Abstract

This thesis addressed the question how the multidimensional socio-cultural world of the learner—the everyday world of the child outside school and the world of the school—interact and constitute the child’s learning of science. The Indian school is believed to have a strongly framed curriculum, where everyday knowledge and school knowledge are separated by a strong boundary. Yet there are many experiences and concepts relating to science which are also a part of the everyday worlds, and we can ask what the interaction is between the two and how this manifests in and constitutes children’s understanding.

This study of children in a middle school in a village Government Malayalam medium school in Kerala was designed to examine their conceptions of ‘matter’ by taking a socio-cultural situated approach to learning in general and to science learning in particular. The concept of matter was chosen because it is an important foundational conception in school science and at the same time it is pervasively a part of the child’s everyday material world. The study attempted to take a situated approach to learning, and to situate children’s understanding of science concepts in the ‘total context’ of science learning—the everyday world, the school, the curriculum and textbooks for science and the science classroom and pedagogy.

Following a Vygotskian approach of situating learning, the socio-cultural, cognitive and science education approaches were seen to be enveloping and related frameworks which can be used together to understand children’s scientific conceptions. The socio-cultural perspective along with the science education perspective was drawn upon to understand the context as constituted by science curriculum of the State of Kerala, pedagogic activities as shaped by the textbooks and carried out by the teachers in the science classroom. The cognitive perspective was brought in while examining children’s conceptions of matter. It drew upon and drew attention to the conceptual analysis of the concept of matter and an in-depth examination in to individual children’s conceptualization through the method of clinical interviewing.

Three groups of research questions were identified and delineated. The first group related to the conceptual categories of ‘context’, ‘school and everyday worlds’ as cognitive and curricular concerns. The second group was to do with the curriculum and pedagogy of science education that children experience. The final group was to do with children’s understanding and conceptions of matter.

1. How does the school science curriculum approach the dimensions of ‘everyday’ and ‘school’—both as a source of knowledge and also as a context of learning? To what extent does the textbook and curriculum support children to negotiate this transition? Related is the question of the extent to which the approach in the school...
science curriculum may be regarded as founded on constructivist principles of learning, and supportive of meaning making in science education. To what extent is the child’s everyday world (including culture and language) included and interacted with, in the context of school?

2. What is the treatment of the concept of matter in the school curriculum (including the textbooks) especially with regard to the child’s everyday experience and access to the material world?

3. What are children’s conceptions of matter? How do they compare with the scientific concepts? Is there any relationship with their gender, caste or other socio-cultural variables? To what extent can their conceptions be related to their everyday experience of matter/material world? What are the pedagogic practices of school and the science classroom, with respect to the ‘distance’ between the child’s home culture and school culture?

Selecting the fundamental scientific concept of matter allowed the study to probe ways of understanding of a specific concept by children from the school science and everyday world. It is a central concept in middle school science and can be related to the everyday world which is filled with a variety of materials. The State of Kerala (India) as a location was also significant as it provided a new dimension to the question of context. Since the early 2000s, the State has been implementing a systematic effort to redefine the school education and science education, with a curriculum that draws on social constructivist learning theory and contextualizes learning and brings in local/community resources to the schooling processes. In addition the researcher was fluent in Malayalam, which is the medium of instruction and the language of the books and curriculum.

