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# Epistemological Beliefs and Philosophical Perspective of the Science and Mathematics Teachers about the Nature of Science

**Abstract** *The focus of the research was to find science teachers' philosophy about the nature of science NOS in philosophical perspectives serving in the public sector universities of Pakistan. The descriptive research method was used to investigate the difference in perceptions of the science teachers about NOS on the basis of gender and subject. An online questionnaire was utilized in order to gather data from respondents. Different constructs of NOS were identified to explore. The female teachers had more understandings about NOS than male teachers. The teachers of mathematics were positivists and decontextualized view of NOS. Male teachers were having an inductivist view of NOS. Physics teachers believed in inductivism. The teachers of chemistry were having process and realism view of NOS. Mathematics teachers were found to have contextualized NOS. It is recommended to provide orientation to science teachers in order to build NOS towards concept clarification during the process of the teaching-learning process.*

**Key Words:** Epistemological Beliefs, Inquiry, Nature of Science, Philosophical Perspectives, Scientific literacy, Science Teaching.

## Introduction

There are numerous myths and misconceptions regarding the nature of science (NOS) during the teaching-learning process, scientists, curriculum developers, and educationists have been trying to mitigate the myths and misconceptions about the NOS. In fact, the study of science is not restricted to the development of fundamental concepts which are helpful for other subjects; therefore, nature and philosophy of teaching science needs more comprehensive view about NOS. "Nature of science refers to the epistemological assumptions underlying these scientific processes and the consequences of these assumptions to the nature of scientific knowledge" (Lederman, Abd-El-Khalick, Bell & Schwartz, 2002). Hence, in order to critically appreciate the NOS, understanding of sociological and philosophical aspects of science is very much essential. The argumentation about a scientific process is a positive aspect for both the teachers and students for conceptual learning. Bartholomew (2004) has stated that a deep understanding of NOS affects the ability of teachers to engage with the science subject and helps to determine a teacher's ability to teach effectively.

Besides studies of subjects, teachers and students get knowledge from their environment too. For a student, the best learning environment is created and provided by parents and teachers. Students believe in the knowledge and expertise of their parents and teachers. But when they pass their Secondary or Higher Secondary School Certificate examinations, they have gained more knowledge from their teachers and think in a similar way as their teachers do. Hence, teachers'' own knowledge and understanding of NOS is a key factor that has a direct effect on the students' learning (Abd-El-Khalick and Lederman, 2000). Therefore, special attention is required in science education for the understanding of NOS to obtain the desired level of scientific literacy (Driver, Leach, Millar, & Scott, 1996). For teachers, pre-service training regarding NOS is an effective strategy (Yalçinoğlu & Anagün, 2012).

By the last century, a great revolution has taken place in the field of sciences and technological innovations. It has given a great breakthrough to every field of life. We are witnessed that the world's

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technological advancements are due to immense development in scientific and technological domains. Therefore, the ability to appreciate the NOS has opened up new ways of industrial advancements. The technological advancements have also influenced the quality of life of human beings. It has empowered our defence, cared our health, facilitated our journeys and strengthened the relations. Therefore, interpretation development and implementation of a new curriculum aligned with technology advancement are inevitable for teachers to understand the true native of science. Palmquist & Finley (1997) are of the opinion that "teachers should be fully up to date in the notions of the NOS and must consider it as an educational outcome rather than merely assigning it pedagogic importance for students to develop an adequate understanding of the NOS". Although understanding the true nature of science is a basic step, but unfortunately, a very small study has been carried out on teachers' views about NOS, especially in Pakistan. According to our knowledge, no information is available in the literature regarding the study of the perceptions of university teachers about NOS in Pakistan. This study will be helpful to understand the teachers' awareness and views about the NOS. From these facts, administration, principals and teachers of the educational institutions can get feedback about the present knowledge of the teachers about NOS. This study may also give the insight to explore further aspects of the area being explored by the researchers.

## Statement of Problem

Several theorists have emphasized that the study of facts, laws and theories of science only is not enough, but to understand the significant progress towards characterizing science is also very important. The complete understanding of the characterization of science is only possible by learning the nature of science. Unfortunately, no particular definition is available to comprehensively define the nature of science, covering its scientific knowledge and enterprises fully (Schwartz & Lederman, 2002). According to Suchting (1995), the nature of science changes as the field of sciences grows. Therefore, this comparative study was designed to document the perceptions of teachers of Physics and Biology about the nature of science as it has become a need to get progress in science and technology.

One of the most significant objectives of science education is to enhance the scientific literacy of students. It can only be possible by understanding the nature of science (AAAS, 1990, 1993; Millar and Osborne, 1998) science teachers must have a clear understanding level for NOS in this regard (Mıhladız & Doğanb, 2013). The university teachers must have a complete understanding of NOS because a large number of science learners need to concept clarification in order to produce critical thinkers in society. Therefore, perceptions about NOS is considered essential for the teaching of science.

