditions also often consider that there is a purpose in the universe (e.g. God's purpose), that individual people may have a place in an overall plan as part of that purpose, and that therefore a person should make choices in keeping with God's plan for them. Sometimes people who adopt such views find comfort in considering that misfortune or apparent tragedy (like the death of a child) is for good reason and part of God's overall plan, and this may be associated with a form of fatalism – that whatever will be, will be.

The rejection of contraceptive technology (such as condoms) by the Roman Catholic church, referred to above, is part of the Church's moral teaching, based on axiological commitments to the sanctity of life and there being a special nature to the relationship represented by marriage between a man and a woman. Science has no value positions on such issues as whether the use of contraception or sexual relations outside of marriage is in principle right or wrong, but science does offer strong evidence of the potential consequences of the use or rejection of contraceptives in those countries where HIV/AIDS is rife and/or where much of the population is already at or near subsistence level. So-called sociocultural or socio-scientific issues are increasingly being explored in science classes (Sadler 2011). These are those issues where science offers evidence and theoretical perspectives but where decision-making necessarily also draws on values that are external to science itself. Student worldviews can be highly significant in such lessons.

3.6 Metaphysical Commitments of the Scientific Perspective

Science itself is also based on a set of metaphysical commitments (Taber 2013a). Some of these may seem obvious, but then that is how metaphysical commitments often work – as what we take for granted. So, for example, science not only assumes

the existence of the material world independent of our minds but also that that world is stable and ordered enough to make it worth our while enquiring into it (e.g. so it is worthwhile looking for ‘universal’ laws) and that it is knowable to a sufficient extent to make scientific knowledge possible. The existence and relative stability of a world beyond our minds is an ontological commitment, and the assumption that humans are able to learn about its true nature is an epistemological commitment. There remains scope for debate among those operating with such commitments: for example, regarding which features can be considered to be fundamental and universal and *to what extent* human knowledge is able to comprehend nature (Taber 2013a).

These assumptions are a priori as they cannot be demonstrated without first assuming them! Furthermore, once we make these assumptions, we go on to interpret our experiences accordingly. A further epistemological assumption adopted in science is that the way to learn about the world is to undertake observation and experiment (supported by reflection and analysis) – rather than, for example, by seeking visions during meditation.

If these assumptions seem fairly unproblematic – as is likely to be the case for many of those working in science education – then it is worth noting that they are not always universally shared beyond scientific circles. For example, in Plato’s philosophy where the directly experienced world was a kind of distorted image of a more ultimate reality, it made more sense to focus one’s efforts on seeking knowledge of that ideal world, rather than enquiring into the illusion of the directly experienced world (e.g. Plato’s student Aristotle, however, adopted a somewhat different metaphysics and put a good deal of effort into empirical studies in biology.)

Science does not offer a moral system like those of many religions, but nonetheless there are certain values – axiological commitments – that are adopted. So science values open-mindedness and indeed a willingness to refute one’s own ideas (Popper 1934/1959), values that are not always aligned with those adopted in religious traditions.

3.6.1 Worldviews Consistent with Scientific Metaphysics: Theism

The view of scientific metaphysics offered here suggests that the foundational assumptions of science have nothing to say about God or the supernatural. Of course science is a socially constructed enterprise, and its tenets have changed over time and could change again (Taber 2013a). Scientists themselves, historically and today, have taken very different views about religious matters and indeed on whether science has anything to say about belief in a God (Coll et al. 2008). There is no consensus about such matters, so it is wrong to suggest that scientists in general (and so therefore science itself) either judge science as compatible with religions or inherently inconsistent with religious faith. There are many professional scientists today who would adopt each of these positions (as well as many who would simply see religion as entirely irrelevant to science).

3.6.2 *Worldviews Consistent with Scientific Metaphysics: Natural Theology*

Many famous scientists of the ‘scientific revolution’ (Westfall 1971) such as Isaac Newton, Robert Hooke and Michael Faraday believed the world was God’s creation. Many of these scientists adopted an approach sometimes called natural theology (Grumett 2009). In this approach it was assumed that because God had created the world for people to live in, He would have created it so that people could understand its workings. Studying God’s work (his creation) was considered complementary to studying His Word (scripture), and an appropriate activity for a devout believer (McCalla 2006). This perspective is also very common in the Islamic world today (Dagher 2009).

