

Looking at Science through the Lens of Diversity: Views of Indian Students and Teachers¹

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The study examined middle school students' and science teachers' ideas on science and diversity parameters like religion. 1522 students from Mumbai completed a survey designed to elicit their perceptions of science, religion and learning experiences. Of these, more than a hundred students were interviewed and it was found that there was a demarcation between students' scientific and religious beliefs. Questionnaires were administered to 48 teachers and 11 teachers were interviewed who gave responses regarding their religious stance, classroom experiences and views on handling conflicts between science and religion. Results indicated that most teachers did not face problems with religious beliefs interfering with the subject matter and its transaction.

Introduction

Since independence, Science and Technology (S&T) have been central to developmental efforts in India, and this focus has a reflection in the Indian education scenario, where science is mandatory at the school level and students have a positive attitude to science (Chunawala & Ladage, 1998). On the other hand, worldwide trends indicate that basic science courses seem to be losing out to other disciplines, particularly to professional courses, in attracting students. This has been a matter of concern especially in nations where there is a decline in numbers opting for basic science fields. A project “*Science Education for Diversity*” (SED), funded by the European Commission under the FP7 programme, was initiated in six partner countries including India. The project aims to understand science education in the context of diversities arising due to differential factors like gender, culture, ethnicity, religion and habitat.

Science and diversity parameters in education

According to Lee and Luykx (2006) different aspects of diversity interact in complex ways to affect science attitudes and outcomes. Frost, Reiss and Frost (2005) advocate that science education orient itself towards the interests of minority groups and girls. Gender differences in attitudes to science, interest and achievement in science, choice of science subjects and careers in science have been extensively researched (Haste, 2004). Several studies on religion and science education have revealed the different views that science teachers and students have towards the theory of evolution (Dagher & BouJaoude, 1997; Kose, 2010). In India individual identity is a result of a complex network between caste, class, religion, language, region, ethnicity and gender. This diversity is not adequately addressed by the education system, which considers students to be homogeneous, has science as a compulsory subject at school, emphasises a uniform curriculum and has central development and dissemination of textbooks (Chunawala & Natarajan, 2012).

Science Education and Religion: The Two Pole Contradictions

Most science curricula depict science as objective, non-negotiable, culture-free and value-free (Schwedes, 2008). Research in science education has uncovered that students hold alternative conceptions of scientific ideas that arise from their personal experiences and backgrounds (Lawson & Thompson, 1988). Such conceptions are considered to be potential obstacles in the path of learning. According to Reiss (2004), scientific understanding and what conceptions individuals in a society have regarding the world differ on account of their gender, religious beliefs, age as well as ethnicity. Hermann (2012) in a study on high school students found that when scientific concepts conflict with religious views, there tends to be less belief in the former. Studies on college students' perceptions of evolutionary theory have found these to be influenced by religious beliefs, world-views or social expectations (Dagher and Boujaoude, 1997, 2005, Sinclair and Pendarvis, 1997, Scheitle, 2011).

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A study by Kose (2010) exploring the attitudes held by Turkish secondary school students and teachers revealed that religious beliefs, teachers' attitude and teaching, all played a crucial role in rejection of theory of evolution by students. A study by Mansour (2008) on 75 Egyptian science teachers found that their pedagogical practices regarding scientific issues related to religion were affected by their religious beliefs. According to Singh (1999), the principles behind science and religion and their inter-relationships are poorly understood by various sections of the Indian society, who as a result experience a philosophical conflict.

In the Indian context, we found limited studies that addressed diversity and science education. We feel that the experiences students and teachers bring to the learning environment and how these interact with the prescribed science curriculum need to be studied. There is a need to focus not only on students' and teachers' understanding of science, but also on the affective domain of feelings and opinions attached to science learning.

Methodology of the Study

Questionnaires were administered and interviews conducted with teachers and students in Mumbai to uncover their perceptions of the role of diversities in science classrooms. The questionnaires were developed in collaboration with all the partner countries of the SED project. The student questionnaires addressed aspects of diversity, attitude towards science as a subject and experiences in science learning. Some students were further probed through interviews. The questionnaires and interviews conducted with teachers addressed their science pedagogical practices and classroom experiences in relation to markers of diversity such as gender, language and religion.