The findings of the study will be helpful for the education of Pakistan as teachers' understanding of NOS plays a key role in conceptual and effective science teaching. Consequently, the learners will be benefited as well.

## Objectives

1. To explore the philosophical perspectives of the science teachers about the NOS.
2. To compare perspectives of science teachers about NOS on the basis of demographics.

## Research Questions

1. What are the philosophical perspectives of science teachers about NOS?
2. What are the philosophical perspectives of science teachers on the basis of gender, etc.?

## Review of Literature

Over the past years, procedures to assess the scientific inquiry and the nature of science has been changed in both psychometric and educational research designs. The assessment of the nature of science evolved from qualitative approaches to measuring instruments, and then standardized scores were derived. In the initial stages of the assessments of scientific inquiry, attention was given to the ability of students to conduct the inquiry. No focus was laid to know what students understood about the inquiry. However, in recent times, the emphasis has been made to provide an extended view of the beliefs of individuals NOS. Researchers have used more open-ended measures and interviews in order to have more detailed understandings of the thinking of students and teachers.

Science education is a field of education which trains the learners, how to work in labs, how to think critically and how to manipulate variables and report results statistically. Science education teaches the ethical values and hence, it provides a platform for learners to make progress in science and technology (Rajakumar, 2006) and at the same time blend of technology in the teaching-learning process provides intrinsic motivation among learners (Javed, Buraira & Asghar, 2019).

Teaching science is not an easy task, especially at the secondary school level because learners are new to science. Duit & Treagust, (2003) said that it is very challenging for teachers to teach students about science at the secondary level, because "students do not come into science instruction without any pre-instructional knowledge or beliefs about the phenomena and concepts to be taught". Therefore, it requires that appropriate instruction should be given before teaching.

It's been a long tradition during the teaching-learning process of science that it is accompanied with the philosophy and history of science (Millar & Driver, 1987; Matthews, 1994). The proponents of science often have emphasized the advantages of employing this combination approach for the teaching science and learning as a "process" for the deeper understanding of scientific ideas and conceptual integrity (Seroglou, Koumaras, & Tselfes, 1998; Van Driel, De Vos, & Verloop, 1998; Wandersee, 1986). It also supports the learning and the philosophical perspectives of the NOS (Dedes & Ravanis, 2008; Galili & Hazan, 2001; Irwin, 2000; Lin & Chen, 2002; Solomon, Duveen, Scot, & McCarthy, 1992).

Over the past few years, the curriculum developers and science education teachers have been of great concern about the nature of science. McComos (2002) considered science education as a tool to enhance the development of society. MsComos was of the opinion that students who appreciate the nature of science are more beneficial than others as it has a positive impact on the lives of people and the culture of the society. But to gain all positive impacts and benefits, students must internalize the scientific spirit to the extent that the resultant scientific form of minds must cover all spheres of life.

Mathews (1994) is of the opinion that like all other professionals, science teacher needs to have a grip over the content of the subject matters as well as the techniques to deliver that content effectively. In addition to this, the science teacher must equip himself with the latest development in inventions and discoveries to meet with the demands of modern society. The teachers need to be professionally competent enough to critically evaluate all these modern scientific trends of the society. Therefore, the responsibility lies on science teachers to evaluate these modern trends and to have answers of the critiques on it ("Nat. Sci. Sci. Educ.," 2002). Therefore, the prime objective we can argue is to make science teachers realize to take responsibility so that students can be facilitated to understand the various philosophical orientations about nature of science, its development patterns and trends (AAAS,1990,1993; NRC,1996). Welch and Walberg (1972) commented that a teacher cannot fulfill his above-mentioned responsibility if the instructions are historically oriented only.

Khishfe & Abd-El-Khalick (2002) advocated to use explicit approaches while deliver of instructions about different aspects of the NOS. According to some researchers, instructions must cover both historical and philosophical elements about NOS (Billeh & Hassan, 1975). We can conclude safely that for effective teaching, the teacher must have a deep understanding about the nature of science. The researchers for years have been emphasizing the direct relationship between their understanding of the NOS and scientific literacy (Ogunniyi, 1983). Because the teachers own understanding of the nature of science can literate the students effectively. Many researches have emphasized on the ample capacity of the teachers to really understanding the nature of science in order to achieve the required level of scientific literacy (National Science Teachers Association, 1982; Klopfer, 1969; Lederman, 1992; Wang & Schmidt, 2001; Schwartz & Lederman, 2002).

There are different shades of nature of science. One such aspect is the scientific world view focusing on the believes and attitudes of scientists regarding their work and their views about it. This view describes that we can understand that worlds' scientific ideas are changeable; scientific knowledge is valid, but it is not possible to get all answers by science only. The other view of "scientific inquiry", considers science in demand of evidence because it's logical as well as imaginative science practical try to identify and get answers by avoiding. Bias, explains usual and have authority. The third view of "scientific enterprise" that considers science as a complex social activity in the need for ethical principles to be followed. It is organized into various principles, and the scientists are specialists at the same time when are the responsible citizens of society. Hence an essential component of the teaching-learning process of science education is to develop knowledge of its concepts with deeper understanding.

