

Science, Religion and Education

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The August 2018 meeting in Cambridge was the fifth Science and Religion Forum at which I have been fortunate enough to speak. In many ways, the one I remember best was back in 1983 when I was doing a post-doc in population genetics and animal behaviour under Tim Clutton-Brock at the University of Cambridge. Tim had been asked to speak on human sociobiology at the SRF Conference that year at the University of Durham. Human sociobiology wasn't really Tim's field and, in any event, Tim has no interest in religion so he suggested me. I can only imagine that the organisers were by that stage desperate as my entire publications list at that time consisted of a four-page article in *New Scientist* and a two-page article in *Biblical Creation*, now known as *Origins*, the journal of the Biblical Creation Trust, in which (from memory) I critiqued a creationist argument.

Anyway, I enjoyed the Durham Conference hugely. I met wonderful people, looked round the Cathedral for the first time in my life, got my paper published in *Zygon* and while I was giving my talk was interrupted by a middle-aged woman shouting 'Rubbish' at one point. I was a confident school teacher at the time so rather enjoyed audience interaction and we had a brief spirited debate part-way through my talk. Afterwards, I sought her out and thus began a lifelong friendship with the remarkable and redoubtable Mary Midgely.

Mark Harris asked me to give all four talks at this Conference under the theme of 'Education' and then, when I accepted, immediately told me he would be out of the country at another Conference. Lizzie Henderson of the Faraday Institute then stepped in to offer to give one of them with Steph Bryant so I gave three and this article presents a tidied-up version of what I said. The first of my talks dealt with education in general, the second with science education and the third with religious education. My hope, of course, was that there would be something of interest within these, however much most of those present already knew about science and religion and the interactions between them.

Education

If we think of formal schooling, there are at least five important considerations: the curriculum (what is taught); the pedagogy (how the teaching is undertaken); the assessment of learning; the values and ethos of the school; and the resources available. I will concentrate on the curriculum, but will include a bit about values towards the end. Let me start by saying something about the contrasting views of two distinguished professors of education, Michael Young and John White, each of whom, by co-incidence, has been at the Institute of Education, where I work, for over fifty years (Reiss, 2018a).

Michael Young's more recent arguments about the school curriculum have been coherently and powerfully expressed in a number of publications, of which perhaps the core text is his *Bringing Knowledge Back In* (Young, 2008). A key conclusion that Young reaches is that "The curriculum cannot be based on everyday practical experience. Such a curriculum would only

recycle that experience” (p.89). He also concludes that “It is important to be cautious about replacing a curriculum based on specialist research and pedagogic communities with one based on the immediate practical concerns of employers or general criteria for employability such as key skills” (p.89).

Michael Young’s ideas about the school curriculum have proved to be enormously fertile, leading him to develop and defend his views in numerous keynotes and debates and a range of publications. A convenient presentation of his recent thinking is provided by his *Knowledge and the Future School* co-authored with David Lambert and with inputs from Carolyn Roberts and Martin Richards (Young *et al.*, 2014). In that book, Young is explicit that “the main function of school ... is to enable all students to *acquire knowledge* that takes *them beyond their experience* (Young, 2014, p.10). There is much in this short quotation that is notable; here let me allow Young to elaborate:

The school, for all its tendencies to reproduce the inequalities of an unequal society, is the only institution we have that can, at least in principle, provide every student with access to knowledge. The only alternative to schools for all is to accept that the majority will never have the educational opportunities that the minority has always treated as their right. We must respect and value the experience of pupils, but we can never allow them to depend on their experience alone. To do so would leave them (and us) in the position of our Stone Age ancestors, or worse; we would be no different from animals, who have *only* their experience.

(Young, 2014, p.13)

John White’s first book, *Towards a Compulsory Curriculum*, was published in 1973 (White, 1973). In it White advanced a number of arguments that he has then developed over many years. There is a central presumption that education must be for the benefit of individual learners and take them as its starting point:

It is at this point that notions of a ‘child-centred’ education and an ‘integrated’ education meet: the child must be at the centre of all he learns; education cannot be ‘subject-centred’ in this sense.

(White, 1973, p.51)

White holds that education is about far more than the acquisition of knowledge about particular subjects. One point stressed in *Towards a Compulsory Curriculum* is that pupils “should finish their education with an understanding of the many different ways of life which they and others may pursue” (White, 1973, pp.43-4). A further argument is that not all school subjects are of equal worth. This argument connects with the issue of whether all ways of life are of equal worth. In contradistinction to the assumptions of recent UK governments – motivated primarily by a naive set of beliefs about the importance of home-grown science, technology, engineering and mathematics talent for economic growth – White argues that “The humanities have a more central role in the curriculum than the natural sciences ... because they alone enable one to weave together a human life” (White, 1973, p.63).

