Science teachers' views and stereotypes of religion, scientists and scientific research: a call for scientist-science teacher partnerships to promote inquiry-based learning

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Abstract

Despite a growing consensus regarding the value of Inquiry-Based Learning (IBL) on students' learning and engagement in the science classroom, the implementation of such practices continues to be a challenge. If science teachers are to use IBL to develop students' inquiry practices and encourage them to think and act as scientists, a better understanding of factors that influence their attitudes towards scientific research and scientists' practices is very much needed. Within this context there is a need to re-examine the science teachers' views of scientists and the cultural factors that might have an impact on teachers' views and pedagogical practices. A diverse group of Egyptian science teachers took part in a quantitative-qualitative study using a questionnaire and in-depth interviews to explore their views of scientists and scientific research, and to understand how they negotiated their views of scientists and scientific research in the classroom, and how these views informed their practices of using inquiry in the classroom. The findings highlighted how the teachers' cultural beliefs and views of scientists and scientific research had constructed idiosyncratic pedagogical views and practices. The study suggested implications for further research and argued for teacher professional development based on partnerships with scientists.

Introduction

One of the main aims of science education at all levels of education from nursery to university is for people to understand 'the nature of science' (NoS) (Abd-El-Khalick, Bell, & Lederman, 1998). It helps students to develop their knowledge and understanding of the ways scientific ideas change through time and how they are affected by the social, moral, spiritual and cultural contexts in which they are developed (Reiss, 2000). Culture and individual beliefs determine the relationship between people, society and science which must be viewed as an integrated system within which each individual finds a place (Munby, Cunningham, & Lock, 2000).

The challenge that science teachers confront in teaching science in a religious context or even in a multicultural context is teaching controversial issues or socio-scientific issues related to religion (Author, 2008; Reiss, 2000; Tal & Kedmi, 2006). A lot of questions go around in our minds as science teachers or even as parents about the main purpose of teaching or learning science, for example: Do we learn/teach science to predicate the role of scientists? And in turn should we be open-minded to gain truthful scientific knowledge, *or* do we learn/teach science for religious purposes? When we think about how teachers view science, scientists and science education in Islamic countries, we need to question first their epistemological and ontological positions of science and scientists. We need to think and ask how teachers view knowledge in general and scientific knowledge. In particular, do they relate it to their religious beliefs and if so, how do they do that and in what context? Teachers' attitudes toward science have previously been explored, but there are a very few studies and mainly in western contexts that studied teachers' views and stereotypes of scientists and the impact of these stereotypes on teachers' pedagogical beliefs and practices in the science classroom. Future teachers as well as classroom professionals have distorted views of who scientists are and what they do (McDuffie, 2001). Gouthier (2007) argues the significance of exploring teachers' beliefs about scientists and its impact on students' science learning. "Yet teachers, for their professionalism and role, are special observers of the children's imagery. They meet pupils on a daily basis and debate their naïve conceptions, their beliefs and attitudes with them. Moreover, they heavily contribute to build not only the knowledge, but also the beliefs and attitudes of students as concerns science, both directly, by teaching, and indirectly, by transferring, even involuntarily and in a non-planned way, their own conceptions and beliefs." (p.1) Negative attitudes towards science and scientists can cause a serious threat to students' interest in taking a career in science (Osborne, Simon & Collins, 2003; Sjøberg, 2000).

This argument raises a research question for the current study concerning the impact of teachers' experiences and views of scientists and scientific research on using inquiry-based learning in the classroom. Since students begin to engage with science and their stereotypes of scientists begin taking shape at an early level of schooling, a science teacher who addresses the nature of science (NoS) and the stereotypical images of scientists is needed in preparatory schools (ages 12-15 years). This is one of the reasons why preparatory or middle school teachers were chosen as a sample for the present study.

Scientists in a religious context

Brooke (1990) argues that historians of science who have made a special study of relations between science and religion have observed that many of the debates that used to report a conflict between the two are in reality more about the cultural meaning of the new scientific ideas. He also argues that the Copernican system as a new system had to be resisted not because it proved ‘the centralisation of the Sun’ but because it implied ‘the decentralisation of humanity’. Pearlstein (1990) argues that the key conflict between religion and science is not in particular scientific ideas such as evolution, but in how the scientist arrives at conclusions. Therefore, debating the relationship between religion and science should consider carefully their epistemological and ontological orientations. Religious evidence is based on religious authority which relies on a book or a set of traditions. In this sense, religion claims ‘Eternal Truth’ (Vroom, 1990; Wiebe, 1981). However, science does not recognise absolute authority. It considers ‘truth’ to be relative and tentative (Abd-El-Khalick, et al., 1998). In this respect, Ball-Rokeach, Rokeach and Grube (1984) suggested that a person’s value-related attitudes toward objects and situations and the organisation of values and beliefs about the self form a comprehensive belief system that provides an individual with a cognitive framework. However, the story is more complex than simply to claim that religion is contradictory to science and hence religious individuals do not go into science (Ecklund & Park, 2009).

In the history of science there are a number of examples about the conflict between scientists and the Catholic Church. Roger Bacon, a thirteenth-century English priest, spent the final fourteen years of his life in jail for writing that in the quest for truth, experimentation and observation are challenges to the uncritical acceptance of spiritual and secular authorities. In the nineteenth century, Charles Darwin was mocked and declared harmful for claiming that all living things evolved from lower life forms (Weerakkody, 2010).

The idea for the current research is based on the arguments above which echo Brecht's play 'Life of Galileo'. This play argued the morality of a scientist's action in a society, scientists' freedom, and the social consequences of scientists' work. Also, Brecht's play argued the debates and wars about 'religious power vs. state control' and 'intelligent design vs. science-based thinking'. The importance of Brecht's play to this study is that it reinforces a point on which the Galileo affair offers a striking demonstration that scientific research does not take place in a cultural vacuum (Brooke, 1990). Therefore, there is a need for research to explore these issues about the relationships between scientists, scientific research and religion within the community of the science teachers in a Muslim country like Egypt. It is worth mentioning that Egypt is predominantly a Muslim country with 90% of its total population Muslims. The remaining 10% are followers of Christianity, Judaism, or do not identify themselves with any religion. Almost the entirety of Egypt's Muslims are Sunnis. A significant number of Muslim Egyptians also follow native Sufi orders, and there is a minority of Shi'a. Christians are mainly Coptic Orthodox along with fewer numbers of followers of the Coptic Catholic Church (Author, 2011). This paper argues that we cannot generalize the relationship between science and scientific research based on the experience of religious believers or atheists in Europe and that there is a need to explore this debate in different contexts and cultures.

