Introduction

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Aims

The focus of this book is on science and religion in education. The three of us, as editors, are passionate about education in general and about science education in particular. We see education as having a tremendous role to play in helping humanity if we are to live together justly and sustainably. Through the perspectives of experts from a wide range of specialisms, the chapters offer research findings, ideas and recommendations from theologians, philosophers, scientists, educationalists and others with a view to encouraging dialogue and helping those engaged in teaching to share good practice. We hope it serves as a useful resource for teachers and researchers in the fields of education, science, RE and the growing specialist field of science and religion. It should also provide a key collection of research and thought for those engaged in research in science education and religious studies.

Structure

The book is structured into three parts which critically consider existing models for the relationship between science and religion, possible new models and empirical studies, and then the practical application of current research in the classroom. In this way the questions explored in the chapters move during the course of the book from examining science and religion to examining science and religion in education. The rationale for developing the book began with work conducted by LASAR (Learning about Science and Religion). Several of the chapters stem from or are linked with LASAR's research and these are complemented by a broad range of invited authors bringing interdisciplinary and international perspectives to bear on the questions and themes that LASAR addresses.

The relationships between science and religion

The relationships between science and religion are complex – and often it seems that talking about those relationships is more complex still. Questions which bridge science and religion cross many boundaries and this is especially the case in schools and other educational institutions. The boundaries that a curriculum puts around different types of knowledge and different ways of constructing knowledge work well in so many ways in education, but they can become barriers if they become systematic and entrenched. At the heart of this book is a belief that a model of the relationship between science and religion that presumes conflict to be the only way in which they can be viewed does neither science nor religion justice, is unhelpful educationally and impacts negatively on other important relationships between science and culture.

The chapters that follow are an opportunity to step outside the immediate pressures of a classroom and to look at ways to think about the relationships between science and religion through each of a series of narratives or focus questions. Research in England and Australia which is reported further in this book has revealed that the pressures of perceiving that it would be 'off-topic', sensitive and contentious to talk about religion in a science lesson means that teenagers tend to hold back questions bridging science and religion which, for these reasons, they deem to be inappropriate. This is not to say that the science classroom is necessarily an appropriate place to discuss these questions but rather to note that the questions can exist for students whether or not they are voiced. In many schools and particularly in many school science departments, it is felt that issues to do with religion are best avoided in school science lessons, even in those schools and countries where the relationships between science and religion are explicitly included in other parts of the school curriculum, notably RE. A lack of opportunity during their initial teacher education to share perspectives and develop their own positions within this state of affairs is one of the many factors which leave teachers of science feeling they are not responsible or qualified to support students' development on questions where science interacts with religious matters (Billingsley et al., 2014). Nevertheless, it is difficult to see how we can design effective and purposive educational activities unless we are curious about how students are interpreting and making sense of what they are taught.

There are a number of ways in which students' lives and their beliefs about science and about religion interact and understanding the lives and worlds that students experience can help us to create more engaging and efficacious education. Too often, school science is perceived by students as irrelevant. What we want is a science education that motivates and engages all learners while also allowing students to develop the scientific knowledge, understanding and skills that they will need if they are to progress with their science studies, once science is no longer mandatory for them. As such omission of any consideration of how to manage students' questions about science and religion when planning school science lessons has certain disadvantages. Some of those disadvantages and missed opportunities are explored and explored further in this introduction and in later chapters.

The natures of science and religion

The natures of science and religion have themselves shifted over time and for this reason, if no other, the relationship between science and religion has also changed over the years (Harrison, 2015); indeed, the use of the singular, 'relationship', risks giving the impression that there is only one way in which the two relate. Similarly, attempts to create or define distinctive roles or realms for science and religion have produced lively discussions but no easy answers, leaving educators with the dilemma of what if anything to say to their students.

This in turn helps to point to two key issues on which science and religion interact: one is to do with understandings of reality; the other to do with evidence and authority. Separating these issues would suggest that they can be analysed and managed separately – but, as we will see, exploring one often raises questions that relate to the other.

World-wide, religion is important to many people, including young people; a survey undertaken in 2011 in 24 countries found that 73% of respondents under the age of 35 (94% in primarily Muslim countries and 66% in Christian majority countries) said that they had a religion / faith and that it was important to their lives (Ipsos MORI, 2011). Consider, now, the vexing question of 'authority' and the scriptures, in particular, as a source of authority. Among 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. Interview studies reveal that the question of which has the greater authority, science or religion, perplexes many young people and that this confusion is already present in primary school children (Billingsley & Abedin, 2016). For some children, this complexity is mostly in the context of a personal commitment to scriptural authority which may be associated with beliefs and practices at home. The sense of perplexity and concern can be all the deeper for those children who recognise that their peers hold different positions on faith and on the authority of scriptures in comparison with their own. Cutting across this already complex picture, in a school science lesson, the voice of authority is a teacher. For a student who supposes he or she is in a science lesson to learn science, it may seem that in science lessons, the right answer is that science is right. A child in primary school described trying to make sense of science and religion as like living with parents who cannot agree.

