

An exploratory examination of Islamic values in science education: Islamization of science teaching and learning via constructivism

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Abstract This exploratory study outlines the perceptions of four Muslim graduate students regarding Islam and its influence on their approach to the teaching and learning of science. All of the four interviewees were enrolled in science related programmes at a Midwestern US university. The interview responses were evaluated both within the frame of the Islamization of science and Ian Barbour's (When science meets religion: enemies, strangers, or partners?, Harper, San Francisco, 2000) classification, which is based on four categories; conflict, independence, dialogue, and integration. Interviews were semi-structured and the data analyzed using a framework of typological and interpretive approaches (Hatch in Doing qualitative research in education settings, State University of New York Press, New York, 2002). The interview findings show that Barbour's classification is a useful tool for categorizing perceptions. However, these perceptions may fall into more than one category. A surprising side effect was the misinterpretation and misuse of constructivism as well as the notion of a scientific theory as ways to negate the theory of evolution, and promote the teaching of intelligent design. These misinterpretations and misuses occur because there is the belief that the interaction between science and religion in daily life is considered part of the cultural setting in Islamic countries, which is what students bring to the table, as well as the notion that reality can only be found in the Qur'an.

Keywords Evolution · Islam · Constructivism · Creationism · Intelligent design

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Fen Eğitiminde İslami Değerlerin Keşif Araştırması: Fen Öğretiminin ve Öğreniminin Yapılandırıcılık Yoluyla İslamileştirilmesi

Bu çalışma tarih boyunca bilimin İslam toplumunda algısına ilişkindir. Araştırmaya dayanak oluşturan temel sorular aşağıda sıralanmıştır. ‘Müslüman doktora öğrencileri hangi ölçüde dinsel inanışları ve bilim eğitimi konusunda ihtilaf yaşamaktadırlar? Böyle ihtilaflar yaşadıklarında nasıl müzakare ediyorlar? Katılımcıların bilim sınıflarında bilim eğitimi ve İslam arasında karşılaştıkları deneyimler nelerdir (hem öğrenci hem de öğretmen olarak)?’ Son olarak ise ‘Öğrenciler bilim ve İslamı yaşamlarında nasıl sınıflandırıyorlar?’

Bu keşif çalışması Müslüman doktora öğrencilerinin İslam ve İslamın bilim eğitimine yaklaşımı konusundaki algılarını sergilemektedir. Örneklemi Birleşik Devletlerde bir Mid-West üniversitesinde bilim ile ilgili alanlarda öğrenim gören dört katılımcı olmaktadır. Görüşme yanıtları bilimin İslamileştirilmesi ve Ian Barbour’un (2000) dört farklı kategoride sınıflandırılması çerçevesinde değerlendirilmiştir. Görüşmeler yarı yapılandırılmış olup; tipolojik ve yorumlayıcı yaklaşımlar çerçevesinde analiz edilmiştir (Hatch 2002).

Bazı görüşme soruları aşağıda sıralanmıştır. 1- Fen eğitimi çerçevesinde bilim ve İslam arasındaki ilişki hakkında ne düşünüyorsunuz? 2- Fen öğretirken ya da öğrenirken hiç İslam ile bilim arasında ihtilafı deneyiminiz oldu mu? Oldu ise bununla nasıl baş ettiniz? 3- Eğer varsa size göre İslam ve bilim arasındaki farklar nelerdir? 4- Din ile bilimi yaşamınızda nasıl konumlandırıyorsunuz?

Mülakat sonuçlarına göre Barbour’un sınıflandırması yararlı bir araç olsa da katılımcıların bazı ifadeleri birden fazla kategoriye düşmektedir. İlginç bir şekilde postmodernist ve yapılandırıcı eğilimlerin Evrim Kuramının bozulmasını sağlarken, Akıllı Tasarım’ın öğretilmesinin yolunu açmak için kullanıldığını göstermektedir. Daha önce yapılan araştırmalar göstermektedir ki, BouJaude, Wiles, Ashgar ve Alters gibi (2011) araştırmacılar yapılandırıcı epistemolojiyi kullanmayı tercih etmektedirler. Yaptıkları araştırmada Mısır ve Lübnan fen eğitimi programlarını dikkatli bir şekilde eleştirmekten kaçınmışlardır. Benzer şekilde yakın zamanda yapılan bir çalışmada, Nasser Mansour (2010) Ulusal Eğitim Müfredatının Mısır’da 1960’dan bu yana seküler zeminde olduğunu bildirmektedir. Ancak Mansour Evrim Kuramı gibi din ile ilişkilendirilebilecek sosyobilimsel konularda fen eğitimcileri ile din bilginleri arasında birlikte çalışılmasını önermektedir (sy.138). Bu kısaca yapılandırıcılık adı altında bilim eğitiminin dini öğelere önem verilmesini ima etmektedir (Mansour 2011).

Bu araştırma ise daha önceki toy (naïve) yapılandırıcılığı öneren araştırmaların aksine bu geleneği red etmektedir. Daha ziyade böyle bir yaklaşımı, yapılandırıcılığın bilimi İslamileştirilmesi için hastalıklı ya da yanlış kullanımı olarak kabul etmektedir.

Sonuç olarak bu çalışma, konu hakkında yapılan daha önceki araştırmaları irdelemekle olup, Terry (2004) ve Jenkins (2001) ile aynı zeminde buluşmaktadır. Çalışma Haydar’ın (1999) 15 yıl önce yapmış olduğu çalışmada neden Müslüman öğrencilerin yapılandırıcılığı olumladıkları konusunu gündeme getirmektedir. Umulan bu çalışmanın gelecekte yapılacak araştırmalar için Müslüman bilim insanlarına yararlı olmasıdır.

For centuries, there have been ongoing cultural-ideological debates on the relationship between religion and science within the frame of monotheistic religions and sociocultural settings. However, these relationships, particularly in Islam and some sects of Christianity, such as Evangelicalism, are fraught with tension (Aydın 2005). The process of enculturation and socialization involves internalization of social values that also influence personal values including an individual’s thoughts about the universe, human beings and society and judgments regarding religion and science (Milner and Browitt 2002).

