

# **Perceptions of the relationships between science and religion held by upper-secondary school students in Church of England schools**

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## **1. Introduction**

How can and should schools prepare young people for questions that go beyond the current frontiers of knowledge and understanding, such as: At what point, if any can a robot be deemed to have personhood? Can a robot think for itself? Why does the universe exist? Do people have free will? and Can science ever prove or disprove the existence of God? These are examples of the so-called Big Questions (Shipman et al., 2002; Ward, 2008; Van Inwagen and Zimmerman, 1998) that occupy the minds of most people at various times during their lives. Helping school students to develop the curiosity and insight they need to address these questions wisely and to be critical of sensationalist headlines has never been as important as it is today.

This paper and our research in general is concerned with forming strategies to support students' capacities to ask and explore Big Questions, by providing schools with ways to develop students' expressed curiosity about Big Questions and their epistemic insight into the natures of disciplines and how they interact.

We define “Big Questions” as questions about the nature of reality and human personhood. These are big multidisciplinary questions—and they are also questions on which both science and religion seem to have something to say. The existence of a science-religion dialogue which explores Big Questions and the relationships between science and religion is widely stated (Polkinghorne et al., 2014; Southgate, 2011; Ward, 2008). It includes a vast literature of books and papers addressing the relationship in general, in the context of history and for individual topics (Murphy, 2014; Humphreys, 2003; Guessoum, 2015; Polkinghorne, 2013; Ward, 2008) together with books designed to support those working in education (Poole, 2007; Southgate, 2011; Billingsley et al., 2018a).

Epistemic insight refers to “knowledge about knowledge” and in particular, knowledge about disciplines and how they interact. There is a basis to say that in England and more widely internationally, there are pressures and barriers in schools that teaching and learning about epistemology is given insufficient attention (Billingsley et al, 2018b). Firm boundaries between the sciences and other areas in secondary schools mean few opportunities to discuss ways to relate science, religion and the wider humanities (Kötter and Hammann, 2017). In England, the current context, students are provided with science education and religious education (RE) as statutory subjects. Both subjects include objectives that could and arguably should prompt explorations of Big Questions and the epistemic bridges and conundrums that Big Questions raise. These pressures and boundaries include the prioritisation of conceptual understanding over epistemological understanding in science, entrenched curriculum subject compartmentalisation (Cloud, 1992; Ratcliffe, 2009; Billingsley et al., 2017) and the “silent treatment” in secondary schools of questions that bridge science and religion (Billingsley et al., 2010). As one secondary school student explained when interviewed, “we don’t do science and religion, we don’t bond them together; we have two different lessons” (Billingsley et al., 2013: 1727).

These pressures add up to mean that the teaching of epistemology is fragmented, compartmentalised and disjointed in schools and also that learning about ways to ask and explore Big Questions in particular are likely to be neglected (Byrne and Brodie, 2013; Barnes, 2015; Konnemann et al., 2018; Sandoval, 2016; Billingsley et al., 2017). Further, many secondary school students are confined to narrow and stereotypical perceptions of science, religion and how they relate (Hanley, 2008; Francis et al., 2018a; Fulljames et al., 1991; Paiva et al., 2016; Author, 2013; Hokayem and BouJaoude, 2008; Shipman et al., 2002; Billingsley and Nassaji, 2019). Conversely, by encouraging students’ curiosity about Big Questions and by exploring ways that science and religion relate, students can gain insight into the natures of science and religion and of the challenges involved when attempting to discern boundaries and relationships between them (Paiva et al., 2016).

To address these pressures and barriers and the gaps in young people’s education that they produce, we have produced a draft Framework for Education which sets out learning objectives for epistemic insight organised into a progression for school students aged 5-16 (Billingsley et al., 2018b). The Framework has three categories, designed to overlay the curriculum compartments and overcome the pressures and barriers that currently operate:

- One category focuses on ways to develop students’ interest in Big Questions and ways to teach about the relationships between science and religion.
- A second category is called “the nature of science in real world contexts and multidisciplinary arenas.” It includes objective and strategies to teach about

cross-discipline relationships between science and other disciplines studied in school and ways to explore questions about the power and limitations of science.

- The Framework has a third category with strategies to develop students' understanding of different ways of knowing and how they interact.

The aims of this paper are firstly to develop the case for this Framework by explaining the objectives in the category for the relationships between science and religion. These are for students to appreciate that “science and religion are mostly concerned with different types of questions including different types of why question” (in upper primary school) and that “some people say science and religion conflict and some people say they do not” (in lower secondary school) and in upper secondary school, that “science and religion do not necessarily conflict”. In a parallel paper we have explained the rationale for the objectives for “Ways of knowing and how they interact” and “the nature of science in real world contexts and multidisciplinary arenas” (Billingsley et al., 2018b) .

Secondly, we report on a large-scale survey study of 1,772 students to investigate students' stances on the nature of science and how science and religion relate in the context of Church of England secondary schools. This is an exploratory study and the opportunity to comprehensively survey secondary school students in 16 schools was created by a project, the God and the Big Bang project, which organises workshops about science and faith for Church of England schools.

The survey focuses on exploring students' ideas about science, religion and how they relate in general and also specifically on the question of how to explain the origins of the universe and life. We have chosen ‘origins’ as a topic because questions about the origins of life and the universe bridge science and religion and are addressed in school science and in religious education. There are other topics we could have chosen (a list of topics have been presented in (Billingsley et al., 2013).

## **2. Big Questions and the relationships between science and religion**

We have explained a basis for saying that teaching epistemology relating to Big Questions is likely to be neglected in schools. In this section we explain some of the key ideas and outcomes that teaching to develop epistemic insight would cover.

In their review of the ways that the relationships between science and religion have been presented by scholars historically and currently, Brooke and Cantor (1998) make the point that science and religion are each multifaceted and there is no single “science” or “religion.” The view expressed by Gould (1999) is that there is no overlap between them because science is concerned with “what is” and the workings of the material world while religion is concerned with “what should be” and questions about ultimate purpose. This view, which is called independence, is criticised as a general

view of the relationship by some who say that in practice it is difficult to find a religion that makes no claims about the material world (Cantor et al., 2012). Nonetheless, it is widely said that science and religion are mostly concerned with different types of questions and that religion is more concerned with questions of purpose, meaning and value and ultimate questions about reality such as, why does reality exist at all (Poole, 2007)? Harrison describes the natures of science and religion by saying that they are like two “categories” (Harrison, 2006: 81). David Hull (2010) uses the metaphor of a species to say that there is more variation between science and religion than within either category.