Generally, the nature of science (NOS) describes "the key principles and ideas pertaining to the description of science not only as a way of knowing but also the characteristics of scientific knowledge". These key principles and ideas are the tenets (characteristics) of science which describe the nature of science (NOS).

Latest researches in the field of development of science education have documented the significance of NOS. National Research Council (2012) has acknowledged this importance in these words: "…there is a strong consensus about characteristics of the scientific enterprise that should be understood by an educated citizen".

Philosophers of science have been scrutinizing and debating about the nature of scientific knowledge and its development for a longer period (Lederman, 2006). Multiple philosophical views have emerged because of the critical evaluation of methods at claims of science. The diverse perspectives grounded in epistemological views of science is categorized into four comprehensive categories, i.e. "patriotism, conventionalism, empiricism or logical positivism and realism". However, others have described some more epistemological views such as "relativism, positivism, inductivism, deductivism, contextualism, decontextualism, process-driven, content-driven, and instrumentalism and realism". Based on above-mentioned views about science, there are following epistemological beliefs and philosophical perspectives of the nature of science.

## Relativism and Positivism

For a relativist, the truthfulness and falsification of things are not based on independent reality; rather it depends on social group's norms, claiming it and the experiments to testify its truthfulness. Therefore, the truthfulness of scientific theories will be relative rather than absolute.

For a positivist, scientific knowledge is more authentic as compared to other forms of knowledge. Positivists consider science as a primary source of the ultimate truth. Positivist believe that science has objectivity due to relationships existing between observable facts and the laws governing these relationships.

## Inductivism and Deductivism

According to inductivism approach, scientists investigate the nature, and this investigation starts from observation. The observation of several specific instances, helps us to infer, determine the laws and development of theories, i.e. it is about making generalizations from observations made about universal law inductively.

On the other hand, according to deductivism, observations are directed by hypotheses. In due process of scientific reasoning, hypotheses are made first. Empirical data obtained through observations about those hypothesis helps us to testify the consequences of the presumed relationship between different phenomenon.

## Contextualism and Decontextualism

The conceptualism view of nature of science considers truthfulness of scientific knowledge and processes dependent on the culture of scientists and its contextual location. On the other hand, decontextualism considers scientific knowledge as independent entity neither depending on cultural location nor on the sociological structure of the society.

## Process and Content

The individuals who consider "science as a characteristic set of identifiable methods or processes, believe that learning of processes is an essential part of science education". On the other side, some individuals consider science as content and characterize it as facts and ideas and believe that achievement and mastery of knowledge about science are of pivotal importance in science education.

## Instrumentalism and Realism

According to Nott & Wellington, (1998) "the scientific theories and ideas are fine if they work, i.e. they allow correct predictions to be made. These are instruments which we can use, but these say nothing about an independent reality or their own truth. The scientific theories are statements about the world that exist in space and time independent of the scientists' perceptions. On the other hand, according to realism, correct theories describe the things which are really there, independent of scientists e.g., atoms, electrons".

Moss et al. (2001) described that to develop a deep understanding of NOS, science students must participate in scientific activity. Several studies around the world reported that at several places, the learning activities which support scientific enquiry are not present. As a result, the societies have ignored the goals of setting scientific literacy as a base for decision-making process in the society. The reasons behind this negligence, is that science education has not equipped themselves with the latest trends in the conduct of science and its influence on the priorities and values of the society. Educators don't consider it necessary to transfer their knowledge about the nature of science and its relation as their social responsibility (Vandervoort, 1983). On the other hand, various researches have given the evidence of the complex nature of the process of transfer of knowledge about the nature of science in classrooms. They reported the differences in context and personality, influencing the curriculum, classroom management practices, students' motivation and teaching capetencies as influential factors in additions to the factors of teachers' own understanding about true NOS and the subject-specific knowledge transfer activities. (Abd El-Khalick et al., 1998; Bell, Lederman & Abd-El-Khalick, 2000; Lederman et al., 2002; Schwartz & Lederman, 2002).

Lederman, (2006) stated that teachers are reported as promoters of scientific view as a simple collection of data, formulation and testing hypotheses and if all the observations are found in the same line, the formation of a general principle. Literature also revealed that in-service education could be useful for enhancing the understanding of teachers about the nature of science (Hodson, 1986). For this research work, the views of university science teacher's about NOS were collected and analyzed.

## Methodology

The study was quantitative by method. It was descriptive in nature. Survey method was used for the study, and data was collected by using a questionnaire from the male and female science teachers teaching at public and private sector universities of Pakistan.

Census approach was used to collect the data from science teachers. The data was collected through an online questionnaire from a sample of 106 science teachers working in public and private sector universities of Pakistan. The detail of the sample is as follows.