Historical perspective

A massive gulf in perceptions of science can be noted between ninth and thirteenth century Muslim philosophers and nineteenth century philosophers. In the past, Al-Farabi, called “The Second Teacher” after Aristotle and Ibn Sina and also called Avicenna in Western Europe, utilized the ancient thoughts of Greek philosophers such as Plato, Aristotle, and Plotinus (Aydın 2005). Al-Farabi and Ibn Sina explicitly considered religious texts as symbols, which had to be interpreted in the context of scientific and reasoning skills (Aydın 2005). In the nineteenth century, modern Muslim philosophers such as Cemalettin Afgani and Said Ahmet Han began to discuss the relationship between religion and science from a Western culture perspective and generally considered religious texts as symbols solving issues using the logic of science. Mu’tazila, one of the Islamic sects, also argued the same, suggesting that in order to solve this clash between reasoning and religion it had to be framed by scientific reasoning (Wensinck 1965).

The tradition of arguing the relationship between religion and science was a result of the influence of Greek and Hellenistic philosophers on the Islamic world during the Middle Ages, which was the period known as the European Renaissance and Enlightenment in the Western world. The consideration of religious texts as symbols and applying the logic of science to solve issues was not sustained within Muslim society. Within the frame of an Islamic perspective in Middle Age Islamic thought, there were three distinct possible relationships between religion and science: *religion and science fight each other; they are compatible with each other; they are different in terms of subject matter and methodology* (Aydın 2005). The second notion of compatibility was the one most commonly accepted in the Middle Ages by Islamics. These are Mu’tazila’s rationalism and Al-Farabi and Ibn Sina’s thoughts based on the idea that religion and science are not in conflict and therefore scientific values can be incorporated into the world of Islam (Aydın 2005).

After the Age of Enlightenment in the seventeenth and eighteenth centuries, science in the Western world embraced the idea of secularism. This paradigm shift did not coincide with the thinking of Muslim society and its scholars during this time. In the nineteenth century, the notion of religious texts as symbols that existed in a dialectical relationship with scientific reasoning skills was further developed by a movement initiated by Cemalattin Afgani and his student Muhammed Abduh (Aydın 2005). Even though the roots of secularism can be found in the works of Ibn Rushd, Ibn Sina, Cemalattin Afgani and his contemporaries, they rejected the idea of secularism in science. This incorporation of science under religion is the foremost difference between contemporary Muslim philosophers and those of the past (Aydın 2009).

Later, the idea of using scientific reasoning skills was challenged by scholars, including Nakib el-Attas, Faruki, S. H. Nasr, Ziyauddin Serdar, and Fazlur Rahman, most of whom had studied in the USA (Stenberg 1996). According to their thesis, the Universe is the symbol of God; God is the main foundation of science and beyond natural phenomena, and includes theological and teleological reasoning (Aydın 2009). Thus God exists over science. This belief is known as the Islamization of Science, which transformed Western values into Islamic ones. In other words, religious scriptures now began to provide a figurative meaning rather than a literal one to the Muslim society and the world of science. For example, the literal meaning of ‘duhan’ in Qur’an is fog or cloud, but its figurative meaning is *nebula*, which suggests Big Bang Theory. Another example is that Qur’an says human-beings were created in ‘merhale’ (step by step) which is a literal meaning, though it also points to ‘evolution’ in a figurative meaning. The implication of both of these meanings is that regardless of what scientists profess, it is all a part of God’s work.

Similar debates have continued in the modern age, particularly with the advent of knowledge transfer from the West to Muslim culture providing a context for a new movement called *Islamic Modernism* (Rahman 1970). This movement attempted to merge two different schools of thought in order to convert and transfer Western oriented knowledge and values to the world of Muslims (Stenberg 1996). These historical developments provide evidence in education, particularly that the teaching and learning of science cannot be considered separately from society and its major social events.

The last thirty years, including now

It should be noted that there is no single, universal interpretation of Islam. Sunni, Shiite, Wahhabis and Baha'is are the most commonly known Islamic sects. The Sunni population constitutes the majority of Islamic society. But there is diversity within these sects as well. Even though this diversity is a result of historical disputes, such diversity has been shaped and regulated by authoritarian, semi-authoritarian and semi-democratic governments throughout history.

Since 1980, there have been numerous social factors that have influenced the perceptions of science-affiliated individuals in Muslim countries. A great influence was the collapse of the former Soviet Union and its satellite states, producing an unstable political situation both in Central Asia and its neighbouring regions, and weakening the affected governments' control over the education system. As a result, financial support for education became the purview of non-governmental organizations (NGOs) frequently with a Muslim background and agenda (Liederman 2000). This agenda is often based on pro-Islamic values regardless of the sect.

The outcome of this involvement was that Islam came to have a tremendous influence on education in Central Asia (Dudoignon and Hisao 2001). But NGO's have established numerous schools from elementary to tertiary levels in many regions of the world, including the USA and Australia. Over the last two decades, many gifted but financially needy students have received scholarships to attend American and other Western universities from such non-governmental religious organizations. Non-secular governments in countries such as Pakistan also support Islamic education by redesigning educational objectives (Hoodbhoy 1985). Even 80 years after the Kemalist Revolution, secularism, a fundamental pillar of Kemalism, and Islamic values have pursued their own "never ending" battle in Turkey (Houston 2006). The Secretary of Education in Turkey "... admitted that many NGOs, which he left unnamed, have supported needy students with the purpose of imbuing future generations with religious faith" (<http://cumhuriyet.com.tr/>). However, government leaders in Turkey as well as in other Muslim countries in Central Asia have been supportive of religion-based organizations and their pragmatic nationalism (Turam 2004).

The Islamization of the teaching and learning of science through science educators

Recently, Nasser Mansour (2010) was critical of the fact that since 1960 the National Curriculum in Egypt has been built upon secularism. Mansour suggests that the teaching and learning of science to include topics such as the theory of evolution (TOE) "should be made in a partnership between science educators and religion scholars, especially with regard to socioscientific issues associated with religion" (p. 138). This implies that consideration must be given to religious viewpoints in the context of the teaching and learning of science (Mansour 2011).

