MAKING CONNECTIONS:
EXPLORING STUDENT AGENCY IN A SCIENCE CLASSROOM IN INDIA

By

Ajay Sharma

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Teacher Education

2006

ABSTRACT

MAKING CONNECTIONS:
EXPLORING STUDENT AGENCY IN A SCIENCE CLASSROOM IN INDIA

By

Ajay Sharma

India has been a free country for more than half a century now. In this time, the state has succeeded to a large extent in providing universal access to at least elementary education to all the citizens. However, the quality of education provided in state-run schools remains far removed from the ideals endorsed in policy documents. The vast majority of Indian poor, especially in rural areas, depend upon state-run schools for access to education. However, the low quality of education provided in these schools militates against their hopes and efforts for a securing a better future through education.

Undergirded by concerns over the raw deal students of government run schools get in rural India, this study is an ethnographic exploration of science learning in a rural middle school classroom in India. The study was conducted in the government middle school at the village Rajkheda, in the Hoshangabad district of the state of Madhya Pradesh, India. The study focused on the nature and scope of student participation in a middle school science classroom of rural school in India. Taking a socio-cultural perspective, it explored student participation in science classroom as engagement in a socioculturally mediated dialogue with the natural and the social world. Thus, two parallel yet intersecting themes run through the narrative this study presents. On one hand, it focuses on students' efforts to both learn and survive science as taught in that school. While on the other, it details the nature of their engagement with and knowledge of their immediate material world.

The study shows that through active engagement with their local material and social world, students of the 8^{th} grade had acquired an extensive, useful and situated funds of experiential knowledge that enabled them to enact their agency in the material world around them. This knowledge revealed itself differently in different contexts. Their knowledge representations about school science and the material world were situated improvised responses to ongoing dialogues that enabled them to survive, negotiate and maneuver their way through their immediate social world. Inside the science classroom, students negotiated their roles as students in a varied, improvised, and contingent manner. Further, whenever the constraints and affordances of the local situation and the resources at their disposal made it feasible, students exercised their social agency to selectively appropriate school science discourse for their own out-of-school purposes. The science teacher did much to encourage this contingent and situated emergence of students' social agency. However, the extant teacher professional and school science discourses allowed him to achieve only limited success in making science more meaningful and relevant to the students.

The study reveals that though much has been accomplished to provide universal access to elementary education in India, the science instruction still persists along traditional lines. Thus, the state is still far from providing access to the type of science education it advocates in its national policy documents. The study urges the state to fulfill its constitutional obligations by providing a science education that enables students to not only students to build a better future for themselves, but also work for peaceful and progressive social change. The study recommends informed bricolage as a goal for teacher education and professional development.

To Venu and Dhruv

ACKNOWLEDGEMENTS

I have a long list of people to thank for helping, cajoling, guiding, and inspiring all along the tortuous path that a doctoral student has to tread in order to reach the stage in dissertation writing where all that is left is to write this section. Without the support of this big group of people, this study would not have been possible.

On top of my list is the wonderful bunch of bright, vivacious students that comprised the 8^{th} grade class in the year 2004 – 2005, in the Rani Pipariya Government Middle School. These students welcomed me into their lives and cheerfully tolerated my daily intrusion into their social worlds. Among them, I must specifically mention Rajesh, Naati Bhaiya, Aman and Saroj for giving me so much of their time at home and school, opening up their innermost ideas, thoughts, desires, hopes and fears, and for being my guides throughout the fieldwork.

I seriously wonder if this study would have been possible had Mr. Pradeep Kumar Rai not welcomed me into his science classroom. Mr. Rai was one of the most inspiring and loving teachers I have ever come across as a researcher or student – a fact attested by the deep affection the students had for him. I thank him and will always owe a big debt of gratitude to him. Thanks are also due to Mr. S. C. Meher, the headmaster of the middle school for welcoming me into the school, and accepting me as one of their own. The teachers of the Rani Pipariya Government Middle School are truly a great bunch, and thus acknowledgements are also due to Mr. Ravindra Shrivastav and Mr. Umesh Shrivastav for their constant support during the fieldwork and for permitting me to observe their classrooms. I also cannot forget the excellent hospitality showered on me by the residents of Rani Pipariya village, district Hoshangabad, Madhya Pradesh, India – the village that gets the pseudonym of Rajkheda in this study. Thanks are also due to the district administration of Hoshangabad and the District Education Officer for allowing me to study one of the their schools.

The key to successful fieldwork is the availability of a peaceful sanctuary that one can withdraw to for reflection, rest and rejuvenation after a hectic day of fieldwork. I cannot thank enough my friends Gopal Rathi and Kamlesh Bhargav of the Eklavya's Pipariya center for providing me such a sanctuary in Pipariya. Gopal Bhai's facilitation of my entry into the research site was crucial. I am also grateful to him for deepening my understanding of the political issues surrounding the never-ending struggle for peaceful progressive social change. As always, I remain eternally indebted to my ex-colleagues and abiding friends in Eklavya for welcoming me back into their fold as if I had never left them. I must mention here the unfailing and unwavering support, guidance and true *Hoshangabadi* hospitality given to me by Rajesh, Subbu, Rashmi, Kamal and Yemuna of Eklavya on my return to Hoshangabad. Any mention of *Hoshangabadis* would be incomplete without Susheel whose friendship and guidance has remained crucial to my evolution as an educator and researcher. The dinners and conversations I had with him at his house in Hoshangabad sustained me throughout my fieldwork.

