

**Scientific and Religious Perspectives on Evolution in the Curriculum:  
An Approach Based on Pedagogy of Difference**

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## **Abstract**

There is a long history of some students finding that the science instruction they receive in schools fails to address their deeply held concerns about the theory of evolution. Such concerns are principally religious, though there are also students with deeply held religious views who are perfectly comfortable with the theory of evolution. New instructional strategies are emerging, aimed at reducing the tensions that may exist between evolution and religion by making space for students to examine their own views and recognize the spectrum of views that exists between atheistic evolution and special creation, as well as the bounded nature of science and different ways of knowing. In this article, we discuss the teaching of evolution in societies where acceptance of the theory of evolution is far from universal, and argue that an approach based on 'pedagogy of difference' has considerable potential to enhance students' development of epistemic insight through recognition of the multiple perspectives that exist concerning the relationship between religion and science. In doing so, we explicate precisely what pedagogy of difference entails and introduce an approach that should enhance evolution education, and even aid students' situating of science as a resource for making decisions about issues with scientific and societal aspects where the acknowledgement of multiple perspectives is valuable.

*Keywords:* epistemic insight, religion, evolution, creation, pedagogy of difference

## **Introduction**

Evolution, while non-controversial scientifically, is often a socially controversial issue for students, and sometimes teachers, in science classrooms (e.g. Reiss 2011). By ‘socially controversial’, we simply mean that substantive differences of opinion exist between individuals within a society. Although many individuals and communities with strong religious commitments accept evolution as scientifically sound and may even consider it to be spiritually fortifying, permutations of religious and cultural frictions with evolution have a long history (Brooke 1991; Deniz and Borgerding 2018). Scriptural literalism is one reason for frequent conflict, but individuals with broader religious sensibilities also often understand evolution to be in tension with their commitments, for instance regarding an intentional universe that has meaning and purpose, as well as with their cultural identities (Barnes and Brownell 2017; Evans 2018; Hameed 2015; Pear et al. 2015). Recent research in science education has focused on proactive approaches to addressing the issue in the contemporary educational context. One important contribution is the suggestion of assisting students’ development of ‘epistemic insight’, including the understanding that there are a number of views on the relationship between science and religion, through direct teaching on this subject (Billingsley et al. 2013).

The current paper builds on this growing body of research and suggests that a framework that has been developed in the context of religious education and citizenship education called the ‘pedagogy of difference’ can be fruitfully applied in the classroom to issues, such as evolution, where, at least in some students’ eyes, science and religion may intersect and even conflict. Specifically, given the typical importance of sacred scriptures to the views of students for whom

their religion is important, we present an exercise that includes a series of questions related to religious and scientific texts that can be asked of students in order to help them develop epistemic insight as well as compare scientific inquiry with religious worldviews in order to develop an awareness of and respect for alternative perspectives (Alexander 2015a). In this spirit, we present questions relating to passages from *On the Origin of Species*, the Hebrew Bible, the New Testament, and the Qur'an, which can lead students not only to reflect on how these passages might form a basis to accept the viewpoint therein, but also to both critique and respect alternatives, thereby adding an evaluative component. Such a practice should aid students in their ability to recognize and acknowledge a spectrum of perspectives concerning the intersection of evolution and religious worldviews specifically, as well as the multiplicity of perspectives they will have to consider when reasoning about issues with scientific and societal aspects more generally, as required by participation in a functional democracy (Kahn & Zeidler, 2016; Sadler et al. 2007). It might also help reduce the tensions that some students feel exist between evolution and religion. Throughout, we envisage our primary audiences as being educators and researchers in science or religious education as well as others with an interest in how the teaching of contentious issues might be improved through developments in classroom practice.

### **Literature Review**

While awareness of the tension caused by evolution instruction for some teachers and students has existed for decades, teaching strategies for addressing this stress have not achieved consensus (Hokayem and BouJaoude 2008). Some of these debates stem from philosophical disputes regarding the relationship of belief, understanding, and knowledge and the implications for evolution curricula; others come from disagreements regarding other theoretical

considerations involved in evolution education, regarding such perspectives as conceptual change, conceptual ecologies, and worldviews (Cobern 2000; Mathews 2009, 2014; Smith and Siegel 2004, 2016).

