Journal of Advances and Scholarly Researches in Allied Education
Vol. 16, Issue No. 6, May-2019, ISSN 2230-7540

A Study of Indian Secondary Science Teachers' Current Orientations toward Teaching Science

Monika[1]* Dr. Harbans Lal[2]

[1] Research Scholar, Sunrise University, Alwar, Rajasthan

[2] Professor, Sunrise University, Alwar, Rajasthan

***Abstract** – National Curriculum Framework aims to provide a more constructivist approach to learning in all topics. Teachers' attitudes toward teaching and learning are critical to the success of curriculum change in other countries (e.g., the United States), according to previous studies. Accordingly, we decided to investigate Indian secondary science teachers' teaching orientations through an examination of two teachers' practises and how these are mirrored in their teaching orientations. As a result of their many external limitations, we found that teachers' orientations agreed with the goals of reform, but their classroom practise did not. This may have been due to the many restraints that teachers felt were placed on them. We examine the implications of these findings for professional development that take into consideration alignment for all three components while taking into account probable cultural barriers.*

***Key Words** – Teaching Orientations; In-Service Teachers; International Science Education*

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INTRODUCTION

Science education was reformed from the late 1980s to the mid-1990s, with the goal of creating a more scientifically literate population. The reform movement's impact on student learning and teacher practise was a major topic of study conducted in the years that followed. Some researchers (see Brickhouse, 1990; Bryan & Abell, 1999; Cronin-Jones, 1991; Duffee & Aikenhead, 1992; Levitt, 2002; Tobin & McRobbie, 1996) have suggested that reform efforts could have occurred more smoothly if teachers' views on science teaching and learning had first been considered before expecting them to implement the reform goals. At this point in time a decade later, India's educational policy is being revised and a new National Curriculum Framework is being developed (NCERT, 2005). This transition has led to a considerable shift in pedagogy from a didactic to a constructivist approach to teaching in all subject areas. There is a shift in focus from traditional lecture-based instruction in science to teacher-guided and student-driven inquiry-based learning in the new curriculum framework. The National Science Education Standards (NSES) (National Research Council, 1996) and their companion publication highlight a similar shift in emphasis as an objective of the 1990s U.S. science education reform (NRC, 2000). The study's objective is to apply to India the reform lessons learnt in the United States. We'd like to learn more about how secondary science teachers now think and act when it comes to teaching science so that we can better influence the debate on what steps should be made to help teachers in India accept the country's scientific education reform. We also believe that it is crucial for instructors to be prepared to think worldwide, given the rising emphasis on preparing pupils to think globally. For this reason, it is critical that we learn from one another's experiences in order to improve science education for all students, no matter where they study. This study's focus on teaching orientations, or teachers' ideas and practises, is rare outside of Western contexts. For the sake of furthering our understanding of science teaching in non-Western contexts, this study provides insights into how teachers' orientations are influenced by contexts, such as government policies and cultural traditions, which may have an impact on our understanding of how to teach science more globally.

RELATIONSHIP BETWEEN ORIENTATIONS AND PRACTICE

According to the literature, the relationship between orientations and practise is complex, and teachers may not always be able to transform their science teaching orientation into practise for a variety of different reasons (Friedrichsen & Dana, 2003; Volkmann & Zgagacz, 2004). As a result, the complexity of science instruction is inherent.

Teachers' views about teaching, as well as their knowledge of pedagogy, all have an impact on how they conduct themselves in the classroom when it comes to teaching science (PCK).

While many empirical research have shown the importance of understanding instructors' classroom behaviours, only a few have looked at the connection between these activities and what we call orientations in this study. An orientation toward science teaching extends beyond generic teaching practises to consider the best methods for teaching a particular topic. Teachers must use both their personal ideas on the best ways to study science and their own expertise in the subject matter they teach to carry out this task effectively. It is because of their teaching orientations that they are guided in their instructional decisions about topics such as daily objectives, the substance of student assignments, the usage of textbooks and other curricular material and evaluation for student learning. To put it another way, orientations serve as filters2 for instructors as they enhance their general expertise for teaching science.