There is a widely adopted tradition in Christianity (at least since Augustine who lived in the fourth and fifth centuries CE) that where investigation of the natural world offered strong evidence that was clearly inconsistent with scripture, then the *apparent* contradiction indicated that the interpretation of scripture should be re-examined. In this tradition scripture was never considered *wrong*, but was capable of being misinterpreted by fallible human readers. This was a tradition that Galileo Galilei called upon when his astronomical observations seemed inconsistent with his Church’s interpretation of scripture.

3.6.3 *Worldviews Consistent with Scientific Metaphysics: Agnosticism*

An alternative tradition of agnosticism, more sceptical of religious beliefs, developed in the nineteenth century. The word agnosticism was suggested by T H Huxley (Gilley and Loades 1981), who was known as ‘Darwin’s bulldog’ because of his strong advocacy for natural selection (‘Darwinism’). The agnostic view was that the existence or otherwise of supernatural beings, such as a creator God, was a metaphysical issue that was not open to scientific investigation. Therefore, a scientist should not commit to a belief in God, nor claim that God did not exist, but rather should focus on matters that could be settled by scientific work. (Sometimes people use the term agnostic to refer to someone who is undecided about the existence of God, but strictly it refers to an epistemological commitment that we cannot be sure whether God exists.)

This approach rather assumes that being a scientist is an approach to life, rather than just an occupation. Many scientists who are religious would accept that the question of the existence of God is not open to scientific enquiry, but however claim to have had personal experience of God that provided them with proof of His existence. Their experience is subjective, and not presented as scientific evidence, but acts as sufficient grounds for their *personal* belief, completely independently of their scientific work. As natural science is not able to investigate supernatural

phenomena, such beliefs should not impact on their scientific work (but may give them moral guidance about such matters as the desirability of different applications of science and so preferred areas of science to engage with).

3.6.4 *Worldviews Consistent with Scientific Metaphysics: Methodological Naturalism*

Many scientists who are theists, and consider that God acts in the world, tend to seek to keep such notions separate from their scientific work. Often such scientists adopt ‘methodological naturalism’ (Moreland and Reynolds 1999), a perspective that assumes that science is the appropriate means by which to investigate the natural world and accepts that supernatural explanations should not be admitted into scientific work.

Historically there has been a tendency for some commentators to recommend acceptance of scientific accounts as far as they go, but to reserve God as the cause to explain anything science cannot explain. This approach, known as a ‘God of the gaps’, has never been a respectable philosophical position though and, if adopted, is likely to result in regular ceding of more ground ‘from’ theology ‘to’ science, as science expands the range of its viable explanations for the natural world (Fergusson 2009; Sagan 1985/2006). Methodological naturalists rather assume that the material world can generally *in principle* be explained by science but may accept that there is another level of explanation and cause underlying the existence of the world that complements (but is not threatened by) scientific explanation (Moreland and Reynolds 1999).

So, in this perspective, God has created the material world and set up its physical laws such that its material form and the laws are themselves open to scientific enquiry. From this view science has precedence as long as it remains in its range of application, but has no apparatus to examine questions relating to ultimate causes. Different types of causes are not seen as being in competition, but working at different levels of explanation (Habgood 2002). By analogy, a question about how the reader comes to be reading this chapter could be answered in terms of the physiology and neurology of reading or in terms of the motivations of the reader. The existence of an explanation in terms of synapses and nerve impulses neither excludes nor is excluded by an explanation in terms of a desire to read about the ‘science and religion’ issue. In the same sense, a mechanistic explanation of the physics of the big bang can be seen as complementary to an ultimate explanation that the universe exists because God brought it into being (perhaps through the big bang as physics suggests).

As noted above when considering miracles, some theists who adopt this kind of perspective will consider that God *only* acts through natural forces and events – so in principle miracles can be shown to have natural immediate causes, whilst their ultimate supernatural cause remains undetected by scientific methods. Others consider

that God can and does intervene in the usual natural state of affairs, but that because these actions are supernatural, they are not open to scientific investigation.

In effect agnosticism (see above) is also consistent with methodological naturalism as strictly agnostics are not those who have *not decided whether* to believe in God, but those who consider that the existence or otherwise of the supernatural is inherently beyond human knowledge. That is, where theism and atheism are ontological commitments (to the existence or nonexistence of God), agnosticism is more an epistemological commitment relating to the limits of human knowledge.