If we move to look at how the issue of authority in science is discussed by philosophers and historians of science, the particular pressures of the classroom are swapped for an emphasis on the changing nature of scientific knowledge and methods over time and on the limitations of any given set of scientific ways of knowing. Newton's *Principia* and Darwin's *On the Origin of Species* are wonderful books. That said, given that science has since made progress, we are in a better position to comment on their power and limitations in explaining observable phenomena of the material world. Historically, we can see the significance and impact for people at each of those times of seeing the material world through Newtonian / Darwinian eyes. However, Darwin knew little about the mechanism of inheritance despite the reliance on inheritance in his argument, so parts of *The Origin* were out of date over a hundred years ago. In some situations, then, a teacher might address the issue of authority by emphasising that science does not have a position on what answer if any is ultimately the truth and indeed makes progress when existing explanations are thrown into doubt by the discovery of new evidence. It would be unhelpful, however, if a teacher's explanation to this effect was applied more widely than intended and suggested to students that the way to address apparent conflicts between science and religion is to say that science may one day move its position.

As a case in point, and as is well known, there are many people including many students who reject evolution on the basis that they perceive it to conflict with their religious beliefs. For those who accept the theory of evolution, there is much about the theory of evolution that is intellectually attractive. For a start, a single theory provides a way of explaining a tremendous range of observations; for example, why it is that there are no rabbits in the Precambrian, why there are many superficial parallels between marsupial and placental mammals, why monogamy is more common in birds than in fish and why sterility (for example, in termites, bees, ants, wasps and naked mole rats) is more likely to arise in certain circumstances than in others.

This raises the question as to what a science teacher might want his or her students to know about the relationships between religion and evolution. Students, indeed most adults, have limited access to activities that would help them to engage with the explanatory power of evolution. For many young people, key ideas about evolution are learnt to pass examinations which means that evolution is a theory which addresses questions, that for the most part, they are not in the practice of asking. As one teenager explained with a shrug, 'well we are here now!' (Billingsley, Taber, Riga, & Newdick, 2011).

As with any large area of science, there are parts of what we might term 'front-line' evolution that are unclear, where scientists still actively work, attempting to discern what is going on or has gone on in nature. But much of evolution is not like that. Evolution is a well-established body of scientific knowledge that has built up over 150 years as a result of the activities of many thousands of scientists. The following are examples of statements about evolution that currently lack scientific controversy:

- All of today's life on Earth is the result of modification by descent from the simplest ancestors over a period of several thousand million years.
- Natural selection is a major driving force behind evolution.
- Evolution relies on those occasional instances of the inheritance of genetic information that help (rather than hinder) its possessor to be more likely to survive and reproduce.
- Most inheritance is vertical (from parents) though some is horizontal (e.g. as a result of viral infection carrying genetic material from one species to another).
- The evolutionary forces that gave rise to humans do not differ in kind from those that gave rise to any other species.

There are many reasons why someone may reject aspects of the theory of evolution. After all, it may seem to defy common sense to suppose that life in all its complexity could evolve from non-life. And then there is the tremendous diversity of life we see around us. To many it hardly seems reasonable to presume that giant pandas, birds of paradise, spiders, orchids and the authors of this book all share a common ancestor – yet that is what mainstream evolutionary theory holds. In additional, the theory of evolution can be unsettling for existential reasons (Tracy, Hart & Martens, 2011; Newall, 2017).

Students (with and without a religious faith) may or may not be ready to look in depth at how science and religion relate. What might be a more important point for teachers to emphasise is that the diverse community of scientists includes many with a religious faith and many without and, further, that religious communities include many scientists. There is as such no need to choose between creation by God and evolution. Some authors (see, for example, Scott, 1999) have attempted to communicate a range of different stances by presenting them as positions on a line. In that case at one pole there are materialists who maintain that there is no possibility of anything transcendent lying behind what we see of evolution in the results of the historical record (fossils, geographical distributions, comparative anatomy and molecular biology) and today's natural environments and laboratories. At the other pole, according to this view, there are advocates of creationism, inspired by a literal reading of certain scriptures. But even when reduced to this linear

continuum, there are many more positions that lie in between, including one for those who hold that evolutionary history can be providential as human history is.