Zipf and Harrison (2003) conducted a study similar to ours in which they studied the dynamic link between two Australian elementary school teachers' orientations and practises. One was found to have a more traditional approach to scientific education, focusing on the distribution of worksheets to students. For her, it was important to have an actual textbook since it allowed students to better engage with the material and assured that they had an accurate knowledge of it. Both teachers used textbooks, but the other used it more to guide her students' excursions and other classroom activities to help them better understand the subjects they were studying in class. The divergent perspectives of these two scientific educators on the role of texts in the classroom influenced their approach to assessment as well. A written exam was preferred by the first teacher, whereas open-ended formative assessments were used more frequently by the second.

In an undergraduate physics course intended for primary education majors, Volkmann, Abell, and Zgagacz (2005) explored how a university professor, a teaching assistant, and students experienced inquiry-based science instruction. With an orientation lens, they discovered that both faculty members' (professor and teaching assistant) battled to decide on the best time and method for providing students with scientifically correct answers and vocabulary. Because of their previous teaching experiences, the instructors' initial orientations were defined as didactic, but the requirement to demonstrate clear inquiry instruction for pre-service teachers promoted a shift in their orientations toward inquiry. This finding implies that students can have an impact on teachers' thinking and practise when they are a part of the educational context.

Other studies show that teachers' intentions and actual practise might diverge depending on the context (Beck, Czerniak, & Lumpe, 2000). While Chinese teachers and teacher educators appreciate the significance of inquiry-based learning, other limitations placed on them prohibit them from teaching in this manner (Zhang et al. 2003). The need to prepare their children for college entrance tests posed a significant challenge. Teachers were often driven to teach in ways that went against their personal preferences in order to conform to the test's objectives and design since the exams' structure examined rote learning and thus did not encourage an inquiry approach to learning science. Large class sizes and a lack of resources were also impediments to teaching science as inquiry.

ALIGNING ORIENTATIONS AND PRACTICE IN AN ERA OF REFORM

A primary goal of Czerniak and Lumpe (1996) was to investigate how teachers' beliefs about how reform plans of the early 1990s would be implemented would be reflected in classroom practise. Many teachers were found to be unaware of the necessity for a hands-on/minds-on approach to learning, and few had adopted any of the reform criteria into their practise, according to the findings. Structured interviews and questionnaires were used to evaluate teachers' intentions to implement the reforms in scientific teaching in 1996 by Haney, Czerniak, and Lumpe (1996). Female instructors were more likely than male teachers to undertake reform, and primary teachers were more supportive of reform aims than upper level teachers, according to the researchers' findings. A lack of professional development opportunities, insufficient administrative support, and restricted resources all contributed to instructors from Haney et alstudy .'s not actually executing the reform's goals.

Roehrig and Kruse (2005) studied the impact of 12 teachers' teaching orientations on their implementation of a reform-based chemistry curriculum. Interviews and observations of a field test deployment of the programme were used to gather data. The authors observed that more teachers had reform-based opinions, although they attributed this to the excitement generated by the new curriculum. As far as I know, it wasn't investigated if this excitement influenced their following practise.

For example, Cuban (1990) asserted that policy makers often fail to acknowledge teachers' orientations toward teaching their discipline, to address the impact of external and/or socio-cultural constraints placed on teachers, and to provide the kinds of support needed to assist teachers in aligning their practises with the goals of reform. Each of these causes could be relevant to the numerous educational reforms India has seen since obtaining independence in 1947. In any case,

To address the concerns raised by prior reform efforts, our research focuses on the following questions: Each of these aspects must be thoroughly examined if the National Curriculum Framework (NCERT, 2005) is to succeed in the context of science. Aiming to begin a dialogue about suitable and effective professional development, this study analysed two secondary science teachers' views and practises on scientific teaching, comparing these to the National Curriculum Framework's goals.