There are other indications of the effort to institutionalize religion-based science education in Muslim countries ironically through the influence of non-Islamist religions. This effort has caught the attention of Jason Wiles (2011), a Western researcher, who states that "... tactics employed by American creationists are being exported to other countries, international challenges to the teaching of evolution are discussed with special attention paid to potential futures regarding evolutionary science within Islamic cultures" (p. 787). Even though Turkey is regarded as one of the most westernized Muslim countries, and is a secular candidate of the European Union, Deniz Peker, Gulsum Comert and Aykut Kence's (2010) research indicate that either biology courses are not properly taught in small town universities or there is no course dealing with the TOE in Turkey, except in metropolitan universities. According to their research, many instructors in universities use creationist rhetoric for teaching evolution, "... Darwin and his ideas today have been scorned by curriculum and education policy makers" (p. 739). In biology programs, the course on evolution is core, however the course content and scope change from university to university and instructors may use creationist views.

Even though there is a lively debate about diversity and secularism in educational settings in the West (Luciak 2006), the contribution of prospective Muslim science educators to this debate, and their influence on the teaching and learning of science in particular, is in general still unexplored. It is important to understand how prospective Muslim science educators, as well as those who are currently science teachers, view orthodox Islam and its position vis-à-vis the teaching and learning of science. The present study approaches the relationship between Islam and the teaching and learning of science from the perspective of compatibility, and how this relationship can shape the teaching and learning of science.

Tonie Stolberg (2007) pointed to the importance of scientific and religious attitudes held by pre-service primary teachers. Research results show that a teacher's own belief systems might influence the way he or she teaches science (Jackson, Doster, Meadows and Wood 1995). Stolberg (2007) states, "Pre-service primary teachers hold a range of views about science and religion, and, therefore, differences emerge in their ontological status" (p. 920), that is, how they respond to the reality of science and religious claims. Similar studies can be found regarding how Western societies reconcile two or more points of view on the relationship between science and religion in educational settings.

In the West, there are two major schools of thought. One school holds that religion and science cannot exist together in their pure forms. For instance, Martin Mahner and Mario Bunge (1996) claim that "science and religion can only coexist if one of them is distorted" (p. 115). Contrary to Mahner and Bunge (1996), Hugh Lacey hopes for a peaceful coexistence between science and religion. Lacey (1996) expresses emotional and philosophical considerations and notes that "... we [intellectuals] are left with only nihilism" (p. 152) without such co-existence. Another example is Tom Settle (1996) who writes that "[q]uite a few scientists share Mahner's and Bunge's mistake of thinking that science implies materialism" (p. 127). He believes that scientific open-mindedness is imperative in both science education and religion.

Muslim scientists and authors generally agree that Islam and science can coexist (Al-Hayani 2005). However, discussions have focused on the Islamization of politics. For example, the establishment of Islamic states and—under the term Islamization of disciplines (Dangor 2005)—on the Islamization of science rather than on the compatibility of science and Islam. These discussions between secular and religious scientists have a tendency to become polarized in Turkey, as well as in other Muslim countries (Sayin and

Kence 1999). Even though heated discussions have continued in the academic circles of Westernized societies concerning the relation between science and religion, it is almost impossible to find any scholarly discussion on the same topic amongst Muslim scholars in the area of science education. For instance, Mansour (2010) believes that Eurocentric science embedded in science classes has discomfited both Muslim students and their teachers. However, there is no science education research attempts to reveal any explanation for this in the context of the Islamization of science. Other than the Peker et al. (2010) study, research papers do not reveal whether or not topics such as the TOE have been taught in educational settings in Muslim countries.

Meanwhile, researchers have generally been interested in the philosophical aspect of the relationship between science education and religion, and have not focused on the practical aspects and outcomes of this relationship in our school systems. As a consequence, it is not clear how Muslim students internalize and subscribe to the fundamentals of scientific thought or the nature of science while immersed in the didactic and pedagogical environment of Western schools.

The misuse and misinterpretation of constructivism: religion as a part of a student's cultural milieu

Contemporary Muslim scientists believe that there is one truth regarding the real world and that all truth can only be found in Holy Qur'an. This philosophy/belief means that all problems found in life can be solved in the context of the Qur'an. As outlined previously in this paper, this approach is different from that of past Muslim scholars in that there is no longer a separation of religion from science instead, religion is understood to exist over science. Belief in the absoluteness of the Qur'an has an interesting implication for many Islamic scholars regarding constructivism, specifically, the need to engage with the idea that the material and spiritual life are inseparable. For them this means that in educational settings science learning can only take place if the knower constructs meaning within the frameworks of science and Islam. This belief is perpetuated by the works of Hayat Hokayem and Saouma BouJaoude (2008) among many that suggest that religious beliefs should be considered as part of an "individual's cultural milieu". It is this belief that justifies the use of constructivism to argue against the TOE and a preference for promoting intelligent design (ID) or creationism.

Muslim scholars or/and science educators use constructivism to promote the Islamization of science in Turkey today. This is to say that a misinterpretation as well as a misuse of constructivism is applied and imposed intentionally in favour of the Islamization of science by Muslim scholars, educators, and other supporters. In my opinion, this is not by accident because Muslim scholars have investigated the relationship between science and Islam in the area of science education using constructivism as one of their frameworks. Generally speaking, the results of these efforts are in favor of constructivism because scholars feel they can include Islamic beliefs by promoting constructivism.

Their argument is based on the understanding that a learner's personal beliefs and even the design of science courses reflect cultural settings, which in this case is the integration of Islam and science. In order to further support their interpretation of constructivism the National Science Education Standards (NSES) (1996) are cited frequently. In particular, their argument is based on two premises of the NSES: Science has not one truth and a learner can learn in different ways. These premises have been used as a disguise for the

misuse of constructivism in science education in favour of Islamization of science and the teaching and learning of the same in which one cannot separate the material world from the Islamic world.

The categorization of science and Islam

In discussions about the compatibility of science and religion, some contemporary scientists and philosophers have tried to construct clear distinctions and show similarities between science and religion based on categorizations such as those of Barbour (2000). In contrast to these categorizations, this paper challenges the idea that science and Islam are inseparable and supports the idea that the two should be kept apart in the teaching and learning of science. This position rejects Barbour's classification and argument that Islamization and science overlap. Accordingly, I attempt in this study to demarcate an important issue and that is whether or not science and Islam are compatible and thus overlap. I will probe into this issue by uncovering individuals' own feelings on the notion of science and Islam compatibility. If they are compatible, how this compatibility is organized in participants' real lives becomes critical to understand. In this sense, interviews were analyzed both in a typological frame based on Barbour's (2000) classification and by an interpretive approach.