Mixed methods of Qualitative Research were used to address the different parts of the study. The study required studying contexts of science learning and children’s thinking with special focus on the axis of school vs. everyday. The study examined children’s lives and interactions with ideas of ‘matter’ within the school and classroom. In the course of field work spread over eighteen months, firstly, the village, school and classrooms, and cluster level teacher training and meetings were observed. Field notes were kept. The contents of various curricular documents, science textbooks and the teacher handbooks were analyzed. Special tasks and worksheets were designed and administered to the children and Piagetian clinical interviews were conducted with children. Children from grade V to Grade VIII were chosen for the study. A total of 113 children (60 boys and 53 girls) from Grade V to VIII participated in the worksheet based tasks which were conducted in the whole classroom setting and a total 87 children (41 boys and 46 girls) from four grades participated in the Piagetian Clinical Interviews conducted around the conceptions of matter. Science textbooks of Grade IV to VIII were analyzed. A total of 66 science classroom sessions (each comprising of 45 minutes) were observed.
Data sources included field notes from observations of children in various contexts, transcripts of the video recordings of children working on concrete materials and audio recording of the clinical interviews, written notes and worksheets produced by children. Data analysis involved evolving a systematic process and a method for reduction of data by categorizing, organizing, establishing criteria and defining codes, analyzing specific statements and transcripts for patterns and emerging themes and situating the analysis within the theoretical framework. The analyses and findings were organized around four dimensions: the village as a socio-cultural context for learning, the curriculum and textbooks, the classroom and its pedagogy and finally children’s conceptual understanding.

The thesis is laid out in eight chapters. Three chapters pertain to the problem statement and methodology. Four chapters lay out systematically the context, analyses and findings and the eighth chapter provides an overview of the major findings and conclusion. In what follows a brief description of each of the eight chapters is provided. Finally a discussion of the major findings and insights from this study are presented.

Chapter wise summary

Chapter I introduces the research problem and the theoretical position through which this problem is addressed. It also presents the background of concerns in science education in general and in Indian school education in particular in which it located the research problem. The chapter also discusses rationale for conducting this study: aim, research questions, significance which is evolving a situated understanding of learning science in general and in learning the concept of matter in particular, with a special interest in the curricular problematic of the everyday world vs. the world of school. The chapter argues for the need to study children’s scientific conceptions by taking a socio-cultural situated approach to learning and a framework was proposed to study children’s scientific conception that bridges the domains of science education, cognitive and cultural psychology. The chapter also discusses the significance of conducting such a study in an Indian classroom where children from heterogeneous backgrounds study science according to a common curriculum.

Chapter II provides a review of the learning theories which form the basis of this study and engages with the issues that define the Indian school education and science education context. The purpose of this chapter is to provide a basic unifying framework and develop two key concerns that are the important focus of this study. The first is the cognitive/constructivist framework developed in a manner that enables us to engage with children’s learning of scientific concepts and contexts of learning. This is elaborated to perspectives and then the chapter discusses major aspects of science education in the Indian Scenario. A few significant studies that have taken place in the Indian context are reviewed. The third part of the chapter examines and reviews the constitutions of and dimensions of the issue of everyday vs. school as it has been constituted and addressed in policy documents and in the space of action (science curriculum and people’s science movements) and in policy. After presenting key ideas of these frameworks, the chapter presents an approach
that informs this study and the consequent sharpening of research questions. The chapter concludes with a delineation of the framework and research questions.

Chapter III discusses the research design and methodology employed for the study. It explains the methods used to study village, school, science classroom, science textbook, and child’s conceptions of matter taking into account the social-cultural dimension of learning. The methodological basis for investigating the culture of school, home and classroom is set out; which then leads to a discussion of the research design. Followed by this is an account of the methods adopted for the textbook and curriculum, and analysis, and the tasks conducted with children, methods of data collection and the procedures adopted for analyzing the data.

The findings of this thesis are laid out in four chapters: introduction to the village and school, the science curriculum and textbooks, the science classroom and finally children’s conceptions of matter.

Chapter IV introduces the field chosen for the study- the village and the larger context of the social life, the school, and the features of the schooling processes in the context of Kerala. In the initial section of the chapter, significant features of the educational system of Kerala were described which is followed by a detailed description of the village—its socio-economic, religious and cultural scapes—to develop a more detailed sense of the socio-cultural situation of the school and the children, which forms a broader context for learning. The chapter also gives a detailed picture of everyday processes and characteristics of the particular school in which this study was conducted. The backgrounds of the children was described and discussed. Issues regarding the changing perceptions, and clientele of the various types of schools, against the larger background of educational reform in Kerala, was also noted as a significant aspect of the context. The chapter brings out the significance and depth of the educational reforms that have been underway in Kerala since the 2000s. The Kerala State Board introduced several changes in the schooling process: the curricular approach, classroom practices, pedagogic methods, textbooks and teaching material, teacher training and empowerment, new evaluation methods, community participation and bringing in local resources to school.