**Table 1.** Description of Participant's w.r.t Gender

| Gender | *f* | % |
|---|---|---|
| Male | 48 | 45.3 |
| Female | 58 | 54.7 |
| Subject | | |
| Physics | 28 | 26.4 |
| Chemistry | 16 | 15.1 |
| Biology | 46 | 43.4 |
| Mathematics | 16 | 15.1 |
| Years of Experience | | |
| 0-5 years | 52 | 49.1 |
| 6-10 years | 22 | 20.8 |
| 11-15 years | 18 | 17.0 |
| 16-20 years | 4 | 3.8 |

| Gender | *f* | % |
|---|---|---|
| 21+ years | 8 | 7.6 |
| Qualification | Frequency | Percent |
| Masters | 52 | 49.1 |
| M.Phil. | 40 | 37.7 |
| PhD. | 10 | 9.4 |
| Post Doc | 4 | 3.8 |
| Total | 106 | 100.0 |

There were total of 106 participants of the study out of which 48 were male, and 58 were female science teachers. There were 28 physics teachers, 16 chemistry teachers, 46 biology teachers and 16 mathematics teachers in the study. Majority of the teachers had less than ten years of working experience. There were 52 teachers having master's degree, 40 teachers had M.Phil. Degree, ten teachers had Ph.D. degree, and 4 teachers had Post-Doc degree.

## Research Instrument

A questionnaire developed by Eric Pyle and Lynn Fichter was used. It is adapted tool used by Monk, M. & Dillon, J. (Eds.) (1995). It consisted of 24 items/statements to rate the opinions of the teachers working in universities included in our sample against each statement on a scale from -5 (strongly disagree) to +5 (strongly agree). Where the score of zero was considered as a balanced view. The scoring of negatively stated items was reversed.

## Data Analysis

For data analysis, different statistical techniques and applications such as mean score, standard deviation, standard error of the mean, sum of squares, degrees of freedom, mean square and significance to seek the perceptions of Physics and Biology teachers' perceptions about NOS and then ANOVA and t-test were employed to find the gender, and subject wise difference of the perceptions of teachers about nature of science to achieve objectives of the study.

Overall perceptions of science teachers about the nature of science (NOS) are presented in the following tables.

**Table 2.** Scoring the Construct of NOS

| NOS Constructs | N | Range | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| Relativist-Positivist | 106 | 37.00 | -14.00 | 23.00 | 4.5660 | 7.84738 |
| Inductivism-Deductivism | 106 | 24.00 | -16.00 | 8.00 | -.9434 | 4.08209 |
| Process Driven-Content Driven | 106 | 21.00 | -17.00 | 4.00 | -7.5660 | 5.06532 |
| Instrumentalism-Realism | 106 | 27.00 | -11.00 | 16.00 | 2.0566 | 5.02722 |
| Contextualism-Decontextualism | 106 | 35.00 | -8.00 | 27.00 | 5.3396 | 8.05208 |
| Valid N (listwise) | 106 | | | | | |

From the responses of science and mathematics teachers of public and private sector universities of Pakistan, it was found that teachers were positivists as the total score, 4.56, was greater than zero. Hence, it was concluded that science teachers strongly believe that "scientific knowledge is more valid than any other forms of knowledge and science is the primary source of truth".

For, inductivism and deductivism (ID) continuum, it was identified that the teachers' scores showed their inductivist view. It shows that "science teachers make a generalization from a set of observations to a universal law inductively. Science teachers believed that scientific knowledge is built by induction from a secure set of observations".

The table also shows that science teachers believe in process-driven perspective of NOS instead of content-driven perspective and science teachers were towards realism rather than instrumentalism.

The total score of the construct of contextualism and decontextualism (CD) is less than zero. Therefore, science teachers were found to have opinion for the construct of decontextualism. Science teachers had the views that "scientific knowledge is not dependent of its cultural location and sociological structure".

The following table represents the analysis of difference of philosophical perceptive of science teachers about NOS with respect to subject and gender.

Table 3. Descriptive Statistics of Views of Science Teachers Regarding Nature of Science

