

# Personal Philosophy about the Nature of Science and its Impact on Teaching Pedagogy; A Case Study of an Elementary School Science Teacher

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The study aimed at making evident the process of change in the classroom practice of a science teacher resulting from personal philosophy about the nature of science. The process of change in teaching practice was addressed by finding the personal philosophy held in comparison to other teachers. The data was collected through a science teacher philosophy questionnaire, audio recordings of classroom practice and a teacher interview. Some encouraging evidence in favour of change in classroom practice about student involvements in science concepts was found. The teacher started valuing students' learning and spent more time in listening to the students rather than instructing them. The sequence in which changes were observed has great potential for facilitating the Continuous Professional Development (CPD) of science teachers.

**Keywords:** *Personal Philosophy, Science Teaching, Change in Classroom Practice*

## INTRODUCTION

Teachers' personal philosophy is one of the most rarely investigated subjects in educational research. The reason is very obvious, for a teacher is very likely to practice whatever he/she assumes is the way content is best learned by the students. The study of teachers' personal philosophy provides an opportunity on part of the researchers to understand classroom practices. Teachers' personal philosophy about the nature of scientific knowledge, objectives



of teaching science concepts, students' role in learning process at classroom level, conducive classroom environment, and the role of the teacher, have been the most searched fields in the area of personal views regarding nature of science (Chan & Elliott, 2000; Davis, Fang, 1996; Fulton & Torney-Putra, 2000; Pajares, 1992). There are adequate examples of research studies to indicate that teachers' personal philosophies have a strong impact on their classroom practices (Brickhouse, 1990; Bryan & Atwater, 2002; Levitt, 2002; Pajares, 1992; Richardson, 1996). But research on how far this personal philosophy in the classroom changes a teacher's pedagogy is provisional (Abd-ElKhalick, Bell & Lederman, 1998; Brickhouse, 1990; Lederman, 1999; Levin & Wadmany, 2005). What researchers are agreed upon is that there is a strong interactive relationship between teachers' personal philosophy and practices that influence each other in a cyclic rotation.

Before considering a review of the current status of the study on science teachers' personal philosophies about the nature of science, it seems important to present the clear image of the term philosophy as used in this research to avoid any confusion as the term has been traditionally used to describe a variety of constructs by different researchers (Pajares, 1992). In the context of this study, it is supposed that philosophies are true reflections of an individual's life experiences. It is also supposed that philosophies are truly conditions dependent (Cooney, Shealey & Arvold, 1998), also that there is a diversity of personal philosophies regarding the nature of science by different individuals as every individual is unique in the sense of regarding their personal philosophy.

### **Developments in research on teacher philosophy**

Teachers' personal philosophies are considered to be very hard constructs to investigate (Pintrich, 1990) but if at once it is explored successfully, can be served as a useful psychological tool for the advancement of the teaching and learning process in science education. Kagan (1992) presented the summary of more than twenty research studies regarding personal beliefs of both in-service and pre-service science teachers in science education. Ideas searched in such research studies included teaching practice, student attitude towards learning and teachers' role in classroom environment. The results of studies showed a strong relationship between teachers' personal philosophies and students' academic achievements. But one domain was missing in Kagan's analysis regarding teachers' personal epistemology in the teaching of science and its implications for teaching pedagogy. All such studies explicitly stated these philosophical issues are very rarely in the field of science but considered the teachers' personal epistemology as a basic element in science teaching at the classroom level. (Tsai, 2002; p.772, Pajares, 1992; p. 325, Gallagher, 1991; p.132, Hashweh, 1996; p.61).

This study presents a case study of a science teacher to investigate the relationship of her personal philosophy regarding the nature of scientific knowledge and its impact on teaching



practice. In the first two months of the study the researcher worked very closely with the teacher in order to develop a mutual understanding about the practicability of very obvious looking regarding the nature of science.

