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# Secondary School Science Teachers' Views About the 'Nature of Science'

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## Abstract

Understanding the contemporary views of nature of science (NOS) by science teachers is considered an important element for developing the same concept in students. That is why we have witnessed a growing interest of the academic community in this important topic and increasing body of research in the field. This paper pertains to exploring secondary schools science teachers' views about the Nature of Science - whether traditional or contemporary, and consequently their approach to teaching science. Although science teacher education programme in Pakistan does not provide courses explicitly aiming at teachers' understanding about the NOS like history and philosophy of science, but pedagogical component stressed in inquiry and science process skills and the course on "Science and Islam" certainly relates to this concept. Data was collected from 200 science teachers selected from secondary schools of Lahore metropolitan area. All the teachers included in the sample were engaged in teaching science subjects (physics, chemistry, biology) at secondary level. The sample was selected from 37 schools through convenient sampling, out of which 19 were public sector schools and 18 were private schools. The questionnaire used to collect data consisted of twenty-five items pertaining to five categories or aspects of science, including scientific theories and models; the role of scientists; scientific knowledge; scientific method; and scientific laws. Analysis of the data show that views of majority of science teachers fall in the traditional domain, except with reference to just three items.

## Introduction

Role of science education in the socio-economic development of the societies and nations hardly needs any arguments or discussion. It is because of this realization that science education has found a secured place in school curricula in almost every country around the world, particularly since the last few decades. However, what kind of science should be taught at different levels and how to teach it has been evolving over a period of last few decades. The modern science curricula in various countries of the world do not solely focus on developing the understanding of science concepts in students. It encompasses a wide variety of goals. For example, the recent reform in science, particularly in developed countries, has put an added emphasis on developing students' understanding about the 'nature of

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science' (American Association for the Advancement of Science (AAAS), 1990; National Research Council (NRC), 1996). However, this aspect of science education has yet to take roots in many developing countries like Pakistan. When one of the researcher (Iqbal) was a school student back in sixties, science students in schools and colleges were given the definition of science as " collection of facts; a fixed body of knowledge; an organised body of knowledge; an absolute truth; agreed upon and objective knowledge (Iqbal, 1998). Such views of science have many consequences both for students as well as teachers. By implication students develop an understanding that there is no room for new discoveries; and that whatever is known about the natural phenomenon is absolute and final. Implication for teaching is that we, as teachers of science have to transmit that fixed body of knowledge to students and students have no other alternative except to learn and memorise what they are told. However, the academic community strongly believe that this description of science is not only far from the contemporary view of science but also detrimental to the development of positive image of science in students. Conversely, the contemporary view held by scientist and science educationist is that science is and evolving phenomena, and meanings and concepts of science are to be constructed by the individual students by negotiation with the teacher and interaction with the material world.

## The Nature of Science

According to Abd-El-Khalik et al. (1998) development of students' understanding of nature of science (NOS) has been one of the long held objectives by science educationist since the past 85 years. However, there is no agreed upon definition of the 'NOS' (Abd-El-Khalik & Lederman, 2000a). The reason is that the 'NOS' is a multifaceted, dynamic and complex concept (Abd-El-Khalik & Lederman, 2000a). How knowledge of science educators, philosophers and sociologists about the 'NOS' evolved and what consensus or disagreement about the NOS exists between philosophers and science educators has been discussed in detail by Abd-El-Khalik & Lederman (2000a) and Eflin et al. (1999) respectively. In general NOS refers to the epistemology and sociology of science; science as a way of knowing and understanding the natural world and the role of values and beliefs of the scientific community in the development of scientific knowledge (Lederman, 1992). Lederman (1998), and Lederman et al. (2001, 2002) characterize NOS as being empirical, inferential, creative, theory laden as well as socially and culturally influenced. In this paper, the researchers accepted the description of NOS as narrated by AAAS (1990), NRC (1996) and further elaborated in NSTA's position statement adopted in July 2003 (NSTA, 2003). The NOS espoused by NRC (1996) involves tentative, historical, empirical and self-substantiated elements. The NRC also recognizes the importance of interaction between personal, social and

cultural beliefs and value of scepticism and open communication in the generation of scientific knowledge.