A further development of what a school curriculum might look like if one were to begin with aims rather than subjects is presented in some of White's most recent writing, notably *An Aims-based Curriculum* (Reiss & White, 2013). The intention behind this publication is to provide a framework for the development of a coherent set of aims for the curriculum, some for implementation at national level, others at the level of each school. The argument begins with the premise that the aim of the school curriculum is two-fold: to lead each learner to lead a life that is personally flourishing; and to help others to do so, too. It is then argued that a central aim of a school should therefore be to prepare students for a life of autonomous, whole-hearted and successful engagement in worthwhile relationships, activities and experiences. This aim involves acquainting students with a wide range of possible options from which to choose, though we need to recognise that students vary in the extent to which they truly are able to make such 'choices'. With their development towards autonomous adulthood in mind, schools should provide students with increasing opportunities to decide between the pursuits that best suit them. Young children are likely to need greater guidance from their teachers, just as they do from their parents. Part of the function of schooling, and indeed parenting, is to prepare children for the time when they will need to, and be able to, make decisions more independently.

John White and I went on to argue that we want children to want other people, as well as themselves, to lead fulfilling lives. This means not hurting them, not lying to them, not breaking one's word or in other ways impeding them in this. It also means helping others to reach their goals, respecting their autonomy and being fair, friendly and cooperative in one's dealings with them. Schools can reinforce and extend what parents and others in families do in developing morality in children. Schools can widen students' moral sensitivity beyond the domestic circle to those in other communities, locally, nationally and globally. They can encourage students to reflect on the basis of morality, including whether this is religious or non-religious.

As part of their moral education, schools should help students to become informed and active citizens of a liberal democratic society. This means encouraging them to take an interest in political affairs at local, national and global levels from the standpoint of a concern for the general good, and to do this with due regard to values such as freedom, individual autonomy, equal consideration and cooperation. Young people also need to possess whatever sorts of understanding these dispositions entail, for example an understanding of the nature of democracy, of divergences of opinion about it, and of its application to the circumstances of their own society.

As future citizens, the great majority of students will contribute to the general well-being, as well as to their own, through work. This will often be remunerated, though much of it, e.g., caring for children or elderly relatives, may not be. As autonomous beings, students will eventually have to make choices about what kind of work to engage in. Schools should be helping them in this by making them aware of a wide range of vocational possibilities and routes into them, as well as their advantages and disadvantages. This is a particularly important function of schools as this is something that few parents can provide for their children.

Comparing Young and White

Everyone, including Michael Young and John White, would surely agree that schools need to complement and build up what their students learn from their families and other extra-school sources. When I was about seven years old I got some childhood infection – measles, chickenpox or something – and missed a couple of weeks of school. On the day I returned, I can remember my teacher, with genuine concern in her voice, saying to me “We’ve started multiplication”. “That’s all right”, I replied; “My mother has taught me that”. And so she had. Many parents teach their children to read and start writing (and virtually all teach them to speak) but my mother had taught me at least the rudiments of my times tables.

The point is that it is precisely when some students have been taught something by their parents (or other extra-school sources) and other students have not that schools need, for both pedagogical and social justice reasons, to be quite skillful. If all students know X, then this provides a baseline from which schools can move forward. (Examples of baseline non-academic knowledge that used to be assumed by many primary schools in England for children arriving at school for the first time included being able to go to the toilet by oneself, using a knife and fork and knowing one’s name. However, I do know one woman whose primary school initially assumed she was deaf because she did not respond to her name; it turned out that neither of her parents ever used her name at home, simply calling her ‘you’.) Equally, if none of the students know almost anything about Y (e.g., the reason why the Periodic Table looks as it does, the past historic in French or the principle of commutativity in mathematics) a teacher can assume a level playing field. The more difficult cases for a teacher to handle are when some students – such as my younger self – do know quite a bit about a topic before it is taught in school.

This of course, raises the issue of what we mean by ‘everyday’. To continue on an autobiographical theme, although my parents provided my sister and me with an intellectually rich home life, so that from a young age it was assumed that we would take place in family discussions on issues to do with politics, current affairs, literature, the arts and general ethical matters, and although we read widely and were taken on visits to museums and art galleries, our home was almost entirely empty of music. I cannot remember either of my parents ever singing and although my parents had a small number of gramophone records, beyond one playing of Prokofiev’s *Peter and the Wolf*, I cannot recall listening to any music at home, beyond that which one would hear on Radio 4 – to which my mother listened a great deal. Unsurprisingly, both my sister and I were considered to be tone deaf when we arrived at our schools and, on seeing the looks I got from others when I tried to sing, I very rapidly learnt that the wisest course of action was to pretend to sing but to keep quiet.