Cultural considerations of science teachers' views of religion and scientists

Social psychologists acknowledge the important role that culture—a social group's beliefs, knowledge, norms and ideologies—plays in shaping and reproducing stereotypes (Sharkawy, 2012). Teachers, students and scientists bring differing expertise to their partnership work. Importantly, this professional and subject knowledge is shaped by different cultural resources (Abd-El-Khalick et al., 1998;

Munby et al., 2000). Stereotypical views of scientists portrayed in the media, and how science is currently taught in schools both contribute to many students not studying science beyond Year 10 (Jane, Fleer, & Gipps, 2007). Although these differences may serve as barriers to collaboration and interaction, they might also contribute to “a social negotiation of ideas” (Johnston & Thomas, 1997). To transform the ideals captured in the National Science Education Standards into the fabric of the classroom, “science education must... foster scientific literacy for all; dispelling stereotypical images of science and scientists is a significant step in this direction, and, moreover, one to which we can all contribute.” (Rahm & Charbonneau, 1997, p. 777) Teachers must abandon the stereotypical view if they hope to encourage females and minorities toward careers in science (Rosenthal, 1993), because teachers’ perceptions of science and scientists influence their students’ attitudes toward science (Kahle, 1988).

The perceptions teachers have of scientists may be formed through the mass media or by learning about scientists they encountered in their own studies (Gouthier, 2007) and those teachers’ perceptions shed light on the links between the social and the epistemic dimensions of science (Gouthier, Cannata, Castelfranchi, & Manzoli, 2006; Author, 2013). In this respect, this paper argues that teachers' perceptions about science and scientists are developed throughout their lifetimes and are influenced by a variety of factors, including events, experiences, and other people in their lives (Knowles, 1992). Some perceptions are directly adopted from their culture. For example, each individual shares similar experiences as a child, as a member of a family, and as a parent or teacher. These experiences shape their beliefs about students, curriculum development, and the overall schooling process (McGillicuddy-De Lisi & Subramanian, 1996). In addition, Reiss (2000) argues that within a particular society, there are some characteristics of the individuals as gender, religious beliefs, ethnicity, age and disability which make these individuals differ in their scientific understanding and conception of the world. Also, he argues that a teacher can play a positive role to react to the interaction between the inter-individual and inter-cultural differences in scientific understanding and practices. McGinnis (2006) has noted similar cultural considerations influencing teachers’ professional lives. Akerson, Buzzelli, and Eastwood (2012) identified interesting relationships between cultural values personally held and pre-service teachers’ conceptions of NoS aspects.

Scientist-teacher partnerships

The word ‘partnership’ has been used widely and can mean many things. In this paper, the term scientist–teacher partnership means collaboration among a group of university scientists or experts in science and science teachers, with the goal of improving science education and science teacher education to implement inquiry-based learning. Partnerships between members of the scientific community at institutes of higher education and the K–12 education community are an increasingly popular approach to science education reform (Tanner, Chatman, & Allen, 2003). According to Loucks-Horsley et al. (2003), partnerships between science teachers and scientists are as diverse as the individuals involved. An important characteristic of a partnership is that both partners bring expertise to the experience with the ultimate goal of improving the teaching and learning of science in the classroom. The scientists and teachers play different roles but must believe that each has expertise to share; each must value the knowledge and expertise of the other.

Tanner, Chatman and Allen(2003: 195) explain that “partnerships between scientists and teachers provide a flexible framework for collaboration between the K–12 community and institutions of higher education, and the proposed benefits of these scientist–teacher partnerships are enormous, including insight into the nature of scientific inquiry and deepened content knowledge for teachers, increased communication and teaching skills for scientists, and enriched science learning experiences for all students involved.” The involvement of working scientists can have a profound effect on teacher optimism. Changing teaching style and/or adopting a new curriculum require tremendous energy and commitment on the part of the teachers involved. Through supportive participation in the process, scientists can provide crucial emotional support for teachers and also advocate for teachers within a programme, school district, and/or community (Bower, 2005). In this respect, Hughes, Molyneaux and Dixon, (2012) argue that science teachers can improve students’ science understanding by implementing scientific inquiry into their lessons but the successful implementation of inquiry needs teachers to engage with the collection and analysis of scientific data and to work with professional scientists. Scientists may be able to help teachers better translate the authentic meaning of scientific inquiry into their classrooms to help students more easily understand scientific practice and content.

Mutual learning requires that all participants in a partnership bring to their conversations and collaborations a learning stance, a willingness to be open to new ideas, a capacity to listen, and, most importantly, the professionalism to examine their own teaching beliefs and practices critically. The relative expertise each scientist or teacher brings to the partnership is dependent on his or her own depth and breadth of experience in teaching and scientific research. When scientists and teachers are mixed together in inquiry teams where no-one has the answer (or better yet, where a 'correct' answer does not even exist), the result can be extremely valuable for teachers (Bower, 2005).

Purpose of the study

The purpose of this study was to understand science teachers' views of scientific research and scientists, and whether this contributed to new understandings about the nature of science, teacher professional development, and the teaching and learning of science using IBL. The questions that guided the research were:

- What are teachers' views of the relationship between religion, scientific research and scientists?
- How do teachers' views of scientific research and scientists influence the use of scientific investigation and inquiry-based learning in the classroom?

Research methods

The study adopted a quantitative-qualitative methodology using a questionnaire followed by an interpretive approach (Bell, 1993; Calderhead, 1996) in an attempt to gain an in-depth understanding of the science teachers' views of the relationship between scientists, religion, and scientific research, and the impact of these views on teachers' pedagogical beliefs and classroom practices.

A 51-item questionnaire was developed to study teachers' views of the relationship between religion, scientists and scientific research based on the review of relevant literature (e.g. Aikenhead, Ryan & Fleming, 1989; McDuffie, 2001; Peker & Dolan, 2012; Sjøberg, 2000; Willcuts, 2009). The questionnaire was translated from Arabic into English for the purpose of publication. Two educators specialising in the English language looked at the translation to be sure that the Arabic and English versions were identical. These 51 items are divided between 6 scales:

- The relationship between science and religion (scale 1) included 6 items.
- Scientific research and the scientists' cultural beliefs (scale 2) included 10 items.
- The role of religion on scientists' decisions (scale 3) included 10 items.
- The role of religious beliefs on scientists' scientific discoveries (scale 4) included 7 items.
- Epistemological views of science, "views of scientific models used in research laboratories (scale 5) included 10 items.
- Ontological views of science, "views of the natural world and a supernatural being" (scale 6) included 8 items.

The items included in scale 1, "the relationship between science and religion" were empirically developed and the researcher gave them a common multiple-choice format. A numerical rating of 1 to 5 was assigned to each response with 5 being the highest and 1 being the lowest for positive statements. In addition to those items, five scales from a Views on Science-Technology-Society (VOSTS) survey were used but any reference to Canada in the original VOSTS was changed to refer to Egypt. These scales were selected because they encompassed aspects of views about scientists, scientific research and the relationship between scientists' cultural beliefs and scientific research. Each sentence explains a reason that develops a particular position (belief) on the stem issue, so the set of options presents a range of different positions within each scale (Aikenhead, Ryan, & Fleming, 1989).