Chapter V examines the science curriculum, the teachers’ handbook and the textbooks to understand the aims of science education in relation to concerns of the everyday, and the approach to the concept of matter. Both pedagogy and selection and organization of content were examined. The chapter also focuses on the question of how the concept of matter is dealt in the Grade IV to Grade VIII Science textbooks. The chapter brings out the chief characteristics of the Kerala science curriculum and science textbooks which subscribed to what may be characterized as a ‘progressive’ view of children’s learning, that emphasize on joyful learning of science, instilling interests and curiosity as the basis and aim of science learning and pedagogy. This Chapter also discusses the pedagogic strategies employed by the science textbook and the approach, treatment, organization of textbooks of Grade IV to Grade VIII, for the concept of matter.
Chapter VI deals with the context of the science classroom. This chapter provides a detailed picture of science classroom—preparation and planning for teaching and teacher training, physical setting and features of the science classroom use of instructional tools—textbook, writing materials, use and handling of concrete materials and equipments, and socio-cultural dimensions of the classroom, classroom processes, modes of instruction, aspects of the practical activities that were conducted in the classroom. What was evident in the middle school science classrooms was that, of all the instructional strategies that were recommended by the teacher handbook, the ones that the middle school teacher was found to employ were four:—demonstration, discussion, projects and seminars. In the classroom process, even those focusing on activity/demonstration primacy was given to teaching the content, and the activity was treated as a method for making the content realistic and interesting.

Chapter VII provides details of children’s conception of matter, which were explored through a variety of tasks, written worksheets and classification of material carried out in groups, and Piagetian clinical interviews. The chapter is divided into four sections. Section 1 presents an overview of literature and findings pertaining to the concept of matter as relevant to this thesis. Sections 2 discusses the findings pertaining to the concept of ‘padartham’ (substance), and section 3 discusses children’s conceptions of solid, liquid and gas. Section 4 explores an investigation into classification of materials. The chapter concludes with a discussion of these findings.

Chapter VIII provides an overview of the key findings of this thesis and dwells on the contributions it makes in furthering the project of making science education a meaningful and contextualized experience for children in India. The chapter then reflects on the implications of these findings, firstly for the conception of ‘everyday’ in science curriculum and science learning, and secondly for drawing out pedagogical and curricular implications. The chapter concludes with some suggestions for future research that have emerged.

Key Findings

The schooling processes, science textbook, teachers, science classrooms and pedagogic processes of the present school in Kerala presented a picture quite contrary to the popular stereotyped perception of Indian government schools which are believed to follow a rote based, strongly framed curriculum. The design of the curriculum, textbook and the pedagogy showed a strong emphasis on bringing everyday and familiar world of children into the classroom and contextualizing science learning in them. Teachers were active in making this happen in their science classrooms. More importantly in the classroom processes, activities, experiments and demonstrations were actually executed and involved bringing in common and everyday materials. Moreover the pedagogic methodology adopted and inquiry learning framework chosen by the textbook had several explicit teaching-learning strategies all of which provided ample scope for connecting learning with everyday world.
The study shows that the science curriculum, classroom, textbook and pedagogic processes mainly constituted the ‘context of science learning’ for the children. These factors attempted to contextualize science knowledge and learning in the everyday world of the child and the pedagogic effort was to initiate children to the scientific world of matter by means of drawing on familiar everyday. This could be seen firstly in the form of the examples, instances of process and phenomena invoked by the textbook, secondly in the topics related to science, technology, and society (STS) and thirdly in the ‘contextualization’ of science content by the various activities that was actively incorporated as pedagogic strategies. While the STS topics employed new pedagogic strategies such as projects, seminar, surveys, field study etc to introduce the environmental issues, and apply science to the everyday life, the fundamental science topics tended to adopt a more conventional pedagogy. The final chapter of the thesis examines the cognitivist’s idea of employing everyday world for the contextual learning of the discipline of science, and argues that the manner in which everyday is being approached by the Kerala science curriculum textbooks and classroom towards teaching-learning of an applied science and cognitive view of contextualizing learning of science in everyday world are different in nature and both approaches serve different purposes. The approach of present curriculum, textbook and classroom processes did not convert to a meaningful learning of the concept of matter or learning of the foundational aspects of the discipline of science. Rather, it seemed to fulfill the purpose of creating a citizenry who are scientifically literate and aware of science to apply it to daily life problems.