The point of this touching story is that what is everyday to one student may be exotic to another. This issue is compounded by the fact that today’s school students have far more avenues for extra-school learning that was once the case. When once the only way a child obsessed with the Russian Revolution was to get down to a good local library or study *Jackdaw No. 42* (let the reader understand), nowadays a single internet search leads to a huge number of images, texts and video clips of both primary and secondary data. All this makes a teacher’s job more challenging but also potentially more fruitful.

The motivational argument for starting from or including the everyday is obvious. For many students, certainly at secondary level, a persistent criticism they voice of much of their schooling is that it's 'not relevant'. By connecting, as a teacher, what one wants one's students to learn with the everyday, one increases the likelihood that they will find it engaging. Of course, the unfamiliar can engage too – the skill of the teacher in no small measure consists of shifting between the everyday and the exotic, the familiar and the unfamiliar, all the time trying to lead students towards a goal that quite a number of them may not initially appreciate.

Consider how science teachers nowadays quite often use everyday understandings of the properties of ropes when teaching about current in an electric circuit. Here the point is that the everyday (an inelastic rope) serves as an analogy (or model) of electric current (the flow of charge due to the movement of electrons). A standard exercise in many schools is to get a group of, say, a dozen students to pass a loop of rope through their hands¹. Most students are asked, passively, to let the rope pass through their slightly closed hands (analogous to being part of the conductor in the circuit, e.g., copper wire) but one student has the job of passing the rope along (analogous to being a battery) and another student is asked (health and safety alert) cautiously to tighten their hands so as to impede the passage of the rope (analogous to being a resistor, such as a bulb). Part of the skill of the teacher is subsequently to get students to think both about ways in which the rope differs from as well as is similar to electric current. In such an exercise, knowledge of the everyday is a powerful basis for the knowledge that the teacher wishes the students to acquire.

The values of a school

Let me end this section on 'Education' – before I get to the specifics of 'Science education and 'Religious education' by saying a bit about the values of the school in the context of faith-based education, specifically Quaker education. Anne Watson points out that Quakers, when they write or talk about education, usually focus on things like pastoral care, peacefulness, good citizenship, caring, the value of self-expression, the liberal arts and RE teaching (Watson, 2018). However, Watson is Emeritus Professor of Mathematics Education at the University of Oxford and is therefore also interested in what a Quaker contribution to mathematics education might be, noting that mathematics is notorious as a school subject for inducing anxiety in some students.

Watson writes about Quaker conceptions of equality and truth in the mathematics classroom. She also writes about love and cognitive care, namely the sort of teaching that does not create anxiety but enhances confidence and self-actualization. She points out that all too often students are required to put aside their own thinking and adopt given methods and truths:

It is as if teachers coerce students into the required behaviour of passing the tests through hard work, compliance, obedience, tolerance and resilience (all worthy

¹ For example, see https://www.youtube.com/watch?v=uyikV_sV7ZQ from 5 min 30 s to 8 min 40 s

character traits) rather than through interest and love of learning and the subject. While these aims are all important in cognitive care, they do not generate and honest and sustainable relationship with the truths of mathematics.

(Watson, 2018, p. 109)

Watson is therefore uncomfortable about educational talk of 'misconceptions' and 'mistakes' and of educational practices that rely on some children giving wrong answers to trigger important teaching points.

Science education

To the bemusement of many science educators in school and elsewhere, and the delight of some, issues to do with religion seem increasingly to be of importance in school science lessons, science museums and some other educational settings. To many science educators even raising the possibility that religion might be considered within science education raises suspicions that this is an attempt to find a way of getting religion into the science classroom for religious rather than scientific reasons. This is not the intention here. In terms of the nature of science, part of the argument is that considering religion can be, on occasions, useful simply for helping learners better understand why certain things come under the purview of science and others don't (Reiss, 2014).

Another argument for considering religion within science education proceeds much as an argument for considering history in science education might. While science can be learnt and studied in an historical vacuum, there are a range of arguments for examining science in its historical contexts. For a start, this helps one understand better why certain sorts of science were pursued at certain times. Wars, for instance, have sometimes led to advances in chemistry, physics and information science (e.g. explosives, missile trajectories, code breaking), while certain botanical disciplines, such as systematics and taxonomy, have flourished during periods of colonisation. Much biology is studied in the hope that medical advances will ensue, so studies of anatomy have developed into studies of physiology and, more recently, genetics and molecular biology. Then there is the observation that for many learners understanding science in historical context can aid motivation. Science courses that take contexts and applications into account are now quite widespread.

Similarly, while many students enjoy learning about the pure science of genetics and evolution, otherwise are motivated and come to understand the science better if they appreciate something of the diversity of religious beliefs held by such principal protagonists as Charles Darwin, Joseph Hooker, Thomas Huxley and Gregor Mendel and the religious views (including the diversity of religious views) of the cultures in which they lived and worked.

