

The Exemplar Approach to Science and Religion¹

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Abstract: We can judge whether some activities are scientific or religious, depending on how similar they are to exemplar scientific activities or to exemplar religious activities, even if we cannot specify the necessary and sufficient conditions for science and religion. The absence of the demarcation between science and religion does not justify the school policy of teaching the creationist hypothesis that God created the universe any more than it justifies the religious policy of teaching evolutionary theory, quantum mechanics, and the Big Bang theory in religious institutions.

Keywords: creationist hypothesis, demarcation, exemplar theory, religion, science.

1. Introduction

How should we distinguish between science and religion? Are there distinctive features of science that set it apart from religion, and distinctive features of religion that set it apart from science? These questions are interesting in themselves, but they also have grave practical implications. As Gregory Peterson (2002) and William Hasker (2009) note, some creationists argue that schools should teach the creationist hypothesis that God created the universe. If there is, however, a tenable criterion for distinguishing between science and religion, we can use it against the creationists' suggestion.

Larry Laudan (1982) is reputed to have demolished the demarcation between science and religion. As Robert Pennock (2011, 180) observes, creationists cite Laudan's putative destruction of the demarcation between science and religion to argue that schools should teach the creationist hypothesis. Those creationists are J. P. Moreland, a philosopher at Biola University, Stephen Meyer, a philosopher at Discovery Institute, and Casey Luskin, a staffer at Discovery Institute. The aim of this paper is to show that Laudan's alleged obliteration of the demarcation between science and religion does not establish that the creationist hypothesis should be included in science texts.

My discussion proceeds as follows. In Section 2, I present Laudan's case against some philosophers' attempts to demarcate between science and religion in terms of necessary and sufficient conditions. In Section 3, I criticize the aforementioned creationists' inference that since there is no strict distinction

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between science and religion, the creationist hypothesis should be taught in science classrooms. In Section 4, I invoke the exemplar theory of concept representation in cognitive psychology to explain why it is inappropriate to teach the creationist hypothesis in schools. In Section 5, I argue that our children should be exposed to exemplar scientific activities, as opposed to exemplar religious activities and borderline activities, in science classrooms. In Section 6, I reply to some possible objections.

2. Laudan's Criticism

What feature of science makes it what it is? What is the feature of science such that if an enterprise does not have it, it is not science, and if an enterprise has it, it is science? In other words, what is the necessary and sufficient condition for science? This question is answered by some philosophers of science. This section examines their answers and Laudan's critiques of them.

Carl Hempel proposes testability as the hallmark of science. On his account, if a hypothesis is not testable, it is not scientific. If it is testable, it is scientific. He says, "no statement or set of statements *T* can be significantly proposed as a scientific hypothesis or theory unless it is amenable to objective empirical test, at least 'in principle.'" (Hempel 1966, 30) A hypothesis is testable if and only if we can obtain observational data to determine whether it is true or false. A hypothesis is confirmed when it agrees with the experimental outcome, and disconfirmed when it disagrees with the experimental outcome.

In contrast, Karl Popper proposes falsifiability as the hallmark of science. On his account, if a hypothesis is not falsifiable, it is not scientific. If it is falsifiable, it is scientific. He says, "The criterion of falsifiability is a solution to this problem of demarcation, for it says that statements or systems of statements, in order to be ranked as scientific, must be capable of conflicting with possible, or conceivable, observations." (Popper 1963, 51) A hypothesis is falsifiable just in case we can conceive of an observation that proves it to be false. Popper's proposal stems from his observation that we can prove a general hypothesis to be false, although we cannot prove it to be true.

Can we use Hempel's or Popper's criterion to distinguish between science and religion? Can we say, for example, that evolutionary theory should be taught in science classrooms, but creationism should not be, on the grounds that evolutionary theory is testable or falsifiable whereas creationism is not? Laudan says no. He observes that creationists make many testable claims. They claim, for example, that "the earth is of very recent origin (say 6,000 to 20 thousand years old)," and that "animals and man were created at the same time." (Laudan 1982, 16) These "claims are testable, they have been tested, and they have failed those tests." (Laudan 1982, 16) Thus, some creationist claims are testable and falsifiable.