### **Background of the study**

In order to understand the teaching of science at a secondary school in the district of Nowshera (KPK) Pakistan, I, being a researcher personally observed the science class of a biology teacher at a government girls higher secondary school Akora Khattak as a participant observer to become familiar with students to minimise the potential impact of the researcher on the classroom environment. During my observation in the science classroom, I developed a close understanding of the science teacher's personal philosophy about the nature of science and to determine their workability for classroom teaching and the learning of science. A science teacher philosophy questionnaire was administered to collect the data for the study regarding teachers' personal philosophy about the nature of scientific knowledge, student participation in the lesson and the teaching of science were recorded incidentally. I become strongly associated with the teacher to know her formally for the sake of the data collection process of my doctoral study to investigate her personal philosophy about the nature of science and the students' understanding of scientific concepts in the science classroom.

### **Teacher's profile**

The science teacher was 40 years of age, at the beginning of this study in 2019. She was a qualified and experienced teacher with a Masters in biological sciences as well a Bachelor of Education from Peshawar University (KPK). She has worked in this school for almost ten years. She remained an active member of the school science society at a district level to encourage the students towards science education. She was also invited by different private institutions to train the science teachers regarding the teaching of science and to develop the students' interest in science education.

### **Objectives**

The purpose of the study was to investigate the science teacher's personal philosophy about the nature of science and its impact on teaching practice.

The guiding questions were:

(a) What is the teacher's personal philosophy of science?

(b) Did her teaching reflect the impact of her personal philosophy about the nature of science towards her teaching practice?

## METHODOLOGY

This section describes sources of data, data collection procedure and data analysis.

### Description of sources of data

Science Teacher Philosophy Questionnaire (STPQ): This questionnaire was constructed to identify the personal philosophy of the science teacher regarding the nature of science and its impact on teaching practice and classroom environment. The Science Teacher Philosophy Questionnaire (STPQ) was comprised of 30 questions on a Likert-type scale about the science teacher's personal philosophy regarding the nature of scientific knowledge and the teacher's personal philosophy was categorised in to three domains of philosophy: ontological, epistemological, and theory building. Therefore, the teacher's response on those three domains (collectively having 20 statements) was used in this study. Table 1 describes the constructs included in the three domains from which data was used in this case study.

The validity of the scale was determined through getting the items reviewed by three experts from public sector universities having experience and publications in the field of teacher philosophy.

Table 1. Description of the constructs inquired in STPQ

Philosophy	Nature of knowledge	Teaching strategy	Learning ability
Ontology, epistemology, and theory building	What is science? What is nature of science?	What to teach, how to teach?	To find the students strength of learning abilities in science classroom

### Interview schedule

The interview was a follow up activity of the STPQ, focusing on collecting elaborative remarks on the teacher's personal philosophy. Only interview questions which related to three domains relevant to this case study (described in table 2) were used. The interview was semi-structured in nature to offer flexibility to the interviewer for asking follow-up questions to collect pertinent information. I started the interview with the questions in the STPQ and by giving a comparison of other teachers responses to it.

### Class observation

Audio recordings of the teacher and students talks in the sequenced lessons were made on selected topics. This session was completed in nine lessons of 40 minutes each and all lessons

were recorded and transcribed. The lessons were carried out in a biology laboratory having six tables with 67 students sitting around each table. An audio recording session comprised of seven lessons was carried out when the teacher taught the same topic to the same grade (different students).

### Framework used for analysing audio recordings

The lesson recordings were transcribed and analysis of the science classroom discourse was undertaken for whole class scenarios only. Science classroom activities were categorised into teacher and student activities that were further divided into subcategories of teacher classroom management activities, demonstration, evaluation and feedback activities. Student activities were categorised into individual or group work responsive and practical work activities. Classroom activities were categorised according to different types of interactions within the science classroom as (CM) classroom management activities by the teacher, (TD) teachers' lecture demonstration activities, (WCI)T, whole class interactive activities initiated by the teacher, (WCI)S, whole class interactive activities initiated by the students, (PGA) practical group work activities, (ISW) individual seat work, and (GSW) seat work in groups.

Each classroom activity was placed within a specific time frame to identify the duration and frequency of each type of interactions within the science classroom.