Context and Participants

It is because of a strict examination system that India's educational system places a heavy emphasis on evaluation (Gupta, 2007). Many government agencies, such as the National Council for Educational Research and Training (NCERT), advocate for a uniform national curriculum that includes a prescribed syllabus and textbooks for every grade level. These books are then suggested to all 42 test boards in the country. Students are assigned to study science, commerce, or humanities based on the results of their 10th and 12th grade exams. Students must score the highest in science on the 10th grade board exam in order to be accepted into the college level science stream. As a result, many students place too much emphasis on quantity and not enough emphasis on quality when preparing for these tests. We decided to conduct our research in an urban area in Western India. Teachers at the participating institution, which was a private boarding school, had additional responsibilities beyond those of a regular classroom instructor. English was the language of instruction and official business at the school. As a result of their willingness to accommodate our request to meet with teachers and examine their procedures over the course of several weeks, we chose this school.

Understanding Teachers' Orientations through Their Views and Actions

We discovered that the teachers consulted a variety of sources while designing and implementing their science lessons, based on our conversations and observations. Thus, we provide our findings by integrating the outcomes of our first two study questions into a single summary. So that we could fully see how their beliefs and actions were linked, we decided to talk about their philosophies alongside the teaching methods we watched them using. A combination of our observations of teachers in action as well as our in-depth conversations with them serves as the basis for illuminating our findings. There are four sub-categories in our findings: (a) orientations toward science, teaching, assessment, and external influences; (b) orientations toward the discipline of science; (c) orientations toward measuring scientific learning; and (d) orientations toward the impact of external factors. The findings of these four sub-categories are described in full below, but a summary of these findings is also presented in Figure 1. This statistic, we believe, illustrates the difficulty these two teachers encountered in balancing their beliefs about what constitutes good science instruction with their actual practises, as well as the numerous restrictions placed on them on a daily basis. Next, we compare and contrast the instructors' orientations and practises with respect to the goals of NCF-2005, following the discussion of our final sub-category, orientations regarding external influences. Table 1 provides a summary of our comparisons, which we hope will make our conclusions even more evident.

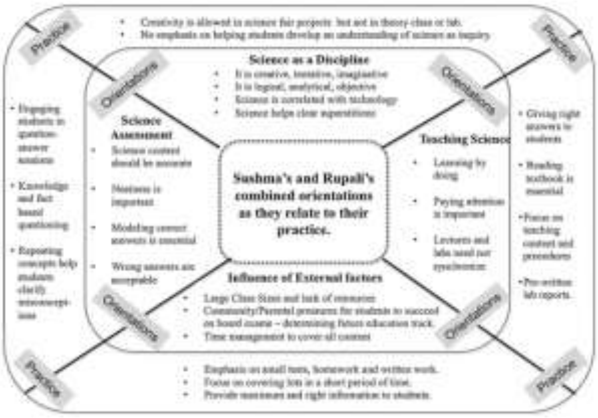

Figure 1. Summary of the teachers' orientations with respect to their practice

Table 1 Comparing teachers' orientations and practice to the goals of NCF-2005

Findings	Summary of Teachers' Orientations and Practice	NCF-2005 Expectations
Goals for learning about science as a discipline	Science is creative, imaginative and tentative; equivalent to technology; objective: logical and analytical; a set facts or a set of truths which will never change	Science is a dynamic, expanding body of knowledge
	There is one scientific method leading to one right answer	Students should understand science as a social enterprise and should understand how social factors influence science development
	At the upper primary and secondary levels students should learn about the complexities of science from a familiar context, and be engaged with scientifically based tools	Science knowledge should nurture natural curiosity and creativity in children
	Science fair projects can be creative but writing in science requires a particular format, as emphasized on the board exams and in labs	
Classroom and laboratory science teaching	If the lab and lecture are unrelated it will have no effect (positive or negative) on student learning	School science should consist of activities and experiments that connect with the world
	Reading is an essential part of learning science	Popular media and other resources should support instruction
	Learning science means memorizing certain concepts	Inquiry skills should be supported and strengthened through experiments
	Purpose of laboratory experiences is to confirm knowledge already learned through lecture and to engage students with the content	Class discussion, including peers and teachers should be encouraged
	Labs are completed following a script to prepare for board exams	
	10th grade board exam is based on particular core topics so only those concepts are focused on from 8th grade forward	
Assessing students' learning of Science	Misconceptions should go away with enough teacher explanation	There should be continuous assessment that informs instruction, as well as periodic summative assessment
	60% of exam questions must be fact based to pass students and prepare them for the board exams. The remaining 40% is application of the concepts	Evaluation should be a way of providing critical feedback
	All assignments from 8th grade on will focus on the core topics evaluated on the tests	Classroom presentations and projects should also be used as means of assessing performance