Analysis of past research reveals that the concept 'nature of science' (NOS) has been studied in a variety of context. According to National Research Council (1996), research on students' understanding of the 'nature of science' has been in place for more than 30 years. Research conducted in early years pertained to the area of students' understanding about scientists and the scientific enterprise and about the general methods and aims of science (Klopfer & Cooley 1963; Mackey 1971; Welch & Pella 1967). Studies conducted toward the end of twentieth century, that is in eighties and nineties, included areas such as students' understanding of the notion of "experimentation," the development of students' experimentation skills, students' understanding of the notions of "theory" and "evidence," and their conceptions of the nature of knowledge (Lederman, 1992).

The earlier studies in the area of 'NOS' were related to assessing students' understanding of the nature of science and developing science curricula to foster such development (Lederman, 1992; Abd-El-Khalik & Lederman 2000a). However, when these studies revealed that students' understanding of the nature of science is inadequate, despite the appropriate science curricula having been put in place (Aikenhead, 1973; Lederman 1999; Lederman & O'Malley, 1990; Ryan & Aikenhead, 1992), attempts were made to assess and develop teachers understanding of the 'NOS'. Research reveals that majority of the science teachers themselves held the views that were not in line with the contemporary views about the nature of science (Abd-El-Khalik & BouJaudem, 1997; Akerson, et al, 2000; Lederman, 1992). These results led to the efforts aimed at fostering and improving science teachers' conception of 'NOS', with the assumption that teachers' understanding of 'NOS' would lead to the development of adequate and proper conception in students (Lederman, 1992). These attempts to develop teachers understanding of the NOS were made both through in-service programmes as well as pre-service programmes, using both explicit (history and philosophy of science) and implicit methods (inquiry and science process skills). Abd-El-Khalik & Lederman (2000a) have given an extensive review of these studies and are of the view that in general these efforts have been less successful. However, Palmquist & Finley (1997) succeeded in making positive change in pre-service teachers' views about the 'NOS' by using conceptual change and cooperative learning techniques.

In this study, the researchers ascertained the participant views about the nature of science with the help of an investigator- developed survey questionnaire and a follow up interview. According to this study, the participants held contemporary views of science theory, knowledge and role of scientists and traditional view of scientific method. There was a little direct instruction about the nature of science, but a change in the pre-service

teachers' views about the nature of science was noted because of the courses like 'teaching strategies', 'concept change' and 'cooperative learning'. Cochran (2003), also found that majority of K-12 students did not hold contemporary views of nature of science and teacher's views also were not consistent. He investigated the change of pre-service elementary teachers' views of the nature of science enrolled in science methods score and found that teachers' views could not be changed through implicit instructional approaches, rather this concept need to be explicitly and internationally addressed during pre-service education programme. Similarly, Lin & Chen (2002) have been able to demonstrate a modest change in chemistry teachers' understanding about the 'NOS' through history of science course. On the other hand, Tsai (2004) investigated the effect of two science education courses on a group of Taiwanese in-service and pre-service teachers' views of the nature of science. One of these courses was for pre-service teachers and the other for in-service teachers. Both of these courses included some common concepts like philosophy of science, students' alternative conceptions and conceptual change. Both the groups were also provided with some classroom activities related to science. Results of the study revealed that as a result of these courses science teachers' views were changed to a certain extent. Their views changed from more traditional to more contemporary and constructivist views. According to the researcher, instructions about student alternative conception and conceptual change theory has better effect on changing the views of teachers as compared to the philosophy of science.

It was probably because these less modest achievements of both teachers and particularly students on various measures of 'NOS' that Mathew (1998) criticized effort to teach the nature of science as being too lofty and leading to indoctrination. He is of the view that it is too unrealistic to expect students to develop such highly sophisticated concepts as the NOS. However, many science educators believe that developing nature of knowledge is an important objective not only as essential component to achieve scientific literacy, but their problem solving skills as well. Because, according to Lin et al. (2002) students having post-positivist-oriented views about science tended to recall more information and, show more flexibility, and demonstrate better metacognitive ability than students with empiricist aligned epistemological beliefs.

On the other hand, students' conception about the nature of science is relatively fixed. Results of the study conducted by Tao (2002) reveal that whatever views about the NOS students have, these are deep rooted and can hardly be changed by short intervention. Sutherland (2002) is of the view that culture and language also have their effect on students' conception of NOS. Teachers' prior experience has a strong influence on their beliefs and teaching styles. Science teachers' beliefs about the best way of teaching science are previously conceived and developed from their experiences as

students. Science teachers' beliefs influence their personal thinking about the nature and philosophy of science and the construction of a personal image of science. Several studies provide insight into the process by which teachers formulate their beliefs about the nature of science.