Alongside their distinctiveness, science and religion have some similarities. Both are truth-seeking and both seek to address Big Questions, but while religion engages with these Big Questions through multiple frameworks, science informs our thinking about the nature of reality and human personhood by framing and investigating 'small' questions that we can investigate using its self-limiting methods (see for example Polkinghorne, 2011). Each of the disciplines has preferred questions, methods and norms of thought. Science values the universality of objective and preferably repeatable data (observations) and the natural sciences analyse this kind of data alongside existing knowledge to generate and investigate questions about the natural world. This is a proposition developed by (Wagner and Briggs, 2016) whose argument is summed up in the title of their book: *The Penultimate Curiosity: How Science Swims in the Slipstream of Ultimate Questions*. John Polkinghorne gives the example of “why did the kettle boil?,” saying that an answer about mechanism refers to the transfer of heat, while an answer about purpose and meaning refers to wanting a cup of tea (see Polkinghorne, 2011). The example illustrates the way that a physicist might put the mind (the observer) outside the experiment (what we observe) and apply a methodological presupposition that we live in an objective physical/material universe. In this way, physicists provide us with useful, sufficient knowledge which builds our understanding of our physical, material and natural worlds.

This is an idea we introduce via a learning objective in our Framework for primary schools where we recommend that students should appreciate that,

- Science and religion are mostly concerned with different types of questions including different types of why questions.

The view that science and religion are mutually exclusive is pervasive in popular culture and is prominent in the findings of surveys of the attitudes and beliefs held by secondary school students, particularly when students talk about the origins of the universe and of life (Konnemann et al., 2016; Hansson and Redfors, 2007; Fulljames, 1996; Billingsley et al., 2016). However, it is only one of many views of the relationship in a complex and sophisticated area of scholarship (Stolberg and Teece, 2010; Brooke, 1991; Polkinghorne, 2013). These findings have prompted our concerns that some

students may be progressing through school with a distorted view of the range of intellectually respectable views that are present in society and scholarship.

In their typologies on how science and religion relate, Brooke and Cantor (1998) and Barbour (2013) both highlight the perception that there are a number of reasons why someone might conclude that science and religion conflict in general or on one or more topics. There are some scientists and philosophers who perceive religion to be incompatible with a scientific worldview because they reject the premise that there are any valid or fruitful questions to explore that are beyond the scope of science (see for example Atkins, 1995). This basis for conflict is widely described as scientism (Barbour, 1988). Scientism is a stance or set of beliefs and attitudes that includes the assertions that science is the only valid way to construct knowledge and that nothing exists beyond the material universe (Stenmark, 2001). Although some scientists and philosophers have claimed that scientism is an essential characteristic of a scientific worldview, this claim is rejected by the vast majority of philosophers of science and science educators, who state that scientism is not a necessary presupposition of science (Cobern, 2000; Hutchinson, 2011).

Fulljames et al. (1991) conducted large-scale surveys and found that a majority of secondary schools students saw science and religion as incompatible and also that a contributing factor is a tendency to conflate science and scientism. Konnemann et al. (2016) drew on data gathered from a cohort of German students to argue that the tendency to see science and religion as conflicting is particularly prevalent in this group and that conflict was frequently associated with a commitment to scientism. These findings are illuminated by other research which reveals that students tend to describe science as a static set of facts that have or are awaiting experimental proofs (McComas, 2006; McComas, 2017; Driver, 1989; Leach et al., 2003; Gilbert et al., 1982; Millar and Osborne, 1998; Osborne and Dillon, 2008). This characterisation of science arises in part because a considerable amount of school science time is spent carrying out recipe experiments (also called closed enquiry investigations) designed to teach scientific concepts (Abrahams, 2017). These practical activities typically produce an outcome that is known prior to the investigation (Sullivan-Watts et al., 2013; Dudu and Vhurumuku, 2012). We surmise that another pressure on students' developing ideas about science is a tendency for science lessons to begin with a question that is already amenable to science, rather than also showing how a multidisciplinary or cross-disciplinary question can be reframed to make it more scientific. Recognising the way we filter and shape questions so that we can address them scientifically is an essential epistemic insight and a way to counter uncritical scientism (Billingsley et al., 2016). Further allocating time to discuss students' questions has a positive effect on students' enthusiasm for studying science (Hagay and Baram-Tsabari, 2015).

Turning now to lower secondary school, in our Framework for Education, the

objective we propose for lower secondary school to guide teaching about the relationships between science and religion is one that already exists in a national “for guidance” framework for religious education. This is that students should appreciate that and why ‘some people say that science and religion are compatible and some say they are not’ (REC, 2013).

There are some groups of people who perceive their religious beliefs to be incompatible with scientific ideas on one or more topics. In our survey we included some questions asking for students’ perceptions about how science and religion relate in general and also on the origins of the universe and living things. The Abrahamic religions (Judaism, Christianity and Islam) share a creation story. Some religious groups, including some Baptist traditions, argue that the correct interpretation of the creation texts is incompatible with some aspects of accepted scientific knowledge. The term “creationism” tends to be used to describe religious stances on the interpretation of the creation text which reject evolution and there is evidence that a proportion of secondary school students associate religion with creationism (Francis and Fulljames, 2019; Francis et al., 2018a; Konnemann et al., 2016; Paiva et al., 2016). This association exists to greater and lesser extents in different educational contexts and is more pronounced in schools in the US (Taber, 2017). The teaching of evolution in schools has prompted concerns that some students hold religious beliefs which mean they may react negatively to the teaching (Sanders and Ngxola, 2009; Reiss, 2013). Religious education in schools is one of the ways that young people can develop an appreciation that many religious people are not opposed to evolution and that one of several positive views of how they relate says that evolution is in some sense guided by God or created by God (see Alexander, 2014).

Someone’s stance on how to interpret the Abrahamic religious creation texts can be the outcome of a consideration of different interpretations and arguments for and against them. In the student population, it can also be an uncritical assumption that accepting the idea of creation by God requires an acceptance of the text read literally. In previous research, we demonstrated that secondary school students typically supposed that the Biblical account of creation specifies that creation happened in literally six or seven days (Billingsley et al., 2016). An interview study with RE teachers reported that although one or more lessons are typically allocated to teaching about the relationships between science and religion, teachers opine that students mostly fail to achieve the curriculum objectives of achieving an appreciation of a range of views on how science and religion relate (Billingsley et al., 2014). One teacher explained that children were entrenched in the view that science and religion are either-or and could not progress from the view that a choice needed to be made between, “do you want to follow the facts of science,” or “do you want to follow the faith and belief of religion?” (p. 387). Drawing these discussions together, we note the possibility that students’ learning about the natures of science and religion may tend to leave them with narrow

characterisations of each, and a tendency to say that science and religion are necessarily incompatible. This leads us to the objective we recommend for upper secondary school, which is for students to appreciate that science and religion are not necessarily incompatible.