I consider myself very lucky in having great mentors at the Michigan State University. On top of the list would be my advisor and dissertation director, Andy Anderson, who took me under his wings from day one and has most kindly remained my constant friend, guide and philosopher till this day. Thank you, Andy, for helping me realize my dreams. I must also thank from the bottom of my heart the other members of my most amazing dissertation committee – Lynn Fendler, Anne Dyson and Lynn Paine. Without their unwavering support and guidance I would be still struggling with the drafting of my dissertation proposal. Anne Dyson played a crucial role in making an ethnographer out of me. Through her love, humor and excellent scholarship Anne showed me how to be an excellent person and a great researcher. I remain indebted to Lynn Fendler for broadening and deepening my understanding of philosophical issues, and for making me realize that "everything is indeed political."

I thank my friends who were with me in the TE 991 course, for Fall 2004 and 2005, for being the core support group and excellent sounding board during the dissertation proposal and data analysis stage of this dissertation. I was also lucky to have the intellectual support of the critical studies discussion group at the College of Education.

I am blessed to have wonderful parents. Without their support and encouragement, this study would not have been possible. I also thank my mother-on-law for coming over and staying with us to support me during the difficult months of dissertation writing. I end my acknowledgements by expressing my eternal love and gratitude for my wife, Venu, and son, Dhruv for their unconditional love and support, and for happily enduring the trials and tribulations that befalls a graduate student's family. I dedicate this dissertation to them.

Their remain many more friends, relatives and well wishers in both United States and India whose help and support I happily acknowledge here. This list is too long to be printed here. Their names and the feeling of gratitude I feel for them, though, would remain forever etched in my memory.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

Chapter 1
Introduction

The motto of the school I studied in read: *Sa vidya ya vimuktye*. It is an ancient Sanskrit aphorism that roughly translates as: the knowledge will set you free.[1] This maxim has held true for my life in many ways. For instance, the knowledge that I got in that school, or the credentials that I got from studying in that school set me free from my social moorings, opened the doors for me to one of the best colleges in the country, and allowed me great many opportunities for social and economic upward mobility in a poor country like India. But, then I was extremely lucky as I studied in an expensive private school that offered good education.

Most Indian kids aren't that fortunate as they lack access to the sort of education I got. In the media, India is often portrayed as a country on the move, a country with great future. What gets under-reported are deep socioeconomic inequities that separate urban areas from rural, and haves from have-nots. India's relative ranking on the United Nations Human Development Index has remained stable at a low of 127 among 177 countries for the last three years in a row. An often ignored corollary of this disturbing trend is the poor quality of education afforded to students in poor rural schools.

Thus, in contrast to someone like me, the education these kids get rarely sets them free. If anything, it only offers them a rudimentary support for an everlasting struggle for a life of modest means and dignity that lies ahead of them. However, children can be diehard

[1] The term for knowledge in this saying, *vidya,* in general connotes knowledge or learning that one receives in formal institutions, such as schools. A student in Sanskrit and Hindi is called *vidyarthi* – a derivative of *vidya,* meaning the one who earns *vidya* (knowledge).

optimists. Still sheltered from cynicism that comes with age, they often gamely try to make best of the deal dealt to them by their life circumstances. They also possess a wealth of knowledge and experiences about the world that most Indian schools as a rule fail to harness for the sake of their learning. This study narrates a story of such kids that studied in a government run school in a village in the state of Madhya Pradesh in India. Two parallel yet intersecting themes run weave this story. On one hand, it focuses on students' efforts to both learn and survive science as taught in that school. While on the other, it details the nature of their engagement with and knowledge of their immediate material world. These two narrative threads often came together and intertwined in the science classroom. This intertwining fills the story with hope as it shows the tantalizingly rich possibilities for meaningful learning of science that these rural kids can actualize if given half a chance. But as it so happens in life, hope comes tinged with a sense of loss and despair at the raw deal state sponsored education offers to such under-privileged children in rural India.

On a personal level, this study is an attempt to re-engage with issues and the region of India that drew me to the field of education in the first place. I had started my career as a forester interested in development of wastelands and social forestry in rural drought prone areas so that people living in villages of such areas have access to an control over natural resources critical for their sustenance. However, working in villages of Saurashtra region in India, I realized that villages in India need access to good quality education much more than they need trees and pastures.