Gallagher (1991) inquired into the role of secondary school science teaching in framing teachers' beliefs and understandings of the nature of science and scientific knowledge. Using science textbooks and studies of classroom practice, he examined teachers' perceptions of science. He concluded that many of the secondary school textbooks gave only perfunctory attention to the nature of science, usually in the first two chapters of the book. Science and scientific knowledge is usually conveyed as truth. During instruction, more attention is given to concepts and principles of science than to the processes by which scientific knowledge is formulated. Gallagher (1991) found that secondary science teachers respond to textbooks in a way that contribute to a transmission mode of science teaching. As their personal views are influenced by their prior experiences, students' views are influenced by teachers' behaviours. Teachers rarely appreciate how influential they are in shaping the lives of students. Even throw- away comments by a teacher have the potential to trigger change in students' mind. Everything a teacher says and does springs from that teacher's inner beliefs. Various studies reveal that in any classroom the science taught and the way it is taught depends primarily on what the individual teacher believes, knows and does.

This paper pertains to exploring Pakistani science teachers views about the Nature of Science and consequently their approach to teach science-whether traditional or contemporary. The traditional approach starts from predetermined body of knowledge where as contemporary or constructivist approach starts from learner rather than from any predetermined body of knowledge. The traditional way of science teaching is strictly based on textbooks, and teacher is believed to be a dispenser of knowledge. According to Newsam (2003) the traditional approach assumes that there is a predetermined body of knowledge that the teacher should pass on to the students. This approach uses testing and competition to evaluate and motivate students.

From a Constructivist perspective, learning is a social process of making sense of experience in terms of extant knowledge. Glasersfeld (1998) defines constructivism as: "a set of beliefs about knowledge that begin with the assumption that a reality exists but cannot be known as a set of truth because of the fallibility of human experience." It is a learning or meaning-making theory that offers an explanation of the nature of knowledge and how human beings learn? It maintains that individuals create or construct their new understandings of knowledge through the interaction of what they already know and believe and the ideas, events, and activities with which they come in contact with (Cannella & Reiff, 1994; Richardson,

1997). Knowledge is acquired through involvement with content instead of repetition. According to Ismat (1998), learning activities in constructivist settings are characterized by active engagement, inquiry, problem solving and collaboration with others. Whereas, Baviskar et al. (2009), argue the constructivist approach can be characterized by four elements i.e. (a) the psychological set of the learners before the activities of normal classroom learning were embarked upon (including lectures!) (b) creating mental clashes of ideas (c) feedback and application of new learning, and (d) constructivist as long as it satisfies the four criteria. Hence, keeping in view the above description of constructivism, the researcher unlike Haider (1999), have not labelled teachers views as traditional and constructivist, rather as traditional and contemporary view. Thus, this paper is aimed at collecting teachers' views about the nature of science, weather traditional or contemporary and to see what would be its implication for development of students' views of the nature of science and for teaching methodologies.

In Pakistan, science is taught as a compulsory subject from grade one through eight, in the form of an integrated science. However, from grade nine, students opt for separate science stream with subjects of physics, chemistry and biology. Science Teachers generally hold bachelor degree in science (14 years of schooling and studying separate science subjects for six years) before enrolling into professional training course of one year. However, some teachers do have master degree in various sciences, or master degree in science education, which is a professional degree. In this paper views of teachers about the NOS are analyzed generally.

## Methodology

*Subjects*

The sample of study includes 200 science teachers selected from secondary schools of Lahore metropolitan area. All the teachers included in the sample were engaged in teaching science subjects (physics, chemistry, biology) at secondary level. This sample of teachers was selected from 37 schools of Lahore city by using convenient sampling, out of which 19 were public sector schools while 18 private schools. During the last two decades or so, Pakistan has witnessed a rapid expansion in the private schools (systems). A substantial number of students study science in these schools using English as a medium of instruction. Hence, it was decided to include almost equal number of private schools in the sample.

*Questionnaire*

The questionnaire used in this study has been adopted from a research study conducted in Arab Emirates by Haider (1999). The questionnaire had two parts. The first part pertained to the demographic information and the second part was consisted of 22 items. All the items

were close ended. The questionnaire as a whole consisted of five categories and each category had different number of items. These categories are actually different aspects of science. Category 1 contains items 1-5 that deals with scientific theories and models; category 2 contains item 6-10 that deals with the role of scientists; Category 3 contains items 11-15 that deals with scientific knowledge; Category 4 contains items 16-19 that deals with scientific method; and Category 5 contains items 20-22 that deals with scientific laws. The questionnaire was in bipolar form, means that two statements were given for each item. One statement was in the left- hand column and depicted traditional views about a particular aspect of science and the second statement in the right-hand column depicted the constructivist views of science. In the centre of these statements, three boxes were given for teachers to record their response against each item. Teachers were asked to put tick mark (✓) either in the left-hand box or in the right-hand box, depending whether they agree to the statement in the left column or in the right column. They were asked to tick (✓) neutral box, if they feel indifferent regarding the two options.