Reliability and Validity

The validity and reliability of VOSTS had been reported elsewhere (Aikenhead & Ryan, 1992; Yalvac, Tekkaya, Cakiroglu, & Kayhaoglu, 2007). In this study, Cronbach's coefficient alpha was used to calculate the internal consistency coefficients of the items included in the questionnaire through a pilot study with 42 science teachers. Results of the reliability analysis showed that the items in the 6 scales had a satisfactory discriminating power. Reliability coefficient alpha obtained for scale 1, "views of the relationship between science and religion" was 0.76; for scale 2, "views of the relationship between scientific research and the scientists' cultural beliefs" was 0.79; for scale 3, "views of the role of religion on scientists' decisions" was 0.78; for scale 4, "views of the relationship between scientists and their religious views" was 0.77; for scale 5, "views of scientific models used in research laboratories" was 0.68; and for scale 6, "views of the natural world and supernatural being" was 0.63.

Content validity of the questionnaire and the interview questions was assessed by five science education experts. Each expert was asked to establish the adequacy of the questions and to identify inappropriate wording or ambiguities. They gave useful feedback that was used to improve the questions in both the questionnaire and the interviews. In addition to the content validity, some procedures were carried out to ensure the rigour of the qualitative data collection. These procedures included:

- Accurate records. "Try to record as accurately as possible, and in precisely the participants' words" the responses given (Wolcott, 1994, p. 249). When notes are taken they should be made as soon as possible after the event, if not during the event.
- Early rough analysis. The researcher should start a rough analysis of the data while still in the process of conducting the study. This procedure helped identifying the gaps in the data collected, and enabled the study to acquire in-depth details from the participants before the data collection was over.
- Respondent validity. This is considered important for understanding that the research represents a shared reality (Cohen & Mainon, 1989). Therefore, in order to provide respondent validity, interpretations of interviews were sent back to some participants to confirm that the researcher's interpretations were accurate.

Research procedures and research sample

A closed-ended questionnaire and interviews were used in consecutive steps to collect data:

In the first phase of the study a closed-ended questionnaire was used to collect information about teachers' views on:

- The science and religion relationship
- Scientific research and the scientists' cultural beliefs
- The role of religion on scientists' decisions
- The role of religious beliefs on scientists' scientific discoveries
- Epistemological views of science
- Ontological views of science.

The samples were convenience samples, but the subsequent interview participants were chosen purposively to provide a reasonably even gender balance and a range of scientific disciplines (chemistry, biological sciences, physics, etc.), a variety of teacher qualifications, teaching experience, age, and school locations. A total of 81 Muslim-Egyptian preparatory science teachers responded to the questionnaire. This sample included both sexes and the teachers ranged from 27 to 52 years old, with a mean age of 45. In terms of teaching experience, respondents were divided up into three experience groupings: newly qualified (from one to five years), semi-experienced (from six to ten) and experienced (11 and more).

After the questionnaire data was completed and analysed using descriptive statistics calculating the percentages of teachers' responses, the findings of the questionnaire helped when selecting the interviewees and developing the interview protocol. Initially, 25 out of the 81 teachers expressed an interest to take part in the interview study. The sample for the interviews was chosen to represent diverse views of the relationship between scientific research, scientists and cultural beliefs. Based on the quantitative analysis of the questionnaires, out of the 25 teachers, 15 were selected for the interviews. The selection of interviewees was guided by both the theoretical sampling principle (Boeije, 2002) that implies that the researcher decides what data will be gathered next and where to find them on the basis of provisionary theoretical ideas, and a "maximum variation strategy" (Patton, 2002), which included the following criteria: teachers' backgrounds, subjects taught, gender, and teaching experiences, as well as teachers who held representative views or contradictory personal visions or stereotypes of scientists and scientific research. The selection also considered their enthusiasm for being interviewed. The 15 participants' real names will not be revealed; participants will be referred to by letters (A, B, C, etc.).

The second phase of the study involved intensive semi-structured interviews, with questions based on the responses made to the administered questionnaires. A series of two to three interviews with each interviewee were carried out using the Key event recall technique alongside the interview protocol. Key event recall is used by taking an event in the closed-ended questionnaire dealing with a particular issue (e.g. techniques used with unborn babies in Egypt, or scientists' discoveries or decisions) and recalled it for the participant, asking them what it meant to them and discussing their responses to this issue (De Laat, 2006).

The interviews were audio-taped and then transcribed immediately after each interview. The transcripts were returned to each of the interviewees before the beginning of the following interview for their scrutiny, confirmation or criticism. In addition an initial analysis of each interview was carried out and notes made on a covering sheet to act as a framework for subsequent questions. Each interview lasted approximately 30-45 minutes. All respondents were told that their responses would be kept anonymous and confidential.

Data analysis

The analysis of the questionnaire findings gave indications of issues to be explored in depth through interviews. For example, some of the codes raised by the questionnaire are: scientists' personalities and beliefs influence their research practices; authoritative groups' voices influence scientists' practices, decisions about socio-scientific issues are community-driven; scientists' practice independent of religion; scientific models are copies of reality; creationist views of science and realistic views of science. These initial codes from the questionnaires were used as a deductive organizing framework that helped and informed the inductive (ground-up) development of codes from the interviews.

The interview transcripts were analysed using an iterative process. Data sources were coded to discern initial patterns and themes, which were continually refined and modified during the analysis to generate both descriptive and explanatory categories (Lincoln & Guba, 1985). Codes were developed to identify relevant and recurring themes that evolved regarding the ways in which teachers viewed scientists and understood scientific research and the relationships between scientists and their cultural views. Also the constant comparison technique helped to find out how teachers' views impacted their use of inquiry with students. Themes were refined, refocused, or altered as new transcripts were analysed. Even after 15 teachers were interviewed initially and analysis was carried out of the results, the second and third rounds of interviews were carried out, asking specific questions of some of the interviewees. At the second and subsequent interviews the teachers were invited for the interviews gradually until the analysis achieved theoretical saturation — i.e. when additional interviews would add nothing to what was already known about the properties of categories and themes of the analysis. Because the interview transcripts were analyzed straight away, the theoretical sampling informed the process of data collection and whether or not there was a need to do follow-up interviews (Bogdan & Biklen, 2006).

Findings

Quantitative findings

Teachers' views about the science and religion relationship

INSERT TABLE 1 HERE

Table 1 shows that 80.3% of the Egyptian science teachers in this study believe that religious claims are reliable and stand even with the advancements of scientific discoveries (Item 1). Some 70.4% of them expressed the view that religious claims and explanations are valid and should be considered over the scientific-based evidence (Item 2). However, 85.2 % of the teachers believe that science and religion share many principles and values (Item 3). In the same sense, all the teachers expressed that taking a scientific approach to studying the natural world does not negatively affect people's religious beliefs (Item 4). Teachers hold strong beliefs that both religion and science are equally necessary for understanding scientific-natural phenomena (Item 5); for instance, 66.7% of the teachers disagreed that religious explanations do not add value to the 'cause and effect' explanation. In addition in item 6, 96.3% of the teachers disbelieved that scientific explanation or discoveries of natural phenomena will make people to not believe in the supernatural work of God.