### **3. Context and Curriculum**

This section considers some of the ways that teaching currently might affect students' capacities to meet these objectives and interact with their understanding of how science and religion relate. In England, science is a statutory subject with a statutory National Curriculum. The current science curriculum has sections that set out the expected content knowledge in biology, chemistry and physics and a fourth section called "working scientifically." The introduction to the curriculum explains that "working scientifically" specifies the understanding of the nature, processes and methods of science for each year group. It should not be taught as a separate strand. The notes and guidance give examples of how "working scientifically" might be embedded within the content of biology, chemistry and physics, focusing on the key features of scientific enquiry, so that pupils learn to use a variety of approaches to answer relevant scientific questions. This instruction to work within a group of questions that are already scientific resonates with our earlier case that students are currently missing out on learning how to reframe Big Questions that bridge across disciplines into smaller, more precise questions for science to address.

Turning to contextual issues around religion, England has a multicultural population but the state religion is Christianity and the majority of those who say they have a faith say that this is Christianity (ONS, 2012). Most schools in England are not associated with a particular religion. While a growing number of Muslim and Jewish schools reflect the increasingly pluralistic makeup of British society, the largest group of Faith schools are Church of England schools, which make up about a third of all schools in England.

The Church of England has a long history of working within and alongside the state-maintained education system. The Durham report argued that two aims underpin the Church's provision of school education today (Ramsey, 1970). One aim is to provide a good quality education for students living in the school's catchment area. Francis (1990) has called this a theology of service. Another aim is to ensure there are schools that offer a Christian education for young Christians (identified by Francis (1990) as a theology of nurture). The ethos or character of Church schools varies from school to school and depends to an extent on the emphasis given to each of these aims (Francis et al., 2018b). In terms of their positions on religious faith, the demographic of students in Church schools typically reflects the demographic of the area in which the school is located (Chadwick, 2001).

Religious Education (RE) is taught in most schools in England, including government-run (public) schools (Schreiner, 2000). The subject is controlled through SACREs (locally-based Standing Advisory Councils for RE) or, in the cases of faith schools, the relevant faith communities. Academies, which are independent, state-funded schools, can in some cases develop their own RE syllabus but they also need to meet certain requirements. Most local curriculum designers draw on a non-statutory National Framework for RE which gives guidance on what should be covered. The aims of this curriculum include that it is non-confessional (meaning that a commitment to a particular faith is not openly encouraged) and meets the needs of a multicultural, liberal-democratic society (Barnes, 2014; Jackson, 2004; Schreiner, 2000). Parents and carers can withdraw their child from religious education. Of particular relevance here, both the previous and current Frameworks state that students in lower secondary school (age 11-14) should learn about how science and religion relate. The objective in the current Framework states that: “Students develop insight into and understanding of why some people argue that science and religion can be compatible and others argue that they cannot” (REC, 2013: 27). The Church of England Education Office advises that Religious Education lessons in its schools aim to “enable pupils to know about and understand Christianity as a living faith that influences the lives of people worldwide and as the religion that has most shaped British culture and heritage” and provide “opportunities for learners to understand and to make links between the beliefs, practices and value systems of the range of faiths and world views”(Holloway, 2016).

To conclude this and the previous section, it appears that in principle in RE and science lessons in England there are opportunities to help students to become familiar with a range of views of the relationship between science and religion. In particular, current and previous science curricula in England acknowledge the importance of teaching students about the limits of science. This could lead to a discussion about the types of questions that science can and cannot investigate and as such could be a conceptual bridge to teaching about the types of questions considered by non-scientific disciplines such as history and religion (Poole, 2007). The RE classroom could then extend this discussion by looking more closely at the nature of religion and the types of truth claims that religions make. This examination of questions, methods and norms of thought in science and religion and discussion of how they relate could focus on the relationship in general and also on narrower topics—such as the origins of life and the universe. While noting that the curriculum appears to support this kind of epistemological analysis in lessons, we have also explained factors such as entrenched compartmentalisation that act as pressures reducing the likelihood of and opportunity for lessons that teach the epistemic insight students need to make and examine connections between these different types of knowledge.

## **4. Research questions**

As mentioned above, there are diverse positions among scholars on how to relate scientific and religious accounts of origins, whereas there is a basis to be concerned that many students may be confined to the view that scientific and religious explanations necessarily sit in a single explanatory category. Further, on the basis of our exploratory studies, we surmise that some of the factors that can impede students' access to a range of positions include: 1) an uncritical conflation of science and scientism, 2) an uncritical conflation of creation and creationism, 3) teachers' attitudes towards discussion and bridging questions, 4) firm boundaries between science and religious education lessons, and 5) insufficient attention given to the roles of inference and interpretation when constructing knowledge and judgements of significance and meaning.

By conducting this research we were able to gather data across year groups and from a significant number of schools. Moreover, the religious character of Church of England schools suggests that there is a commitment to ensuring students have opportunities to learn about Christianity and to the effective provision of religious education. As such our research questions for the current study are:

RQ1: How do students in Church of England schools understand the relationships between science and religion? And are they interested in whether science and religion can fit together?

RQ2: What are students' attitudes to and perceptions of scientific theories of origins?

RQ3: What are students' attitudes to and perceptions of creation?

RQ4: What are students' perceptions of how questions and interactions concerning science and religion are managed in school?

## **5. Methodology**

We had previously constructed a questionnaire with statements and options for rating levels of agreement designed to discover the extent to which secondary school students perceived science to be inconsistent with a religious faith (Taber et al., 2011b). The survey data from four schools together with an interview study with 12 students selected from those who had completed the survey (Taber et al., 2011a; Taber et al., 2012) indicated that the majority of participating students perceived science and religion to give conflicting accounts of the origins of life and the universe. In a parallel study, the questionnaire was further refined for secondary school students and validated using statistical analysis by Paiva et al. (2016) in an investigation of students' attitudes towards science and religion in two secondary schools in Portugal. The resultant survey

has eight Likert scales including religious faith (e.g. I believe God created the universe), trust in science (e.g. I accept the scientific theory that the whole universe was created by the Big Bang) and relationship for a given topic (e.g. the scientific and religious version of how the universe was created cannot both be true). There are also Likert scales for openness towards discussion in science and religious education lessons (e.g. In our science classes, the teacher doesn't like to answer questions that relate to religion) and curiosity about how science and religion relate (e.g. I would like to know more about the possibility of science and religion being compatible). For the current study, we were guided by these well-honed instruments for secondary schools together with the data drawn from focus groups and exploratory survey work with school students.

The survey was administered by teachers during supervised class time in each of four schools to one class of students. Students were invited to add a written comment below each statement and were given ample time to complete the survey. At the end of the survey they were asked to add a written comment about the experience of filling in the survey. Our methodology is designed to help us to have sight of the range of attitudes and levels of understanding in a group. We use a range of strategies (supervised class time for completion, access to full classes of students, ample time for completion and multiple rounds of piloting) to reduce self-selection by students (Nulty, 2008; De Vaus, 2013).