Table 2: General Classroom Interaction

	Time frame	Classroom interaction	Classroom activities
CM	2 minutes	Classroom organising activities	Teacher asked about homework assignments, or directed the students to open the books etc
TD	15minutes	Teacher demonstrated the lecture to the students	Teacher's daily lesson presentation activities
WCI(T)	2 minutes	Whole class interactional activities initiated by the teacher	Question/responding activities in classroom
WCI(S)	2 minutes	Whole class interactional activities initiated by the students	Students responding and asking questions activities
PGA	5 minutes	Practical group work	Student work in groups
ISW	2 minutes	Seat work activities	Students work individual on their seats
GSW	2 minutes	Students work in groups remains on their seats	Group discussion on specific topic among the students



Small group practical work was a significant component of all lessons examined in this study. The practical activities in the class and how to perform the experimental activities as small groups comprised of 10 students during the lab hours were demonstrated to the students.

### **Data collection procedure**

Multiple data sources were used to address the research questions and to identify various components of the study. Information regarding the teacher's personal philosophy about the nature of scientific knowledge was collected through the STPQ, an interview with the science teacher about the nature of science and the impact on teaching practice was observed through classroom discourse analysis by the audio recording of lessons, and an interview of the science teacher about the nature of science was conducted.

The next stage of data collection was the audio recording of lessons on the selected topic "photosynthesis"

There were 38 and 37 students of mixed ability in the science class of the respective teacher.

### **Results**

The experienced teacher of this study reflects the traditional mode of teaching in their classroom the teaching of science. The personal philosophy of the participant teacher was consistent with the traditional philosophy of science of inductive-empiricism and positivism. The teacher's philosophy about the status of scientific knowledge was found to be strongly linked with philosophical theories of naive, realism, objectivism. However, the teacher's and students' beliefs systems were not favouring the current reform expectations and were heavily depend on a positivist naïve view about both the nature of science, teaching and the learning of scientific concepts.

Furthermore, their classroom teaching of science focused on the structure of scientific knowledge rather than process of science. In turn, her classroom practices reflect her philosophy about science and the students' learning abilities were devoid of formulation and validation. The science teacher in this study overemphasises the factual basis of science with traditional assessment formats and presented the scientific knowledge as tentative. This identified her role as the controller, to hold on to all the classroom activities, and reflected her classroom atmosphere as teacher-centred. Students were directed to follow the teacher and students were just passive listeners, not active participants of the classroom environment.



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## **Discussion**

Three aspects of the participant teacher's personal beliefs: ontological beliefs, epistemological beliefs and theory building beliefs regarding nature of science have been reported in this study.

### **Ontological views of science**

The participant teacher in this study reported to have implicit views about the nature of science. Naïve realism was found to be the basic feature of the teacher. Observation of the natural phenomena was found to be the main focus of the teacher's science classroom discourse.

### **Epistemological views of science**

The participant teacher observed scientific knowledge as secure, unchanging and followed the epistemological theory of objectivism. The teacher's beliefs of scientific knowledge were found to be inherently objective and have independent existence in the teacher's utterance, textbooks, notes on the white board and in the students' notebooks.

### **Theory building views of science**

The participant teacher reported to have a positivistic view regarding the development of scientific knowledge.

The teacher has inadequate knowledge of science dependent on textbook material for students' understanding of scientific concepts. Her reliance on textbook indicates an inductive-empiricists view of the nature of science. The participant teacher presented her secure and unchanging nature of scientific knowledge to the students in the classroom. Such a secure and unchanging conception of scientific knowledge directed the teacher to implement the teacher-centred practice.

This study reported that the teacher's personal views regarding the nature of science strongly impact her teaching practice.

## **Conclusions**

This study presents a strong relationship between a teacher's personal beliefs about the nature of science and teaching practice in the science classroom and also on classroom environment.



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The findings of this study seem to suggest that personal beliefs of a science teacher about the nature of science may not be adequate to develop a full understanding of the nature of science. Further research is recommended with large samples, using a revised questionnaire and interviews, as well as document analysis to reveal how a teacher's personal philosophy about the nature of science is taught and learnt in the science classroom.



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