In the U.S. there is also a legal component to the debate, as many contend that the perspective of keeping religion removed from the public school curriculum is endorsed by the non-establishment clause of the First Amendment. Some U.S. teachers and researchers, however, have contended that there is an “inherent connection ... between [evolution and creation] that occurs naturally in students’ minds” and that teachers should not neglect their students’ questions regarding these connections (Meadows et al. 2000, p. 104). Reiss has discussed how the British and American recommendations by national bodies differ on this subject, with American institutions, such as the National Academy of Sciences, suggesting that creationism not be discussed in science class as it is not science, while British agencies such as the Department of Children, Schools and Families recommend that discussing why creationism is not science is an opportunity for science teachers to demonstrate to their students what science is and what it is not (e.g. 2011, 2014). However, even in countries such as England, where religious education is included as part of public (state) schooling, studies have found that it is difficult for students to make cross-disciplinary connections without direct instruction on the possible relationship between science and religion (Mujtaba et al. 2017). As a result, students often view science as a worldview that excludes other ways of seeing the world, thereby missing the opportunity to develop interdisciplinary insight (Billingsley et al. 2016).

In exploring views on the compatibility of evolution and religious worldviews, studies have found a wide range of perspectives expressed by students and teachers (Basel et al. 2014; Yasri and Mancy 2014). For instance, in an investigation into Lebanese college students’ views,

broad opposing poles were identified and, with particular reference to two students – one who thought that evolution was universally accepted by all fellow biology students and another who contended that evolutionary theory should not be considered part of science but rather cultural studies – the authors concluded that “it would be safe to say that neither of these two students could put himself in the other’s shoes” (Hokayem and BouJaoude 2008, p. 409). As will be discussed below, the current article argues for the value of students being able to step into another’s shoes and presents an exercise that can assist in attaining this goal.

One recent study has brought attention to the prevalence of a scientific attitude among some students, which depicts science as a superior way of knowing while failing to recognize its bounded nature (Konnemann et al. 2016). Another study divided respondents into one group who see both those who contend that ‘science trumps religion’ and those who contend that ‘religion trumps science’ as perpetrators of the conflict thesis between religion and science, and a second group who do not presume conflict to be necessary (Yasri and Mancy 2014). Other studies have found that there are also respondents who have an ‘unexplored’ or ‘undetermined’ approach to these issues, in addition to those whose views could be categorized into the more standard designations of viewing science and religion as independent, compatible, or contradictory (Billingsley 2004). The exercise proposed below aims to help students identify some of these common attitudes, as well understand that a broader spectrum of perspectives exists.

It is also important to note that cultural context significantly affects the proportions of students who self-identify with one categorization of the relationship between science and religion or another. For instance, in comparing the data collected in Thailand, Scotland, and Pakistan, it was found that 22% of Thai students contended that science and religion ask different questions, while only 12% of Scottish and 3% of Pakistani students did; and that 40% of

Pakistani respondents contended that ‘religion trumps science’, while only 5% of Scottish and 4% of Thai respondents did (Yasri et al. 2013). Therefore, looking at views on the interaction of scientific and religious perspectives in general, and evolution and creation in particular, in both a global and local perspective is essential; tracking the different responses to the exercise proposed below in different geographical and cultural contexts would be valuable for further understanding of these issues.

Indeed Thomas, writing about contemporary Indian scientists and their relationship with religious worldviews, recently questioned the culturally laden and historically contingent nature of the categories of science and religion (2018). Following Latour, he argues for a non-dualistic perspective that sees science and religion as two distinct modes of existence that should not be judged as conflictual or complementary, but be allowed to be experienced each on its own terms. Similarly, Tang and Yang recently presented their study of religious Christian biology students in Singapore as a counter-narrative to the science and religion dichotomy often described in research, and stressed the importance of agency on the part of individuals to negotiate differing worldviews (2017). In the U.S., sociologists have been calling for recognition of new social identities that deviate from the modern vs tradition split, using the term ‘post-secular’ to describe a group of individuals found to have positive views of both science and religion but who privilege religious accounts over scientific ones in certain instances where religion and science are thought to conflict, such as regarding evolution and creation (Alexander 2015b; O’Brein and Noy 2015).