*Data analysis*

Response percentages were calculated for each item under traditional, neutral and contemporary categories. Results of the study have been presented in tabular form. Table 1 gives overall views of science teachers about various aspects of science; scientific theories, role of scientists, scientific knowledge, scientific method and scientific laws. Teachers' views with respect to the variables such as gender, age, academic qualification, professional qualification, length of experience, medium of instruction, and the type of schools (private/ public) have been discussed in a separate article (Iqbal et al. in press).

## Results and Discussion

The detail of responses of the teachers to the questionnaire is given in table 1. The results show that teachers' views about the nature of science mostly fall under traditional category. Overall analysis of teachers' responses reveals that teachers' selection of the neutral choice was only 7.23%. Most of the teachers' views fell into the traditional category (60.45%). Only 32.32% responses were consistent with contemporary view of science. If analysed in terms of elements, Pakistan science teachers hold traditional views with respect to 17 elements and contemporary views with respect to three elements of science. There are only two elements in which teachers expressed their neutral views. Analysis of teachers' responses with respect to different aspects of science is given at the end of table 1.

Table 1
Percentages of science teachers' beliefs about the nature of science

| | T | N | C | |
|---|---|---|---|---|
| **Scientific theories** | | | | |
| 1- Theories are based directly on observation, where observation is exactly what you see. | 6 6 | 1 0 | 2 4 | 1. Observation is influenced by theories scientists hold. Because experimental procedures differ according to theories, hence observation differs. |
| 2- Scientists discover theories, because theories are there in nature and scientists just have to find them. | 6 9 | 5 | 2 6 | 2- Scientists invent theories, because theory invention come from the mind |
| 3- Old theories are those, which had been proven untrue, are of no use to scientists. | 1 5 | 5 | 8 0 | 3- Theories fit within certain paradigms, hence if these are old or untrue these are still helpful to scientists. |
| 4- A theory is a hypothesis that has been proven to be correct, because a hypothesis must be subjected to empirical test and if proven true it becomes a theory. | 7 4 | 6 | 2 0 | 4- A theory is validated by its connections to other theories generally accepted within the scientific community. |
| 5- Scientific models (e.g. the model of an atom) are copies of reality, since they describe reality as it is. | 4 4 | 1 3 | 4 3 | 5- Scientific models do not describe reality as it is. These are scientist's ideas or educated guesses, because scientists cannot see real things. |
| **Role of Scientists** | | | | |
| 6- A scientist evaluates scientific claims exclusively through empirical evidence. | 7 1 | 1 2 | 1 7 | 6- A scientist dose not exclusively needs to use empirical evidence; he may use imagination or creativity. |
| 7- A scientist is someone who is objective and open minded in all of his acts. | 5 3 | 1 1 | 3 6 | 7- A scientist is influenced by many factors, e.g. previous knowledge, logic and social factors. |
| 8- The best scientists are those who follow the steps of the scientific method. | 8 2 | 3 | 1 5 | 8- The best scientists are those who use any method that might obtain favourable results. |
| 9- A scientist strives to discover the absolute truth. | 6 2 | 7 | 3 1 | 9- A scientist works within the scientific community to find the best way to explain the part of nature. |