There are a number of places where religion and science interact. Consider, first, the question of 'authority' and the scriptures as a source of authority. To the great majority of religious believers, the scriptures of their religion (the Tanakh, the Christian bible, the Qur'an, the Vedas, including the Upanishads, the Guru Granth Sahib, the various collections in Buddhism, etc.) have an especial authority by very virtue of being scripture. This is

completely different from the authority of science. Newton's *Principia* and Darwin's *On the Origin of Species* are wonderful books but they do not have any permanence other than that which derives from their success in explaining observable phenomena of the material world and enabling people to see the material world through Newtonian / Darwinian eyes. Indeed, as is well known, Darwin knew almost nothing of the mechanism of inheritance despite the whole of his argument relying on inheritance, so parts of *The Origin* were completely out of date over a hundred years ago.

Then consider the possibility of miracles, where the word is used not in its everyday sense (and the sense in which it is sometimes used in the Christian scriptures), namely 'remarkable', 'completely unexpected' or 'wonderful' (as in the tabloid heading 'My miracle baby'), but in its narrower meaning of 'contrary to the laws of nature'. Scientists who do not accept the occurrence of miracles can react to this latter notion of miracles in one of three ways: (i) miracles are impossible (because they are contrary to the laws of nature); (ii) miracles are outside of science (because they are contrary to the laws of nature); (iii) miracles are very rare events that haven't yet been incorporated within the body of science but will be (as rare meteorological events, e.g. eclipses, and mysterious creatures, e.g. farm animals with two heads or seven legs, have been).

Understandings of possible relationships between science and religion

It is clear that there can be a number of axes on which the science/religion issue can be examined. For example, the effects of the practical and ritual dimension are being investigated by scientific studies that examine such things as the efficacy of prayer and the neurological consequences of meditation; a number of analyses of religious faith, informed by contemporary understandings of evolutionary psychology, behavioural ecology and sociobiology, examine the possibility or conclude that religious faith can be explained by science (e.g. Dennett 2006, Hinde 1999); the narrative/mythic dimension of religion clearly connects with scientific accounts of such matters as the origins of the cosmos and the evolution of life; the doctrinal and philosophical dimension can lead to understandings that may agree or disagree with standard scientific ones (e.g. about the status of the human embryo); and the ethical and legal dimension can lead to firm views about such matters as land ownership, usury and euthanasia.

Perhaps only the social and institutional and the material dimensions of religion are relatively distinct from the world of science (understand as the natural sciences rather than the social sciences more broadly), in that science has little if anything to say about such manifestations of religion – e.g., in Christianity, the Church and such things as religious artefacts.

As is well known, there are a number of ways in which the possible relationships between scientific and religious understandings of the world can be conceptualised. The best known one (conflict, independence, dialogue, integration) remains that of Barbour (1990). I think it can be difficult for those who have never had a religious faith, or have only had one rather tenuously, to imagine what a life is like that is lived wholly within a religious ordering. For such a person, the relationship between science and their faith may be described as

'integrated' though this is to give an epistemological framing to the relationship, whereas what may be going on is that the person has little overt interest in the precise nature of the relationship between science and religion other than that there can clearly be no conflict between them.

Anthropologists provide good accounts of what it can be like to live a life where one's religious faith integrates with every aspect of one's life. One of my favourite such accounts is that of du Boulay (2009) who studied life in a Greek Orthodox Village in the late 1960s and early 1970s. Everything that happened in the village needs to be understood by reference to Greek Orthodoxy. To give just one instance, the annual liturgical and agricultural cycles intermeshed, so that after the harvest, the sowing of the seed for next year's harvest was closely related to the Christian calendar:

The main sowing of the wheat is carried into November, and the Archangel Michael, celebrated on 8 November and seen on his icons with drawn sword, is a formidable figure associated with the darkening November days with the leaves being stripped from the trees and the smoke gusting in ashy draughts down the chimneys; but this is a month named after the preeminent agricultural task – 'The Sower' (Σποριας). And the Entry of the Mother of God into the Temple on 21 November, soon after the Christmas fast has begun, is also in the village given the character of the time as the 'Mother of God Half-Way-Through-The-Sowing' (Παναγια Μισοσπειριτσα). The task of the sowing of the wheat then continues into the time know as 'Andrew's' (St Andrew, whose day is 30 November, but who has given his name to the following month of December), and can go on up to Christmas – and even beyond, if the weather has not been fit.