While recognizing the problematic danger of reifying the shifting nature of the categories of science and religion, there is still the educational challenge of helping students understand possibilities for the relationship between these different understandings of life at a given moment

in a given context. In this article, we propose an exercise that parallels work done in cross-cultural education through the method of ‘scriptural reasoning’ (Ford 2006). Indeed, it is of interest that when scriptural reasoning was implemented as a cultural competency course for Jews, Muslims, and Christians working in Israeli hospitals, secular Israeli participants contended that the strictly religious sources did not reflect their identity (Kaye 2012). Breaking down the barriers between scientific and religious perspectives and allowing for ‘border crossing’ (Aikenhead 1996), this intervention could be implemented in secondary school subjects including science, religious, and citizenship education (Alexander and McLaughlin 2003; McLaughlin 1992), and could answer the call for educational resources that foster understanding across different perspectives of science and religion specifically (Barnes and Brownell 2017), and issues with scientific and societal aspects more generally (Meyer and Crawford 2011), in addition to reducing tensions between evolution and religion.

### **Pedagogy of Difference**

The approach of ‘pedagogy of difference’, developed within the contexts of religious education and citizenship education, can be applied to the issue of evolution education to promote dialogue between scientific and religious views concerning the origins of the universe and of humankind (Alexander 2015a). This perspective views science and religions as reflecting different, sometimes overlapping, but also sometimes incommensurate, ways of knowing (Moore, 1984). One seeks empirical explanations of how the world works that among other consequences enable us to better control our environments; the other seeks teleological explanations about the purposes of existence often grounded in theologies or associated with ethical traditions about how one should live. In addition to acquiring understanding and, perhaps, acceptance of evolution, this approach asks learners to consider other perspectives based on the

distinction between instruction *in*, *about* and *from* worldviews (Byrne 2014). Whereas instruction *in* a tradition aims to initiate into a particular path, to become an insider as it were, instruction *about* an orientation calls for phenomenological understanding, to imagine oneself an insider without actually becoming one, or historical, cultural, or political knowledge, from an outsider's perspective, and instruction *from* a worldview encourages consideration of its wisdom without requiring assent.

Students should learn *about* and *from* varieties of belief and unbelief, following this pedagogy, whether or not they are initiated *in* a particular position, and to juxtapose dichotomies and differences among alternative viewpoints. In this spirit, we support the juxtaposition of scientific and religious attitudes toward evolution in the curriculum, drawing on relevant philosophical resources; however, this does not necessarily mean that we advocate teaching religion in the science classroom or science in religious education. The aspects of pedagogy of difference in this approach relate to learning about or from scientific or religious viewpoints, not being initiated into accepting or believing one or the other. This approach is not intended to relativize the epistemic or ethical legitimacy of one or the other. The claims of each remain entirely intact within the ways of life in which they are pursued, including claims about universality or being the best possible explanation of one kind or another. Rather, to ask a person of faith to learn about or from science, or an individual who seeks to ground belief and behavior in rational argument or evidence alone to learn about or from religious narratives, calls them to recognize the possible value of perspectives that are different from their own. In other words, this approach would ask people to “learn to critique, not only according to the internal standards of traditions to which one is heir or with which one has chosen to affiliate, but also according to

the criteria of at least one alternative, if not more” (Alexander 2017, p. 312). This should enrich rather than threaten existing beliefs, including ways of thinking, knowing, and practice.

### **The Goal of an Evaluative Position**

Cultivating epistemic insight in terms of the appreciation of multiple perspectives is only the first step, however. Next must be the move to an evaluative position that requires critical thinking (Taber et al. 2015). Our position on this is based in part on a line of scholarship concerning epistemic thinking in cognitive psychology that has described three primary ways learners conceived the nature of knowledge: absolutist, multiplist, and evaluativist (Hofer and Pintrich 1997; Kuhn 2001; Barzilai and Zohar 2014).

According to an absolutist perspective, for an assertion or putative fact to count as genuine knowledge, it must be grounded in relevant and indubitable evidence that lends itself to certainty, such as the empirical findings of natural science or the logical conclusions of mathematical reasoning. Advocates of a multiplist perspective hold that there may be competing conceptions of what should count as evidence relative to conceptual frameworks drawn from such human experiences and embodiments as culture, class, religion, race, ethnicity, gender, or sexual orientation. Hence, there may be multiple ways of explaining natural phenomena depending on the conceptual framework within which one formulates an assertion, a fact, or the sort of evidence or reasoning on which it might be based. Those who adhere to an evaluative position acknowledge that there may be more than one explanation for a particular assertion based on relevant evidence, but question whether evidence can ever be as solid or indisputable as supposed by the absolutists. Hence, followers of this view seek to evaluate assertions according to the best evidence available to discover the best possible explanation of the phenomenon in question in an otherwise uncertain world (Barzilai and Chinn 2018).