| | T | N | C | |
|---|---|---|---|---|
| 10- Scientist report data exactly as their senses perceive them. | 53 | 8 | 39 | 10- Recording data is influenced by other factors, e.g. previous knowledge. |
| **Scientific knowledge** | | | | |
| 11- Scientific knowledge corresponds directly to reality. | 49 | 7 | 44 | 11- Scientific knowledge is our understanding of reality, not reality as it is. |
| 12- Scientific knowledge is cumulative. It increases with increasing observation. | 80 | 6 | 14 | 12- Scientific knowledge is not cumulative; it also goes through jumps. |
| 13- Scientific knowledge is final not tentative. | 20 | 12 | 68 | 13- Scientific knowledge is tentative. |
| 14- Scientific knowledge is formed only through scientific means. | 0 | 7 | 33 | 14- Scientific knowledge is formed through scientific and non scientific means. |
| 15- Scientific knowledge is generated first only through observations. | 67 | 8 | 25 | 15- Scientific knowledge might also be generated through imagination or creativity. |
| **Scientific methods** | | | | |
| 16- There is a single method to perform science that is the scientific method. | 54 | 8 | 38 | 16- There is no single method to perform science. There are methods, e.g. creativity, imagination and originality. |
| 17- The scientific method is a step by step process. | 82 | 0 | 18 | 17- Scientists do not necessarily have to follow the sequence of the scientific method. |
| 18- The scientific method must be planned out in advance of inquiry. | 59 | 14 | 27 | 18- Scientist can adjust their method of inquiry in the middle of an investigation and still get valid results. |
| 19- The use of scientific method is necessary to discover and validated theories. | 67 | 4 | 29 | 19- Scientists use several methods according to circumstances. The scientific method is only one of those methods. |
| **Scientific laws** | | | | |
| 20- Scientists discover scientific laws, because these laws are there in nature and scientists just have to find them. | 87 | 1 | 12 | 20- Scientists invent scientific laws. Scientists do not invent what nature does but they invent the laws, which describe what nature does. |
| 21- Scientists interpret the laws found in nature. | 77 | 5 | 18 | 21- Scientists invent scientific laws. |
| 22- Scientific laws can be proven to be absolutely true. | 39 | 7 | 54 | 22- Scientific laws are only scientists' best attempts to explain a part of nature. |

**Key**: T = Traditional beliefs, N = Neutral beliefs, C = Contemporary beliefs.

*Scientific Theories*

There were five statements pertaining to the scientific theories. In three items, teachers expressed their views that were consistent with traditional views. Only in one item teachers views were consistent with contemporary views, that is, with respect to the role of old theories. Teachers were of the view that even the old and untrue theories can be helpful for scientists in understanding the scientific reality. In one item pertaining to scientific models, percentage of teachers holding traditional as well contemporary views were almost equal, that is, 44% believing that models are the copies of the reality(traditional view), while 43% believing that scientific models are scientists' educated guesses(contemporary view).

*Role of Scientists*

Five items of the questionnaire were pertained to the role of scientists. In all five items, teachers held the views that were consistent with traditional views, believing that scientists use empirical evidence to study nature, are objective and open minded in their outlook, report exact data truthfully and follow scientific method step by step.

*Scientific Knowledge*

Five items 11-15 assessed teachers' views about scientific knowledge. In three out of these five items, teachers have traditional views, indicating that scientific knowledge is cumulative, formed only through scientific means and generated first only through observation. In one item, pertaining to whether scientific knowledge corresponds to reality or not, teachers' views are almost equal, although slightly in favour of traditional view. However, in one item teachers held constructivist views, believing that scientific knowledge is tentative and not final and absolute.

*Scientific Methods*

Four items in the questionnaire were meant for assessing teachers' views about the scientific method. In all four items teachers held views that were consistent with traditional views, that is, scientific method is the only method used in investigation; it is a step by step process that must be planned out in advance and is essential to discover and validate theories.

*Scientific Laws*

Three items pertained to scientific laws. In two items, majority of the teachers expressed traditional views, indicating that scientists just discover scientific laws already present in the nature and that they just interpret and do not invent these laws. In item 22, teachers' opinions were consistent with constructivist views, that is, scientific laws are just scientists' best attempts to explain part of the nature.

As already mentioned, the overall results of this study indicate that teachers' views about the nature of science are mostly consistent with traditional views. Out of 22 items 3 items (3, 13, and 22) are those in which most of the teachers held views that are consistent with contemporary beliefs. These results are in contrast with that of Haider's (Haider, 1999) who concludes that science teachers in Emirates hold mixed views, equal number of teachers holding traditional and contemporary (Haider used the term constructivist) views. Haider (1999) attributes the existence of traditional views to historical factor and the constructivist views to religious background. He is of the view that in 60s and 70s most of the young Arabs believed in science as the only weapon against ignorance, imperialism and under development. They developed positive image of science as a mean to achieve development, progress and productivity, although, some of them viewed science with scepticism as well. This view of science, as a mean of achieving progress is also held by people in other developing countries as well, for example in India (Nanda, 1997) and Pakistan (Iqbal, 1994). Haider (1999) also holds that development of constructivist views in science teachers in Emirates is because of the influence of their religious beliefs. Traditional beliefs and Islamic teachings are in conflict with each other. Islam teaches its adherents that only Allah Almighty knows the final truth and holds absolute knowledge. If they believe that science is an absolute truth and in future they discover some findings that are in conflict and in contradiction with Islamic teachings and beliefs, they will find themselves in chaos and confusion. Therefore, we need to consider scientific knowledge as intuitive and tentative knowledge. Also in Islam, knowledge can be gained by several ways, as Nasr (1978) states that Al Biruni used several methods to study nature, e.g. 'observation and experimentation, reason and reflection, as well as ancient sources. Pakistan is predominantly a Muslim society, having more than 97 % Muslim population and the country being separated from India on the name of Islam. Still it is amazing that science teachers hold views that are mostly in contradiction with their religious beliefs.