By extension, some teachers may feel that a more helpful model when talking about how religion and evolution relate with young people is to theorise two orthogonal axes (Billingsley, Borgeaud, & Knapp, 2016). This means that an analysis of contemporary and student attitudes to religion and to evolution can help to disrupt the misperception held by some students that 'the more the religious, the less the scientific' (Billingsley, Taber, Riga, & Newdick, 2012).

This discussion helps to illustrate why in the organisation of this book, the chapters in the first section of this book engage more deeply with ways to understand and convey how science relates to religion; the second section of the book includes research and discussion exploring students' responses to evolution and the third section offers educational activities that are designed to take these kinds of considerations into account.

The natures of religion and science on reality

Turning now to the second major point of interaction and beginning with religion, there are many religions and it is difficult to answer the question 'What does religion say about the nature of reality?' in a way that satisfies the members of all religions. Keith Ward (2008) has reviewed the six major world religions (Buddhism, Christianity, Judaism, Hinduism, Islam and, Sikhism) and concludes that most talk about the existence of a supernatural god or gods and all discuss human existence as a journey towards some kind of improved form. So, if this is something that can be said about religion, what can we say about science? Can science be described in relation to or as a counterpart to religion?

Consider, to begin with, boundary treatments which suggest that the fields and enquiry of science can be isolated from those in religion. One such boundary was shared by Galileo and is that the Bible explains how to go to Heaven, not how the heavens go (Gingerich, 1982). Another attempt to create a firm boundary which has some similarities to this proposition was mounted by (Gould, 1997) and included the argument that science is concerned with seeking to explain what is whereas religion is more often concerned with questions about what should be. There is also a very influential view of reality in the West which takes up a platonic/Cartesian view of reality in which matter and mind are said to be two separate categories which can be studied independently. While 'mind' is not a religious entity as such, for many people this 'mind-matter' dualism has also become a useful way to separate and characterise the domains of science and religion in relation to the 'material body and nonmaterial spirit/soul'. The idea is that the mind/soul/spirit is not made of a material substance and is opaque to scientific enquiry.

Physics sits more comfortably with this proposition compared with biology because physics questions can be framed in a way that suggests they are about only about material non-living objects which exist and interact in a material non-living system. In this duality, we can suppose that the physical/material universe is mechanistic, orderly, predictable and transparent to scientific enquiry. There is also a mind (the experimenter) outside the

experiment. The experimenter designs and sets up the experiment, controls and changes the variables and notices and measures the observable changes that take place. By keeping the experimenter outside the experiment and by being selective about what is inside the experiment, we remove the difficult cases if we say that science is only objective (and not subjective) and/or only about what is (and not what should be) or is only about the natural (and not the supernatural) or only about the material (and not what is nonmaterial). Now the portion of reality we are investigating excludes the observers and we can put aside an examination of the mental business of wondering about reality, of designing the experiment, of deciding whether or not to go ahead, and of rationalising and deliberating on what the outcomes mean. The physics and chemistry classrooms in a school take up this convenient frame and apply it – although not necessarily explicitly. In biology this dualism and its firm boundary becomes strained. To introduce some of the themes that will follow, the boundary that is suggested by separating mind and matter does not seem to address the range of living things that students learn about in biology and also steps around the issue that the fields that are open to scientific enquiry are shifting over time.

Educationalists have also engaged with these kinds of boundary questions. While writing about the need for students to "recognise the limits of science and the power of other ways of thinking that are also functional in the world", DeBoer (2000, p. 592) explains that "There are emotional and spiritual aspects to our existence that fall outside the realm of science, and the line between these and the nature of scientific thought needs to be drawn so that students can more fully comprehend what science is and what it is not". Rather than a firm boundary it has been proposed that questions can be more or less amenable to science because science "produces, demands and relies on empirical evidence" (McComas, 2008, p. 251).

Perhaps you agree that, intrinsically, religion seems to be concerned with big questions of meaning, purpose and the ultimate nature of reality – what are called the Big Questions (Brickhouse, Dagher, Letts, & Shipman, 2000). In that case, by way of further comparison, we can say that science seems to be about smaller questions in comparison with the Big Questions that religion explores. It is more difficult to say now, and particularly in the future, what kinds of questions and methods are as such beyond the scope of science. Some of the areas that scientists are currently investigating are already contentious and new areas are likely to be added as science advances. For education and educationalists, these difficult questions are pertinent because the young people in school today include the scientists who will be working in these fields. Consider with this said, the implications of developments of instrumentation. We can now study events that happen at very low temperatures, at great distances, at enormous speeds and at magnifications that simply were not possible even a few decades ago. It is interesting to ponder on the extent to which certain matters currently outside of mainstream science may one day fall within the compass of science and how this may in turn change how causal relationships are characterised and understood within science. Take dreams, for example. It may be that these will continue to be deemed by journal editors and other gatekeepers of science to be too subjective for scientific study but it may be that developments in the recording of brain activity will swing scientific opinion to the view that we can obtain a sufficiently objective record of dreams for them to be amenable to rigorous scientific study. Given the importance of dreams in religion and religious histories (if for no other reason) it will be important that scientists are thoughtful