| Construct | Subject | N | Mean | Std. Dev. | Std. Error | 95% Confidence Interval for Mean | | Min. | Max. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound | | |
| Relativist-Positivist | Physics | 28 | 1.78 | 7.025 | 1.327 | -.938 | 4.510 | -13.00 | 11.00 |
| | Chemistry | 16 | 7.25 | 10.04 | 2.512 | 1.894 | 12.60 | -9.00 | 23.00 |
| | Biology | 46 | 3.34 | 7.534 | 1.110 | 1.110 | 5.582 | -14.00 | 15.00 |
| | Mathematics | 16 | 10.25 | 3.130 | .782 | 8.581 | 11.91 | 6.00 | 15.00 |
| | Total | 106 | +4.56 | 7.847 | .762 | 3.054 | 6.077 | -14.00 | 23.00 |
| Inductivism-Deductivism | Physics | 28 | .28 | 2.507 | .473 | -.686 | 1.257 | -6.00 | 5.00 |
| | Chemistry | 16 | -1.37 | 2.418 | .604 | -2.663 | -.0862 | -5.00 | 3.00 |
| | Biology | 46 | -1.56 | 5.213 | .768 | -3.113 | -.0169 | -16.00 | 8.00 |
| | Mathematics | 16 | -.87 | 3.703 | .925 | -2.848 | 1.098 | -8.00 | 3.00 |
| | Total | 106 | -.943 | 4.082 | .396 | -1.729 | -.1572 | -16.00 | 8.00 |
| Process Driven-Content Driven | Physics | 28 | -7.92 | 3.409 | .644 | -9.250 | -6.606 | -12.00 | -1.00 |
| | Chemistry | 16 | -6.25 | 4.312 | 1.078 | -8.548 | -3.951 | -14.00 | .00 |
| | Biology | 46 | -7.60 | 6.530 | .962 | -9.547 | -5.669 | -17.00 | 4.00 |
| | Mathematics | 16 | -8.12 | 3.117 | .779 | -9.786 | -6.464 | -12.00 | -3.00 |
| | Total | 106 | -7.56 | 5.065 | .491 | -8.541 | -6.590 | -17.00 | 4.00 |
| Instrumentalism-Realism | Physics | 28 | .428 | 4.158 | .785 | -1.183 | 2.041 | -11.00 | 7.00 |
| | Chemistry | 16 | 4.750 | 5.603 | 1.400 | 1.764 | 7.735 | -3.00 | 16.00 |
| | Biology | 46 | 1.695 | 5.361 | .790 | .1034 | 3.287 | -8.00 | 14.00 |
| | Mathematics | 16 | 3.250 | 3.678 | .919 | 1.289 | 5.210 | -1.00 | 11.00 |
| | Total | 106 | +2.05 | 5.027 | .488 | 1.088 | 3.024 | -11.00 | 16.00 |
| Contextualism-Decontextualism | Physics | 28 | 4.00 | 7.906 | 1.494 | .934 | 7.066 | -8.00 | 21.00 |
| | Chemistry | 16 | 4.75 | 5.000 | 1.250 | 2.085 | 7.414 | 1.00 | 17.00 |
| | Biology | 46 | 6.04 | 9.552 | 1.408 | 3.206 | 8.880 | -5.00 | 27.00 |
| | Mathematics | 16 | 6.25 | 6.038 | 1.509 | 3.032 | 9.467 | -1.00 | 17.00 |
| | Total | 106 | +5.33 | 8.052 | .782 | 3.788 | 6.890 | -8.00 | 27.00 |

Table 3 gives the comparison of the views of science and mathematics teachers regarding NOS. It was found that mathematics teachers were found more positivists than science teachers. It is apparent from the table that mathematics teacher (M=10.25, SD=3.130) had positivist view of nature of science. The overall mean (M=4.56, SD=7.84) of this construct shows that that all science teachers were found more positivists than relativists.

For Inductivism-Deductivism continuum, although, Physics teachers found to have more deductivism view (M=.28, SD= 2.507) however the total value (M= -.943, SD=4.082) shows that science teachers had more inductivism view than deductivism view.

Regarding process driven content driven continuum, Chemistry teachers (M= -6.25, SD=4.312) had more inclination towards process rather than content. The overall value (M= -7.56, SD=5.065) of this continuum shows the same finding.

For Instrumentalism-Realism continuum, again Chemistry teachers (M=4.750, SD=5.603) had more inclination towards realism. Similarly, overall value (M=2.05, SD=5.027) shows science teachers views towards realism rather than instrumentalism.

For Contextualism- Decontextualism continuum, Mathematics teachers were found to have (M=6.25, SD=6.038) more decontextualism view than contextualism view. Similarly, the same pattern was found overall (M=5.33, SD= 8.052) about nature of science.

**Table 4.** Comparison of Views of Science Teachers Regarding Nature of Science

| Construct | | Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Relativist-Positivist | Between Groups | 916.889 | 3 | 305.630 | 5.618 | .001 |
| | Within Groups | 5549.149 | 102 | 54.403 | | |
| | Total | 6466.038 | 105 | | | |
| Inductivism-Deductivism | Between Groups | 63.142 | 3 | 21.047 | 1.273 | .288 |
| | Within Groups | 1686.519 | 102 | 16.534 | | |
| | Total | 1749.660 | 105 | | | |
| Process Driven-Content Driven | Between Groups | 36.474 | 3 | 12.158 | .467 | .706 |
| | Within Groups | 2657.564 | 102 | 26.055 | | |
| | Total | 2694.038 | 105 | | | |
| Instrumentalism-Realism | Between Groups | 219.064 | 3 | 73.021 | 3.059 | .032 |
| | Within Groups | 2434.596 | 102 | 23.869 | | |
| | Total | 2653.660 | 105 | | | |
| Contextualism-Decontextualism | Between Groups | 91.861 | 3 | 30.620 | .465 | .707 |
| | Within Groups | 6715.913 | 102 | 65.842 | | |
| | Total | 6807.774 | 105 | | | |

Table 4 shows the comparison of science teacher's views regarding NOS. It shows that there is significance difference found regarding nature of science among science teachers on relativist-positivist continuum $F_{0.05}$ (3,102) =5.618, p=0.01 and instrumentalism- realism continuum $F_{0.05}$ (3,102) =3.059, p=0.032. For further detailed analysis of these differences, Post Hoc LSD multiple comparisons test was applied.