(du Boulay, 2009, p.106)

Evolution and creationism in school science

Until fairly recently, little attention has been paid in the school classroom or the philosophy of education literature to creationism. However, creationism appears to be on the increase, and there are indications that there are more countries in which schools are becoming battlegrounds for the issue. For example, while the USA has had several decades of legal battles about the place of creationism and (more recently) intelligent design in schools (Moore, 2007), school-based conflicts over these issues are becoming more frequent in a range of other countries (Blancke, Hjerimitslev & Kjærgaard, 2014). There was consternation in the UK science education community when, in December 2009, many secondary school and higher education libraries received a complimentary copy of the book by Stephen Meyer et al. titled *Explore Evolution*, which, in the words of its website, sets out:

to examine the scientific controversy about Darwin's theory, and in particular, the contemporary version of the theory known as neo-Darwinism. Whether you are a teacher, a student, or a parent, this book will help you understand what Darwin's

theory of evolution is, why many scientists find it persuasive, and why other scientists question the theory or some key aspects of it.²

Such events have led to a growth in the educational literature examining creationism and/or intelligent design (Reiss, 2018b). Most of the literature on creationism (and/or intelligent design) and evolutionary theory puts them in stark opposition. 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 (from eugenics, Marxism, Nazism and racism to juvenile delinquency) – e.g., Baker (2003), Parker (2006) and articles too many to mention in the journals and other publications of such organisations as Answers in Genesis, the Biblical Creation Society, the Creation Science Movement and the Institute for Creation Research.

One approach to understanding the persistence of creationism is the notion of ‘worldviews’, which can be introduced by considering the film *March of the Penguins* (Reiss, 2009). *March of the Penguins* is a 2005 National Geographic feature film. It runs for approximately 85 minutes and has been an exceptional success. It won an Academy Award in 2006 for Best Documentary Feature and has been the most financially successful nature film in American motion picture history. The reasons for its success are no doubt several: the photography is phenomenal; the emperor penguin’s story is extraordinary; the adults are elegant; the chicks are irredeemably cute as they look fluffy, feebly wave their little wings and learn to walk; the way in which the birds survive the Antarctic winter is awesome; the plaintive cries of mothers who lose their chicks in snow storms are heartrending. But one perhaps unexpected reason is that the film has been a great success among the Christian right.

For example, if I enter “march of the penguins” Christian’ into Google, at the time of writing (27 August 2018) there are 91,200 hits. The second of these is a review of the film by Mari Helms (n.d.) on ChristianAnswers.Net, which describes itself as “a mega-site providing biblical answers to contemporary questions for all ages and nationalities with over 45-thousand files” (<http://christiananswers.net/>). After a fairly detailed summary of the subject matter of the film, the review goes on to discuss the lessons that the film has to teach about love, perseverance, the existence of God and friendship. An extended quotation from the review [underlinings indicate hyperlinks to other pages on the ChristianAnswers.Net website] illustrates the presuppositions of the author:

“March of the Penguins” has lessons to teach about:

² http://www.exploreevolution.com/about_the_book.php.

“LOVE”: According to the film, the penguins take this tremendous journey for “love” and to find a mate and reproduce. The dedication, cooperation, and affection are exemplary between the pair.

PERSEVERANCE: We could learn a lot about perseverance from Emperor penguins. I was quickly reminded of the [ant](#) in [Proverbs 6:7-8](#) “It has no commander, overseer or ruler, yet it stores its provisions in summer and gathers its food at harvest.” No one is reminding these penguins what to do; they know what to do, and they do it. They are prepared, persistent and committed, much like we are called to be as [witnesses](#) for [Jesus Christ](#). [1 Peter 4:15](#) “Always be prepared to give an answer to everyone who asks you to give the reason for the hope that you have.”

The penguins endure treacherous conditions, yet they continue on their journey, focusing on what lies ahead (new life). It may be a bit of a stretch, but I thought of what we, as Christians have to endure to get what lies ahead for us ([eternal life](#)). [Philippians 3:14](#) “I press on toward the goal to win the prize for which God has called me heavenward in Christ Jesus.”

THE EXISTENCE OF GOD: One year in the life of an Emperor penguin is a great indication of the existence and character of God. [Romans 1:20](#) ‘For since the creation of the world God’s invisible qualities – his eternal power and divine nature – have been clearly seen, being understood from what has been made, so that men are without excuse.’ He is absolutely perfect! Every detail has been taken into account, and every provision has been made. Witnessing all the love and care that He must have put into creating the penguins is small compared to what He put into creating us. [Matthew 6:26](#) “Look at the birds of the air; they do not sow or reap or store away in barns, and yet your heavenly Father feeds them. Are you not much more valuable than they?” Leaving the theater, I was more in awe and in love with my [Creator](#).
(Helms, n.d.)