The most strident examples of struggle between scientific and religious accounts of the origins of the universe and of species in both science and religion education stem from absolutist thinking about the nature of knowledge. This creates a zero sum game in which only one of the two putative cosmogonies could possibly be true, either scientific explanations involving a big bang and the evolution of species from inorganic precursors or (in Judaism and Christianity) the first chapters of *Genesis* in which God created the world in six days and extracted the first woman from a rib of the first man, to take but one example from an influential religious tradition. Formulated in this way, both sides of the debate tend toward a somewhat rigid or literalist way of reading the evidence they deem relevant, whether empirical or textual.

A multiplist response to this dilemma would suggest that scientific and religious perspectives reflect different ways of knowing, and that the criteria for assessing and accepting evidence, reasoning, assertions, and facts according to one way of knowing cannot be legitimately applied to the other. However, many science and religious educators would feel uncomfortable with this response because it appears to embrace a strong form of relativism. This sort of relativism holds that assertions seeking to express truth or goodness can only be properly understood within the conceptual frameworks in which they are formulated, and also that they can only be reasonably assessed within those frameworks. This is widely held seriously to weaken the epistemological standing of all knowledge claims, including those grounded on scientific evidence, textual reasoning, or religious faith, and yields a form of protectionism that precludes commentary and critique among competing ways of life or worldviews.

The evaluativist perspective offers a softer form of relativism, sometimes also called ‘weak objectivism,’ which is related to what Quine has referred to as ‘ontological relativity’ (1969) and Blackburn as ‘quasi-realism’ (1993). This position accepts the idea that assertions are

best understood within the contexts in which they are formulated, without precluding commentary and criticism across frameworks (Alexander 2001). For example, alternative research programs both within and among academic disciplines may produce alternative, even competing, ways of conceiving or explaining particular phenomena. According to this understanding, such cross-fertilization should generate dialogue across research programs, both within and among disciplines, which can eventually yield considered judgment about which of these various conceptualizations or explanations best fits the available evidence (Alexander 2015a). But if concepts and definitions of evidence are not shared across research programs, it may not be so easy to resolve differences or reach agreement about what could possibly count as the best explanation of a phenomenon. For example, experimental psychologists and psychoanalysts not infrequently disagree about the very nature of what might count as evidence to explain a behavior. Whereas the former often only consider behavioral evidence that can be observed, measured, and controlled, the latter are more inclined to examine manifestations of the internal dynamics of a person's feelings and relationships. The best possible explanation according to the one perspective may not even count as an explanation from the other viewpoint. And this is where there is at least an in principle agreement that assertions and explanations should be grounded in empirical evidence of one form or other. What are we to make of dialogue between scientific ideas grounded in hypothetico-deductive reasoning of some sort and religious ideas whose logic is rooted in other ways of life altogether? The suggested distinction between teaching for 'knowledge' and 'understanding' of evolutionary biology, on the one hand, and 'belief' in the veracity of its findings, on the other (Smith and Siegel 2004, 2016; Laats and Siegel 2016), for example, does not adequately consider how to engage with perspectives that draw on different, overlapping, and often incommensurate ways of life.

## **An Epistemic Insight Exercise**

In order to aid students in the consideration of other perspectives based on the distinction between instruction *in*, *about* and *from* worldviews, as well as the adoption of an evaluative stance towards religious and scientific ways of knowing regarding evolution, the following intervention is suggested. Throughout, we have kept in mind high school students in the 14-18 age range though we consider that the approach is suitable for higher education students and, perhaps in a simplified version, might be suitable for some younger students. We envisage a classroom in which there are some differences of opinion about religion, more precisely, about the pertinence of scripture for an understanding or acceptance of evolution. We doubt that less than 40 minutes would suffice for the exercise and subsequent debrief to be run.