For the current study, we arranged to administer a survey to students attending a day of workshops at the beginning of the school day, before the workshops began. Returning the survey was voluntary, but because full year groups of students took part in each event and were supervised when they filled in the survey, we anticipated that the total number of respondents would be significant and that within each participating year group, the return rate of surveys would be relatively high. As such this provided our research team with an opportunity to discover more about the reasoning that students in secondary Church of England schools apply when they discuss questions that bridge science and religion.

## **6. Questionnaire design**

The first few questions ask students for their school names and locations while at the end of the survey there are some questions asking gender and age group. The main body of the questionnaire features 26 statements, each followed by six options so that students can express their positions. The options are strongly agree, agree, neither agree nor disagree, disagree, strongly disagree and "I don't understand the question." This paper will only focus on the Likert type items relating to the research questions given above (17 statements). Of the 17 statements, five are concerned with students' perceptions of how science and religion relate and their attitudes towards science and religion.

Analysing these statements provides information for answering the main question of this study (RQ1). Another four statements are concerned with how students perceive the position of science, while a further four statements are intended to discover how students perceive the position of religion. These two groups of statements are related to the second and third research questions for this study (RQ2 and RQ3). There are also four statements which are intended to discover students' perceptions of the teaching they have received. We will analyse these statements in order to answer the final research question (RQ4). The statements use both positive and negative phrasing to try to create a balanced survey. Almost all the statements are drawn from previous studies conducted by the LASAR (Learning about Science and Religion) project and as such are carefully worded after many trials to remove ambiguities and words that students may not understand. Further, the survey was trialled in its current form in pilot studies at two events in July 2014 prior to this study to ensure that the survey could be completed within the allocated time.

The list of the statements we analysed in this paper categorised under the research questions is as follows:

RQ1: How do students in Church of England schools understand the relationships between science and religion? And are they interested in whether science and religion can fit together?

- (1) I am interested in whether science and religion can fit together.
- (2) I believe science and religion fit together.
- (3) Science is compatible with the view that God created humans.
- (4) Science makes it hard to believe in God.
- (5) Science supports my faith in God.

RQ2: What are students' attitudes to and perceptions of scientific theories of origins?

- (6) The scientific view is that the universe started with a big bang.
- (7) I do not accept what scientists say about human origins.
- (8) Science shows that the universe was not created by God.
- (9) The scientific view is that God does not exist.

RQ3: What are students' attitudes to and perceptions of creation?

(10) I believe that God created the universe.

(11) Christianity teaches that the universe was created in six days.

(12) The Church of England does not accept evolution.

(13) People who have a strong religious faith do not accept evolution.

RQ4: What are students' perceptions of how questions and interactions concerning science and religion are managed in school?

(14) Our RE teachers avoid answering questions that relate to science.

(15) Our science teachers avoid answering questions that relate to religion.

(16) Science teachers and RE teachers work together when they teach topics that bridge science and religion.

(17) I know enough about theistic evolution to explain it to a friend.

### *Sampling and analyses*

The survey was administered to students in sixteen Church of England secondary schools on the morning before they attended a God and the Big Bang event in their school. The schools were geographically diverse and the 1,772 participants were in Year 10 to Year 13. The students taking part were in most cases a full year group. In some cases they were a selection of full classes from within the year.

Questionnaires were completed by students while supervised in a comfortable and reasonably quiet classroom. Before students began to fill in the questionnaires, they were told that participation in the research was voluntary and they could choose whether or not to turn in their questionnaire and if they chose not to, their data would be discarded. They were also informed that their answers would be confidential and that they could skip any questions they did not want to answer.

The paper surveys were scanned using a system called Remark to import the data which were then exported to SPSS 21 for analysis. In this, our treatment of the Likert type items first collapsed the Agree/Strongly agree responses to a single "Agree" category

and the Disagree/Strongly disagree responses to a single “Disagree” category. The cohort gender balance of the cohort was 45.5% girls and 49.8% boys, 4.7% missing data.

The frequency of respondents in each year group is as follows: 37.1% from Year 10, 13.7% from Year 11, 23.0% from Year 12 and 26.2% from Year 13.

The distribution of responses based on schools is shown in the table below:

Table 1: Distribution of responses based on schools

School	Frequency	Percent
A	77	4.3
B	165	9.3
C	70	4.0
D	146	8.2
E	64	3.6
F	64	3.6
G	84	4.7
H	92	5.2
I	71	4.0
J	246	13.9
K	130	7.3
L	89	5.0
M	90	5.1
N	140	7.9
O	104	5.9
P	140	7.9
Total	1772	100.0

## 7. Findings: General

For most of the statements analysed for this paper, the proportions of students who ticked “I don’t understand the question” are at, or below, 5%, which suggests that almost all students were able to make sense of the questions. Only for two statements the level of “I don’t understand the question” was above 5 percent:

The Church of England does not accept evolution (6.4%)

I know enough about theistic evolution to explain it to a friend (8.2%)

The reason for not understanding the first statement might be that school students were not familiar with the term “Church of England”. For the second statement, it seems that students did not know about the term “theistic evolution” which is a key term in science and religion debates, and therefore ticked the “I don’t understand the question” option. However, as the aim of the statement itself was to see if respondents knew about this concept, the high level of not understanding the statement did not invalidate the statement.

RQ1: How do students in Church of England schools understand the relationships between science and religion? And are they interested in whether science and religion can fit together?

Table 2: Students’ responses to the statements related to RQ1

	Agree	Neither agree nor disagree	Disagree	I don’t understand the question	Chi-square Goodness of Fit Test (‘I don’t understand the question’ responses removed)
(1) I am interested in whether science and religion can fit together.	48.9%	31.2%	19.2%	0.7%	$\chi^2 = 238.048$ df=2, p<0.001
2) I believe science and religion fit together.	32.1%	37.4%	29.4%	1.0%	$\chi^2 = 17.298$ df=2, p<0.001
3) Science is compatible with the view that God created humans.	23.4%	32.2%	41.7%	2.7%	$\chi^2 = 90.701$ df=2, p<0.001
(4) Science makes it hard to believe in God.	53.0%	24.6%	21.6%	0.7%	$\chi^2 = 317.645$ df=2, p<0.001
(5) Science	13.5%	41.1%	41.3%	4.2%	$\chi^2 = 278.192$

supports my faith in God.					df=2, p<0.001
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In this cohort near to 50 % of participants agreed with the statement that “I am interested in whether science and religion can fit together.” Just under a third (32%) of respondents said that they believed that “science and religion fit together” while a similar proportion (29%) of students disagreed with this statement and the rest of the cohort neither agreed nor disagreed.

Turning to students’ perceptions of how to explain the origins of the universe, just under a quarter of the cohort (23%) agreed that “science is compatible with the view that God created humans,” and more than forty percent (42%) disagreed with this statement.