The reason for this long quotation is not to subject it to theological or scientific critique. Rather, the value of the quotation is that in Barbour’s (1990) classification, it manifests an integrated relationship. The worldview is one in which it is straightforward to read from penguin behaviour to human behaviour though it is worth noting that the argument is neither entirely anthropomorphic (where non-human behaviour is interpreted as if it was the behaviour of humans) nor one in which the natural world is seen as *the* source of instruction as to how humans should behave. Rather, it is scripture that has primacy; the natural world is held up not so much as a model for us to imitate but as an illustration of how the natural world can manifest that which God wishes for humanity.

The ‘worldviews’ perspective on creationism suggests that standard ways of addressing the diversity of student views in a science classroom may be inadequate. Creationism can profitably be seen not as a simple misconception that careful science teaching can correct, as careful science teaching might hope to persuade a student that an object continues at uniform velocity unless acted on by a net force, or that most of the mass of a plant comes from air. Rather, a student who believes in creationism can be seen as inhabiting a non-scientific worldview, that is a very different way of seeing the world.

Few countries have produced explicit guidance as to how schools might deal with the issues of creationism or in the science classroom. One country that has produced such guidance is

England. In the summer of 2007, after months of behind-the-scenes meetings and discussions, the then DCSF (Department of Children, Schools and Families) Guidance on Creationism and Intelligent Design received Ministerial approval and was published (DCSF, 2007). The Guidance points out that the use of the word 'theory' in science (as in 'the theory of evolution') can mislead those not familiar with science as a subject discipline because it is different from the everyday meaning (i.e., of being little more than an idea). In science the word indicates that there is a substantial amount of supporting evidence, underpinned by principles and explanations accepted by the international scientific community. The Guidance goes on to state: 'Creationism and intelligent design are sometimes claimed to be scientific theories. This is not the case as they have no underpinning scientific principles, or explanations, and are not accepted by the science community as a whole' (DCSF, 2007). The Guidance then goes on to say:

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

(DCSF, 2007)

This seems to me a key point (OK – I admit, I helped write it) and one that is independent of country, whether or not a country permits the teaching of religion (as in the UK) or does not (as in France, Turkey and the USA). Many scientists, and some science educators, fear that consideration of creationism or intelligent design in a science classroom legitimises them. However, when I was taught physics at school, and taught it extremely well in my view, what I remember finding so impressive was that we could discuss almost anything providing we were prepared to defend our thinking in a way that admitted objective evidence and reasoned argument.

Whatever the subject matter and age range of a class, and the country in which a teacher is teaching, there is much to be said for a teacher bearing in mind that for some students, evolution, creationism and intelligent design are likely to be sensitive issues. Rather less has been written in the philosophy of education literature about sensitive issues than about controversial ones. Death, sexuality, drugs policy and animal experimentation are examples of issues that are sensitive for many students and many teachers are used to dealing respectfully with students when dealing with sensitive issues.

An advantage of shifting the discourse from controversy to sensitivity is that one shifts the focus from epistemology to pedagogy. One can be sensitive with someone in respect of an issue without implying that one shares the same perspective (or worldview) as the person to whom one is being respectful and considerate; different notions of respect are discussed by Rosenblith and Bindewald (2014) who "make a case for an approach to civic education in the public schools that is rooted in engagement" (p. 596). Explicitly accepting the teaching of evolution as controversial is difficult for many science teachers as the distinction between

this and evolution as controversial is a fine one and many science teachers are likely to see it as selling out to creationists (cf. Hermann, 2008).

In a school science lesson when teaching evolution there is much therefore to be said for allowing students to raise any doubts they have and doing one's best in such circumstances to have a genuine scientific discussion about the issues raised. The word 'genuine' does not mean that creationism or intelligent design deserve equal time with evolution, nor does it mean that a science teacher should present creationism or intelligent design as valid alternative to the theory of evolution. It is perfectly appropriate for a science teacher to critique arguments for creationism or intelligent design that purport to be scientific. However, in certain classes, depending on the comfort of the teacher in dealing with such issues and the make up of the student body, it can be appropriate to deal with these issues. If questions about the validity of evolution 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 and how scientific knowledge is built up over time, while always being open to the possibility of refutation and change.

Having said that, teaching about evolution, creationism or intelligent design, in whatever lesson, is often not straightforward. Some students get very heated; others remain silent even if they disagree profoundly with what is said. We need to seriously and respectfully the concerns of students who do not accept the theory of evolution while still introducing them to it. There is much to be said for aiming to get students to understand rather than necessarily to believe or accept the theory of evolution (Smith & Siegel, 2004; Reiss, 2008). While it is unlikely that even respectful teaching 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 (cf. Long, 2011).