### **Step 1**

Each student reads:

1. A religious text excerpted from the Hebrew Bible (e.g. *Genesis* 1: 24-28), the Qur'an (e.g. Surah 16: 3-11), or other relevant scripture depending on the make-up of the student body.
2. An account of evolution excerpted from *On the Origin of Species* (e.g. the first and last paragraph of Chapter 14: Recapitulation and Conclusion – widely available online, e.g. <http://www.talkorigins.org/faqs/origin/chapter14.html>).

Each student then writes on a sheet of paper their own perspective concerning each of the two passages:

1. One paragraph concerning the creation account from scripture;
2. One paragraph concerning the excerpt from *On the Origin of Species*.

3. One paragraph detailing similarities and differences that exist between the two accounts.

Students fold and place the sheet of paper with their perspective in one of their pockets, a practice which functions as a symbol of setting their own perspective aside for the time being.

## **Step 2**

Students are divided into groups of three. Each student in the group is randomly assigned to one of the following three positions. That knowledge is based on:

1. *Science-only* (as the student perceives the perspective of an atheistic scientist to be, e.g. Richard Dawkins);
2. *Religion-only* (as the student perceives the perspective of a creationist to be);
3. *An integrated perspective that accepts both science and religion* (i.e. integrationist, though we acknowledge that this term has also been used in the literature in a narrower sense than we do here).

Each student takes the perspective of his or her assigned way of knowing to construct a written response to each passage.

1. One paragraph concerning the religious account;
2. One paragraph concerning the excerpt from *On the Origin of Species*.

Each student then shares their two statements written from their assigned perspective with the other two students in their group. The group works to reach six consensus positions (if possible) as to their understandings of the perspectives of (i) an atheistic scientist, (ii) a creationist, and (iii) an integrationist, in each case (a) for the creation account from scripture, and (b) for the excerpt from *On the Origin of Species*.

A class-wide discussion then ensues. If possible, the class reaches six consensus positions with respect to their understandings of the perspectives of (i) an atheistic scientist, (ii) a creationist, and (iii) an integrationist, for (a) the creation account from scripture, and (b) the excerpt from *On the Origin of Species*.

### **Step 3**

Students take out the accounts of their own perspectives from their pockets. Each student compares their own perspective of the two passages with those of the consensus perspectives (*science-only, religion-only, an integrated science and religion perspective*) and writes about the similarities and differences between their own perspective and the three consensus perspectives. Individuals in their group of three then discuss how their own views are similar to or differ from the class consensus perspectives.

### **Step 4**

Students reflect on and write about the following four questions:

1. Do science and religion answer the same questions? Explain.
2. What are some of the similarities and differences between scientific and religious ways of knowing?
3. How does learning *about* a tradition (i.e. scientific, religious) differ from learning *in* or *from* one?
4. What is the best way for society to move forward, knowing that a spectrum of views is represented within it?

### **Debrief**

Following the exercise, it is important for the instructor to debrief the activity. Debriefs are widely used in role plays and other activities that benefit from students reflecting on what

they have just done. The key point is to help students appreciate *why* they have just undertaken the exercise that they have. This is best done using straightforward language without simply repeating what the students have already been told. Regarding questions 1 and 2, we recommend that the teacher take time to review aspects of the nature of science to help students distinguish between religion and science as ways of knowing in the context of evolution. For example, in comparing the religious account with Darwin's, students might have recognized the following:

Science is restricted to the provision of naturalistic explanations of phenomena, while “explanations employing supernatural events and/or deities are beyond nature and, hence, beyond the realm of science” (Clough 1994, p. 412); Evolutionary theory does not have much to say about the origin of life. Rather, it provides our best naturalistic explanation of the origin of species, that is, those “pathways and mechanisms of organic change” that lead to organismal diversity (Gould 1987, p. 7); Scientific theories, such as evolutionary theory, are “well-established, highly substantiated, internally consistent systems of explanations” (Lederman et al. 2002, p. 500), but they are not passed off as absolute truths of reality (Ryan and Aikenhead 1992), which Einstein and Infeld explained with the following analogy (1938, p. 31):

In our endeavor to understand reality, we are somewhat like a man trying to understand the mechanism of a closed watch. If he is ingenious he may form some picture of a mechanism, which could be responsible for all the things he observes, but he may never be quite sure his picture is the only one, which could explain his observations. He will never be able to compare his picture with the real mechanism and he cannot even imagine the possibility or the meaning of such a comparison.