3.6.5 Worldviews Consistent with Scientific Metaphysics: Atheism

Just as many scientists are religious, and many are agnostic, there are also many scientists who are atheists, who do not believe in a God. Many (but not all) of these would see their atheism as having little to do with their scientific work, just as many theist scientists would see these two aspects of their life as largely separate.

3.6.6 Worldviews Consistent with Scientific Metaphysics: Philosophical Materialism and Scientism

In recent decades, however, a group of scientists who claim that atheism should be inherent in science has been increasingly vocal. These scientists adopt an approach sometimes called ‘metaphysical naturalism’ (Moreland and Reynolds 1999) or materialism which not only considers that science is limited to studying the material world, but that indeed that is *all there is*. For these scientists, God is an illusion. Human spirit or soul is at best an emergent property of the complexity of the nervous system and perhaps even an epiphenomenon – simply a by-product of effective cognition (Taber 2013b) – and that the only forces that operate in the world are natural forces open to scientific investigation.

Often these scientists – of whom Richard Dawkins is the most high profile (Cray et al. 2006) – take the stance that only science can offer reliable knowledge (Moreland and Reynolds 1999) and sometimes also suggest that in principle everything can be explained by science and so that scientific laws should be seen as prescriptive (how the universe must behave) rather than descriptive (how the universe appears to behave). In effect this view is one of scientism – that all there is can be explained by science – so in effect that science is the one true epistemology.

This group of atheist scientists is especially significant for the public understanding of science because they wish to expand the basic metaphysical commitments of science to include those of their own materialist worldview. Whereas the scientific perspective has previously been that science is limited to studying the material

Table 3.1 Scientists may differ in both their belief in God and their views on whether religious convictions have any direct relevance to their scientific work

	Religious belief is seen as irrelevant to scientific work	Religious belief is seen as relevant to scientific work
Theist	Considers belief in the supernatural to be largely irrelevant to scientific enquiry into nature. Spiritual and professional life kept separate except in terms of ethical decision-making	Sees God at work in all things and underpinning nature and its laws. Science seeks to understand God’s creation
Atheist	Does not believe in the supernatural, but does not consider religious beliefs an impediment to science, providing the religious scientist does not let them take priority over empirical evidence	Sees atheism as a proper commitment for scientific work and so considers religious scientists to be compromising the scientific attitude by believing in beings/forces for which there is no objective evidence

world and has nothing to say about the supernatural, these materialistic naturalists suggest that a true scientific perspective is that all that exists is the material world, and science excludes the possibility of the supernatural. Dawkins, for example, claims that ‘any belief in miracles is flat contradictory not just to the facts of science but to the spirit of science’ (Cray et al. 2006).

It would seem then that scientists vary not only in terms of their personal religious convictions, but also in whether they feel such beliefs potentially interact with how science can be understood (see Table 3.1).

3.7 Implications of Worldview on Understanding Scientific Knowledge

People with different worldviews adopt different stances to scientific knowledge and religious beliefs. The brief analysis presented above suggests not only that metaphysical commitments of a religious nature can impact upon how people (e.g. school or college students) understand and respond to scientific teaching, but also that some scientists who conceptualise the nature of science itself within an atheistic materialist worldview perceive religious beliefs as *necessarily* counter to science.

Consider, for example, how prayer may be understood. In some religious traditions, prayer is seen as communication with God that has the potential to lead to changes in future events (e.g. recovery of a loved one from illness) should God choose to act in the world in response to prayers. Some scientists who adopt theistic worldviews would find this acceptable on the grounds that as God is the all-powerful creator of the world, so He is free to intervene to influence it at any time, and as such interventions are supernatural – they cannot be explained by science.

Other scientists who hold theistic worldviews will consider that although God acts in the world, His extreme intelligence allows this to occur within the natural

processes He has set up, and so there will be nothing outside of scientific explanation (and so no evidence of miraculous intervention). However, the atheistic materialists will exclude any possibility of there being a God and suggest that if prayer is shown to have an effect then this must be due to influences open to scientific investigation and totally depending on natural processes, even if possibly processes that science has yet to discover. Both of these latter groups will in principle consider that any measurable effects of prayer will potentially have a scientific explanation – but the atheists consider such an explanation excludes a complementary theological explanation that the theists would hold.