As mentioned above, I used Barbour's (2000) categorization to classify the perceptions of the participants regarding science education and Islam. Even though this categorization is based on the relationship between understanding science in daily life and in religion, logically this relationship also comprises the perceptions regarding the experience of teaching science and reconciling this with religious beliefs as stated by Tonie Stolberg (2007). These categories are described in the following sections.

The first category, *conflict*, applies to both scriptural literalists and atheistic scientists. Both groups have in common the belief that religion and science, particularly the TOE, are incompatible. The second category, *independence*, is the alternative view that science and religion are strangers but tolerate each other as long as they keep their distance. The third category, *dialogue*, holds that there are similarities between science and religion. The last, *integration*, claims that there are systematic and extensive linkages between science and religion. Within the category of integration, there are two major directions. One is *natural theology* that seeks in nature, proof of the existence of God. The second direction, *theology of nature*, tries to reformulate religious tenets in the light of science.

The concept of Islamization of science fits into the categorical section of integration in Barbour's classification. Basically, natural theology is the dominant direction of the Islamization of science and theology of nature is a useful didactic tool for making Westernized science more Islamic. How the participants consciously or unconsciously rationalize the Islamization of science constitutes the core of this paper. To that end, how participants rationalize the Islamization of science is examined together with emergent patterns of rationalization.

In order to explore the relationship between Islam and science education the following questions were explored:

1. To what extent do Muslim graduate students experience a conflict between their religious beliefs and science education? If they do experience such a conflict, how do they negotiate it? What are the participants' experiences in their science classes (both

as students and instructors) regarding the relationship between Islam and science education?

2. How do students categorize science and Islam in their lives?

In this study I sought to explore how Muslim graduate students, whose background is mostly the Sunni sect of Islam and who have grown up in an Islamic-socio-cultural environment, furthered their formal education in the area of science education and applied-life sciences in the USA. Since they grew up in an Islamic-socio-cultural society it was important to understand the influence of their belief on the relationship between the teaching and learning of science and Islam while studying in the USA.

There were two primary reasons, which encouraged me to undertake this project. First, while there are many studies of Christian perceptions on the teaching and learning of science, there are only a limited number of studies on the perceptions of Muslims regarding the same. One example is the study by Saouma BouJaoude, Jason Wiles, Anila Ashgar and Brian Alters's (2011) on the beliefs of Muslim students in Egypt and Lebanon regarding biological evolution. Whether the students were Shiite or Sunni, the TOE was rejected because students were influenced by their Islamic beliefs (BouJaoude, Wiles, Ashgar and Alters 2011). Second, most studies address this topic within the framework of constructivism. Basically, the authors were in favour of constructivism and cultural milieu. However, the study reported here interrogates constructivism and its relationship with science education in the frame of Islamization of science.

Unearthing the context

I used interviews conducted in 2002 as a main source of data. I interviewed three graduate students who were majoring in science education and one faculty member who was a science educator. I used a semi-structured interview process. After asking the lead questions, other sub-questions were also asked when necessary. All interviews were recorded on audiotape and then transcribed. Two of the interviews were conducted in English, the other two in Turkish. The interviews conducted in Turkish were translated into English. My rationale for translating the interviews in English was to facilitate reporting in an English language environment. Participants' real names were replaced with pseudonyms. Once the interview process had ended, I allowed the participants the means and time to confirm their statements or engage in the member check process (Lincoln and Guba 1985). Each interview lasted approximately 2 hours.

Many prospective participants that I approached considered this research topic delicate. Their concern about participating may be attributed to their belief that the United States is not friendly towards Islam. Such belief created a severe limitation for participation of Muslims in this study. Specifically, the majority of the Muslim graduate students that I asked to participate were not enthusiastic about sharing their perceptions of Islam and science education and declined to be involved. I gained entry by eventually using personal contacts to find participants. In order to limit anxiety on the part of the interviewees, I conducted the interviews in coffee shops or similarly neutral places chosen by the participants.

Once transcribed, the interviews were analysed looking for similarities and differences in themes and patterns in individual utterances. I used two different analysis techniques to achieve an in-depth understanding: typological analysis (LeCompte and Preissle 1993) and

interpretive analysis both of which were used with the interviews. Typological analysis requires using an existing categorical scheme, in this case Barbour's classification scheme, to categorize participant responses regarding science education and Islam. Even though interpretive analysis was challenging, interpretations were constructed by the researcher's deep engagement with the interview data. Here in this framework, interpretation meant multiple meanings of events. The purpose behind using different techniques was to reveal contradictions or emergent patterns (Hatch 2002), particularly since the topic was considered delicate. Conclusions were drawn within the contextual boundaries of the study (Bogdan and Biklen 2003). However, as mentioned by Douglas Ezzy (2002), I also examined questions and issues beyond the basic classification of perceptions. Thus, I worked according to what Paolo Freire calls a "reading of the world" (1973, p. 6) in that I tried to understand Muslim graduates' worlds as they related to Islam and science education.

The individualization of perceptions

Even though the sample size was small, the study's qualitative research focus allowed for plausible results. As Frederick Erickson (2003, p. 1115) remarks, "The emphasis [of the qualitative tradition] is on discovering kinds of things that make a difference in social life; hence, an emphasis is placed on *qualitas* rather than on *quantitas*". The purpose of the interviews was to reveal a range of perceptions (Merriam 1998). Interview participants differed from each other in terms of religious commitment. This distinction helped me to capture a credible variety of perceptions.

Qualitatively oriented researchers generally use the terms validity or viability. However, Harry Wolcott suggests the phrase "plausible interpretations" made from the data rather than this term (1994, pp. 366–367). Some researchers propose another term, "justifiability of interpretations" (Auerbach and Silverstein 2003, p. 78). In the present study, logical connections between literature, research questions, theoretical framework, data collection and their interpretation without fear of generalization represent plausibility. This study considers plausibility to be the cumulative result of the following features: meaningful and convincing evidence (Mason 2002); interpretation supported by data (Auerbach and Silverstein 2003); the quality of interpretation; and disciplined subjectivity as defined by Erickson (1973).

Questions I asked to elicit data

The following are my initial questions. During the interview process the participants' experiences surfaced, sub-questions arose, particularly with regard to the TOE.