Let me now turn to Thomas Kuhn's distinction between science and other enterprises. He claims that to be scientific is almost the same as to do normal

science. He says, “this is for now my main point, a careful look at the scientific enterprise suggests that it is normal science, in which Sir Karl’s sort of testing does not occur, rather than extraordinary science which most nearly distinguishes science from other enterprises.” (Kuhn 1970, 6) When scientists do normal science, they solve puzzles within a paradigm, i.e., they articulate the paradigm, they apply it to diverse parts of the world, and they develop scientific instruments, such as electron microscopes and particle accelerators. Most importantly, they do not discard the paradigm, even if it conflicts with experimental results. When experimental outcomes clash with the paradigm, blame is put not on the paradigm but on scientists’ ability to perform experiments.

Can we use Kuhn’s criterion to distinguish between science and religion? Park (2016, 48) says no on the grounds that there is an aspect of science that Kuhn’s philosophy of science cannot account for. Theoretical physicists today attempt to unify quantum physics and general relativity. These two theories are fundamental physical theories belonging to different paradigms. It is not clear whether the theoretical physicists are doing normal science. It is clear, though, that they are doing science. So doing normal science is not the hallmark of science.

Can we say that scientists are open-minded, so they revise their beliefs in the light of new experimental results, whereas creationists are closed-minded, so they do not revise their religious beliefs in the light of counterevidence? Laudan says no. He observes that creationists sometimes modify their opinions in response to new evidence, changing “their minds from time to time.” (Laudan 1982, 17) Moreover, “the scientists of any epoch likewise regard some of their beliefs as so fundamental as not to be open to repudiation or negotiation.” (Laudan 1982, 17) In short, creationists are open-minded just like scientists at times, and scientists are closed-minded just like creationists at other times.

Laudan has made a valuable contribution to the debate over the demarcation between science and religion. He has shown that it is difficult to define science and religion in terms of necessary and sufficient conditions. Counterexamples spell doom for the proposals that the hallmarks of science are testability, falsifiability, normal science, and being open-minded.

3. Critiques of the Creationist Inference

What can we conclude from the fact that Laudan has provided counterexamples against some philosophical attempts to demarcate between science and religion in terms of necessary and sufficient conditions? As already noted in the introduction of this paper, some creationists conclude that the creationist hypothesis should be taught in schools. Their inference exemplifies the inference scheme that since there is no demarcation between two enterprises, a view taught in one enterprise should also be taught in the other enterprise. This section aims to reduce this creationist inference scheme to absurdity.

The creationist inference scheme has the following three absurd consequences. First, we should also teach science in religious institutions. For example, we should teach evolutionary theory and the Big Bang theory in religious institutions, such as churches, Buddhist temples, mosques, and Hindu temples. To implement this policy, religious institutions should be equipped with scientific instruments, such as particle accelerators and electron microscopes, and religious leaders, such as ministers, priests, and Buddhist monks, should be required to have at least master's degrees in science. After all, it is wrong to say that the absence of the demarcation between science and religion justifies the policy of teaching the creationist hypothesis in science classrooms, but not the policy of teaching evolutionary theory and the Big Bang theory in religious institutions.

Second, different religions have different creation stories about how the universe came about. The creationist hypothesis is just one of them. Muslims reject it, and accept instead that Allah created the universe. If we should teach the creationist hypothesis in schools, we should also teach the creation stories of other religions in schools. After all, it is unfair to teach the former, but not the latter, in schools.