**Table 5.** Post Hoc Multiple Comparisons of Views of Science Teachers Regarding nature of Science

| Dependent Variable | (I) Subject | (J) Subject | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| Relativist-Positivist | Physics | Chemistry | -5.46429* | 2.31153 | .020 | -10.0492 | -.8794 |
| | | Biology | -1.56211 | 1.76795 | .379 | -5.0688 | 1.9446 |
| | | Mathematics | -8.46429* | 2.31153 | .000 | -13.0492 | -3.8794 |
| | Chemistry | Physics | 5.46429* | 2.31153 | .020 | .8794 | 10.0492 |
| | | Biology | 3.90217 | 2.14077 | .071 | -.3440 | 8.1484 |
| | | Mathematics | -3.00000 | 2.60776 | .253 | -8.1725 | 2.1725 |
| | Biology | Physics | 1.56211 | 1.76795 | .379 | -1.9446 | 5.0688 |
| | | Chemistry | -3.90217 | 2.14077 | .071 | -8.1484 | .3440 |
| | | Mathematics | -6.90217* | 2.14077 | .002 | -11.1484 | -2.6560 |
| | Mathematics | Physics | 8.46429* | 2.31153 | .000 | 3.8794 | 13.0492 |
| | | Chemistry | 3.00000 | 2.60776 | .253 | -2.1725 | 8.1725 |
| | | Biology | 6.90217* | 2.14077 | .002 | 2.6560 | 11.1484 |
| Inductivism-Deductivism | Physics | Chemistry | 1.66071 | 1.27433 | .195 | -.8669 | 4.1883 |
| | | Biology | 1.85093 | .97466 | .060 | -.0823 | 3.7842 |
| | | Mathematics | 1.16071 | 1.27433 | .365 | -1.3669 | 3.6883 |
| | Chemistry | Physics | -1.66071 | 1.27433 | .195 | -4.1883 | .8669 |
| | | Biology | .19022 | 1.18019 | .872 | -2.1507 | 2.5311 |
| | | Mathematics | -.50000 | 1.43764 | .729 | -3.3516 | 2.3516 |
| | Biology | Physics | -1.85093 | .97466 | .060 | -3.7842 | .0823 |
| | | Chemistry | -.19022 | 1.18019 | .872 | -2.5311 | 2.1507 |
| | | Mathematics | -.69022 | 1.18019 | .560 | -3.0311 | 1.6507 |

| Dependent Variable | (I) Subject | (J) Subject | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| Process Driven-Content Driven | Mathematics | Physics | -1.16071 | 1.27433 | .365 | -3.6883 | 1.3669 |
| | | Chemistry | .50000 | 1.43764 | .729 | -2.3516 | 3.3516 |
| | | Biology | .69022 | 1.18019 | .560 | -1.6507 | 3.0311 |
| | Physics | Chemistry | -1.67857 | 1.59967 | .297 | -4.8515 | 1.4944 |
| | | Biology | -.31988 | 1.22349 | .794 | -2.7467 | 2.1069 |
| | | Mathematics | .19643 | 1.59967 | .903 | -2.9765 | 3.3694 |
| | Chemistry | Physics | 1.67857 | 1.59967 | .297 | -1.4944 | 4.8515 |
| | | Biology | 1.35870 | 1.48149 | .361 | -1.5798 | 4.2972 |
| | | Mathematics | 1.87500 | 1.80467 | .301 | -1.7045 | 5.4545 |
| | Biology | Physics | .31988 | 1.22349 | .794 | -2.1069 | 2.7467 |
| | | Chemistry | -1.35870 | 1.48149 | .361 | -4.2972 | 1.5798 |
| | | Mathematics | .51630 | 1.48149 | .728 | -2.4222 | 3.4548 |
| | Mathematics | Physics | -.19643 | 1.59967 | .903 | -3.3694 | 2.9765 |
| | | Chemistry | -1.87500 | 1.80467 | .301 | -5.4545 | 1.7045 |
| | | Biology | -.51630 | 1.48149 | .728 | -3.4548 | 2.4222 |
| Instrumentalism-Realism | Physics | Chemistry | -4.32143* | 1.53109 | .006 | -7.3583 | -1.2845 |
| | | Biology | -1.26708 | 1.17104 | .282 | -3.5898 | 1.0557 |
| | | Mathematics | -2.82143 | 1.53109 | .068 | -5.8583 | .2155 |
| | Chemistry | Physics | 4.32143* | 1.53109 | .006 | 1.2845 | 7.3583 |
| | | Biology | 3.05435* | 1.41798 | .034 | .2418 | 5.8669 |
| | | Mathematics | 1.50000 | 1.72730 | .387 | -1.9261 | 4.9261 |
| | Biology | Physics | 1.26708 | 1.17104 | .282 | -1.0557 | 3.5898 |
| | | Chemistry | -3.05435* | 1.41798 | .034 | -5.8669 | -.2418 |
| | | Mathematics | -1.55435 | 1.41798 | .276 | -4.3669 | 1.2582 |
| | Mathematics | Physics | 2.82143 | 1.53109 | .068 | -.2155 | 5.8583 |
| | | Chemistry | -1.50000 | 1.72730 | .387 | -4.9261 | 1.9261 |
| | | Biology | 1.55435 | 1.41798 | .276 | -1.2582 | 4.3669 |
| Contextualism-Decontextualism | Physics | Chemistry | -.75000 | 2.54296 | .769 | -5.7940 | 4.2940 |
| | | Biology | -2.04348 | 1.94496 | .296 | -5.9013 | 1.8143 |
| | | Mathematics | -2.25000 | 2.54296 | .378 | -7.2940 | 2.7940 |
| | Chemistry | Physics | .75000 | 2.54296 | .769 | -4.2940 | 5.7940 |
| | | Biology | -1.29348 | 2.35510 | .584 | -5.9648 | 3.3779 |
| | | Mathematics | -1.50000 | 2.86885 | .602 | -7.1903 | 4.1903 |
| | Biology | Physics | 2.04348 | 1.94496 | .296 | -1.8143 | 5.9013 |
| | | Chemistry | 1.29348 | 2.35510 | .584 | -3.3779 | 5.9648 |
| | | Mathematics | -.20652 | 2.35510 | .930 | -4.8779 | 4.4648 |
| | Mathematics | Physics | 2.25000 | 2.54296 | .378 | -2.7940 | 7.2940 |
| | | Chemistry | 1.50000 | 2.86885 | .602 | -4.1903 | 7.1903 |
| | | Biology | .20652 | 2.35510 | .930 | -4.4648 | 4.8779 |