Scientific research and the scientists' cultural beliefs

INSERT TABLE 2 HERE

As shown in Table 2, when teachers were asked whether the religious and ethical views of the culture in which scientists work will have an influence on the scientists and scientific research, they tended to favour the positions (72.8% A-E) that suggest that religious or ethical views DO influence scientific research. A large number of teachers (D; 32%) believed the influence of the culture will vary from one scientist to another depending on the scientists' cultural beliefs and their interaction with their societies. In contrast, some teachers (E; 18.5%) were drawn to the notion that some influential groups or decision-makers might support or orient the scientists to carry out certain research projects. Along the same vein, 13.6% of the teachers believed that scientific discoveries are guided by the needs of some cultures. Few teachers (6.2%) chose C, that scientists will be influenced by their own religious and ethical beliefs and will carry out researches that match their beliefs. On the other hand, a number of teachers (23.5%) leaned towards positions F and G, that religious or ethical views *do not* influence scientific research. The majority of those teachers (19.8%) inclined towards position F which suggests that scientific research is independent of the conflict that might exist between scientists' cultural beliefs and the cultural groups in the society. Very few teachers (3.7%) believe that scientists are free to carry out the research they are interested in.

Teachers' views of the role of religion on scientists' decisions

INSERT TABLE 3 HERE

As shown in Table 3, a substantial number of the teachers (63%) stated that they don't know enough about the subject of 'unborn babies in Egypt' to make a choice from A-G. The rest of the teachers were divided into two positions. On one hand, a very small number of the teachers (A; 3.7%) supported the notion of scientists and engineers to make decisions because they are technically and scientifically qualified to make such decisions. But some teachers (C; 4.9 %) supported the same notion but under consultation with the public, while a significant number (12.4 %) chose position D that all parties' views including scientists, engineers, other specialists, and the informed public should be considered equally when making decisions about sensitive and controversial issues related to society. On the other hand, 6.1% of teachers believe that scientists and engineers should just give advice to the government (E; 4.9%) or the public (F; 1.2%).

Teachers' views of the role of religious beliefs on scientists' scientific discoveries

INSERT TABLE 4 HERE

As shown in Table 4, a majority of the teachers (80.3%) were inclined to believe that scientists and scientific discoveries are influenced by the scientists' religious beliefs (positions A, B, & D). They believe that scientists' own religious views (B; 27.2%) might have a stronger influence on scientists than guidance that the religion might offer the scientists. In contrast, 28.4 % of the teachers believe that scientists carry out their research guided by scientific theories and scientific research methods.

Epistemological views of Science

INSERT TABLE 5 HERE

As shown in Table 5, teachers take two main positions:

Group 1 "Scientific models ARE copies of reality". Some 64.2% of the teachers in this study held A-D positions, that scientific models are simple 'true models' that duplicate the natural world. These results indicate that there is a significant group of teachers with a narrow and naïve understanding of the concept of a scientific model as duplication of the reality but who also hold naïve views about the epistemology of knowledge and NoS. For example, the majority of the teachers in group 1 (45% of teachers) hold a position D: they believe that the models replicate the reality because they have been developed through scientific research. These teachers who represent position D held a naïve experimentalism view that experimentation makes possible conclusive verification of hypotheses or theories. The latter view shows that teachers hold naïve views about the NoS and the use of scientific models.

Group 2 "Scientific models are NOT copies of reality". Some 32.3% of the teachers held E-G positions regarding scientific models as representations of ideas or abstract entities. This group of teachers recognized that scientific models are useful in understanding a theory or testing an idea. Teachers who held positions E-G showed that they have an understanding of the nature of knowledge but also an understanding of the affordances and imitations of these scientific models. For example, 10% of the teachers held position F about the relativism of knowledge and believed that the scientific models are changeable with time and with our changing knowledge.

Ontological views of Science

INSERT TABLE 6 HERE

As shown in Table 6, a substantial number of teachers (D; 79%) held creationist views, that the natural world is created and controlled by God and that modern science is not able to rule out the existence of God. These teachers held beliefs that science cannot explain all the natural phenomena or changes, and they advocated that scientists should simply accept that a supernatural being could alter the natural world. They believed that the role of science is to discover and investigate how the natural world is altered or changed by a supernatural being. A small number of teachers (C; 6.2%) believe that scientists' ontological interpretation of natural phenomena will be influenced by their interpretation of a supernatural being, which in turn might influence their use of the scientific approach toward and explanation of natural phenomena. In contrast to the former two groups, a third group of teachers representing the minority (A, B; 3.7%) held a belief in the scientific realism that the natural world should be described by science independently of religious beliefs. They believed that scientists assume that a supernatural being will *not* alter the natural world because either the supernatural is beyond scientific proof or scientists repeatedly get consistent results. In contrast and surprisingly, a few teachers (E; 2.5%) believed that science can explore or confirm the existence of supernatural beings.

Qualitative findings

Teachers' experiences with scientific research

Subjectivity of the scientists. In the interviews teachers stated different views of the scientific method, but mainly they expressed naïve views of science and scientific research and they expressed concerns about the objectivity of scientists and scientific research. This view about the subjectivity of scientists was emphasised in Table 2, that 72.8 % of teachers believe that scientists and scientific research are affected by the religious or ethical views of the culture where the work is done.

One teacher commented on the subjectivity of scientific research and its outcomes:

I don't know much about scientific method in research. But I think from its name, it is applicable to study pure scientific materials, for examples, electrons, and atoms. I don't think that scientific method can establish truth because researchers are human who have backgrounds which will influence their understanding and interpretations of their research findings . (Teacher B)

Another teacher supported the issue of the subjectivity of the scientists. She said:

We should use scientific method carefully, especially as we are human and our interpretations of the results of these research methods are limited to our abilities. Scientists and researchers are not machines. They do have attitudes towards what they are doing. (Teacher D)

Teacher E agreed with both teachers B and D about the subjectivity of scientists and explained how these views of scientific research and scientists influence their practices:

Research methods based on religious framework are truthful. When I teach any experiments I always remind students that whatever we do or know in science is not true 100%. What is completely true is the religious proof. (Teacher E)

Science and scientists value-free. Another group of teachers expressed a belief that science requires that scientists be value-free and their belief system shouldn't influence their research. Scientists must feel free to express their scientific views based on evidence and not based on their own beliefs or other people's in society. As teacher N says:

From my experience with experiments on science, I can tell that scientific method is value-free. It doesn't consider any values or emotions.