- Q1. What do you think of the relationship between science and Islam in the frame of science education?
- Q2. Have you ever experienced any conflict between science and Islam while you were teaching/learning in the science classroom? If so, how did you reconcile this conflict?
- Q3. In your opinion, what are the differences between science and Islam, if any?
- Q4. How do you regard religion and science in your own real life?

Depending on the flow of the conversation sometimes in my questions I substituted evolution for science. For example, I asked some of the interviewees how they felt about teaching creationism and evolution in science courses. The following are some of the

subquestions that arose during the interviews, which allowed me to dig more deeply into the study participants' perceptions.

- SQ1. How do you respond to teaching both creationism and evolution in science course?
- SQ2. Do you think that religion can solve problems in scientific issues?

Making sense of it all through typological analysis

As stated in the section on the conceptual framework, Barbour's definitions were applied to categorize the participants' perceptions of Islam and science education. Afterwards, emergent patterns were explored. In order to ensure that I had appropriately translated the participants' language I engaged two experts, one in the area of language education and the other in science education. I personally translated the text and read with the language expert to establish whether or not I captured the real meaning of the statements when I translated from Turkish to English. The language expert's mother tongue was Turkish. The science educator read the English text and commented on whether or not my science content representations were valid and appropriate. In the following section, I discuss in more detail my analysis.

The participants

All interview participants grew up in Sunni Muslim countries. The first participant, Mehmet, 25 years old, was a graduate student teaching science courses at a private high school. He identified himself as a Muslim. He fasted during Ramadan and other Islamic religious holidays and prayed five times a day. The second participant, Suleman, 40 years old, was a graduate student who had taught science courses at the high school level in Pakistan before coming to the US; he also identified himself as a Muslim. He prayed five times a day and fasted during Ramadan. The third participant, Shafiq, was 51 years old, a scientist and academic who taught advanced science courses at a university in Pakistan, and had graduated from a prestigious university in the US. He identified himself as a secular person without any reference to Islam. He did not engage in any religious practices. However, because of social pressure, he did not eat anything outside his home during Ramadan. The last participant, Fatima, 29 years old, was a graduate student in the science education department who also had 2 years' teaching experience in a public high school in Turkey, where she taught science courses in a rural area. She identified herself as a secular Muslim. She hardly took any part in religious practices apart from some days of fasting during Ramadan.

Although there are other 'pillars of Islam' aside from fasting and prayer, such as offering alms, the Islamic testimony of faith, and the hajj (the pilgrimage to Mecca). Even one of the most dogmatic philosophers of Islam, Imam Gazzali, declares that the Islamic testimony of faith is enough to be a Muslim. (Basically, one must say 'I testify "La ilah illa Allah, Muhammad rasoolu Allah."' These Arabic words mean "There is no true god (deity) but God (Allah), and Muhammad is the Messenger (Prophet) of God.") Nor is a hajj absolutely required (Atay and Cubukcu 1961). My research concerns the attitudes of self-declared Muslims. Needless to say, the way self-declared Muslims practise does not necessarily fully represent the extent and content of their beliefs. However, it should be noted that Ramadan, which is a month of fasting, is the most publicly visible pillar of faith in Islam. In this month, a Muslim is expected neither to eat nor drink from sunrise to sunset.

Their educational experiences, including schools attended, constitute another potentially formative factor that might affect participants' attitudes, beliefs and/or perceptions regarding scientific thought. Courses on religion are mandatory in all the school systems in which the participants' were educated, and instruction would have included memorizing important verses from the Qur'an. Typically, there is also out-of-school religious instruction in Muslim countries. This instruction is often provided in mosques and boarding schools. The participants, Mehmet and Suleman, had similar out-of-school religious instruction during their childhood.

Some of the interview statements and their analysis according to Barbour's categorization can be found in Table 1. This categorization is also discussed in the context of the Islamization of science. Participants' thoughts are classified in order from the religious to the relatively secular.

For Mehmet (see Table 1), the first participant, the relationship between science education and Islam can be defined as belonging to the category of dialogue. He believes in an open discussion about evolution in biology classes and in giving students an opportunity to develop their own positions on science and religion. In his opinion, this was the most constructive and democratic way of eliminating arguments about evolution from biology classes. He added, "One of my science teachers [who was religious] allowed us to discuss both creationism and evolution in science class." For Mehmet, science courses should not be limited to strictly scientific discourses, but should include other perspectives as well, including religious ones, in order to broaden students' perspectives.

Mehmet used the terms "irreducible complexity" and "intelligent design" (ID) throughout the interview as examples in support of his approach to religion and evolution, which I, characterize as dialogic. In the interview process, I asked Mehmet to communicate his thoughts about biology instruction. I pointed out that creationism is the main focus of instruction in all religion courses taught in the Turkish school system. I then asked whether he still considered it necessary to teach creationism or ID in biology courses. He answered, "Yeah, they should be taught ID or creationism. Students have to discuss everything about evolution so that they believe whatever they want to believe." He opposed excluding the topic of creationism from biology textbooks.

Mehmet also stressed the influence of politics on curriculum design and particularly on biology education. He reminded me that in the 1980s the Turkish Secretary of National Education sent official memos to all high school administrations, in which he claimed that the TOE is poison for the new generation. Mehmet continued:

...The Secretary of Education [in Turkey] in the mid 1980s sent a letter to all high schools that suggested not stressing the TOE...It [the curriculum] changes depending on government's ideology... As a subject matter, the TOE was ignored (April, 2002).

However, he did not comment on whether the memo from the Turkish Secretary of National Education had a positive or negative effect on the teaching and learning of science. To him, dialogue begins with allowing the teachers to include ID and creationism in biology courses; he considered these topics the most important components of the dialogue process he advocated (see Table 1).

Mehmet preferred to verbalize his perceptions through an indirect didactic approach. When I asked him whether he personally supported teaching ID in biology courses, he avoided a direct answer and instead foregrounded popular educational values such as open discussion, creation of one's own thoughts, being constructive, and adhering to a democratic way. It should be noted that there is no evidence that all participants understood the

Table 1 Data analysis- categorized perceptions of participants according to Barbour (2000)

Dialogue (Mehmet)	Integration (Suleman)	Conflict (Fatima)	Independence (Shafiq)
'One of my [religion-affiliated] science teachers allowed us to discuss both creationism and evolution in science class'	'Science is integral part of religion'	'The Qur'an does not have problem with the evolution of the universe. The problem is the origin of life'	'[Science and Islam] are like apples and oranges. They are totally different'
'I believe that anything could be taught in that class'	'Religion [Islam] is the major [thing][in the life]'	'Both religion [Islam] and science are interested in a human being...'	'Fundamentally, science is prediction, you look ... [event] create hypothesis...on the other hand, religion [Islam] is spiritual'
We discussed and broadened our perspectives	'Religion [Islam] can explain everything'	'... The conflict between them is not surprising'	'[Since, Muslim countries could not separate religion and state], they are completely out of age'

term ID in the same way. Mehmet was the only participant who strongly supported ID in the educational setting.