Children’s perception of the tension between science and religion extended to their positions on the existence of God. More than half of the respondents believed that “science makes it hard to believe in God” (53%), and only one in five (22%) disagreed with this statement. Less than 15% of the children with a faith position agreed with the statement, “science supports my faith in God,” and near to one third of the religious respondents disagreed with this view.

Analysing the statement “I believe science and religion fit together” based on individual schools revealed that there is a substantial difference between schools. The level of agreement with this statement varied from 12.5% to 57.3%. Conversely the range of disagreement with the statement ranged from 0% to 46.6%.

We ran a chi-square test to see if there was an association between schools and their level of agreement with this statement and the result was statistically highly significant ( $\chi^2=173.093$ ,  $df=30$ ,  $p<0.001$ ).

Table 3: Responses to the statement “I believe science and religion fit together” based on individual schools

	I believe science and religion fit together	Agree	Neither agree not disagree	Disagree	
	School A	57.3%	25.3%	17.3%	100.0%
	School B	12.5%	40.6%	46.9%	100.0%
	School C	40.0%	40.0%	20.0%	100.0%
	School D	22.5%	48.6%	29.0%	100.0%
	School E	37.5%	42.2%	20.3%	100.0%
	School F	39.1%	42.2%	18.8%	100.0%
	School G	19.3%	38.6%	42.2%	100.0%
	School H	43.8%	38.2%	18.0%	100.0%
	School I	55.6%	44.4%	0.0%	100.0%
	School J	30.2%	39.3%	30.6%	100.0%
	School K	26.6%	28.1%	45.3%	100.0%
	School L	17.9%	40.5%	41.7%	100.0%
	School M	45.3%	30.2%	24.4%	100.0%
	School N	35.3%	33.1%	31.7%	100.0%
	School O	51.0%	32.0%	17.0%	100.0%

	School P	28.1%	39.6%	32.4%	100.0%
Total		32.5%	37.8%	29.7%	100.0%

RQ2: What are students' attitudes to and perceptions of scientific theories of origins?

Table 4: Students' responses to the statements related to RQ2

	Agree	Neither agree nor disagree	Disagree	I don't understand the question	Chi-square Goodness of Fit Test ('I don't understand the question' responses removed)
(6) The scientific view is that the universe started with a big bang.	80.4%	12.4%	5.1%	1.0%	$\chi^2= 1884.031$ df=2, p<0.001
(7) I do not accept what scientists say about human origins.	10.6%	30.8%	53.3%	5.4%	$\chi^2= 505.897$ df=2, p<0.001
(8) Science shows that the universe was not created by God.	42.9%	27.7%	28.4%	1.0%	$\chi^2= 77.532$ df=2, p<0.001
(9) The scientific view is that God does not exist.	38.0%	34.6%	26.0%	1.4%	$\chi^2= 40.397$ df=2, p<0.001

The data indicates that most students are confident about the scientific position on the origins of the universe. More than 80% of the sample agreed that the scientific view is that the universe started with the big bang and only 5% disagreed with this view.

However, the data suggests that the level of agreement based on students’ personal opinions on this view is not high. In responding to the statement “I do not accept what scientists say about human origins,” about one in three of the respondents were not sure about their position, while more than 50% disagreed with this view and the rest were in agreement with this position.

Apart from looking at school students’ understanding of and attitudes to the scientific account of origins, we were interested to explore their attitudes to scientism and additionally the extent to which students associate science with scientism. There were two statements in the questionnaire relating to this view: “science shows that the universe was not created by God” and “the scientific view is that God does not exist.” As shown in the table above, for both statements, the level of agreement was around 40% while only about a quarter disagreed and the rest (apart from few people who did not understand the question) chose the “neither agree nor disagree” option.

RQ 3: What are students’ attitudes to and perceptions of creation?

Table 5: Students’ responses to the statements related to RQ3

	Agree	Neither agree nor disagree	Disagree	I don’t understand the question	Chi-square Goodness of Fit Test (‘I don’t understand the question’ responses removed)
(10) I believe that God created the universe.	33.5%	29.1%	36.0%	1.4%	$\chi^2 = 13.115$ df=2, p=0.01
(11) Christianity teaches that the universe was created in six days.	69.4%	17.5%	11.3%	1.8%	$\chi^2 = 1084.279$ df=2, p<0.001
(12) The Church of England does not accept evolution.	23.8%	48.5%	21.3%	6.4%	$\chi^2 = 252.472$

					df=2, p<0.001
(13) People who have a strong religious faith do not accept evolution.	31.8%	35.1%	31.0%	2.2%	$\chi^2=4.760$ df=2, p=0.093

School students' expressed positions on whether the universe is created by God were divided more or less equally with 33.5% of respondents agreeing with the statement, "I believe that God created the universe," while 36% disagreed. A further 29.1% chose "neither agree nor disagree."

However, students' positions are often more complex. Some students personally believe that God created the universe but they also think that science is not compatible with this belief which could be a source of tension between students' own belief and what they think science says. The table below shows the proportion of students who believed science says that God did not create the universe within the group who believe that God created the universe.

Table 6: I believe that God created the universe \* Science shows that the universe was not created by God cross tabulation

		Science shows that the universe was not created by God			
		Agree	Neither agree nor disagree	Disagree	Total
	Agree	25.9%	24.7%	49.4%	100.0%
I believe that God created the universe	Neither agree nor disagree	37.3%	40.1%	22.6%	100.0%

	Disagree	65.0%	20.9%	14.1%	100.0%
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The data indicates that students associate Christianity with creationism. Most respondents believed that “Christianity teaches that the universe was created in six days.” However, they were not sure whether this view is compatible with evolution or not, and therefore, the majority of students did not agree or disagree with the statement, “the church of England does not accept evolution.” Similarly, in responding to the statement that “people who have a strong religious faith do not accept evolution,” which is about religious faith in general and not just Christianity, the highest proportion of responses belonged to the “Neither agree nor disagree” category (31.8% Agree, 35.1% Neither Agree nor Disagree, 31.0% Disagree and 2.2% I don’t understand the question).

RQ 4: What are students’ perceptions of how questions and interactions concerning science and religion are managed in school?