Religious education

Religious education (RE), even if we set aside debates about worship in schools, is going through quite a tough time in England. The subject was excluded by the Government from the English Baccalaureate and, as a result, GCSE entries have been decreasing pretty rapidly. In addition, while there are many pockets of excellence, it remains one of the least popular school subjects. And yet the case for having RE in schools has perhaps never been stronger, given the increasingly acknowledged fact that we live in a multi-faith society (including those of no faith), while religion is now more in the public sphere than perhaps at any time in my lifetime.

There have been a number of attempts to reform the RE curriculum in schools – RE is the only compulsory school subject that is not within the National Curriculum and so lacks a national curriculum. One recent approach, in which I have been involved, is called the 'Big Ideas for Religious Education' project (Wintersgill et al., 2017).

Big Ideas are generalised summaries of what we want students to understand by the end of their RE in school. They are common destinations, which can be reached by many alternative routes. Because Big Ideas describe what we want students to understand, they

frame the questions that lead to that understanding. They are unable to do this without contexts in which to work and the contexts are provided by content. It is therefore unlikely that students will ever encounter a unit of work with the name of a Big Idea as its title, but in every unit of work the learning outcomes will be defined in relation to them.

Big Ideas are therefore:

- Criteria for the selection and prioritising of subject knowledge in the curriculum. If Big Ideas summarise what students' understanding should be, the content selected must enable students to achieve that understanding.
- Transferable to events outside the classroom. An essential indicator of understanding is the ability to transfer learning to new settings. Religions and non-religious worldviews can only be properly understood when students recognise them as important elements of 21st century life.
- Memorable. If Big Ideas are to have this life-long impact they must be summarised in headlines that are short enough to be remembered but focused enough to act as reminders of their full significance.
- Capable of differentiation so that they may become the basis of progression. Big Ideas can be expressed at increasing levels of complexity and sophistication to describe the understanding expected of different age groups.

They should also:

- Have long term relevance. Big Ideas reflect situations for the foreseeable future so that students will take from their school days understanding of religious and non-religious beliefs, practices and values that will help them understand their personal quest for meaning and the world in which they live.
- Make sense of lots of what might otherwise be confusing information/experiences and isolated facts. An important contributor to understanding is the ability to 'join up the dots', to see how the many different beliefs, practices and values of religions and non-religious worldviews relate to each other. Big Ideas make these connections.
- Act as lenses which, when used to 'view' content, help to clarify it. When used as a 'lens' through which to view a mass of possible content, Big Ideas illuminate what is relevant to RE and hide what is not.
- Taken together, express the core or central concerns of the subject. The essential test of subject knowledge is that as well as meeting the above criteria it reflects what is central to the subject, not what is peripheral.

Big Ideas for RE

We came up with six Big Ideas for RE:

Big Idea 1: CONTINUITY, CHANGE AND DIVERSITY

Religions and non-religious worldviews involve interconnected patterns of beliefs, practices and values. They are also highly diverse and change in response to new situations and challenges. These patterns of diversity and change can be the cause of debate, tension and conflict or result in new, creative developments.

Big Idea 2: WORDS AND BEYOND

Many people find it difficult to express their deepest beliefs, feelings, emotions and religious experiences using everyday language. Instead, they may use a variety of different approaches including figurative language and a range of literary genres. In addition, people use non-verbal forms of communication such as art, music, drama and dance that seek to explain or illustrate religious or non-religious ideas or experiences. There are different ways of interpreting both verbal and non-verbal forms of expression, often depending on a person's view of the origin or inspiration behind them. The use of some non-verbal forms of communication is highly controversial within some religious groups, particularly their use in worship or ritual.

Big Idea 3: A GOOD LIFE

Many religions and non-religious communities strive to live according to what they understand as a good life. Their members share an understanding as to the sort of characteristics and behaviours a good person will seek to achieve, as well as dealing with what is, or is not, acceptable moral behaviour. People have different ideas about how and why we should lead a good life. The ideal is usually presented in the lives and character of exemplary members. There may be considerable agreement across different religions and non-religious worldviews on some matters, and considerable differences on others. Also, there are often major disagreements over the interpretation and application of moral principles between members of the same religion or worldview.

Big Idea 4: MAKING SENSE OF LIFE'S EXPERIENCES

Many people have deeply felt experiences, which they may refer to as being religious or spiritual or simply part of what it means to be human. These experiences may result in their undergoing transformative change and on rare occasions the experience of a single person has led to the formation of a new religion or worldview. Through religious rituals and other practices people sometimes experience a deep connection with God or gods, nature, their own consciousness or with each other. This can give them a heightened sense of awareness and mystery. Many people find that belonging to religious or non-religious groups with others who share their beliefs, values and traditions gives them a sense of identity and belonging.