**. The mean difference is significant at the 0.05 level.*

Table 5 shows output of LSD test. It shows that for Relativist-Positivist continuum, there was significant difference between physics-chemistry (p=0.20) and physics -math teacher's views (0.000), bio-math (0.002) teacher's views. A significant difference was also found regarding Instrumentalism-Realism views among Physics-Chemistry (0.006) teachers and Chemistry-Biology teachers (p=0.034).

Table 6. Comparison of Views of male and female science teachers about NOS

| NOS Construct | | Gender | N | Mean | Std. Dev. | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | F | Sig. | t | Df | Sig. (2 tailed) | 95% Confidence Interval of Difference | |
| | | | | | | | | | | | Lower | Upper |
| Relativist-Positivist | Equal variances assumed | Male | 48 | 2.5833 | 8.271 | 0.850 | 0.359 | -0.2.42 | 104 | 0.017 | -6.59 | -0.65 |
| | | Female | 58 | 6.20 | 7.139 | | | | | | | |
| Inductivism-Deductivism | Equal variances assumed | Male | 48 | 0.0833 | 3.194 | 2.940 | 0.089 | 2.409 | 104 | 0.018 | 0.331 | 3.421 |
| | | Female | 58 | -1.793 | 4.545 | | | | | | | |
| Process Driven-Content Driven | Equal variances assumed | Male | 48 | -7.791 | 4.837 | 1.165 | 0.283 | -0.416 | 104 | 0.679 | -2.380 | 1.555 |
| | | Female | 58 | -7.379 | 5.280 | | | | | | | |
| Instrumentalism-Realism | Equal variances assumed | Male | 48 | 2.000 | 4.575 | 2.061 | 0.154 | -0.105 | 104 | 0.917 | -2.057 | 1.851 |
| | | Female | 58 | 2.103 | 5.411 | | | | | | | |
| Contextualism-Decontextualism | Equal variances assumed | Male | 48 | 3.291 | 7.070 | | 0.216 | -2.438 | 104 | 0.016 | -6.78 | -0.697 |
| | | Female | 58 | 7.034 | 8.470 | | | | | | | |

Table 6 gives the comparison of the philosophical perspectives of science teachers with respect to gender regarding nature of science. A significant difference between the groups on Relativist-Positivist continuum can be seen from above table as female were found more positivists (M= 6.206, SD=7.139) than male (M = 2.5833, SD = 8.271) participants, *t*(104) =-2.421, p < .005. Levene's test showed that variances are equal (F = 0.850, p = .359).

Similarly, a significant difference appeared on Inductivism-Deductivism continuum where male had deductive view about nature of science positivists (M= 0.0833, SD=3.194) than female (M = -1.7931, SD = 4.545) participants, *t* (104) =2.409, p < .005. Levene's test showed that variances are equal variances (F =2.940, p = .0.089).