It seems then that both religion and science offer accommodating and exclusive positions where they might be considered to potentially overlap (see Table 3.1). Religious perspectives may either lead us to expect to see theological explanations that take precedence over scientific ones or alternatively consider that theological and scientific accounts are parallel and complementary.

In a similar way, core scientific commitments do not exclude a supernatural realm or religious accounts, but lead us to seek physical explanations for the phenomena of the material world. Yet within the broad ‘scientific church’ are those who would expect there are some special events in the material world beyond scientific explanation; others who expect science to be able to address all material phenomena, but limited to immediate rather than ultimate causes; and yet others who adopt a worldview that excludes the possibility of anything supernatural and considers everything to fall wholly within the realm of science. There are also variations and graduations within and between these gross positions.

3.7.1 The Prominence of Debates Around Evolution

Based on this analysis, the rather high-profile arguments about how science educators should respond to the rejection of evolution by people from some religious communities can be understood at two very different levels. This debate has largely been played out in the context of objections to evolution in some Christian, and increasingly Muslim, communities.

There is certainly an issue in terms of meeting curricular aims that set out evolution as a teaching topic, as some learners may reject evolution on principle (see Chap. 4). However, debate does not just depend upon people with religious convictions rejecting scientific accounts, as there is also a distinct argument being made by some scientists drawing on their particular (atheistic, materialist) understanding of the nature of science rejecting the religious beliefs of theists who themselves accept the scientific account (such as many religious scientists).

Interpretation of religious accounts of the origins of life, and interpretation of the nature of science itself, interact. Therefore the question of whether religion and evolutionary theory are compatible depends upon both (i) which religious, and (ii) which scientific, position is adopted. Reaching one of these positions in relation to

a particular topic will clearly depend upon both one’s religious beliefs and one’s understanding of the nature of science. This is illustrated in Table 3.2 using the examples of the case of evolution and Christianity, where the teaching of some Christian churches absolutely excludes the possibility of humans evolving from other species by natural selection, yet other Christian churches have no problem with this issue.

The columns of Table 3.2 represent two possible Christian understandings of teaching about human origins. In both cases a core tenet of Christianity is represented: that there is a creator God who is responsible for the creation of human beings. In some Christian traditions (represented by religious perspective 2), the accounts of how God created the world (the two accounts in the early chapters of Genesis) are understood to be technical accounts: God created the first man from dust and then formed a woman from one of the man’s ribs so that he could have a companion. In this account all the rest of humanity subsequently descended from this original couple. However, there are other Christian traditions (represented by religious perspective 1) that see these accounts in scripture as presenting narratives offering a theological truth about humanity (that humankind is part of God’s creation and that people are considered to have a special relationship with their God) in terms that are poetic and would have been accessible to the original historical audience several thousand years ago.

Table 3.2 How two different scientific and religious perspectives can interact in relation to evolution

	<i>Religious perspective 1:</i> religion teaches that God created humankind but does not specify the mechanisms he used	<i>Religious perspective 2:</i> religion teaches that God created the first human directly from dust by an act of special creation
<i>Scientific perspective 1:</i> science teaches that there is extensive evidence that humans evolved over a long period from other earlier species by a natural process called ‘natural selection’ – but has no view on whether there was a purpose or intelligence behind this process	It is perfectly consistent to believe in a creator God and to accept natural selection as the means by which God created human beings	Notions that man evolved from other non-human species are directly contradicted by scripture that reveals how God created humans: religion excludes the scientific account
<i>Scientific perspective 2:</i> science teaches that events in the world occur by natural processes that occur without any supernatural input and that there is extensive evidence that humans evolved over a long period from other earlier species by a natural process called ‘natural selection’	Seeing evolution as anything other than a series of events following natural laws inherent in the universe (and needing no supernatural explanation) is contrary to scientific principles: science excludes religion	The scientific and religious perspectives exclude each other both because religion rejects scientific accounts and because science rejects the foundational tenets of religion

The rows in Table 3.2 represent two possible positions that scientists may take about the scientific theory of human origins, that is, evolution by natural selection. One of these views (represented by scientific perspective 1) sees science as offering a mechanism for how humans came to be on this planet, but takes no position on whether this mechanism reflects the will of a God or other supernatural entities. However, the other perspective (scientific perspective 2) considers it inherent in the natural mechanism that it has to be a sufficient explanation without being driven by any supernatural force or agent (such as God).