Table 7: Students’ responses to the statements related to RQ4

	Agree	Neither agree nor disagree	Disagree	I don’t understand the question	Chi-square Goodness of Fit Test (‘I don’t understand the question’ responses removed)
(14) Our RE teachers avoid answering questions that relate to science	10.7%	36.1%%	51.4%	1.8%	$\chi^2 = 449.288$ df=2, p<0.001
(15) Our science teachers avoid answering questions that relate to religion	22.1%	37.1%	39.4%	1.4%	$\chi^2 = 93.154$ df=2, p<0.001

(16) Science teachers and RE teachers work together when they teach topics that bridge science and religion.	20.8%	32.9%	42.8%	3.5%	$\chi^2 = 133.223$ df=2, p<0.001
(17) I know enough about theistic evolution to explain it to a friend.	18.8%	22.8%	50.3%	8.2%	$\chi^2 = 332.512$ df=2, p<0.001

As indicated in the above table, in the survey we were looking at whether questions about bridging science and religion are raised and addressed in lessons. The data indicates that from these students' perspectives, RE and science teachers in church schools are not resistant to answering questions related to science and religion, although RE teachers are more open to answering questions that relate to science compared to asking science teachers questions related to religion. At the same time, students typically felt that science teachers and RE teachers do not work together to coordinate their teaching about topics that bridge science and religion.

We also sought to discover students' familiarity with some of the positions expressed in the literature on how science and religion relate on origins. We found that about half of students felt they were not in a position to give an account of theistic evolution to a friend and that less than 20% feel that they "know enough about theistic evolution to explain to a friend," and the rest of the respondents were not sure about their answer or did not understand the question.

## 8. Discussion

This study was designed to explore Church of England upper-secondary school students' views on how science and religion relate, focusing on how they explain the origins of the universe and life. Our first research question focused on discovering their perception of how science and religion relate. We see that a minority of students endorsed statements about the compatibility of science and religion and a majority said they found science to be an obstacle for believing in God. We also found that almost 70% of the cohort agreed with the statement that "Christianity teaches that the universe was created in six days." We noted previously the religious character of Church of England schools and their aim to ensure that students learn about Christianity including

perspectives on how religion (particularly Christianity) and science are connected. The findings in this survey indicate that school students' understanding of these themes is limited. This is consistent with our findings from previous studies in secondary schools seeking to understand students' perceptions of and attitudes to religion more generally (see for example (Taber et al., 2011a; Billingsley et al., 2013; Billingsley et al., 2016). We also note that a considerable number of students (more than 40%) in this cohort believed that "science shows that the universe was not created by God" and near to 40% believed that "the scientific view is that God does not exist." Both statements are consistent with a scientific view of science—thus there is a perception that accepting science includes accepting that science is the only valid source of knowledge, that the universe is material and that the conclusion of science is that there is no supernatural god.

As discussed in the conceptual background, scientism and creationism are positions that are frequently expressed by those who describe science and religion as incompatible. We also speculated in that section that when students associate science and religion with scientism and creationism respectively, some may be doing so without the epistemic insight they need to access an understanding of a range of positions. The data gathered for the current study are consistent with this claim for these upper secondary school students in Church of England schools.

## **9. Conclusion**

Various factors may lead young people to feel that science and religion are incompatible. School students' view of the relationships between science and religion are sometimes formed via their experiences with media reports rather than via experiences of professional teachings. For instance, exaggerated media headlines and reports present scientific advances in ways that suggest that scientists are on the brink of having a sufficient model and explanation for how reality behaves. These inaccurate and exaggerated reports are important factors for feeling tensions between science and religion. Some examples are, "GCSE results 'influenced by children's genes, not teaching'" (Paton, 2013) "New blood test targets depression" (Roberts, 2016) and "Scientists prove chocolate 'better than being in love'" (Freeman, 2002). Among many factors, in this study we focused and discussed the problem of lack of epistemic insight which is partly the result of school compartmentalisation. Overall, our findings from this large scale study indicated that students who attend Church schools do not have a sufficient level of epistemic insight to appreciate that science and religion are not necessarily opposed. More investigations need to be done to capture the detail of students' deliberations.

Given the commitment that the schools in our study make to providing effective

religious education, it is noteworthy that less than a quarter of the cohort (23%) agreed that “science is compatible with the view that God created humans,” and more than 40% disagreed with this statement. It is also interesting to notice that the positions that school students took—individually and also school by school—on understanding the relationships between science and religion were diverse. Thus in some schools the level of agreement with the statement that “I believe science and religion fit together” was less than 20%, while in other schools the level of agreement was near to 60%. We propose that a more in-depth qualitative study in these contrasting schools would be valuable.

Although a majority of students in this cohort said they found questions about the relationships between science and religion interesting, the data suggest that students have limited access to an appreciation of why science and religion are not necessarily incompatible. Thus we found that for many students in this cohort, the creation story seems to be conflated with creationism, and science as scientism. Very few students expressed familiarity with terms that are frequently used in the literature to describe harmonious views of how evolution and creation interact.

Further, while a small minority of students felt that their teachers avoid or resist addressing their questions in class, there is also a basis to say that teachers are not providing coherent and collaborative teaching on these topics. This leads us to conclude that the students’ experiences of learning about science and about religion in these schools is negatively impacted by subject compartmentalisation and that the fragmentation of topics bridging science and religion into the two separate compartments is disrupting students’ understanding of how these two perspectives relate.

## **10. Recommendations, Limitations and Opportunities for Further Research**

We draw from this study that entrenched subject compartmentalisation appears to reduce students’ opportunities to have access to a range of scholarly positions on how science and religion relate—even in schools and classrooms in which students perceive their teachers to be generally open to exploring their questions and concerns. Elsewhere and in this study, we have proposed the term “epistemic insight” as a way to characterise (for example) a progression from the perception that science and religion are each absolutes towards an appreciation that scholars express diverse positions on the natures of science and religion.

The division of secondary school education into separate subjects reduces access to opportunities or spaces where students can encounter and form types of reasoning

associated with cross-disciplinary questions and relationships. We suggest that schools should be encouraged to find a teaching space and allocate time to develop this theme and to do this regularly as students advance through school.

It is noteworthy that when presented with the statement, “I believe science and religion fit together” the level of agreement from school to school varies from 12.5% to 57.3%. These significant differences from school to school again suggest that there is no formularised approach to this aspect of children’s education. We propose that there is a need for further research to discover whether the differences are outcomes of different pedagogies in school or whether this is mostly to do with other factors such as differences between local community stances on either science and/or religion.

A central focus for work going forward in this field would be, we argue, to develop tools and pedagogies that teachers can use to encourage cross-disciplinary reasoning. Our recommendation is to see these aspects of education as endeavours that take place across the school rather than in one or two classrooms alone. This raises the question of what types of inter-subject collaboration and what types of holistic approaches would be suitable and supportive. Our position is that the answers to these questions will vary from school to school but also that there are ways to make classroom walls more permeable which would not necessarily put more pressure on already crowded curriculum spaces. Firstly the corridor spaces between classrooms could be used to help students see how the focus of attention shifts when a similar question moves from discipline to discipline. A second strategy might be to introduce a question box in each classroom and in other selected places in school. Students could be told that the boxes are for questions which they consider to be potentially off-topic or squeezed out of curriculum time. The questions could be collated each week by a staff committee who would decide whether, which and how they should be followed up. Thirdly, a graphic like the one offered here (Figure 1) could be displayed on classroom walls and/or on whiteboards at the beginning of lessons as a way to visually express the contextualisation of each subject and each discipline within a broader conceptualisation of scholarship.