For Mehmet, ID was a didactic tool that should be included in science courses to facilitate a constructivist approach to science. This conviction is discussed by Abdullateef Haidar (1999) who emphasizes, “The presence of constructivist views can be attributed to religious [Islamic] beliefs. Students’ views that scientists cannot see the real thing is consistent with the Islamic understanding that only God [the Omniscient] knows the real truth” (Haidar 1999, p. 813).

Even though Mehmet’s answers reveal that he preferred a dialogue between science and Islam, he selected terms such as “creation of one’s own thoughts” rather than “scientific process skills” and supported all his ideas within the frame of constructivism, which he interpreted as allowing personal constructions as appropriate forms of knowledge. At this point it is not clear whether the participant’s responses were an indication of the Islamization of science.

The notion of teaching ID in science courses is a fairly popular approach under the name of constructivism in the USA (Terry 2004). For instance, ID supporters in the USA present ID as the latest science and try to convince the public that those who object are closed-minded (Terry 2004). Because ID supporters can demand that as an alternative theory, ID should be afforded the same level of presentation as TOE and, if a science teacher resists they can be accused of being closed-minded and against the spirit of a democratic education. Creation does not sound scientific so “... in their public battles ID proponents try to shift the entire discussion away from religion. Their claim is that science has discovered evidence of the work of a designer ...” (Terry 2004, p. 267).

Mehmet’s approach to dealing with the problem of evolution in biology courses has been supported by the Institute for Creation Research (ICR), which is an essentially Christian organization (Shapiro 1999). There has been a growing affinity between Christian and Muslim non-governmental organizations, such as ICR, the Discovery Institute, and Bilimsel Arařtırmalar Vakfı (BAV), a Scientific Research Foundation established in Turkey in 1990 (BAV 2006). This growing affinity can also be found in the documents of the Council of Europe. According to these documents, “Since its establishment, BAV has been very active in trying to have any reference to evolution removed from Turkish education. It also organizes many conferences on creationism in the principal Turkish towns and cities. It would seem that BAV has close links to the American Institute for Creation Research (ICR)” (Council of Europe 2007, Title 54).

In light of these connections, if there is indeed a clash of civilizations, as Samuel Huntington (1993) has claimed, this confrontation does not take place in the area of science education. Contrary to Huntington’s belief, there is a harmony between the perceptions of Muslim and fundamentalist Christian science educators. As Arthur Shapiro (1999) quotes, based on an ICR document “[T]he movement in Turkey is a ‘literalist’ translation of Christian creationism a la Henry Morris and ICR.... Islam, Christianity, and Judaism share so many common religious ideas.” (p. 15). Thus, there is no reason not to use the same or similar didactic strategies across all these religious communities.

While this paper does not discuss the weaknesses or strengths of constructivist approaches in science courses, it does suggest that constructivism is often perceived as compatible with a new Islamic approach that affords science educators an opportunity to point out gaps in biological science, which can then be filled with creationist lines of argument. Thus, it is not surprising that proponents of an Islamic brand of constructivism consider the TOE a purely mental construct.

Meanwhile, the similarity of the terminology used in ID to scientific discourse helps some science educators hide their creationist assumptions about the origin and development of organisms. Indeed, it is not uncommon among Islamic elites to use scientific terminology in a purely rhetorical manner, that is, without adhering to the methodological principles implied in scientific discourse. Thus, ID is used as a scientific theory promoting creationism. For example, Mark Terry (2004) argues that ID has been presented as a substitute for the TOE. Also, in a review essay Tyll Van Geel (2006), critiques popularly accepted sentiments occurring in Kent Greenawalt's book, *Does God Belong in Public School?* In particular, van Geel (2006) says, "Greenawalt wants to escape this trap by claiming that ID is not in fact a religious doctrine because it does not explicitly use God language" (p. 603). Alan Colburn's and Laura Henriques's (2006) study also shows that clergy have used a similar argument to support ID. As long as ID is presented as a theory, it offers orthodox Muslim students an easy, yet unquestioning, way to imagine the development of life. Numerous examples of such a misuse of the term theory can be found in *Teaching about Evolution and the Nature of Science* (NRC 1998) and similar prestigious publications. The interpretation of statements such as "scientific ideas are tentative and open to change" (NRC 1996, p. 171) and can sometimes be used improperly to impose religious or political agendas in school curricula.

Fouad Abd-El-Khalick, Mindy Waters and An-Phong Le (2008) also point to the existing problematic situation of misuse or deliberate misinterpretations for personal gain. Specifically, these researchers point to commercial science textbooks, curricula and practices in science teacher education. For instance, recently conducted research shows that biology textbooks in Pakistan have been designed under the influence of Islamization of science (Ashgar, Alters, and Wiles 2010). However, in many cases this tendency can be deemed as a part of the cultural setting. For example, applications of postmodernist thought in the science education area, commonly accepted in scientific society—namely the idea that scientific truth is a construct—might be distorted on behalf of cultural milieu. Edgar Jenkins (2001) even asks whether this approach is a "dangerous intellectual tendency".

Suleman, my second interviewee says that Islam explains everything in the world. From his point of view, without Islam science, science education would be meaningless. He believes in integrating science into Islam: "Science is one part of religion" (April, 2002). In his view, science sometimes tries to explain more than it can and then clashes with Islam. He stresses that, "Theory is human made; it is not made by God" (April, 2002). By theory, he means the TOE, which some fundamentalist Christians and Muslims with a literal understanding of scripture find to be a contradiction to revealed truth.

Also, Suleman applied to science terms, such as human made, thereby characterizing science as an illegitimate human intervention in the realm of religious truth. He also stressed the importance of Islam in his life. Throughout the interview process, he expressed his perceptions using verses taken from the Qur'an. He had never underestimated the importance of science in his life; however, he was a strong supporter of creationism.