The subjects in this study were drawn from two different pools of professionally trained teachers. Most of the teachers had more than 15 years of teaching experience, held bachelor degree in education (B.Ed.) and have studied separate subjects of physics and chemistry along with either mathematics or biology at graduation level. They were also offered a science method course during their professional training. The second category of teachers, relatively less experienced were the graduates of Master degree programme offered by a large metropolitan University. These students were offered three courses that were indirectly related to nature of science. These courses were: Science Methods, Concept Learning in Science; and Science and Islam. In science methods course students were introduced to inquiry as a method of teaching science, while concept learning in science also gives orientation to the science as an enterprise incorporating various concepts

related to scientific inquiry. The third course, Science and Islam is supposed to give orientation to students about the difference between two domains of knowledge. It was logically expected that in the last mentioned course students would have been introduced about separate realm of science and Islam and the characteristics that separates science form religion as a domain of knowledge. But, it is paradoxical that despite having these three courses, science teachers are not able to develop contemporary views of Nature of Science. They rather, have traditional views despite being introduced to the courses mentioned earlier in their professional degree programme.

One possible explanation for this lack of development may be traced to the way science is taught in schools. During science teaching in schools, strong emphasis is placed on content knowledge and teachers promote the view of science that they themselves were oriented to. Curriculum, teaching methods as well assessment system promote the same view (traditional) of science. Because, for so many years they have been explicitly and implicitly told about the empirical nature of science and have been required to verify the results of their science investigations (as told by their teachers), they have deeply embedded traditional beliefs or view points about science and scientific phenomenon. Thus, teachers' beliefs not only strongly influence students' development, but also their actions as teachers and the way they approach teaching and science as an enterprise.

While development of contemporary and constructivist view of science has become an essential goal of science education programmes in many parts of the world, teachers still are holding to the traditional beliefs. Floes et al. (2000) suggest that passing from empiricist and behaviourist perspective of teaching science towards constructivism is a difficult and complicated transformation for teachers. The contemporary view of science may be advocated for two reasons. Firstly, as Haider (1999) argues, although Islamic and contemporary views are based on different perspectives, religious and materialist, these are in agreement with each other on certain beliefs, e.g. the scientific method is not the only way to gain knowledge and science is only scientists' best efforts to understand the world. If students are given the contemporary views of science, it would relieve them off the symbolic violence (religious disturbance) resulting from understanding the science from traditional perspective. Secondly, even from the psychological point of view, students need to be introduced to contemporary perspective in order to make them independent and confident and play an active role in their own learning. The contemporary view might help students to integrate science in their daily lives. They can use it to make personal and social decisions without reserve—it is only a way of thinking. Therefore, if science is introduced from the contemporary perspective, students will have the opportunity to realize that science is just one way of knowing and it is tentative not final, that has proved to be helpful, and will not feel a sense of violence.

Hence developing teachers' understanding about the constructivist epistemologies should be considered an essential component of teacher education programs. It becomes imperative both for teachers and teacher educators to analyze what traditional beliefs are and how far these are valid? Teacher educators need to address those beliefs through explicit discussions and help teachers to develop new set of constructivist beliefs through personal and social construction. This needs a concomitant change in teacher education curricula and the way teachers are provided professional courses.

However, the researchers are view that a further research in this regard is needed where the instrument is developed on likert scale in order to provide teachers the opportunity to provide more detailed information for more meaningful analysis. Instead of analyzing data on three point scale and in terms of frequency, if detailed scale is constructed on five or seven points after carrying out factor analysis, teachers' views can be measured in term of item means and scale means to provide more meaningful information. Such information should then be used to revise teacher education courses to incorporate NOS component accordingly.

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