Monika[1]* Dr. Harbans Lal[2]

Continuous assessment of students' learning is essential and best conducted through exams for quick grading and confirming accuracy of content knowledge	Students should be taught to self-evaluate their learning
Discussion is needed in the classroom, but structured by the teacher as a means of assessing accuracy of understanding	Teachers should develop reflective practice to modify instruction based on their students' needs
The purpose of homework is to improve students' science writing and memorization habits	

Comparing Teachers' Orientations and Practice to the Goals of NCF-2005

To answer our third study question, we compared the NCF-2005 objectives to the teacher orientations and practises. We discovered a lot of disparities between the teachers' perceptions and how the NCF-2005 depicted science education when we compared these aspects. In this area, we've utilised similar sub-sections to the ones mentioned above to structure our conversation. According to the goals of NCF-2005, the teacher's orientations and practises are summarised in Table 1.

Goals for Learning about Science as a Discipline

Teachers, as previously indicated, felt that science necessitates the use of imagination and creativity, and that as a result, scientific knowledge may be considered tentative and subject to change based on fresh observations. Teachers, on the other hand, argued that science should be taught in the classroom as a matter of fact, and that students should be taught how to conduct scientific research objectively in order to come up with reliable results. In the teachers' practise, we witnessed students following lab activities prescribed by the teachers, with the outcomes already provided and students only needing to verify those results. Many of the professors' discussions revolved around asking students factual questions and then expecting them to provide detailed replies. There are examples of both of these approaches in Vignettes 1 and 2. In accordance with NCF-2005 recommendations, students should be taught science in the classroom in a way that they begin to appreciate all aspects of the nature of science, and particularly of science as a social enterprise. From our discussions with the teachers, it was clear that they had no idea what they were teaching their students or how to conduct scientific research. According to them, students are required to discuss their views with their teachers in order to learn about science as a social enterprise. A objective for school science is to assist students develop distinct process skills and good attitudes toward inquiry-based science, so that they are more open to acquiring the necessary material of science for each grade level, according to the NCF-2005 document. When asked if increasing students' process skills and attitudes for inquiry science may serve this goal, teachers agreed that the emphasis should be on improving students' content understanding. Their belief was that the pupils learnt best by practise, direct instruction, and rote memorization, all of which they thought were necessary to prepare them for their 10th grade board exams.

Classroom and Laboratory Science Teaching

For those concepts they didn't know, they looked out resources to learn more about them. In order to answer students' queries, teachers believed that they needed to have more knowledge than their students did. It is important to research all of the relevant information when preparing lesson plans so that you can respond to your students' inquiries effectively. It's a challenge to teach high school children because they're curious and ask a lot of questions, so you need to be prepared and take the time to search up additional information so you don't make a mistake.

While preparing for their lectures, teachers stated that they rely extensively on textbooks to help them determine what topics they should teach and the order in which they should teach them. Students were taught subject and followed processes in the labs, but the focus was on teaching students how to do things rather than how to do things. It is also clear that in both contexts, the majority of talks focused on the definitions of science concepts, comprehending the results of experiments and applying both the content knowledge and process to new situations so that they could replicate the same responses.

In contrast, in NCF-2005, students study science by first experimenting with concepts, and then generating their own explanations based on those experiences. Furthermore, "'Rote learning should be avoided,... whereas inquiry skills are fostered and improved (NCERT, 2005, page 49) These two classes had laboratories that had previously been written with methods and outcomes, so the students were only required to follow a scripted report to verify the results. The teacher even went so far as to provide pupils detailed instructions on how to arrange and evaluate the data they gathered in the experiments (see Vignette 2 for the example of calculating the angle of incidence). The textbook was also seen as necessary by teachers as a way to fill in any gaps in their pupils' knowledge. It was therefore necessary for them to read the textbook aloud, stopping to discuss certain themes as needed. Because the board exams were designed to cover all the material in the textbooks, the professors wanted to make sure that the pupils had a thorough understanding of the material. NCF2005 does not provide any assistance to teachers on how to achieve these requirements of the tests without relying on direct instruction from the text.