Another teacher, G, agrees with teacher N, that:

Using scientific methods when studying human behaviour might be helpful to get the reality of the situation without any bias.

Experiences with research and doing Inquiry-Based Learning (IBL). The majority of the interviewees did not have experience with scientific research or scientific investigation. They also indicated that using inquiry in the classroom with their students could be challenging, either due to a lack of confidence in their ability to teach by inquiry or their knowledge and skills about research.

One teacher expressed his experience of learning the scientific research method and inquiry as a spoon-feed mode or a training-oriented approach:

I never practiced open inquiry as a learner. As part of my teacher education preparation at a faculty of science, we used to use a scheme for experiments that explained exactly the steps we should follow to carry out our experiments in the science laboratories. But I do not use [open inquiry] with my students for many *reasons but mainly [because] I do not feel confident and I don't have the skills to support my students' inquiry learning. (Teacher B)*

Teachers' views of scientists

Dialogic views of scientists and religion. A majority of the teachers expressed the opinion that scientists should work closely with religious scholars especially about controversial issues (e.g. cloning and organ transplant). They believed that without religious guidance, scientists might test claims which are against the religious beliefs or against the cultural values of their society. These teachers always use religious discourse to argue the relationship between science and religion. One teacher says:

There is an area of agreement between science and religion such as the case of stages of foetus growth mentioned in the Qur'an and proved by science. Science always discovers what religion previously tells us about natural phenomena. (Teacher E)

Authoritative views of Religion on scientists. All the interviewees believed that the Holy Qur'an is a source of all knowledge. Their view was that scientists should not only be guided by the scientific phenomena mentioned in the Holy Qur'an but also to take its scientific models to guide and design their own scientific research. The teachers believed that scientists should be independent to be creative as long as their discoveries do not damage any religious values. This authoritative view of religion on science can be explained by the quantitative findings presented in Table 6 that 79% of the teachers believed that the role of science is to discover and investigate how the natural world is altered or changed by a supernatural being. This also explains that teachers hold beliefs in the value of scientists and scientific research to explore natural phenomena. This belief about the value of science was shown in the quantitative findings presented in Table 5: that 64.2% of teachers viewed that scientific models are copies of reality mainly, because they are based on scientific observations and research.

Teachers held strong beliefs that the Qur'an is full of scientific miracles that can lead to discoveries if the scientists give attention to the Holy Qur'an. For example, teacher A commented:

I do strongly recommend that scientists should be guided by the Qur'an whenever it is possible. For example there are verses that show the change of the status of matter. (Teacher A)

Teacher A supported his argument by recalling verse 27 from Surat al-Muminun in the Holy Qur'an to give examples of some of the scientific phenomena presented there. The verse says*:*

"We revealed to him: 'Build the ship under Our supervision and as We reveal. When Our command comes and water bubbles up from the earth, load into it a pair of every species, and your family – except for those among them against whom the word has already gone ahead. And do not address Me concerning those who do wrong. They shall be drowned'." (Surat al-Muminun, 27) (Teacher A)

Views of the scientists in society. The findings of the interviews with teachers showed that some teachers in this study, as shown in Table 4, do believe that scientists are influenced by their personal experience and views of their societies.

Teacher H commented that scientists and teachers form beliefs and views through their life experiences in their societies which in turn can influence their professional beliefs and inform their practices:

I am a science teacher but I have never met a Muslim scientist directly since I graduated from university. I do not know much about their personal lives. But as humans living in society, held traditions and values form our views and do influence our life or scientific behaviour. In my class, I always remind students that our religion encourages us to understand the natural world, to be able to live in it and protect it. (Teacher H)

Another teacher G argues that scientists' cultures might influence or limit their interpretations of the research findings.

The scientists are human and live in a society that influences them directly and indirectly. That is why we need to be very careful when using the science made by scientists from different societies or cultures. (Teacher G)

Attitudes towards Non-Muslim scientists. Some teachers expressed negative attitudes about western (non-Muslim) scientists because of the media. One teacher commented:

I strongly believe that Muslim scientists are different from non-Muslim scientists. Muslim scientists hold scientific ethics which might be different from non-Muslim scientists but also their views and interests would be different. But I have to say I have never talked to scientists, Muslim or non-Muslim, but I got these views from films and from media. (Teacher A)

Partnerships with scientists

The interviewees reported that there was no formal channel to involve scientists in science education. They suggested that students and science teachers should communicate directly with the scientists. They argued that this communication or dialogue with scientists might have a big influence on students' views about science and might correct their perceptions about studying science in the future, and would also help teachers' use of scientific investigation in the classroom and implementation of the inquiry method with students.

Teacher M argued the necessity to establish partnerships between schools and scientists or engineers to help students develop their inquiry skills. He says:

We try to teach our kids to act as scientists when they are in the laboratories or having scientific debates. I do encourage my students to listen to each other carefully and to bring the scientific evidence. But what really can help the way we teach inquiry or integrating scientific inquiry in the classroom is to offer these students opportunities to visit factories or universities to talk to engineers or scientists. (Teacher M)

Another teacher highlighted the importance of cooperative lesson-planning with scientists and engineers and said,

I would like to try planning a lesson with a scientist or an engineer, this would help me implement ideas about the relationship between science and engineering in my lessons. (Teacher G)

Some participants emphasized that due to their lack of knowledge about some socio-scientific-religious issues, they found it hard to teach these issues or encourage students to debate them. This finding about lack of knowledge about the socio-scientific-religious issues can explain why 63% of the teachers responding to the closed-ended questionnaire presented in Table 3 expressed that they don't know enough about which techniques can be used with unborn babies in Egypt (for example, amniocentesis for analyzing chromosomes of the foetus, altering embryo development, test-tube babies, etc.) and they could not make decisions about whether or not scientists should be the ones to decide these techniques in Egypt.

Teacher H suggested that communicating with scientists and religious leaders about these issues can help planning and teaching these issues in a way that encourages dialogue in the class. He said:

I try to avoid teaching these socio-scientificissues that might lead to conflict in the classroom, e.g.test-tube babies. I do not have enough knowledge about these issues and just teach the content in the textbook and refer to religion when teaching these issues. It would be very helpful to meet scientists specialized in these issues and ask them questions about these discoveries but meeting with religious scholars will help by clarifying the religious views about these issues and will make me confident to teach these issues. (Teacher H)

In line with teacher H, teacher K explained how this partnership with scientists can help her understanding of science and the socio-scientific issues and inform her teaching and planning. Teachers H and K's views of the dialogic partnership between teachers and scientists can explain teachers' views presented in Table 3, that discussions about scientific issues related to different parties in society should be created by collecting the viewpoints of scientists, engineers and other specialists, equally with the informed public, who should all be considered in decisions which affect the society.