Public debates about evolution, and the teaching of evolution, are therefore often being played out at two very different levels, one relating to empirical issues and the other to metaphysical ones. The first issue relates to how evolution is a central idea in biology, and worldview commitments that lead to learners misunderstanding or rejecting evolution are therefore problematic for science learning. That issue is considered in more detail in Chap. 4. For science educators *this* issue is quite straightforward – evolution is the currently accepted scientific theory, and it should be taught as just that: a well-accepted idea supported by a wide evidence base.

The other aspect of the evolution debate revolves about scientists using the topic as a context for attacking religion and what Dawkins (2010) has described as ‘the uniquely ridiculous nature of religious belief’. In this context evolution has become something of a ‘cause célèbre’ (Moreland and Reynolds 1999), probably because the claims of some who support young earth creationism seem to deny so much empirical evidence that it is easy to rhetorically associate their literal interpretation of scripture (and so support for positions that seem untenable to many outside their communities) with irrational thinking. Given this, a belief in a creator (and the possibility of eternal salvation, etc.) is targeted *by association* as irrational as well. This argument is akin to claiming that Newton’s mechanics should be dismissed as the product of a primitive and superstitious mind because of his apparent commitment to numerology (Pescic 2006), or that Kepler’s laws should be rejected because he used horoscopes, or that Linus Pauling’s fixation on the imagined health benefits of megadoses of vitamin C should lead us to discount his findings in chemistry.

Richard Dawkins, probably the most high profile of the philosophical materialists to campaign on this issue, sets out the debate as being a clash between modern, rational, evidence-based science and illogical, outdated superstitions – although of course when scientists are interviewed about their beliefs, it is found that ‘believers, atheists and agnostics’ all use rational argument to justify their positions (Falcão 2008, p. 1261). These two distinct threads to the evolution debate are set out in Table 3.3.

The educational position presented in Table 3.3 would be adopted or at least accepted by the vast majority of scientists and science educators. From that perspective it is important to explore how to facilitate effective teaching of evolution, even among communities where religious or other cultural beliefs are inconsistent with the science. The metaphysical position presented in Table 3.3, however, whilst being strongly held and advocated by some scientists, is not a consensus view of the scientific community. However, it becomes important to science educators because (a) science education in many countries puts increasing emphasis on teaching about the nature of science and (b) the claims of the materialistic naturalists are often high profile in media discussions of areas of science such as evolution. Indeed, it has been reported that, in part, the

Table 3.3 Evolution is not only a major issue in science education, but has become something of a cause célèbre for a group of scientists who consider science should supplant religion

Level of debate	Focus of debate	Issue	Role of evolution	Status
Educational	Effective teaching of scientific ideas	Science education is concerned with teaching people about the scientific models and theories of the material world. Sometimes learners fail to appreciate, or even reject, scientific ideas because of commitments drawing upon religious and other cultural beliefs	Evolution by natural selection is an especially important scientific theory, which is fundamental to an understanding of modern biology. Rejection of evolution is a major impediment to developing a scientific understanding of the living world, including many aspects of medicine and health, and of ecology	Close to consensus position in science and science education
Metaphysical	Nature of science	Science is a modern, rational way of understanding the world based on logical analysis of evidence that is superior to more primitive modes of thought based upon superstition and supernatural entities. Science education should persuade people to abandon their primitive beliefs and adopt a more rational approach to the world	Evolution is an important ‘battleground’ because it is one of the most visible areas where common superstitions (e.g. religious beliefs) lead to people denying evidence and rejecting the rational approach of science. Evolution provides a valuable case study that illustrates just how problematic religious ideas are in obstructing education that should be promoting rationality	The views of a pressure group within the scientific community, which are not shared by scientists generally

development of the intelligent design movement (see Chap. 4) was a response to the atheistic gloss on evolution in the writings of Dawkins (Alexander 2008).