Tool	Number of schools from which sample is taken	Sample Size		
		Female	Male	Total
Student's Questionnaire	5	672	850	1522
Students Interview Schedule	8	55	53	108
Teacher's Questionnaire	9	41	7	48
Teacher's Interview Schedule	4	10	1	11

Table 1. Description of sample

Findings

Students and religion

When asked to state their religion, only 6% of students chose not to answer. This indicates that there is no stigma associated with revealing religious identity. The students represented all the major religions of India (Hinduism, Islam, Christianity, Sikhism, Buddhism and Jainism). Regarding religious practice, only 3% said that they never visit places of worship, while 52% stated that they visit places of worship every week, with boys (56%) outnumbering girls (46%). However this need not imply that boys are more religious, since other factors could play a part such as greater mobility and restricted access to religious spaces. A majority of the students, 75% stated that they prayed at least once or more than once a day. When students were asked what they would like to reveal about themselves to a new person, 26% of the students considered religion not important enough to be divulged, whereas 43% considered it very important and 31% thought it was of little importance.

Origin of life: Students' multiple perceptions

The student sample was probed about the origin of life by the question "where do we come from?". They had to state which of the three statements they agreed most with. The first option which supports evolutionary theory (*life on earth including human life has evolved over millions of years and some creatures like dinosaurs became extinct long before humans evolved*) was accepted by 42% students with some gender based variations in terms of the boys outnumbering (46%) the girls (37%). However, the other two options- *most life on earth evolved over millions of years but God created human life* (34%) and *God created all forms of life on earth at the same time, about 10,000 years ago* (24%) did not show much gender differences. More students accepted that God was responsible for either human or all forms of life, and the view that most life evolved but God created human life was favoured more.

Students’ ideas about the beliefs of their families and teachers about origin of life

When asked about their families’ beliefs, most students (45%) responded that they think their families would support the option that God is the creator of human life and only 33% felt that their families would support the evolutionary explanation. This pattern was the same for girls and boys.

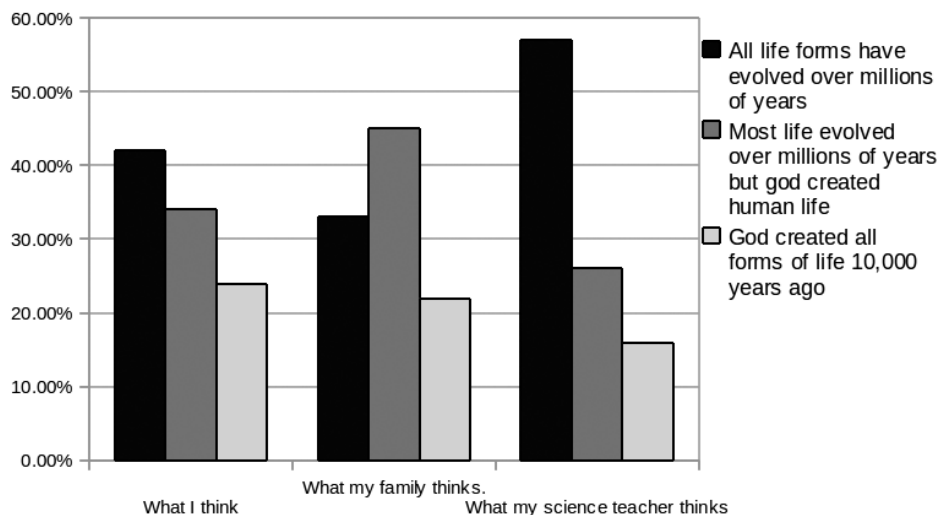


Figure 1. Student’s ideas on self, family and science teachers’ stance about origin of life

A striking feature emerged when these students were asked to comment on the beliefs of their science teachers. More than half (58%) of the students stated that their science teachers would support the evolutionary explanation of the origin of life. This suggests that students can demarcate between ideas that are scientific with those that are not and are aware of who supports what. It is therefore essential to analyse the experiences of students in dealing with their personal systems, family beliefs and scientific explanations. There may be instances of conflicts, whether internal or external, which may go unnoticed in a class session.

In-depth interviews conducted with students sought to analyse their responses to the question: *Suppose you had a friend who said that their religious holy book explained the beginning of the earth and of human life very differently from what scientists said, and so your friend thought the scientists were wrong. What would you say to your friend?*

Around 63% of students felt that only the scientific argument is valid because it is based on evidence while religion is based on belief not evidence. Around 27% of the students acknowledged the arguments of both science as well as religion and gave equal weight to both. Less than 5% of students acknowledged both science and religion, while recognizing the difference on the basis of argument in both cases, and 3% considered religious argument to be paramount. Only 3% of the students said they did not know or could not answer. The responses of the students to the above question have been categorized in Table 2.