Teacher K recommended partnerships with scientists:

It would be great to hear from different scientists about their discoveries and the models they created for their scientific theories. This would help me as a teacher to understand science and be able to teach models as part of the scientific inquiry. (Teacher K)

Scientist-teacher partnerships as CPD (continuing professional development

Some interviewees found it difficult to express their views about scientists because they never met or had contacts with scientists. Teachers strongly suggested that working with scientists would help them to understand scientists' views of socio-scientific issues and scientific inquiry, and get to know their history, career or study that led them to be scientists and their motives in becoming scientists. One female teacher said:

I have never met a scientist face to face or dealt with them directly. We always hear about scientists' work or news through the media, TV or newspapers. It would be great if we could work with scientists as part of teaching science. This would help, giving us stories about scientists that we can share with our students. (Teacher O)

Another teacher, L, emphasised the necessity of this partnership with scientists for teaching socio-scientific issues, e.g. cloning or organ transplants that might cause sensitevity with teachers and students' religious beliefs. She recommended a partnership with religious scholars too. She said:

I never studied issues at university related to science and religion. So it would be great to hear from religious scholars and scientists about their views of these issues, like organ transplant or cloning and their recommendations [of how] to teach these issues. This would help also in teaching about the nature of science and the views of religion about the nature of science. (Teacher L)

Teachers strongly suggested CPD (continuing professional development) based on a partnership between scientists and science teachers. They suggested that scientists should talk to students at universities and schools about their discoveries and their scientific research approach which in turn could help in teaching IBL.

Teacher K was very critical about her role as a teacher to support and develop students' inquiry skills. She emphasised that she did not practise inquiry or have training that focused on using inquiry with the students in the classroom.

Not sure how I can train students to be scientists or act as scientists. I should learn first, myself, to act as a scientist. I should experience Inquiry to be able to teach it to our students. Our preparation at university to teach Inquiry was very theoretical but *also the teacher professional development does not allow us to act as an inquirer or a learner. (Teacher K)*

Teacher K emphasised the need for professional development that focuses on implementing inquiry and putting it into practice. Also CPD should involve experts, professionals or scientists related to the topics they teach. She argued that this CPD can help teachers' understanding of the content but also their understanding of the religious and scientific views of the issue which indeed can help the teaching of complicated and controversial issues and of using IBL. She said:

I hope for our professional development to become more practical and to involve experts in science, not just educators. I would imagine that a professional development workshop about nuclear energy should involve scientists who know about nuclear energy. But also, to grasp the issue of cloning, religious scholars and biologists should be involved in these professional development workshops. (Teacher K)

Teacher I argued for the need for a partnership with scientists to help the scientific literacy of the students.

It would be very helpful for the public if scientists could communicate and announce their discoveries and explain them to the public before they implement them in the society. In this way, the public would be scientifically well-informed about the scientific discoveries and could offer support to these discoveries. (Teacher I)

Some teachers expressed that their research skills could benefit from cooperating with scientists. For example, Teacher J commented,

My experience with scientific research is very small. We just teach our students how to do inquiry as it is mentioned in the science textbooks. Our students can benefit from talking to a scientist and his beliefs and interests. I remember when I was very young, our school invited a scientist in solar energy and we had a chance to ask him about his life and his kids and why he chose to be a scientist, and how. This visit influenced me and my colleagues and this is one of the reasons I became a science teacher. (Teacher J)

Discussion and Implications

Teachers' views and experiences of scientists and scientific research and how they impact on using IBL

The study's results explain that a lack of experience with scientists and scientific research and practices influence how teachers understand the relationship between religion and scientific research. This study argued that teachers have naïve views of scientific research and most of them did not practice scientific research, and this in turn had influenced their understanding of inquiry or using inquiry as pedagogy with their students. Research on teachers' use of inquiry in the classroom argues that teachers who have never conducted scientific research feel unprepared to use IBL and they fail to help their students in formulating questions, designing experiments, and representing data (Singer, Marx, & Krajcik, 2000; Windschitl, 2003). The findings of this study concur with Loucks-Horsley et al. (2003), that teachers' direct cooperation with the scientists can model inquiry and provide new insights on the nature of the practice of science in the real world. But equally the scientist can benefit from this cooperation as scientists might become familiar with the needs and realities of a school system and become advocates for quality science education. In this sense, a study conducted at the University of Florida (Brisco & Peters, 1997) indicates that the partnership between elementary teachers with scientists facilitated change in the teachers' teaching practice, because it provided opportunities for the teachers to learn both content from the scientists and pedagogical knowledge from one another.

Another important finding was that the majority of the teachers did not experience scientific research or authentic scientific inquiry during their pre-service or in-service training. Instead, teachers entered and studied at universities as part of scientific laboratories that had pre-defined structures in place. Teachers would have pre-defined procedures for all the experiments they carried out in the laboratories at university. They were provided with all the tools and with a dedicated area to do the experiments. They knew the conclusion they wanted to reach before they started the experiments. This experience of scientific experiments, 'cookbook laboratories', had an influence on teachers' views of the nature of science but also on how science should be taught. It is this study's belief that teaching science with a lack of understanding of scientists' roles about developing science and scientific discoveries, or without understanding the process of scientific investigations or scientific research, will lead to activities directed toward using ready-made science as represented in the textbooks. In addition, teachers with a lack of scientific investigation skills will be less confident to use inquiry–based learning in their classroom.

Teachers' views of scientists' religious and cultural beliefs and their impact on teaching science

The findings discussed that some teachers believed that scientists' religious beliefs influence their scientific research and discoveries (see Tables 2 and 4). These views about scientists coincided with Ecklund and Park's results (2009) which concluded that scientists raised in religious homes often remain relatively religious. In the same respect and as shown in Table 3 about the influence of their cultural beliefs on the scientists' decisions, most of the teachers thought that scientists should be guided and influenced by their internal or external cultural beliefs. They believe that scientists should interact with their society's needs, traditions and morals. Therefore, scientists can create a dialogue with people in society. This will help scientists understand the beliefs of this society, which can inform the scientists' views and guide their discoveries. But also and most importantly, this might minimize the society's resistance to these discoveries. In this sense, Katz (2002, p. 46) argues, "To begin a more effective dialogue, some scientists have suggested that religions of the world [should] become more informed about science. They believe that misunderstandings in the religious community prevent research that would be based on good, practical, instrumental grounds. In essence, these scientists believe that misinformation and insufficient understanding of what the issues really are have led to some of the resistance and impasses." On the other hand, teachers expressed concerns about the process by which questions are or are not selected for investigation, by suggesting that religious views may affect what scientists do or what problems they choose to work on. In this case, scientists will be limited by the religious influence and not by their religious beliefs (see Table 3).