Figure 1



Fourthly, some schools choose to have an occasional student enrichment day or some other apportioning of time that is off-timetable in which questions bridging science and religion are articulated and discussed. These occasions are opportunities for facilitating questions and discussions with invited scholars such as scientists with a perspective on religion and/or theologians with a particular interest in science. Fifthly, we recommend that on a termly basis teachers from two or more subjects could plan a collaborative session designed to take place in a multidisciplinary space such as a library and designed to develop students' cross-disciplinary curiosity, epistemic insight and scholarly reasoning. In parallel there is likely to be a need for professional development for teachers to ensure that teachers are well placed to respond formatively to students'

comments and reasoning.

## 11. References

- Abrahams I. (2017) Minds-On Practical Work for Effective Science Learning. *Science Education*. Springer, 403-413.
- Alexander D. (2014) *Creation or evolution: Do we have to choose?*, Oxford: Monarch Books.
- Atkins PW. (1995) The limitless power of science. In: Cornwell J (ed) *Nature's imagination: The frontiers of scientific vision*. Oxford: Oxford University Press, 122-132.
- Barbour I. (1988) Ways of relating science and theology. In: Russell RJ, Stoeger WR and Coyne GV (eds) *Physics, Philosophy and Theology: A Common Quest for Understanding* Vatican City State: Vatican Observatory, 21-42.
- Barbour I. (2013) *Religion and science*: HarperOne.
- Barnes J. (2015) *Cross-curricular learning 3-14*: Sage.
- Barnes LP. (2014) *Education, Religion and Diversity: Developing a New Model of Religious Education*: Routledge.
- Billingsley B. (2013) Students' Perceptions of Apparent Contradictions Between Science and Religion: Creation Is Only the Beginning. In: Mansour N and Wegerif R (eds) *Science Education for Diversity*. Dordrecht: Springer, 329-338.
- Billingsley B, Abedin M and Chappell K. (2018a) *A Teacher's Guide to Science and Religion in the Classroom*, Abingdon: Routledge.
- Billingsley B, Brock R, Taber KS, et al. (2016) How Students View the Boundaries Between Their Science and Religious Education Concerning the Origins of Life and the Universe. *Science Education*: n/a-n/a.
- Billingsley B and Nassaji M. (2019) Exploring Secondary School Students' Stances on the Predictive and Explanatory Power of Science. *Science & Education* 28: 87-107.
- Billingsley B, Nassaji M and Abedin M. (2017) Entrenched compartmentalisation and students' abilities and levels of interest in science. *School Science Review* 99: 26-31.
- Billingsley B, Nassaji M, Fraser S, et al. (2018b) A Framework for Epistemic Insight. *Research in Science Education* 48: 1115-1131.
- Billingsley B, Riga F, Taber KS, et al. (2014) Secondary school teachers' perspectives on teaching about topics that bridge science and religion. *Curriculum Journal* 25: 372-395.
- Billingsley B, Taber K, Riga F, et al. (2013) Secondary school students' epistemic insight into the relationships between science and religion—a preliminary enquiry. *Research in Science Education* 43: 1715-1732.
- Billingsley B, Taber KS, Riga F, et al. (2010) Teachers' perspectives on collaborative teaching about the 'Big Questions' in secondary schools: The silent treatment. *Annual conference of the British Educational Research Association*. Warwick.

- Brooke JH. (1991) *Science and Religion: Some Historical Perspectives*, Cambridge: Cambridge University Press.
- Brooke JH and Cantor G. (1998) *Reconstructing Nature: The engagement of Science and Religion*, Edinburgh: T&T Clark Ltd.
- Byrne E and Brodie M. (2013) *Cross Curricular Teaching and Learning in the Secondary School... Science*: Routledge.
- Cantor GN, Christie J, Hodge M, et al. (2012) *Companion to the history of modern science*: Routledge.
- Chadwick P. (2001) The Anglican perspective on church schools. *Oxford Review of Education* 27: 475-487.
- Cloud JD. (1992) Ending Our Practice of Compartmentalization. *School Administrator* 49: 24-25.
- Cobern WW. (2000) The Nature of Science and the Role of Knowledge and Belief. *Science and Education*,9: 219-246.
- De Vaus D. (2013) *Surveys in social research*: Routledge.
- Driver R. (1989) Students' conceptions and the learning of science. *International Journal of Science Education* 11: 481-490.
- Dudu WT and Vhurumuku E. (2012) Teachers' practices of inquiry when teaching investigations: A case study. *Journal of Science Teacher Education* 23: 579-600.
- Francis L. (1990) Theology of education. *British Journal of Educational Studies* 38: 349-364.
- Francis LJ, Astley J and McKenna U. (2018a) 'Science disproves the biblical account of creation': exploring the predictors of perceived conflict between science and religion among 13-to 15-year-old students in the UK. *British Journal of Religious Education*: 1-14.
- Francis LJ, Casson A and McKenna U. (2018b) Christian ethos secondary schools in England and Wales: a common voice or wide diversity? *Journal of Beliefs & Values* 39: 445-462.
- Francis LJ and Fulljames P. (2019) Creationism among Young People in Kenya and Britain. In: Coleman S and Carlin L (eds) *The Cultures of Creationism: Anti-Evolutionism in English-Speaking Countries*. Abingdon: Routledge, 181-190.
- Freeman C. (2002) *Scientists prove chocolate 'better than being in love'*. Available at: <http://www.dailymail.co.uk/news/article-128858/Scientists-prove-chocolate-better-love.html#ixzz1nawzmO00>.
- Fulljames P. (1996) Science, creation and Christianity: a further look. In: Francis L, Kay W and Campbell W (eds) *Research in Religious Education*. Leominster: Gracewing, 257-266.
- Fulljames P, Gibson HM and Francis LJ. (1991) Creationism, Scientism, Christianity and Science: a study in adolescent attitudes. *British Educational Research Journal* 17: 171 - 190.
- Gilbert JK, Osborne RJ and Fensham PJ. (1982) Children's science and its consequences for teaching. *Science Education* 66: 623-633.
- Gould SJ. (1999) *Rocks of Ages: Science and Religion in the Fullness of Life*, New York: Ballantine Books.