Big Idea 5: INFLUENCE, COMMUNITY, CULTURE AND POWER

Religious and non-religious worldviews interact with wider community and cultures. They affect the way communities have come to identify themselves over time by shaping their traditions, laws, political systems, festivals, values, rituals and the arts. The patterns of influence vary significantly in different communities and at different points in time. Some communities are influenced predominantly by one religion. More diverse and plural communities are influenced by several religious and non-religious worldviews, whose appeal to a highly respected authority or vision, whether religious or non-religious, can lead them to make positive and life-changing contributions to their communities. It can also give them considerable power, which may lead to both positive and negative outcomes.

Big Idea 6: THE BIG PICTURE

Religions and non-religious worldviews provide comprehensive accounts of how and why the world is as it is. These accounts are sometimes called 'grand narratives'. They seek to answer the big questions about the universe and the nature of humanity such as 'Does anything exist beyond the natural world?', 'Is there life beyond death?', 'What is the path to salvation?' and 'Do we have one physical life or many?'. These narratives are usually based on approaches to life, texts or traditions, which are taken to be authoritative. People interpret and understand these traditions in different ways.

Progression in Big Ideas

Let me end by indicating, again using Wintersgill et al (2018), how one could envisage a student gaining in understanding through the four key stages of the National Curriculum. The example given is for Big Idea 4:

5-7 years

Some people have amazing, puzzling or mysterious experiences that make them ask big questions about life. Others find deep spiritual meaning in everyday experiences. There are many stories about people's experiences and encounters that have made them change their lives. Some people find that belonging to religious or non-religious groups which share their beliefs, values and traditions gives them a sense of belonging.

7-11 years

Many people have amazing, puzzling or mysterious experiences with the wonders of nature, other people, the arts, or with a power above or beyond the material world. These encounters may be highly affecting, changing their lives in a positive way and sometimes giving them a sense of destiny. Some people account for these experiences by saying that humans have an inner consciousness or spiritual nature. Certain individuals throughout history are said to have had extraordinary insights into the meaning of human life and have passed those insights on to others. In many cases their experiences have had a major impact on religions and non-religious worldviews or have even led to a new one. Many people find that religious rituals and other practices provide opportunities for them to make connections with God or gods and each other, or with what is most important to them. When practised in community with others, these experiences may give them a deep sense of identity and belonging.

11-14 years

Many people find profound meaning at some points in their lives in mystical, religious, spiritual or peak experiences. These experiences may be prompted by encounters with the wonders of nature, beautiful works of art or music or with tragic events. Some people believe that any of these experiences are capable of putting them, or others, in touch with a greater power or powers or with other realms of existence and provide insights into the world and their place within it. Some

individuals and groups say that experience of religious rituals and other practices help them make a connection with God or gods and with each other, or with what is most important to them. The experiences of a few key people are believed to have given them extraordinary insights into the nature of reality. They hold important and different places within one or more religions or non-religious worldviews. Some believe that these experiences are related to a spiritual dimension of human beings, which may or may not be associated with religion. Others deny that humans have a spiritual nature, believing that a human being is no more than a complex, highly evolved animal. Whether they see themselves as spiritual, religious or not, many people get a sense of identity from belonging to the same group as others who believe the same things, see the world in the same way, and have the same values. This can develop strong feelings of identity, belonging, loyalty and commitment.

14-16 years

Some believe that consciousness is the key feature of being human. It is believed by some to be God-given, constituting people's spiritual nature, which marks them out from the rest of the animal world and enables them to think beyond their ordinary experience. Some people regard their spirituality as the inner personal dimension of being religious, while others see themselves as spiritual rather than religious because they do not identify with traditional religious institutions or meta-narratives. There are also people who do not identify with either religion or spirituality. A few individuals are believed to have had exceptional experiences that have resulted in insights into the meaning and purpose of life which they have communicated to others. This can lead to the formation of new religions and non-religious worldviews, something which is still happening today. People from different religions and non-religious worldviews might disagree about the origin and meaning of religious, mystical, spiritual or peak experiences. Some find that religious rituals and other practices may enable them to experience a deep connection with God or gods, nature, their own consciousness or with each other. Membership of groups with whom they share beliefs, values and traditions often gives people a heightened sense of awareness, mystery, identity and belonging, and bring about a transformation in their lives.

Conclusions

Education, including formal education, plays a key role in helping us to develop as individuals and in inducting us into society. Done poorly, it achieves little and can put people off learning for life. Done well, it both introduces learners to the great ideas and activities of humanity and helps them develop those character traits that benefit both themselves and others. Within school, both science education and religious education have great potential to contribute to a high quality education, one that can help students to learn what they would not otherwise learn, to respect others, even when those others have very different ways of understanding the world, and to develop into adults capable of leading flourishing lives and helping others to do so too.

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