The teacher should help students compile a list of the similarities and differences they identified concerning religious and scientific ways of knowing, highlighting aspects of the nature of science that contributes to its great explanatory power but also indicates limitations that preclude it from answering certain questions that religions might address. In this manner, demarcating

science and religion as ways of knowing should contribute to students' development of epistemic insight while reducing their resistance to learning about evolution and so possibly reducing tensions they experience between evolution and religion.

If we want students to be able to answer question 3, this requires thinking about religions and science in ways other than as parallel ways of knowing. Science is indeed a way of knowing in the empirical sense. It is intended to produce and confirm what is sometimes called knowledge or belief that such and such is the case. However, if religion entails knowledge of any kind, it is more along the lines of what Israel Scheffler (1983) once called personal knowledge. This entails knowledge of another person, such as a friend, parent, or lover. In the case of monotheistic religions, knowledge of God can be understood in this way, as resulting from a personal or intimate encounter or dialogue of some kind. One might accept that which is received from a partner because a relationship of trust emerges from the encounter that bestows epistemic authority to that which is received from it – as recorded, for example, in sacred texts. But, to the extent that this sort of personal knowledge offers a description of events in the world, such as the *Genesis* creation narrative, its primary purpose has to do with how to live in the world, not how the world actually works. In this sense, science and religions can be seen as representing different forms of life that entail what Ludwig Wittgenstein (1953/1983) once called different, if sometimes overlapping, language games.<sup>1</sup> At the same time, some students may find such a view unsettling, even threatening. There are many ways of understanding what a religion is (e.g. Smart

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<sup>1</sup> By the term “form of life” we are not speaking biologically, to describe different biological species. Rather we are speaking of diverse ways in which human beings live in the world, modes of thinking and practicing, believing and behaving, in which people participate at various times and in various ways, sometimes professionally, sometimes personally, sometimes collectively, sometimes individually. Science is a form of life in this sense in that it involves a ways of thinking and inquiring intended to produce knowledge based on the systematic examination of empirical evidence. Religions are also forms of life as they too entail thinking and acting. For the most part, however, these attitudes and practices are not intended to produce empirical knowledge in the scientific sense of the term. Rather, they rely on other possible ways of knowing, which might be based on personal experiences, direct encounter, or interpretation of sacred texts.

1998; Hinnells 2010); in some of these, the scriptures are indeed seen as providing explanations that overlap with those of science in the sense that they do present accounts of data about the world, including how the world works.

According to this account, scientific or religious education often entails initiation *in* scientific or religious forms of life. This involves coming to value and accept certain practices and ways of thinking, including how one justifies one's beliefs. For example, scientific inquiry requires that conclusions be based on the rigorous examination of empirical evidence while religious thinking is often based on various forms of textual reasoning relating to sacred texts such as the Hebrew or Christian Bible or the Qur'an.

But initiation and acceptance are not the only stances that one can take with respect to these forms of life. One can come to respect and learn *from* a scientific or religious form of life without necessarily accepting all of its customs and tenets. One can appreciate the rigor of scientific investigations or the curiosity that drives scientists to seek to explain how the world works, for example, while not necessarily agreeing with all of the conclusions derived from scientific investigations. Similarly, one might come to admire the egalitarian sentiment in the idea that all humans are created in the divine image without believing that the world was created by God. This could then contribute to a fundamental respect for human life that might influence how scientific research on human subjects is conducted.

However, to be in a position to learn from a form of life that may be different from the one's own, one must know something about them. Knowledge *about* scientific or religious forms of life can be acquired by viewing them from the outside, as it were, without necessarily receiving the sort of initiation required to become an insider, a believer, so to say. This can be accomplished by viewing a form of life historically or sociologically, for example. Students with

deep religious convictions might be exposed to selected topics in the history or sociology of science, for example, to help them learn how and why people who accept scientific ways of thinking have come to do so. Similarly, scientifically minded students without a religious background could be exposed to topics in the history or sociology of religion, perhaps with special attention to religious beliefs about the origins of the universe or of species. This could contribute to an appreciation of why religious people believe and behave as they do.