Students’ responses to how they would counsel a friend who thought scientists were wrong?	
Reconciliation - but science is more valid	<p>“You can believe both also, because holy book is your religion... every one follows in your caste... in your religion... so you can follow that. But scientist (sic) thinking is more correct because they study about all this in the past... and present they are studying. So I think scientist would be better” (Girl)</p> <p>God is a belief that we have... we can't tell hundred percent that yes God has made it... ..yes in religious books it's written... but scientists have a scientific reason they have researched” (Girl)</p>
Reconciliation	<p>“Both are correct as they are free to give ideas about the starting of life... of earth... of humans” (Boy)</p> <p>“Scientists tell the evolution of earth in scientific ways, but the religious books tell the mythological way of how earth has evolved. We can say both are right, we should not hurt the religious sentiments, it will lead to quarrel” (Girl)</p> <p>“If their holy book is explaining it then I would not insult it but I would like to explain in a friendly way. He/she should refer to some Geographical book which will explain it in a better way according to science. So she should not feel I am making her holy book wrong. She should feel that her friend is at her side also and not on scientist side, so she can understand it better” (Girl)</p>

Students' responses to how they would counsel a friend who thought scientists were wrong?	
Religion is valid	"Sometimes, they can be wrong because scientists are not God" (Boy) "Some scientists may be wrong, but the (holy) books are right" (Boy)
Science is valid	"I will say scientists are right. This is the generation of science. It is better to be with the scientists, to accept truth and know more" (Girl) "Scientists are right because they have done research" (Boy)
Unsure	"I will tell no one is sure whether the scientist are right or the holy books" (Boy) "I will not tell anything, as we also don't know the truth" (Boy)

Table 2. Categorization of students' responses to conflict between science and religion

Teachers' experiences of conflict between science and religion

Around 73% of teachers said that they were believers, but not active believers, while nearly a fourth of the teachers (24%) said that they were active followers of their religion. Only 2% of teachers said that they were non-believers. During the course of teaching science there is a possibility that certain aspects taught in science (e.g. evolution) may contradict religious ideas, and may cause the student/ teacher to experience conflict. Teachers were asked whether they had experiences of any student/s stating that the science lesson conflicts with his/her religious beliefs. A small percentage of teachers (13%) said that they had such experiences. All the teachers, regardless of their experiences, were probed on how satisfactory they felt were each of the given statements regarding such conflicts in the classroom. The results in Table 3 indicate that teachers are satisfied or very satisfied with the given statements. The first two statements emphasize scientific evidence, the third and fourth identify the compartmentalization of science and religion and the fifth gives the choice to individuals to follow science or religion as they are both seen as two plausible explanations.

Statements	Very satisfactory	Satisfactory	Unsatisfactory
1. In science we look for evidence and scientific evidence supports what I said in the lesson	16 (38%)	23 (55%)	3 (7%)
2. Religion is based on faith and tradition and people may take lessons on how to live from these but this is separate from scientific evidence which looks for facts and tests theories unrelated to religious beliefs	23 (54%)	15 (35%)	5 (12%)
3. Many scientists hold religious beliefs but see no conflict between their religion and their science because they see them as different parts of their life.	19 (43%)	22 (50%)	3 (7%)
4. Many scientists have religious beliefs and the wonders they discover about the world through their science makes them appreciate religious ideas but they do not mix scientific and religious explanations.	21 (48%)	22 (50%)	1 (2%)
5. Religion and science are two ways of explaining – everyone must make their own choice.	18 (41%)	18 (41%)	8 (18%)

Table 3. Teachers' responses to handling conflicts between science and religion

During the interviews, the teachers were asked if they had encountered any challenges in teaching science to students due to the students' different religious belief systems. Of the ten teachers interviewed only three reported that they had faced such challenges, and their responses were; "Many times it happens but I always stick to science", "I will explain, not get angry", and "I will explain to him/her in a scientific way & ask them to choose, but I will not pressurize them, they can choose to go on scientific way or religious way, but I will definitely tell the reason". The other teachers were asked to hypothesise such a situation arising in their classes and respond. Three teachers said that they would respond in terms of affirming scientific evidence and facts, two teachers said they would state that science is based on theory and this is what scientific people accept and believe. One teacher recognised the possibility of a conflict between religion and science and used this as a basis for getting students to acknowledge existence of many points of view. One teacher denied that there can be religious diversity issues in relation to science.