Third, there is no strict distinction between different religions. So if the creationist inference scheme is correct, we should also teach Christian doctrines in Hindu temples, Islamic doctrines in churches, Hindu doctrines in mosques, and so forth. Furthermore, ministers should cut their hair short like Buddhist monks, and chant Buddhist scripture in churches. Buddhist monks should grow their hair long like ministers, and sing hymns in Buddhist temples. Muslims and Hindus would also have to follow the customs of other religions.

In sum, Laudan has opened a street between science and religion. On close examination, however, the street is not a one-way street but a two-way street. Moreover, it obliterates not only the separation between science and religion but also the separation between different religions. The obliteration of the separations would be unsavory even to creationists. They would find it disagreeable that we should teach the Big Bang theory in religious institutions, Muslims' creation story in science classrooms, Buddhist doctrines in churches, and so forth.

An interesting question arises. Why is it inappropriate to teach the Big Bang theory in religious institutions, the creationist hypothesis in schools, Christian doctrines in Buddhist temples, and so on? A tenable answer to this question cannot be found in the definitions of science, religion, Christianity, Islam, Buddhism, and Hinduism, appealing to necessary and sufficient conditions for these enterprises. It can rather be found in the exemplar theory of concept representation to which I turn now.

4. The Exemplar Theory

Ordinary concepts are not represented by necessary and sufficient conditions. Think about the concept of bird. An animal does not have to be able to fly to be a bird, given that there are birds that cannot fly, such as ostriches and kiwis. So the ability to fly is not a necessary condition for a bird. Even if an animal can fly, it might not be a bird. For example, a bat and an insect can fly, but they are not birds. So the ability to fly is not a sufficient condition for a bird. It is difficult to provide the specification of the necessary and sufficient condition for a bird. Naturally, it is also difficult to provide the specification of the necessary and sufficient condition for science.

Even if ordinary people do not know the necessary and sufficient condition for a bird, they do not usually have a problem in classifying an object as a bird or a non-bird. Show a picture of a crow to children and ask them whether it is a bird or not. They will immediately answer that it is. Show a picture of a dragonfly to them and ask them whether it is a bird or not. They will immediately answer that it is not. How can ordinary people classify an object with ease, when they do not know the necessary and sufficient condition for the object? An answer to this question can be found in cognitive psychology.

Cognitive psychologists (Medin and Schaffer 1978; Estes 1986) argue that we use excellent examples called 'exemplars' to classify objects. For example, we use such birds as an eagle and a pigeon to classify birds. When asked to judge whether a crow is a bird, we compare the crow with the exemplar birds for similarity. The similarity between the crow and the exemplar birds is above the threshold. So we classify the crow as a bird. How about a dragonfly? The similarity between the dragonfly and the exemplar birds is below the threshold. So we classify the dragonfly as a non-bird. To generalize, when asked to judge whether an object is an instance of a certain kind, we compare the object with exemplars of that kind for similarity. If the similarity is above a threshold, we classify the object as an instance of that kind. If the similarity is below the threshold, we classify it as an instance of another kind. Thus, it is exemplars, not necessary and sufficient conditions, that enable us to classify objects.

The exemplar theory of concept representation sketched above has three interesting implications for the present issue of demarcating between science and religion. The first implication is that it is inappropriate to look for the necessary and sufficient condition for science. Hempel, Popper, and Kuhn put forward testability, falsifiability, and normal science, respectively, as the necessary and sufficient condition for science. They undertook a task that was fated to fail. We do not use a necessary and sufficient condition, but rather exemplars, to determine whether a target activity is scientific. When asked to judge whether a given activity is scientific, we compare it with exemplar scientific activities for similarity. If the similarity is above a threshold, it is classified as scientific. If it is below the threshold, it is classified as non-scientific.

What are exemplar scientific activities? My tentative answer is that setting up a hypothesis, performing an experiment to test it, operating scientific instruments, publishing research results, securing research funds from funding agencies, and so forth, are exemplar scientific activities. Let me emphasize that these activities are neither individually necessary nor jointly sufficient for being scientific. All I am saying is that if a certain activity is sufficiently similar to them, it is classified as scientific.