Teachers' epistemological and ontological views of science and their impact on teaching science

The findings of the study showed that the majority of the teachers in this study (64.2%) hold naïve realist views about the scientific models in relation to their views about the knowledge of reality (see Table 5) (Grosslight, Unger, Jay, & Smith, 1991; Harrison, 2001). These naïve views about models showed that these teachers hold naïve realist epistemologies of science and NoS as well. This finding concurs with Justi and Gilbert's (2003) conclusion that "teachers' understanding of the nature of models is part of their understanding of the nature of science" (p. 1371). In this sense, those teachers with their naïve views about the NoS and the use of scientific models might transfer realist epistemologies to their students when using the scientific models as a pedagogy for learning science, learning about science or doing science in the classroom (Justi & Gilbert, 2002a). Grosslight et al. (1991) found that students have conceptions of scientific models that are basically consistent with a naïve realist epistemology. Justi and Gilbert (2003) argue that teaching students modelling hinges on two conditions being met: "The first condition is the textbooks which should contain a philosophically valid treatment of models and modelling. The second condition for success is that teachers themselves have a valid understanding of the nature of models and modelling. These are vital conditions if such ideas are to be taught to students." (p. 1370). This second condition is the concern for the current study about teachers' realist views of models. This study strongly recommends that science teachers need to develop their knowledge about the nature of the scientific models and modelling as pedagogy in the science classroom as part of their initial teacher education and professional development programmes. This is because without such understanding and pedagogical skills, teachers will not even realise the relevance of modelling-based pedagogy in promoting a more authentic science education or helping students to learn science or about the nature of science (Justi, 2009; Justi & Gilbert, 2002b; Justi & van Driel, 2005; Mendonc & Justi, 2011).

A very important finding of this study discussed that teachers held epistemological and ontological beliefs that science and scientific discoveries are or should be guided by cultural and religious beliefs. As shown in Table 6, the majority of teachers (79%) held creationist views despite the modern science in relation to understanding natural phenomena. These teachers believe that science does not have an explanation for all the natural phenomena. This is because the natural world is created or can be changed by a supernatural being. In this sense, these teachers do not express conflict between science and religion but they adopt a convergent perspective (Harry, Brickhouse, Dagher, & Letts, 2011) or an integrative perspective (Author, 2011) when thinking about science and the natural world. These teachers take an integrated way of making sense of the Universe or the natural phenomena which makes sense of the scientific approach to our world in light of the religious.

Teachers' call for a scientist-teacher partnership to promote IBL

The findings of this study have shown that teachers did not have the practical skills that can help them implement inquiry-based learning in the classroom. But also teachers did not feel confident to use inquiry to teach socio-scientific topics that require multi-discipline knowledge and religious-scientific views. Teachers in this study emphasised that involving scientists or experts in science learning activities in science classrooms, or at universities or workplaces where scientists perform science, can offer students and teachers learning opportunities that support inquiry-based learning and learning science through doing participatory science with scientists. The study advocates that a dialogue between scientists, religious scholars, science educators and science teachers is very important and very much needed in order to improve the teachers' professional development and develop models to teach controversial issues. This experience allows learners to gain insights into the communal nature of science and may facilitate the learners' adoption of ways of perceiving and interacting with the world that are consistent with those of real scientists (Barab & Hay, 2001). Universities should create opportunities for academics and company researchers and executives with shared interests to come together and develop a dialogue (Gaskill et al., 2003).

The findings of this study argue for a scientist-teacher partnership model to support teaching IBL and to challenge both teachers and students' cultural models and stereotypes of scientific research and scientists' practices. It was theorized that these partnerships situated in classrooms where participation in pedagogical decision-making and action was possible, and where dialogue could be grounded in this participation, had the potential to transform participants' understanding and practices relevant to science education (Lave & Wenger, 1991). Therefore, the study strongly calls for a partnership programme between scientists and teachers as professional development for science teachers. This programme should involve both teachers and scientists in authentic, formal and informal settings. This partnership will help teachers' understanding of the NoS but also explore the scientists' views of science. In addition, this partnership between science teachers and scientists will help teachers explore the scientists' cultural views and how scientists negotiate their cultural beliefs when they are studying natural phenomena. A study by Willcuts (2009) showed that scientist-teacher partnerships are a unique contribution to the professional development of teachers of science, something that is not replicated in other forms of teacher training.

Conclusion

The findings of the study explored in depth some underpinning epistemological-ontological religious and cultural views from science teachers of science, scientific research and scientists that explain their views and practices of using IBL in the science classroom. The study argued that science teachers with a narrow and naïve understanding of the concept of a scientific model as duplication of the reality hold naïve views about the epistemology of knowledge and NoS. In addition, the study showed that teachers hold epistemological and ontological beliefs that science and scientific discoveries are or should be guided by cultural and religious beliefs. These epistemological and ontological beliefs about science alongside some stereotypes about scientists and their scientific research practices inform teachers' practices of using inquiry as pedagogy in the classroom.

It is worth mentioning that the teachers in this study made judgments about scientists without direct contact with any scientists. In the present case, it is proposed that teachers' religious beliefs may act as just such a 'perceptual filter' to determine which pieces of information are attended to and retained about scientists and scientific research (Brossard et al., 2009). Studies in science education indicate that cultural values held by teachers influence how they teach science, and also that there may be a gap between the culture of the home and that of school (Aikenhead & Jegede, 1999; Akerson et al., 2012; McGinnis, 2006). Hence, we might expect that those teachers with ideologies incompatible with some of the implications of scientific discoveries will form attitudes that reinforce their dislike, compared to those relying on direct communication with scientists. This in turn might lead teachers to form false stereotypes about the NoS, scientists and scientific inquiry which in turn will influence how teachers present scientists and their discoveries to the students in the classroom.

The study argued that a dialogue between scientists, religious scholars, science educators and teachers is very important and very much needed to improve the teachers' epistemological views of science and the use of IBL in the science classroom. The study argued that this dialogue among these groups can take part in the CPD needed for teachers or can develop models to teach controversial issues. The study argued for a scientist-teacher partnership model to support teaching IBL and to challenge both teachers' and students' cultural models and stereotypes of scientific research and scientists' practices. The study debated that teachers' direct cooperation with the scientists can model inquiry and provide new insights on the nature of science and the practice of science in the real world. Therefore, the study strongly calls for a partnership programme between scientists and teachers as professional development for science teachers.

Future research

Research argues that individual, contextual, and cultural elements play a role in partnership interactions. Gender, personality, power, and the community, school, and classroom cultures were evident as factors affecting co-participation and dialogue. Research is needed to examine the relationships between these factors and the influence of these relationships on the teaching of science and students' engagement in the classroom (Nelson, 2005). In addition, future research should also explore the impact of the science classroom partnership with the scientists on the students' engagement, inquiry practices, scientific modelling and future careers in science. Also, the findings of the current study call for research to study a professional development programme based on a partnership between scientists and science teachers. This professional development programme might consider using action research to develop models of the possible partnerships between scientists and teachers, and to study the impact of the programme on science teachers' professional development and their views and practices of socio-cultural issues or controversial issues.