Teachers learning from diversity in classroom

In response to whether the teachers themselves had learned from the experience of teaching multi-cultural and diverse classrooms, 3 teachers stated that they had never reflected on such experiences. A teacher said that she had learned the importance of knowing about different views and of teaching tolerance: *“Everyday I learn tolerance, how to be more patient... you learn from different individuals”*. Another teacher through experience had learned the importance of being sensitive to students' different perspectives. One teacher felt that it was best to ignore diversities in the classroom: *“In science classroom we do not discuss about religion, for me they all are same, they are children - not boys or girls”*. Another teacher preferred to support science in the face of diversity: *“I respond by giving scientific reasons and clearing doubts. Religion and castes we only created... so... by giving correct reasons and explanation... It's up to them to believe it or not”*.

In another context where 7 teachers were interviewed, one of the teachers when asked about teaching diverse students, responded that for teaching the theory of evolution, he often established linkages with culture by using a specific mythological interpretation – the *Dashavatars* (term for the ten different incarnations of the Hindu God Vishnu). This example was used with students in the Standards 9-10 where heredity and evolution is introduced. When this teacher was asked to comment on how students from other religions would respond to such an interpretation pertaining to one religion, the teacher responded that as he had no knowledge about the religious beliefs of other religions, he would teach evolution to such students using the scientific explanation.

Discussion

Many studies have concluded that in comparison to men, women are more religious (Argyle & Beit-Hallahmi, 1975; Stark, 2002). But in this study more boys reported visiting places of worship frequently in comparison to girls. However, this does not suggest that boys were more religious. In a country like India, there is an amalgamation of many religions, each with their own set of restrictions, as well as other cultural norms, which may hamper mobility of females. Conversely, many studies (Cornwall, 1989; Feltey & Poloma, 1991) have also concluded that the stereotypic imaging of women as being more religious is misleading. This has also been reflected in the finding of this study regarding frequency of praying which showed little dependence on gender difference.

In our study, over half the students disregarded the scientific theory of origin of life and accepted that God created human life, or that God created all forms of life. This finding is aligned with the study of Dagher & Boujaoude (2005). Most students also responded that their families would believe that life evolved over millions of years but God created human life, or that God created all life. The reconciliation of religion and science demonstrated by students in our study are similar to the findings of a study conducted by the British Council and Ipsos MORI (2009). The latter surveyed over ten thousand adults across ten countries worldwide. From all the countries that were surveyed, adults in India showed the highest level of agreement to the statement that *'it is possible to believe in a God and still hold the view that life on Earth, including human life, evolved over a time as a result of natural selection'*. Though this study was conducted with adults, it is interesting to note the similarities in views expressed by the middle school students in our study on the origin of life.

An interesting finding in our study was that students felt that their parents would believe that God created human life more often than they themselves did. A study by Woods and Scharmann (2001) on the attitude of high school students towards evolution concluded that religious factors were the greatest influence on students' attitudes to evolution, followed by factors such as personal relationships with parents, teachers and friends, and the extent to which students can comprehend the knowledge presented to them regarding the topic of evolution in terms of the evidences provided.

In our study, the students had probably very little or no exposure to the topic of evolution as the topic gets introduced in later school years. In this regard, while many students regarded God as the supreme creator of life, a striking feature that emerged was that, when the students were asked to comment on the beliefs of their science teachers, more than half of them said that the teachers would consider evolutionary explanation for the origin and variety of life, and not God. Thus students could clearly differentiate between the beliefs of their families and teachers with the former highly influenced by religion and latter more by scientific views.

Students when faced with a situation where a friend is rejecting the scientific viewpoint due to religious reasons responded with different options. The largest responses were “only the scientific argument is valid as it is based on evidence,” followed by “acknowledging both the arguments from science and religion”. Most students gave interesting quotes in the interview which had elements of (a) reconciliation of science and religion, (b) validity of science, (c) validity of religion, and (d) a reconciliatory approach but inclined towards scientific argument.

Similarly, teachers also had mixed opinions on handling challenges to science on the basis of religion. A study on the religiosity of professors has shown that while professors are religious, they are secular and believe that the boundaries of religion and science should not be crossed (Gross & Solon, 2009). In the current study, teachers either emphasize science over other evidence, compartmentalize science and religion or overlook the conflicts that arise or ignore these conflicts. It is crucial for teachers to be aware of students' beliefs. The deliberate avoidance of religion by textbooks and teachers creates a situation where the topic is evaded and students are left on their own to find a way to resolve the contradictions. They then either hold on to their beliefs, reject science or experience conflicts.

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