Assessing Students' Learning of Science

"In the Indian system, the phrase "evaluation" is associated with examinations that cause tension and worry," write the NCF-2005 developers. "NCERT, 2005, p.71." As a result, NCF-2005 has made a special effort to address assessment in terms that move away from the notion of judging student learning primarily through a fixed test system, and instead encourages flexibility in assessment techniques. For this reason, the NCF-2005 proposes group work assessments, oral exams, and open book exams as possible solutions. This shift in assessment was not made clear to teachers when asked about it; instead, their bosses and administrators continue to stress the importance of standardised testing, according to their responses. We noticed teachers actively engaging students in conversations through teacher question/student response sessions as part of the day-to-day evaluation in the classroom. When pupils were unsure of the correct response, teachers would encourage them to repeat it multiple times until they did. This helped them memorise the correct answer and kept it in their minds for future reference. No one in the classroom had ever heard of "formative assessment," and neither teacher had any idea how to incorporate it into their teaching or assist students learn. It was thought that kids didn't have any misconceptions as they progressed from one school year to the next, therefore little review of past subjects was required. During the course of the school year, the NCF-2005 emphasises the importance of formative assessment and the need for continual assessment. As a result, neither teacher felt motivated to work toward this reform objective since they were unfamiliar with its vocabulary and saw no signs of a shifting testing culture.

Rationale for the Design of Our Study

For reform to be successful, researchers have determined that instructors' orientations must be taken into account initially (Abell, 2007). Additionally, it is necessary to have a grasp on how their personal ideologies affect their professional choices (Crawford, 2000). Professional development programmes can benefit from learning about these difficulties in order to assist teachers turn their attitudes and actions into practise that is aligned with reform's goals (Musikul & Abell, 2009). Two Indian secondary physical science teachers' teaching attitudes for science and how these orientations are reflected in their practise were the focus of our investigation. An introductory investigation, based on the recommendations of other researchers, has been constructed to acquire crucial information about the present philosophies and practises of Indian science teachers. Using this method, we intend to begin a dialogue among science teacher educators and professional developers on the design of effective professional development programmes for Indian teachers and those in similar national contexts in other countries that will (a) support teachers in modifying or merging their orientation(s) for teaching science (as needed) to better reflect the goals of reform (e.g., India's 2005 National Curriculum Framework), and (b) help science teachers to ultimately transfer their newly developed reform-minded orientation(s) into practice.

CONCLUSION

According to research conducted in the West, instructors' beliefs about their discipline, how pupils learn about the subject matter, and how they evaluate their students' learning can have a significant impact on their ability to implement reform. Despite the fact that the Indian teachers' views on science education were mostly in line with the NCF-2005 objectives, there were also some discrepancies between their ideals and their day-to-day activities, which may be attributable to the numerous restrictions they felt they had to work under (e.g., large classes, limited time, emphasis on board exams as focus for learning, etc.). As a result, they were able to explain the discrepancy between their beliefs and their actions because of their understanding of the Indian educational system's cultural/contextual aspects. Consequently, they were under the impression that they needed to educate in a more didactic approach rather than one based on inquiry and reform. Due to their differing approaches, the goals of NCF-2005 were not met by their practises. Teachers, for example, felt a significant deal of responsibility for their students' success on the 10th grade board examinations, which is the only element that determines which track children will take in high school to pursue a job. Similarly, Zhang et al. (2003) observed that teachers' views and practises may be at odds because of their concentration on preparing pupils for college entrance tests. Teachers in our survey frequently stated that they were compelled to teach to the exam in order to ensure that their pupils were appropriately prepared. In Zhang et al. (2003), the teachers made similar statements. As a result of this impression, Asian countries may place considerable premium on learning scientific facts. As a result, teachers may resort to relying on the textbook as a source of information while pupils passively absorb it. In addition, laboratory experiences are used to reaffirm what the students have already learned rather than to allow them to experiment and apply their knowledge in new ways.

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Corresponding Author

Monika*

Research Scholar, Sunrise University, Alwar, Rajasthan