Learning about a form of life can also be accomplished phenomenologically, by experiencing what life might be like either as a practicing scientist or a religious believer. This involves learning about a particular form of life from the inside, as it were, not in order to accept all of its practices and attitudes, but in order to appreciate it more profoundly, and then learn *from* that perspective those elements which appears to be most valuable. This could form a strong justification for science teaching to religious students, who would benefit from an insider's appreciation of scientific inquiry even if at the end of the day they might remain doubtful about some of its assumptions, practices or conclusions. Similarly, students with little or no background in a religion might gain a better understanding of religious forms of life from visiting worship services of different faiths, not as a worshipper, but as amateur anthropologists, seeking to understand from personal experience at least the beginnings of what it might be like to worship in this or that way.

The debriefing associated with question 3, then, should explore with students what it might mean to be initiated into scientific or religious forms of life, based on the texts that they have read. It would also examine with them what they might be able to learn from scientific or religious perspectives on evolution, whether or not they accept them, and the ways in which they

could learn about these forms of life by participating in them, in one form or another, as a visitor or participant observer.

How will understanding a variety of views concerning evolution help students to negotiate the issue of learning about evolution, as well as other issues about which there might be a plurality of viewpoints to consider? We often consider a view on a particular topic such as evolution to be an educated one, as opposed to a dogmatic, arbitrary, or indoctrinated view, when our understanding entails what is sometimes called a critical perspective. For many science educators it has long been believed that such a perspective entails the ability to assess statements according to the rigorous rational and empirical criteria associated with scientific inquiry. And this is surely the case when assessing statements formulated within a scientific form or life or way of thinking. However, a respectful dialogue between scientific and religious forms of life suggests that a variety of views may be in competition with one another about what it might mean to possess a critical perspective, to take a genuinely educated position on a topic such as evolution. Another possible understanding of the sort of critical perspective important for an educated viewpoint on a subject such as evolution, then, would suggest the ability to consider issues from a variety of vantage points, from the perspectives of both insiders and outsiders. This way of thinking about the sort of critical orientation required of education is not inconsistent with the more traditional rational or empirical position stated above, and it is especially consistent with the requirements of citizenship in diverse democratic societies.

### **Epistemic Insight Exercise for Science, Religion, and Citizenship Education**

The question arises: in which subject of instruction would it be most appropriate to employ the exercise for epistemic insight described above: science, religious or citizenship education? We suggest the intervention is appropriate for science education, while

acknowledging that in some countries it may not be feasible, as it contributes to a contextual understanding of the nature of science, including what can and cannot be answered by science. Religious education, in those countries that have religious education in school, would equally benefit from the exercise, as individuals develop epistemic insight that allows them to compare scientific and religious/spiritual aspects of their ways of knowing. Similarly, citizenship education would certainly benefit from individuals having a better understanding of the plurality of views concerning evolution, which might even contribute to compassion and empathy. In all instances, we advocate a search for what Harvard philosopher Robert Nozick (1981) has called ‘philosophical explanations’, in which students learn to explain within their own belief systems how it is possible to believe one thing given other opposing things.

### **Discussion and Implications**

In many areas of life, science and religion are posed as conflicting, especially concerning evolution and creation. Some religious individuals perceive evolution instruction as imposing a form of scientific hegemony in schools that belittles traditional cosmogonic narratives as mere superstition. Equally, some evolutionists view religion as the ‘root of all evil’ (Dawkins 2006). In doing so, each side cultivates a devotion to one perspective while debasing the other (Alexander 2017; Hull 2000). In reality, however, such perspectives represent two end points on a spectrum concerning the relation between science and religion.

Students often perceive a firm boundary between science lessons and religion lessons (in countries that have such lessons) that makes it difficult to transfer instruction about science and religion across subject boundaries. Research has suggested that examples of direct instruction that explore the relationships between the two disciplines, such as the exercise presented above, are needed (Billingsley et al. 2015). More broadly, “it is incumbent upon religious, political, and

educational leaders who desire societies that foster peaceful coexistence across difference to conceive and promote intelligent interpretations of their respective world views” (Alexander 2017, p. 302). The proposed exercise aims to do just that by helping students recognize, acknowledge, and articulate the diversity of perspectives regarding the relationship between scientific and religious understandings of evolution with the goal of fostering an understanding of the nature of science and other forms of life, and recognizing the possibility of learning about and from diverse orientations.