Let me focus on the first exemplar scientific activity, viz., setting up a hypothesis. Scientists do not advance any hypothesis, but only certain kinds of hypotheses. The following two hypotheses can be regarded as exemplar scientific hypotheses:

(S₁) $F=ma$

(S₂) Antarctica, Australia, and South American once formed a giant continent, and marsupials moved from South America to Australia via Antarctica millions of years ago.

(S₁) is Newton's second law of motion. It depicts how force, mass, and acceleration are related to one another. (S₂) is a hypothesis about the continents and the marsupials. It makes the true novel prediction that marsupial fossils exist in Antarctica (Woodburne and Zinsmeister 1982). We can classify a hypothesis as scientific or non-scientific, depending how similar it is to hypotheses like (S₁) and (S₂).

I have chosen (S₁) as an exemplar scientific hypothesis because it is a law of nature. Scientists are more interested in discovering regularities of nature than in collecting facts that bear no relationship to one another. (S₁) enables us to make quantitatively accurate predictions about objects. It tells us what acceleration an object will have, if a certain amount of force is imposed on it. By contrast, religious hypotheses, including the creationist hypothesis, do not yield such precise predictions. Moreover, even if they do, it is not clear whether they can be regarded as exemplar religious hypotheses. Imagine that ordinary religious followers go to churches or to Buddhist temples. To their surprise, however, ministers and Buddhist monks deal with mathematical equations like (S₁), demonstrating quantitatively accurate predictions instead of performing religious rituals. The followers would think that that is not an exemplar religious activity, and hence that is not what they would expect from their religious leaders.

I have chosen (S₂) as an exemplar scientific hypothesis because it made a novel prediction as a result of combining the knowledge from different fields of science. Scientists combined biological knowledge with geological knowledge to think up (S₂). In contemporary science, different fields of science are not isolated from one another, but interact with one another (Trefil and Hazen 2012). Interdisciplinary research is common in contemporary science. In contrast, Christians, Muslims, Buddhists, and Hindus seldom form joint research teams for

common religious agenda. Even if they do, they neither make nor confirm novel predictions comparable to (S₂). Even if they do, it is not clear that their activities can be regarded as religious. Imagine again that ordinary religious followers go to churches or Buddhist temples for religious purposes. To their surprise, however, ministers and Buddhist monks combine the information from Christianity and Buddhism to make novel predictions instead of performing religious rituals. The followers would again think that that is not an exemplar religious activity, and that their religious leaders are not doing what they are supposed to do.

The second implication of the exemplar theory for the issue of demarcating between science and religion is that there is no necessary and sufficient condition for religion either. There is no feature of religion that makes religion what it is. We can only judge whether an activity is religious, depending on how similar it is to exemplar religious activities. What activities are exemplar religious activities? My tentative answer is that believing a scripture, worshipping a deity, participating in congregations, giving prayers, and singing songs like *Amazing Grace* are exemplar religious activities.

Let me focus on the first exemplar religious activity, viz., believing a scripture. A scripture is different from a science text in that it contains statements not like (S₁) and (S₂) but like (R₁) and (R₂):

(R₁) God resurrected Jesus on the third day of his death.

(R₂) The Sun stood still, and the Moon stayed, until the people avenged themselves upon their enemies.

We classify a statement as religious or non-religious, depending on how similar it is to exemplar religious statements like (R₁) and (R₂).