Suleman's thoughts can be easily explained in the frame of the Islamization of science. According to his beliefs, theories are human made and the Qur'an provides explanations for everything. In the light of his teaching experience, he states that he teaches creationism in science courses because it is not human but God made. Mansour's (2010) research reveals similar beliefs in his study of Egyptian science educators. For teachers, like Suleman, there seems to be an epistemological problem in the understanding of the word "theory" and it seems an axiological dialect has been created. In other words Suleman provides a value-laden world-view regarding creationism, which he justifies as being more important in a scientific context, because it provides the "truth".

Fatima, the third participant, describes experiences in which traditional Islamic perceptions among science teachers often create a hidden barrier that prevents them from discussing certain sensitive topics such as sexuality and evolution. The role of these inhibitions in the process of education has as yet to be investigated in research studies. Fatima's statements and perceptions can be classified under the conflict section of Barbour's definitions. When describing the scientific process she said:

Science must be skeptical... If not, science is not science. How can we ignore a scientific process that was developed in 25 years, after Darwin visited Galapagos ... We have proofs [of evolution]. Religion [Islam] does not admit evolution. Here is the conflict (April, 2002).

However, she prefers not to become involved in disagreements and not to show her own commitment to secular science education. For instance, she said at the end of the interview: "If my Dad knew of this interview, he would get angry with me." Fatima also implied that the limited comfort zone of teachers made discussions of controversial topics, such as biological reproduction and the TOE, impossible. In the traditional Turkish school system, it is regarded as appropriate to teach reproductive biology only to same-sex classes or student groups. Even though Fatima does not agree with this practice, she follows it.

My colleague [male] and I were talking in the sitting room for the teachers. He wanted me to get together female students in one classroom and he said he would do same thing for the male students. I said yes (April, 2002).

When I asked why she did not say no, she reminded me of the difficulties of living in the small conservative town of Anatolia and being a single woman. She also said she does not want to get involved in controversial issues. She continued,

I took an evolution class at the undergraduate level, and there was a disagreement among the students... Two of them [students], one of them a girl with a headscarf and the other one secular, discussed about creationism and evolution... They just discussed. There was no solution. The other class participants were all silent (April, 2002).

Controversial issues are not limited to disagreements about the TOE and Islam, but extend into sensitive areas such as talking about sexuality in biology courses. In Fatima's experience, her male colleague at the high school preferred not to give a lecture on the topic of reproductive organs to a mixed gender class. Eventually, they separated the class into male and female groups. She felt she had no alternative. There were two reasons for her accepting the idea of separate classes. First, she was a woman and unmarried. There was no one to protect her. Second, taking personal risks and arguing about this issue could create other problems, such as undesirable changes in her working conditions, her working place or her employment. According to Madiha Didi Khayatt (cited in Alat 2005), female teachers are often under pressure to maintain an appearance of conventionally understood decency, pressuring them into the role of passive and docile participants in the school system. Jo-Anne Dillabough (1999) also points out how the mechanism of hierarchy favours male-dominated supervision. That is why Fatima's reaction to her situation might be very common, particularly in a conservative society such as Turkey. It is likely in these contexts that female science teachers are emotionally more vulnerable than their male counterparts.

My last participant, Shafiq, addressed how Muslim people have unconsciously integrated science and Islam into their everyday lives. According to him, the fundamental

mistake of many Muslim people is that they have not separated the sciences from Islam in their thinking and Islam and science have still not been compartmentalised in their everyday lives. His perceptions fall into the category of independence. "Science and Islam are like apples and oranges ... [S]cience is a prediction ... [O]n the other hand, religion [Islam] is spiritual ... Muslim countries are completely out of touch because state and religion have not been separated" (April, 2002). Because of his extensive experience in education compared to the other participants, Shafiq is concerned about the social consequences of interactions between Islam and science in educational settings. In his view, there cannot be any progress in Muslim countries in terms of science and science education unless state and religion are separated and therefore independent of each other.

Shafiq claimed that the Muslim people were not able to separate religious dogmatism from the skepticism of science. As he put it, "Darwinian theories of evolution" had been considered as dogma by Mawdudi, a highly considered fundamentalist Islamic scholar widely read across Islamic states. Mawdudi maintains that the TOE was planted by Europeans as a façade for an underlying atheism (Jan 2003).

Let me make some suggestions and discuss a few ideas

Barbour's classifications help to categorize perceptions about the relationship between science and Islam. However, these classifications cannot capture the particular problems experienced by teachers in a science-education context trying to negotiate their pedagogical and didactic goals and reconciling their teacher persona with the demands of their environment. For example, Fatima's difficulty in resolving the demands of science teaching with her role as a single woman suggest that Barbour's classifications lack an appreciation for the sociocultural context in which these teachers are expected to work. Also, participants' perceptions could in some cases be classified under more than one category. For this reason, Barbour's categorization may not always promote insight into how the Muslim graduate students I interviewed view the relationship between science education and Islam. Instead my interpretive analysis reveals more of the complexity of their interactions with the environments in which they work as educational professionals.

This research does not question and/or bring to light a great number of shortcomings in science and the teaching and learning of the same for Muslim societies. However, during this study some critical questions and comments were developed. Do Muslim scholars research the implications of using science textbooks, which are published in their countries? Why do Muslim scholars and supporters persist in imposing a constructivist application of science in Islamic countries?

Until now the perceptions of the Muslim participants of this study regarding a controversial issue such as TOE have been situated in the context of constructivism that allows other perspectives to be presented under the guise of providing equal time and space to alternative perspectives on aspects of science and religion such as TOE. I believe that some participants are willing to use constructivism as a tool to disguise attempts to teach creationism and/or ID in science courses. This is a dangerous intellectual tendency particularly for Muslim societies (Jenkins 2001) and I believe a misuse of constructivism.

Even though Jenkins (2001) does not talk about the relationships between an Islamic point of view and constructivism, he claims that constructivism has some pedagogical drawbacks. These drawbacks, particularly when a young learner has misconceptions unconsciously or consciously, and the learner is not provided opportunities to challenge his/her misconceptions. He points out how paradigms change and 'children are natural

scientists' (p. 155) a claim, which makes more sense in a Muslim world. Looking at constructivism out of a Muslim world, I ask if constructivism is also used as a tool to cover up the Islamization of science in the Western world?