There was also significant difference found on contextualism-decontextualism continuum where female was found to had more strong perspective of decontextualism view of nature of science (M=7.034, SD=8.470) than male's perspective (M=3,291, SD=7.070), *t* (104) =-2.438, p < .005. Levene's test showed that variances are equal (F = 1.552, p = .216).

## Discussion

This study explored philosophical perspectives of science teachers regarding nature of In Pakistani universities, science teachers were found to have positivists view of nature of science. This finding is also reinforced by the opinion of science teachers as they were found as inductivist. This finding is in line with Hagège, Dartnell and Sallantin (2007) as they reported that previous research showed the students and Teachers to be positivists and realists. Significance difference was found regarding nature of science among science teachers on relativist-positivist continuum and instrumentalism-realism continuum. In this study, mathematics teachers were found more positivists than other science teachers as the value on RP continuum. Detailed analysis showed that on Relativist-Positivist continuum, there was significant difference was found between physics-chemistry and physics -math teacher's views, bio-math teacher's views and chemistry -biology teachers. While comparing views of male science and mathematics teachers and female science and mathematics teachers about nature of science, significant difference between the groups on Relativist-Positivist continuum was identified where female were found more positivists than male participants.

The findings of this study showed that science teachers believed science is a process instead of content. Park and Lee (2009) compared science teacher's views of two different countries i.e. USA and Korea and found that nearly all sampled preserve teachers of U.S. and Korea considered science as Process rather than Content.in this study, chemistry teachers were found to have more process-oriented view of nature of science.

For Contextualism- Decontextualism continuum, science teachers were found to have more decontextualism view than contextualism view. It was also found that, mathematics teachers were more of opinion that science has decontextualized nature. It showed that science teachers had the views that scientific knowledge is not dependent of its sociological structure and cultural location. This finding is in line with Park and Lee (2009), that the preserve elementary teachers of U.S. were of the opinion of decontextualism, however, preserves elementary teachers of Korea had a split view i.e. half of the teachers were of contextualism perspective while remaining 37.5% teachers had decontextualism perspective of nature of science. Therefore, the Korean preserve teacher's view were in between that how the truth of scientific knowledge and processes are affected by cultural and sociological structure. This finding is contrary to the findings of Apostolic and Koulaxizis (2010) as the researchers interviewed science teachers and sought their views about epistemology and science education. The researchers found that for most of the epistemological issues, a combination of "empiric-inductive" and contextualism positions were influential among science teachers. Mansour (2007) also reported that the relationship between science teachers' beliefs and their practices is complex and context dependent. There was also significant difference found on contextualism-decontextualism continuum where female was found to had more strong agreement about perspective of decontextualism view of NOS than male's perspective. Similarly, male was found to have inductivism view of nature of science while female had deductivism view of nature of science.

For Inductivism-Deductivism continuum, science teachers had more inductivism view than deductivism view. The teachers believed that the job of scientists is to do interrogation of nature and scientists make generalizations from set of observations to a universal law using inductive approach. This finding is contrary to Apostolic and Loulaidis (2010) where they found science teachers supporting the "hypothetico-deductive" views seemed to have slight support. Regarding Process Driven versus Content Driven continuum, science teacher's inclination towards inductivism rather than deductivism. Similarly, significant difference appeared on Inductivism-Deductivism continuum where male had deductive view about nature of science positivists than female teachers.

For Instrumentalism-Realism continuum, inclination of science teachers was found towards realism. Similarly, on the whole, science teachers were found to have views towards realism rather than instrumentalism. This finding is contrary to Park and Lee (2009) found that more than half of the preserve elementary science teachers U.S. had the Instrumentalist view of science, while thirty eight percent participants had the realistic view. It reflects that the preserve teachers of U.S had belief that "scientific theories are tools that can be used to explain the natural world". I this study, a significant difference was also found regarding Instrumentalism-Realism continuum among Physics-Chemistry teachers and Chemistry-Biology teachers.

## Conclusions

This study concludes that science teachers had varied perspectives about the nature of science. University science teachers have a positivist view of NOS. Moreover, university teachers held the view that generalizations can be made on the basis of inductivism. University science teachers also believed that nature of science is based upon realism. Moreover, university science teachers believed that science is not dependent upon context and culture. Perceptions about NOS of male and female teachers of also not different from each other except inductivism and deductivism, where male was towards inductivism while female was towards deductivism. It was found from comparison that there is no difference between the views of the male and female teachers about the philosophical/epistemological views about the NOS. From comparison of university science teachers about NOS, it was concluded that science education teachers' views also differ as per science subjects. Mathematics teachers are more positivists. Physics teachers are more inductivist, chemistry teachers are more process-oriented and are realists while mathematics teachers had views of contextualized nature of science. The science teachers under study were found to be realistic.

## Recommendations

i. Orientation regarding nature of science must be given to the in service and pre service science teachers.
ii. Male teachers must give more attentions to understand the nature of science like female teachers.
iii. The same study can be carried out among university teachers of other subjects like Engineering, Medical, Psychology etc. and then results should be compared across the subjects as understanding NOS is a basic need for conceptual teaching-learning process.

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