Our work builds on the work of other educators and researchers who have begun to implement strategies aimed at rejecting the position that there is necessarily conflict or tension between evolution and religion, instead making space for students to examine their own views through journaling and discussion, clarifying the nature of science and religion as different ways of knowing, and even highlighting potential compatibilities between the two. Barnes and Brownell (2017) recently summarized much of this work in their formulation of ReCCEE (Religious Cultural Competence in Evolution Education) practices. The exercise proposed here includes many of their suggestions.

In addition to educators in science or religion and other educators with an interest in how contentious issues might be taught, we believe that our work has implications for policy makers. We maintain that it is possible to have an education that addresses difference in views between students but that does so in a way that both respects students and opens the way, without requiring it, to the possibility that students may change their minds. Not only should the exercise presented here assist evolution education directly, it should also aid students in situating science as a resource for making decisions that range from everyday tasks to making the types of informed decisions that are required of democratic citizens. Scientific literacy that informs

everyday decision-making is of the utmost importance and serves as a primary objective for science education (AAAS 2008; Roberts and Bybee 2014). An understanding of the types of questions science can and cannot answer is critical to scientific literacy. For example, there are questions of science, such as whether smoking causes cancer or obesity leads to diabetes, which can be answered objectively by way of the systematic collection and analysis of data (Marincola 2006), while questions also exist that are outside the realm of science, such as questions to do with aesthetics, morality and meaning.

There are also issues that are informed by science, such as how to predict and mitigate the effects of anthropogenic climate change, the desirability of nuclear power or the regulation of genetically modified organisms, that cannot be addressed in full without due consideration of non-scientific factors, such as moral, ethical, political, and economic factors (Owens et al. 2017). These sorts of socioscientific issues (SSI), which are often contentious, require an evaluativist perspective that enables the balancing of multiple points of view (cf. Zeidler and Sadler 2011). Consider gene therapy or cloning – issues that are certainly undergirded by science but are also informed by a number of factors that fall outside the purview of science. Central to an individual’s ability to reason about complex biology-based SSI is an understanding of evolution (cf. Fowler and Zeidler 2016; Sadler 2005), as well as moral and ethical considerations (Zeidler et al. 2014). Students’ engagement with the pedagogy of difference as illustrated in the exercise we propose above can assist students in their utilization of scientific and other forms of understanding in their decision-making processes concerning SSI (Sadler, 2004; Tal et al. 2011; Walker and Zeidler 2007; Zeidler and Kahn 2014).

## **Conclusion**

Science teachers often feel uncomfortable with teaching topics, such as evolution, that are socially controversial, not wanting to offend students, their parents, or the administration under which they work (Asghar et al. 2007; Jackson et al. 1995; Schilders et al. 2009). When they do teach the subject, they often remain wedded to empiricist philosophies and present such topics as facts to be understood and accepted without consideration of students who perceive their worldview to differ significantly from the facts provided (Duschl 1985). While instructing from an authoritative position as the source of reliable knowledge (Cobern 2000) might comfort the teacher, students who may disagree can simply ignore the authoritative source and reject the facts as presented, in which case no amount of authoritative explanation can aid students in, for example, the integration of evolution into their existing worldview; as a result, an opportunity for learning is lost.

When teachers also engage with the issue of creationism, and students are willing to share ideas and opinions, teachers can still miss opportunities to manage these ideas and give credence to the scientific perspective, thereby showing the need for further guidance regarding how to shape the discussion (Oliveira et al. 2011; Sickel and Friedrichsen 2013). It is therefore requisite that instruction makes space for the teacher and students to consider the perspectives of others and the reasons each has for holding their beliefs. In this article, we present the pedagogy of difference and an intervention that aids students in developing epistemic insight and an evaluative perspective when considering evolution and religion.

In conclusion, students may come from a perspective where religion has been defined in the singular and presented as oppositional to science. Broadening students' perspectives on the possible relationships between science and religion can allow students to be more open to the study of evolution. Learning that evolution does not necessarily contradict their faith or values is

often a criterion more fundamental for readiness to engage with evolution than understanding the soundness of the science. Once this barrier and hurdle has been lessened, science teaching can then proceed more fruitfully.

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