and epistemically insightful about the language that is ascribed to what they are discovering and how much it explains. The fields of science also shift for reasons that are as much to do with theorisation as with technical advances (Reiss, 2013). Consider beauty. Aesthetics for a long time was not considered a scientific field. But there is now, within psychology and evolutionary biology, growing scientific study of beauty and desire (e.g. Ryan, 2018). Indeed, a number of the social sciences are being nibbled away at by the natural sciences and if one believes some scientists, we are moving towards a day when the only valid knowledge will be scientific knowledge (Atkins, 2011). These are just some of the factors that are increasing the pressure on schools and school curriculum boundaries to take into account these kinds of metaphysical discussions and offer students some support.

Issues around reductionism which are hinted at here will be explored more deeply in the chapters to come together with explorations to consider which views of reality (i.e. metaphysical positions) are consistent with science. While these are difficult questions for schools, to our advantage and to the advantage to all the authors who have chapters in this book, issues around the nature and borders of science have long been a focus for scholars of science and religion. To address and inform the ways that educators approach these kinds of epistemic issues, rather than begin with questions raised by modern science, many of the chapters here seek to provide some initial clarity by providing historical context and discussion around longstanding questions and cases. Examples are Galileo and Copernican heliocentrism, Darwin and evolution, science and miracles and arguments about the sanctity of life. Each of these studies exposes ideas and assumptions that are widely held about the natures of science and religion that may otherwise remain unexplored. Teaching which explores these cases is one way that a teacher can help his or her students to become more insightful about the 'nature of science' or, in other words, to deepen their understanding of what the fields of scientific enquiry are and also of what the methods used in scientific enquiry are. Beginning with these longstanding cases can also work as an invitation to students to raise and reflect on their own situations – and, after all, many of the social pressures, pedagogies and subject boundaries experienced in schools today reflect priorities and ways of understanding reality that have historical beginnings.

While educators cannot exactly replicate for their students the questions and issues that future scientists and citizens will need to address, we can help them to maintain open minds by looking at the frameworks and principles that are applied by those considering today's contentious questions. Here and as a layperson's introduction we give a snapshot of what a metaphysically reductive account might look like. In that case, our sense of self and perception of a continuous 'mind at work' is an illusion; feelings that we ascribe to our moral compass cannot be explained using any kind of reference to an external greater good and our thoughts, hopes, passions and memories are illusions produced by the complex biochemistry of the brain. A different view of the person is offered by those philosophers, theologians and scientists who argue that reality does not only consist of material particles (atoms, electrons, quarks) and objective entities (tables, chairs) but also of things that only become apparent once we widen the scope – thus thoughts, memories, a sense of self. These entities are experienced subjectively but they can still be real and have real influence even if they are not within the scope of science and its instruments.

A risk, arguably, for a science teacher who references or discusses the changing content of science and different perspectives on its borders is that students will become less enthusiastic and less committed to the study of science (Konnemann, Asshoff, & Hammann, 2016). After all, one of the characteristics of science lessons which teachers hear from their students is that at least in 'science', there *is* a right answer. This highlights the need for another lens through which the relationships between science and religion can be discussed. Students are in school to learn (among other things) how knowledge is constructed, articulated and tested in scholarship. For many decades, this learning has been shaped by subject boundaries, text books, units, topics and the further atomisation of learning about knowledge into individual lessons and homework tasks. To what extent, we might ask, is it useful in an age of search engines and free online resources for students to be learning about knowledge only within these atomistic boundaries versus also learning about the nature of knowledge when they look across their subjects and beyond? One of the key responsibilities of the teacher of science is to teach students about the nature of science. Students' capacities to become epistemically insightful about science's nature are impeded, however, if their practical experiences are focused on activities designed to showcase existing and established knowledge. Students enjoy the reliability of school science but as we have already identified, it is important that they are not misled by their experiences into supposing that attempting to investigate and explain reality scientifically is less complex than it is.

In setting up these book sections and borders between them, we artificially separate our authors and our themes into groups and then order their discussions. The grouping and the ordering are akin in many ways to the grouping and ordering of units in a course. It might be worth saying at this point that we see borders in education – and in books – as useful when teaching and communicating; our concerns pertain to where those borders have become entrenched and their influences on students' learning are not examined and addressed. Fortunately, this book also has an index and there is no duty on the reader to move sequentially from one chapter to the next.

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