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Science teachers' views and stereotypes of religion, scientists and scientific research: A call for scientist-science teacher partnerships to promote Inquiry-Based Learning IBL

Table 1

Teachers' views of the relationship between science and religion

There are different views regarding the relationship between science and religion. To what extent do you agree with these issues:

	Item	SA	A	N	D	SD
1	The discoveries of science consistently rule out the claims of religion.	6 (7.4)	4 (4.9)	6 (7.4)	13 (16)	52 (64.2)
2	When scientific and religious descriptions of natural phenomena conflict, the scientific description should have the clear priority.	5 (6.2)	9 (11.1)	10 (12.3)	26 (32.1)	31 (38.3)
3	There is little common ground on which science and religion can meet.	0	3 (3.7)	9 (11.1)	25 (30.9)	44 (54.3)
4	The more humans learn scientifically about the natural world, the less reason they have for religion.	0	0	0	17 (21)	64 (79)
5	If a natural phenomenon can be described scientifically in natural "cause and effect" categories, then any religious description of that phenomenon must be excluded.	1 (1.2)	17 (21)	9 (11.1)	35 (43.2)	19 (23.5)
6	Scientific understanding of natural phenomena has made impossible any belief in the supernatural work of God.	2 (2.5)	1 (1.2)	0	8 (9.9)	70 (86.4)

SA= Strongly Agree, A= Agree, N= Neutral, D= Disagree, SD= Strongly Disagree (percentages in brackets)

Table 2

Teachers' views of the relationship between scientific research and the scientists' cultural beliefs

Some cultures have a particular viewpoint on nature and man. Scientists and scientific research are affected by the religious or ethical views of the culture where the work is done. Your position, basically: (Please read from A to J, and then choose one.)

Item	%
Religious or ethical views DO influence scientific research:	
A. because some cultures want specific research done for the benefit of that culture.	13.6
B. because scientists may unconsciously choose research that would support their culture's views.	2.5

C. because most scientists will not do research which goes against their upbringing or their beliefs.	6.2
D. because everyone is different in the way they react to their culture. It is these individual differences in scientists that influence the type of research done.	32
E. because powerful groups representing certain religious, political or cultural beliefs will support certain research projects, or will give money to prevent certain research from occurring.	18.5
Religious or ethical views do NOT influence scientific research:	
F. because research continues in spite of clashes between scientists and certain religious or cultural groups (for example, clashes over evolution and creation).	19.8
G. because scientists will research topics which are of importance to science and scientists, regardless of cultural or ethical views.	3.7
Neutral views	
H. I don't understand.	2.5
I. I don't know enough about this subject to make a choice.	1.2
J. None of these choices fits my basic viewpoint.	0

Table 3

Teachers' views of the scientists' decisions about techniques that will be used with unborn babies in Egypt

Scientists should be the ones to decide what techniques will be used with unborn babies in Egypt (for example, amniocentesis for analyzing chromosomes of the fetus, altering embryo development, test-tube babies, etc.) because scientists are the people who know the facts best. Your position, basically: Please read from A to G, and then choose one.

Item	%
A. Scientists and engineers should decide because they have the training and facts which give them a better understanding of the issue.	3.7
B. Scientists and engineers should decide because they have the knowledge and can make better decisions than government bureaucrats or private companies, both of whom have vested interests.	-
C. Scientists and engineers should decide because they have the training and facts which give them a better understanding; BUT the public should be involved — either informed or consulted.	4.9
D. The decision should be made equally; viewpoints of scientists and engineers, other specialists, and the informed public should all be considered in decisions which affect our society.	12.4
E. The government should decide because the issue is basically a political one; BUT scientists	4.9

and engineers should give advice.	
F. The public should decide because the decision affects everyone; BUT scientists and engineers should give advice.	1.2
G. The public should decide because the public serves as a check on the scientists and engineers. Scientists and engineers have idealistic and narrow views on the issue and thus pay little attention to consequences.	3.7
H. I don't understand.	3.7
I. I don't know enough about this subject to make a choice.	63
J. None of these choices fits my basic viewpoint.	2.5

Table 4

Teachers' views of the relationship between scientists and their religious views

A scientist's religious views will NOT make a difference to the scientific discoveries he or she makes. Your position, basically: Please read from A to G, and then choose one.

Item	%
Religious views do not make a difference.	
A. Scientists make discoveries based on scientific theories and experimental methods, not on religious beliefs. Religious beliefs are outside the domain of science.	28.4
B. It depends on the particular religion itself, and on the strength or importance of an individual's religious views.	27.2
Religious views do make a difference:	
C. because religious views will determine how you judge science ideas.	4.9
D. because sometimes religious views may affect what scientists do or what problems they choose to work on.	24.7
Neutral responses	
E. I don't understand.	3.7
F. I don't know enough about this subject to make a choice.	3.7
G. None of these choices fits my basic viewpoint.	7.4

Table 5

Teaches' views of scientific models used in research laboratories

Many scientific models used in research laboratories (such as the model of heat, the neuron, DNA, or the atom) are copies of reality. Your position, basically: Please read from A to J, and then choose one.

Item	%
Scientific models ARE copies of reality:	
A. because scientists say they are true, so they must be true.	7.4
B. because much scientific evidence has proven them true.	2.5

C. because they are true to life. Their purpose is to show us reality or teach us something about it.	8.6
D. Scientific models come close to being copies of reality, because they are based on scientific observations and research.	45.7
Scientific models are NOT copies of reality:	
E. because they are simply helpful for learning and explaining, within their limitations.	10
F. because they change with time and with the state of our knowledge, like theories do.	19.8
G. because these models must be ideas or educated guesses, since you can't actually see the real thing.	2.5
H. I don't understand.	1.2
I. I don't know enough about this subject to make a choice.	
J. None of these choices fits my basic viewpoint.	2.5

Table 6

Teachers' views of the natural world and supernatural being

Science rests on the assumption that the natural world cannot be altered by a supernatural being (for example, a deity). Your position, basically: (Please read from A to H, and then choose one.). Scientists assume that a supernatural being will NOT alter the natural world:

Item	%
A. because the supernatural is beyond scientific proof. Other views, outside the realm of science, may assume that a supernatural being can alter the natural world.	2.5
B. because if a supernatural being did exist, scientific facts could change in the wink of an eye. BUT scientists repeatedly get consistent results.	1.2
C. It depends. What scientists assume about a supernatural being is up to the individual scientist.	6.2
D. Anything is possible. Science does not know everything about nature. Therefore, science must be open-minded to the possibility that a supernatural being could alter the natural world.	79
E. Science can investigate the supernatural and can possibly explain it. Therefore, science can assume the existence of supernatural beings.	2.5
F. I don't understand.	2.5
G. I don't know enough about this topic to make a choice.	1.2
H. None of these choices fits my basic viewpoint.	4.9