At the start of the chapter, the rather unsavoury matter of Prof. Reiss’ departure from his role as education director for the Royal Society (RS) was raised. Reiss is a highly respected science educator with a background in evolutionary biology. He accepts natural selection as the best scientific account of the origin of species and is concerned that learners in schools and colleges should learn about evolutionary

theory. Given that Reiss is unambiguously pro-evolution, and pro-teaching evolution, his dismissal seems a miscalculation and overreaction by the RS. Reiss's comments were reported in the press:

In his speech, Reiss said that while creationism had no scientific basis, science teachers risked alienating pupils who believed in the idea by dismissing it out of hand. "They should take the time to explain how science works and why creationism has no scientific basis", he said.

(guardian.co.uk 2008)

Reiss's comments were, however, also misreported (as supporting teaching of creationism in science) by some media outlets immediately after the speech, and there were then public reactions to those reports by people who had not heard the talk. Reiss issued a clarifying statement, but the RS asked for his resignation – apparently on the grounds that he had uttered comments capable of being misinterpreted in ways that reflected badly on the RS. It is in the nature of controversial issues that statements are readily misconstrued (deliberately or otherwise), so one might expect the RS to have taken a more principled approach and to have supported its officer.

However, it seems that Reiss was a victim of the tension within science about the nature of science itself and whether it should encompass an atheistic, materialist worldview. A number of Fellows of the Royal Society had already criticised Reiss's appointment before he made any public pronouncements because he was a committed Christian and an ordained minister of the Anglican Church. Even though Reiss does not dress as a priest when working as a science educator, and does not use his academic positions to push theological views, some Fellows objected that such an openly devout Christian was unsuitable for a high-profile office in a scientific society (Vallely 2008). So, there was a campaign to remove Reiss from his position at the RS because *some other scientists considered his personal beliefs incompatible with science*.

The behaviour of the RS in capitulating to its materialist Fellows illustrates that the science and religion issue is a complex one. It also demonstrates that where there are conflicts, they can originate from either direction: (some) people of religion rejecting science or (some) people of science being intolerant of religion.

3.7.2 *Implications for Education*

Reiss has argued that:

It is perfectly possible for a science teacher to be respectful of the worldviews that students occupy, even if these are scientifically limited, while clearly and non-apologetically helping them to understand the scientific worldview on a particular issue.

(Reiss 2009, p. 783)

Perhaps what some of Reiss's critics found unacceptable, but seems sensible and appropriate from an educational perspective, is that the teacher's aim should be

limited to helping students *understand* the scientific ideas and the arguments and evidence for them. It is not the science teacher's job to ask learners to *commit* to accepting those ideas (Taber 2013b) – even when the teacher finds the case for them as overwhelmingly convincing. Science teaching should not be about persuading learners to adopt beliefs, but about providing a solid understanding of core scientific ideas that students can then make up their own minds about. Science should certainly not be learnt as dogma – and indeed when scientific principles come to be taken for granted as if articles of faith, they can act as obstacles (Bachelard 1940/1968) to scientific progress (e.g. the existence of the ether, the central dogma of molecular biology and the noble nature of the inert gases).

In recent years there has been research in a number of countries exploring students' notions of the relationship between science and religion (Francis et al. 1990; Fulljames et al. 1991; Hansson and Redfors 2007; Taber et al. 2011a, b). Given the complexity of the intellectual 'landscape' around this issue, it is not surprising that students fail to appreciate many of the subtleties of the different positions adopted. Moreover, and of some concern, there is some sense that learners' perceptions often tend to demonstrate particular awareness of the less conciliatory positions. Learners tend to recognise those more fundamentalist religious positions that reject scientific accounts and are likely to assume that atheistic and scientific perspectives are the norm in science. One US study reported that high school students could be sufficiently troubled by the perceived incompatibility of science and religion 'that a significant percentage of our most motivated and capable students feel they may be deterred from a science career' (Esbenshade 1993, p. 336). This is surely an important topic that should be a priority for further research in different national contexts (Reiss 2008).

Science educators need to adopt sensitivities to students and colleagues, bearing in mind that there can be deep convictions to both religious and materialistic worldviews. Those working in science education also need to be aware that the subtleties and complexities of the 'science and religion' issue are unlikely to be accessible to many of the learners coming to our classes, who are increasingly likely to unhelpfully consider 'science *and* religion' in terms of 'science *versus* religion'.

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