The third implication of the exemplar theory regards the fact that there are many religions in the world, including Christianity, Buddhism, Islam, Judaism, and Hinduism, to name a few. How do we differentiate between different religions? Each religion has its own exemplar activities. Believing the Bible and singing a hymn in front of a cross in a church are exemplar activities of Christianity. Having a very short hairstyle, chanting a Buddhist scripture, and making deep bows in front of a Buddha statue in a Buddhist temple are exemplar activities of Buddhism. Islam and Hinduism have their own exemplar activities too. Imagine that you go to a church. To your surprise, however, some people in the church wear hijabs on their heads. You would think that their behavior is inappropriate in a church. But why is it inappropriate? A natural answer to this question is that wearing a hijab is more similar to exemplar activities of Islam than those of Christianity. So it is an appropriate behavior not in a church but in a mosque. In short, each religion has exemplar activities. We judge whether a target activity belongs to Christianity, Buddhism, Islam, or Hinduism, depending on how similar it is to the exemplar activities of those religions.

5. The Exemplar Theory and Science Education

Suppose that you aim to help children to acquire the concept of bird. The exemplar theory implies that the best way to achieve your aim is to show them exemplar birds, such as an eagle and a pigeon. You should not present to them the objects that are near the borderline between birds and non-birds, such as a penguin and a bat. A penguin is a bird, although it swims in the sea. A bat is not a bird, although it flies in the sky. Showing such objects to children is not the best way to help them acquire the concept of bird.

How should we teach science to school children? The exemplar theory implies that the best way to do it is to expose them to exemplar scientific activities, such as setting up hypotheses and performing experiments. We should expose them neither to exemplar religious activities nor to borderline activities. An interesting question is whether the creationist hypothesis that God created the universe is an exemplar scientific hypothesis, an exemplar religious hypothesis, or a borderline hypothesis. Intuitively, it is more similar to (R_1) and (R_2) than to (S_1) and (S_2) . After all, it is not a law of nature. It does not enable us to make quantitatively accurate predictions, as (S_1) does. Nor is it a result of knowledge from different fields of science, as (S_2) is. Neither does it make a novel prediction, as (S_2) does. Moreover, it clashes with the first law of thermodynamics, which states that mass-energy can neither be created nor be destroyed. The first law implies that it is impossible to create even an atom, let alone the universe, although it is possible to move an atom from one place to another.

Creationists would reply that God is omnipotent, so he can break the first law of thermodynamics. If they say so, however, the creationist hypothesis only moves farther from exemplar scientific hypotheses, for no scientist defends his or her hypotheses by invoking the omnipotence of God. If a manuscript invoking the omnipotence of God were submitted to scientific journals, such as *Nature*, *Science*, and *Cell*, editors would reject it without even sending it to external reviewers. Their decisions are based on the fact that the statements invoking the omnipotence of God are more similar to exemplar religious statements than to exemplar scientific statements.

Some creationists try to justify the creationist hypothesis by tapping into science. For example, they claim that they have found the remains of Noah's Ark near the top of Mount Ararat in Eastern Turkey and the archaeological evidence for the location of the Garden of Eden.

Let me say, however, that even if such attempts are successful, the creationist hypothesis can at best be viewed as a borderline hypothesis between scientific and religious hypotheses. As I argued earlier, a borderline hypothesis between science and religion does not have a place in science texts.

My suggestion that we should expose our schoolchildren to exemplar scientific activities, as opposed to exemplar religious hypothesis or borderline hypotheses, goes well with Kuhn's philosophy of science education. According to

Kuhn, students become scientists by being exposed to exemplars. In this context, exemplars are problem-solutions that set the precedents for future research. For example, the outcome of the Michelson-Morley experiment was a puzzle to physicists in the nineteenth century who had been working under the framework of the ether theory. Einstein solved the puzzle with his special theory of relativity, which led scientists to think that it can be used to solve other puzzles as well.

6. Objections and Replies

Many readers will take issue with my suggestion that (S_1) and (S_2) are exemplar scientific hypotheses, and with my suggestion that (R_1) and (R_2) are exemplar religious statements, and with the suggestion that wearing a hijab is an exemplar Islamic activity. There are other scientific hypotheses that can better serve as exemplar scientific hypotheses, and there are other religious statements that can better serve as exemplar religious statements. Moreover, any similarity judgment about a target activity and exemplars is controversial. Different people make opposite similarity judgments about an activity and exemplars. For example, some people may claim that a certain activity is more similar to exemplar activities of Christianity, while other people may claim that it is more similar to exemplar activities of Islam.