The existing situation in the Muslim world can create dangerous tendencies including solipsism and pseudo-science. Jenkins skilfully criticises many proponents of constructivism but in a Western Judeo-Christian context. However, there is not one research paper that criticises how Muslim science educators use constructivism as a guise for teaching creationism or ID.

According to Barbour, categorization of dialogue somehow depends on the connection between science and religion. Specifically, the connection is based on similarities between science and religion. But, Barbour does not claim that the dialogue includes the idea of pseudoscience or that religious thoughts can be taught in science classes. I believe that when one uses the nature of science as a filter, including aspects such as the nature of theories, this affords science teachers the ability to differentiate between science and pseudoscience. However, if the teacher cannot or does not want to filter pseudoscience from science, a mystic or religious meaning to science will be the emphasis in any science course. Thus, it is critical that science teacher educators ensure that pre and in-service science teachers understand the nature of science and theories to counter the teaching of pseudoscience such as Creationism or ID.

Categorizing Mehmet's rhetorical dialogue approach depends on creationism and the TOE being taught together. As mentioned earlier, Mehmet's approach is considered part of a democratic and constructivist educational setting and considered as part of the cultural milieu. Unfortunately, there is no way to categorize Mehmet's point of views within Barbour's framework. On the other hand, Suleman considers science as a part of Islam and as such should be classified under integration. I am reminded of Andrew Dickson White who argued that "After having lost one battle after the other against scientific progress, many religionists have turned 'liberal' (cited in Mahner and Bunge 1996, p. 108).

At this point, Jenkins's (2001) critical question emerges and should be modified: "Is constructivism a dangerous intellectual tendency in Muslim countries?" (p. 153) I would add the following question: Is it a cover-up which allows for pseudoscience to be taught in Muslim countries? If this is the case, then can the categorization of dialogue as defined by Barbour explain the relation between science and Islam? For example, Islamists, using constructivism to theoretically justify such an approach, have supported the teaching of both ID and creationism. Constructivism came from Western thinking and yet, to the best of my knowledge, it is not used as a theoretical tool to permit the teaching of creationism or ID in specific Western countries. Interestingly, most of the Muslims in this study, whether they have good intentions or not, describe constructivism as cultural milieu which fosters pseudoscience in their countries. For example, Abdullateef Haidar (1999) states, "Although most Muslim teachers hold a view that looks to be consistent with the constructivist view, ... this may be attributed to a religious background" (p. 814). It is very surprising to me to not find any research that investigated Haidar's critical finding 13 years ago of the misuse of a constructivist framework in education.

The close links between the BAV and the American Institute for Creation Research (ICR) speak to the teaching of both creationism or ID and the TOE in science courses under the guise of constructivism (Council of Europe 2007). Raising the question of why such an approach is not used in science courses in the USA and European countries. And also why creationism is not included in science textbooks in these countries. I am sure it is not for a lack of trying, but the science community in the USA and in Europe has mounted resistance to thwart such an effort.

Even though the Committee on Culture, Science and Education of the Council of Europe harshly criticized some Foundations and countries in their document regarding the inclusion of Muslim creationist thought both in Turkey and other European countries (Council of Europe 2007), there is almost no research like that of Peker, Comert and Kence (2010) that seeks to understand whether the TOE has been taught in Muslim countries in a manner consistent with its formulation within the discipline of Science. Instead, findings from related studies have been evaluated and represented within the frame of constructivism. According to most Muslim scholars, the cultural setting of a country to include religion is a reasonable explanation for the inclusion of creationism and ID with TOE in science education.

In contrast to previously published studies, I have not used verses from the Qur'an to support my findings although many other authors have used specific verses from the Qur'an in order to show how science and Islam are compatible with each other. Similar verses can be found in the Christian Bible too (Clarifying Christianity 2010). However, one cannot find any published article in the area of science education that is supported by verses from the Bible. In other words, whether it is Islam or Christianity, one can easily find verses to sustain findings that religion and TOE are compatible. However, I argue that science and religion should be separated and not co-mingled. If science educators justify the inclusion of religious beliefs and practices into science education based on the role of religion in a sociocultural setting, then they are advocating the teaching of pseudoscience.

As this study has shown, there are epistemological challenges regarding understanding of the term, theory. For example, Muslim undergraduate students define a theory as man-made (Taskin et al. 2008); specifically, theory is man-made and a hunch, but the Qur'an is absolute truth. This belief affords theory lower status because it is not divine, meaning that the term theory for many Muslims is not afforded the status it has in scientific disciplines. However, the issue of the status of theory cannot be considered only as an epistemological problem but should be acknowledged as a direct outcome of the integration of science and religion or more directly the Islamization of science.

In order to achieve an in-depth understanding of the relationship between science and the Muslim faith, many facets of social life need to be considered. According to Robert e Dowd (2003), religion matters depending on where a person lives, not on whether she or he is a Muslim. In this case though it is difficult to excise Islam from Muslim societies. Islam is the basis for a Muslim society.

Final statement

Obviously, this paper can sound quite offensive to my Muslim colleagues and friends. That is not my intent. There are many examples of non-religious influences in science education. For example, Jesse Bazzul's (2012) critical paper looks at the connection between science education and global capitalism. Bazzul criticizes the subjectivity regarding curriculum materials that through their objectives promote global capitalism. He also points out that science education is a political field designed to promote certain political views. However, there is no counterargument in Muslim science educators. Even though oppressive governments exist, and inequities have been fully felt in society particularly in the area of science education, little research has been conducted in Muslim countries that explore the relationship between sociocultural factors and science education.

Even though the present results cannot be generalized, upcoming studies might benefit from these findings that highlight both the pervasiveness of Islamization of science and the

complex ways in which specific educators engage with this element. We need to encourage researchers to pursue different facets of science education and Islam. These facets include the role of female Muslim students in the present, the interaction between instructors and Muslim graduate students, and, most importantly, the perceptions of Muslim science educators regarding constructivist and postmodernist critiques of science at schools. All of these aforementioned relationships should be understood within the context of Islam and the influence of religion be made explicit. Hopefully, future research results will help us to take a step forward in our understanding of the assumptions of Muslim students, and science educators who are and will be entrusted with the education of future generations.

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