What the clinical interviewing and examination of children’s conception of matter suggested was that children’s everyday understanding of materiality and sensorial experiences of matter had not been reconciled with the scientific concept of matter. Regardless of the grade in which children studied and their familiarity with the science textbook idea of substance, ‘solid-liquid and gas’, almost all children used experiential and external characteristics of materials while approaching everyday materials. This was evident in their classification of a wide variety of materials. Children approached their everyday world of materials from functional criteria and properties, and the major way they saw their world is through the materiality that makes it. Children’s direct action on material seemed to be the chief instrument to develop material conceptions. The range of properties children elaborated upon was quite wide and impressive and they used multisensorial tests to examine everyday world materials. What was evident regarding children’s conception of ‘substance’ was that children’s understanding of substance was very much based on perception—seeable and tangible matter. This was different from the concept of chemical substance which was the target of the middle school curriculum. The properties that dominated children’s thinking of solid, liquid and gas were everyday experiential properties and they did not support the children to explain the everyday material world employing scientific categories provided by the science classroom. On the whole what can be concluded is that science classroom concepts had very limited use in enabling children to approach and handle the requirement of real everyday material world. Children’s extensive multisensorial capabilities in distinguishing and relating to materials were not drawn upon in the course of learning about matter.
Yet, though the curriculum, textbook and classroom process included a great deal of the everyday world of the child, what the study suggest is that the child’s everyday world and the world of science are two distinct worlds and manner in which the two worlds approach the material world are also distinct. The aims, purposes and processes in which the material world is approached, nominalised, categorized and viewed by the everyday world and discipline of science are different in nature. In the everyday world, children construct concepts about matter, materiality and objects based on their functions, by acting on them; by seeing what they can be used for, or what happens to them when an action is performed. Science has its own conceptual categories, process, structure and language to talk about the material world. In the school the everyday world was appropriated for school purposes and science class rooms imposed its conceptual categories, processes and language of science. In other words, the school science ‘recontextualised’ the everyday. The everyday world was not in a similarly position of power to impose on children any ‘recontextualisation’ of school reality.

This is one of the few systematic studies undertaken after introduction of the new curriculum and reform processes happened in Kerala under the aegis of District Primary Education Progarm and Sarva Shiksha Abhiyan, to understand the Kerala science curriculum, textbook, science classroom, teaching learning process and bring this to bear on questions relating to children’s learning of science. The study provides insights into the efforts of the Kerala science curriculum, textbooks, science classrooms and teaching-learning processes to extend the science learning beyond the acquisition of textbook facts and application of science learning to the everyday world. It also provides significant insights on the challenges and opportunities of building a constructivist and project-based science curricula and classroom, and ‘contextualising’ science learning.

Proponents of experiential learning argue that is vitally important that the skills and knowledge which students learn in classroom need to be integrated fully into their lives and vice versa. This seemingly simple and obvious value is far more complex and subtle when we examine how, even in the case of this Kerala science classroom, where the everyday world is being almost constantly invoked, the two worlds are still distinctive for the child. At best we may say that the everyday is appropriated by the science classroom, the reverse is hardly in evidence. Whether the two can ever be seamlessly integrated into one reality for the child is still a question.