The existence of such problems, however, does not mean that religion should be taught in science classrooms, that science should be taught in religious institutions, and that a doctrine of a religion should be taught in the religious institution of another religion. Critics disagreeing with this reply owe us an account of why it is inappropriate to teach science in religious institutions, and to teach a doctrine of a religion in the religious institution of another religion. Why is it inappropriate to wear a hijab in a church? Why is it inappropriate to sing a hymn in a Buddhist temple? Christians cannot say that wearing a hijab in a church is inappropriate because such behavior does not fit the definition of Christianity. Nor can Buddhists say that singing a hymn in a Buddhist temple is inappropriate because such behavior does not fit the definition of Buddhism. After all, it is extremely difficult to provide the specification of the necessary and sufficient conditions for Christianity and Buddhism.

Creationists might now argue that the creationist hypothesis deserves a place in the US public schools, whereas the creation stories of Buddhism, Islam, and Hinduism do not, because the majority of the taxpayers in the US are Christians. On this account, it is legitimate to teach the creation story of Buddhism in the public schools of Buddhist countries, that of Islam in the public schools of Islamic countries, and that of Hinduism in the public schools of Hindu countries. Let me call this argument 'the argument from politics.'

The argument from politics is reminiscent of Pascal's wager. It holds that we should believe in God because he might exist. If he exists, we will go to heaven. If he does not exist, we have nothing to lose. Pascal has provided the pragmatic justification for the view that God exists. To advance such an argument is to

admit that there is no good epistemic justification for the view that God exists. Similarly, to advance the argument from politics is to admit that there is no good epistemic reason for teaching the creationist hypothesis in schools. It is not clear whether creationists are willing to go this far or not.

The traditional approach to science and religion attempts to find necessary and sufficient conditions for science and religion. By contrast, the exemplar approach to science and religion attempts to determine whether an activity is scientific or religious, depending on how similar it is to exemplar scientific and religious activities. Objectors might point out that there is a similarity between the two approaches. Defenders of each approach can agree that we learn important scientific and religious ideas by looking at the practices of science and religion.

The objectors are right on this account. I want to, however, emphasize an important dissimilarity between the two approaches. The traditional approach affirms, while the exemplar approach denies, that we can define science and religion in terms of necessary and sufficient conditions. It follows that the defenders of the traditional approach need to specify the conditions to prove that the creationist hypothesis does not count as scientific. In contrast, the defenders of the exemplar approach need not specify the conditions to prove that the creationist hypothesis does not count as scientific. They need only to prove that it is more similar to exemplar religious hypotheses than to exemplar scientific hypotheses. Laudan's case against the traditional approach makes it clear that the exemplar approach is preferable to the traditional approach.

7. Conclusion

Laudan has refuted a few philosophers' attempts to define science in terms of necessary and sufficient conditions. Even so, we can judge whether certain activities are scientific or religious, depending on how similar they are to exemplar scientific activities or to exemplar religious activities. Also, we should teach exemplar scientific hypotheses to our children in science classrooms, and we should not teach exemplar religious hypotheses or borderline hypotheses to them. The creationist hypothesis that God created the universe is an exemplar religious hypothesis. Therefore, it should not be taught in science classrooms.

Christianity, Buddhism, Islam, and Hinduism are different religions, although they cannot be defined in terms of necessary and sufficient conditions, because each of them has its own exemplar activities. Analogously, science and religion are different enterprises, although they cannot be defined in terms of necessary and sufficient conditions, because there are exemplar scientific activities and exemplar religious activities. Science and religion can maintain their identities and can have their independent domains, as long as there are exemplar scientific activities and exemplar religious activities. Science education and religious education ought not to encroach upon each other's domains, even if there is no demarcation between science and religion.

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