- Guessoum N. (2015) Understanding Qur'anic Miracle Stories in the Modern Age By Isra Yazicioglu. *Journal of Islamic Studies* 26: 199-202.
- Hagay G and Baram-Tsabari A. (2015) A strategy for incorporating students' interests into the high-school science classroom. *Journal of Research in Science Teaching*.
- Hanley P. (2008) Controversy in school?: Origin of life and the science/religion overlap. *British Educational Research Association Annual Conference, Heriot-Watt University, Edinburgh, September*. Heriot-Watt University, Edinburgh.
- Hansson L and Redfors A. (2007) Upper secondary students in group discussions about physics and our presuppositions of the world *Science & Education* 16: 1007-1025.
- Harrison P. (2006) "Science" and "Religion": Constructing the boundaries. *The Journal of Religion* 86: 81-106.
- Hokayem H and BouJaoude S. (2008) College Students' Perceptions of the Theory of Evolution. *Journal of Research in Science Teaching* 45: 395-419.
- Holloway D. (2016) *Religious Education in Church of England Schools: A statement of Entitlement*. Available at: <https://www.churchofengland.org/sites/default/files/2019-02/RE%20Statement%20of%20Entitlement%20for%20Church%20Schools.pdf>
- Hull DL. (2010) *Science as a process: an evolutionary account of the social and conceptual development of science*, Chicago: University of Chicago Press.
- Humphreys C. (2003) *The Miracles of Exodus: A Scientist's Discovery of the Extraordinary Natural Causes of the Biblical Stories*, San Francisco: Harper Collins.
- Hutchinson I. (2011) *Monopolizing Knowledge: A scientist refutes religion-denying, reason-destroying scientism*, Massachusetts: Fias Publishing.
- Jackson R. (2004) *Rethinking religious education and plurality: Issues in diversity and pedagogy*: Psychology Press.
- Konnemann C, Asshoff R and Hammann M. (2016) Insights Into the Diversity of Attitudes Concerning Evolution and Creation: A Multidimensional Approach. *Science Education* 100: 673-705.
- Konnemann C, Höger C, Asshoff R, et al. (2018) A Role for Epistemic Insight in Attitude and Belief Change? Lessons from a Cross-curricular Course on Evolution and Creation. *Research in Science Education*: 1-18.
- Kötter M and Hammann M. (2017) Controversy as a Blind Spot in Teaching Nature of Science. *Science & Education* 26: 451-482.
- Leach J, Hind A and Ryder J. (2003) Designing and Evaluating Short Teaching Interventions About the Epistemology of Science in High School Classrooms. *Science Education* 87: 831 – 848.
- McComas WF. (2006) *The nature of science in science education: Rationales and strategies*: Springer Science & Business Media.
- McComas WF. (2017) Understanding how science works: the nature of science as the foundation for science teaching and learning. *School Science Review* 98: 71-76.

- Millar R and Osborne J. (1998) *Beyond 2000: Science education for the future*, London: King's College.
- Murphy N. (2014) Mind, Soul, and the Cognitive Neurosciences. In: Fuller M (ed) *The Concept of the Soul: Scientific and Religious Perspectives*. Newcastle upon Tyne: Cambridge Scholars Publishing, 39-55.
- Nulty DD. (2008) The adequacy of response rates to online and paper surveys: what can be done? *Assessment & evaluation in higher education* 33: 301-314.
- ONS. (2012) Religion in England and Wales 2011. London: Office for National Statistics.
- Osborne J and Dillon J. (2008) Science education in Europe: Critical reflections. London: The Nuffield Foundation.
- Paiva JC, Morais C and Moreira L. (2016) Attitudes towards Science and Religion: Insights from a Questionnaire Validation with Secondary Education Students. *International Conference New Perspectives in Science Education—Conference Proceedings*. 430-434.
- Paton G. (2013) GCSE results 'influenced by children's genes, not teaching'. *The Telegraph*.
- Polkinghorne J. (2011) *Science and religion in quest of truth*: Yale University Press.
- Polkinghorne J. (2013) Science and Religion in Dialogue. *The Boyle Lectures*. St Mary-le-Bow, Cheapside Gresham College, 1-8.
- Polkinghorne J, Hedley J and Chartres RJC. (2014) The Boyle Lectures: Science and Religion in Dialogue.
- Poole M. (2007) *A User's Guide to Science and Belief*, Oxford: Lion Books.
- Ramsey I. (1970) The Fourth R: The Durham Report on Religious Education. London: SPCK: 1.
- Ratcliffe M. (2009) The place of socio-scientific issues in citizenship education. In: Ross A (ed) *Human Rights and Citizenship Education*. London: CiCe, 12 - 16.
- REC. (2013) A Review of Religious Education in England. In: Wales RECoEa (ed). London: Religious Education Council of England and Wales.
- Reiss MJ. (2013) Religion in science education: Theory and practice. In: Mansour N and Wegerif R (eds) *Science education for diversity: Theory and practice*. New York/Heidelberg: Springer.
- Roberts M. (2016) New blood test targets depression. *BBC News*. (accessed 16 August 2016).
- Sanders M and Ngxola N. (2009) Addressing teachers' concerns about teaching evolution. *Journal of biological education* 43: 121-128.
- Sandoval WA. (2016) Disciplinary insights into the study of epistemic cognition. *Handbook of epistemic cognition*: 184.
- Schreiner P. (2000) Religious education in Europe. *A collection of basic information about RE in European countries, Münster*.
- Shipman HL, Brickhouse NW, Dagher Z, et al. (2002) Changes in student views of religion and science in a college astronomy course. *Science Education* 86: 526-547.
- Southgate C. (2011) *God, Humanity and the Cosmos-: A Textbook in Science and Religion*: Bloomsbury Publishing.

- Stenmark M. (2001) *Scieintism: Science, ethics and religion* Aldershot: Ashgate Publishing Limited.
- Stolberg T and Teece G. (2010) *Teaching religion and science: Effective pedagogy and practical approaches for RE teachers*: Routledge.
- Sullivan-Watts BK, Nowicki BL, Shim MK, et al. (2013) Sustaining reform-based science teaching of preservice and inservice elementary school teachers. *Journal of Science Teacher Education* 24: 879-905.
- Taber KS. (2017) The relationship between science and religion: A contentious and complex issue facing science education. *Science education: A global perspective*. Springer, 45-69.
- Taber KS, Billingsley B, Riga F, et al. (2011a) Secondary students' responses to perceptions of the relationship between science and religion: Stances identified from an interview study. *Science Education* 95: 1000-1025.
- Taber KS, Billingsley B, Riga F, et al. (2011b) To what extent do pupils perceive science to be inconsistent with religious faith? An exploratory survey of 13-14 year-old English pupils. *Science Education International* 22: 99-118.
- Taber KS, Billingsley B, Riga F, et al. (2012) Thinking about 'big questions': a website to support teaching about how science works. *Education in science*: 16.
- Van Inwagen P and Zimmerman DW. (1998) *Metaphysics: the big questions*.
- Wagner R and Briggs A. (2016) *The Penultimate Curiosity: How Science Swims in the Slipstream of Ultimate Questions*: Oxford University Press.
- Ward K. (2008) *The big questions in science and religion*, West Conshohocken, Pennsylvania: Templeton Foundation Press.

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