So I shifted to the field of education, and to the region - district of Hoshangabad, in the central Indian state of Madhya Pradesh – that offered me an opportunity to work in an intervention, the Hoshangabad Science Teaching Program, aimed towards improvement of science education in rural schools. The school where this study is situated was one of the good rural schools of the region where the science teachers, with their hard work and commitment, had largely been able to translate, the program's guiding pedagogical principles of learning-by-discovery, learning-through-activity and learning-from-environment, into daily praxis. Thus, this was a school where rural kids learnt science that was relevant and meaningful to their daily lives, and in a way that respected and harnessed their own experiences with nature. Under the Hoshangabad Science Teaching Program, I collaborated with two science teachers of this school in organizing professional development workshops for science teachers, and development of science curriculum material. Unfortunately, the Hoshangabad Science Teaching Program was shut down in 2002, and most schools of the region, especially those in the rural areas, went back to teaching science in their schools the old traditional way: A way that presents science as a series of canonical stories about nature; A way that denies these poor kids an education that is meaningful and useful for their present and the coming future.

Rationale of the Study

Undergirded by such concerns over the raw deal students of government-run schools seem to get in rural India, this study is a narrative account of an ethnographic exploration of science learning in a rural middle school classroom in India. It is also motivated by my personal and abiding connection with science education in rural schools of the Hoshangabad region in the central part of India. This study then is an attempt to enter and influence the ongoing conversation in India about the quality of educational experiences government schooling provides to kids from under-privileged and rural backgrounds.

There have been many large scale surveys and quantitative methodology based analyses of students academic achievement outcomes in Indian schools (Reddy, 2004). These studies have yielded important insights into the schooling of Indian kids. However, such studies are by design incapable of carrying the voices of the kids and making them matter in the current discourse on the quality of education they deserve. Further, studies that gauge 'quality' of instruction in terms of students' scores on high stakes tests, such as end of the year exams, are incapable of throwing much light on the complex nature of learning experiences that are jointly constructed by the teacher and taught throughout the academic year (Cochran-Smith, 2003; Kennedy, 1999). These are tasks most suited for research in the qualitative, interpretative tradition because of it ability to highlight the meaning-perspectives of actors in particular events, such as those occurring in a science classroom (Erickson, 1986). Through its ability to give a "rich description" of the complex nature of teaching-learning process that occurs in schools, such research can best convey and critique state's efforts to translate its educational goals, as enshrined in national policy documents and curriculum frameworks, into reality for the majority of students in Indian schools. Such a critique is lacking in the current discourse on science education in India. This study by providing such a critique aims to enrich the ongoing conversations in this area.

Further, the current science education research and discourse in India, the voices of the students themselves are at the margins, and thus rarely heard. For instance, there is little research that speaks about the kinds of educational experiences in science that students themselves consider meaningful and important for their lives and purposes. If school science has to be made meaningful and relevant for students and policy statements are to be translated into praxis, the importance of making the voices of the students heard and matter in the ongoing conversations about education in India can scarcely be underestimated. Ethnographic exploration of science learning, most suited for this purpose, is however a largely uncharted research territory in the Indian context. This study, thus, represents an attempt to (partially) fill this lacuna, and hopes to make the familiar strange and commonplace problematic for the researchers and policy makers alike (Emerson, Fretz, & Shaw, 1995; Erickson, 1986).

Research Questions

Students, like the rest of us, through their engagement in and with the world around them, acquire a wealth of experiences, and ways of making sense of and communicating these experiences. Depending upon the context, their knowledge about the world may get revealed in different ways and for different purposes. Students also have a life outside school, and a sense of where and how school and the education it provides fits in this life. Thus, when students enter a science classroom, along with their school bag and books, they also bring with them their personal histories, hopes, desires, current concerns, interests, motivation and worries, and experiences with and knowledge about the world that exists around them. In class, they encounter a teacher with a similar yet distinct potpourri, an agenda and practice of teaching science, and science as a school discipline that they are expected to learn. What happens during and emerges out of this encounter, in a science classroom in a rural school in India, lies at the heart of this study.

Thus, this study focuses on the nature and scope of student participation in a middle school science classroom of rural school in India. Taking a socio-cultural perspective, I explored student participation in science classroom as engagement in a socioculturally mediated dialogue with the natural and the social world. The research questions guiding the study were:

1) *What is the nature of students' engagement with and knowledge representations about the material world?*

Through this question, I investigated the different activities students as members of rural communities were engaged with in their daily life outside school so as to understand the range and nature of their experiences with the material world. Further, I chatted with them both within and without school, visited their homes, observed them in the class, looked at their notebooks and exam answer sheets to understand the different ways and forms their knowledge about the material world got revealed in different contexts.

2) *What is the nature of student participation in the school science discourse?*

This question enabled me to focus on students actions in the classroom. I wanted to understand what happens when students encounter school science discourse in a classroom. To better understand students' actions, I also investigated how the science teacher set up and managed this encounter in his classroom. Thus through observation, audio and video recording, I explored the different patterns of student participation in the class as they went about learning science in science periods.

What lies ahead: An Overview of the Dissertation

As mentioned earlier, two leitmotifs run through this study – students' situated dialogues with the material world, and their situated dialogues with the social world. These recurring themes sometimes run parallel yet intertwined and mutually informing each other throughout the chapters that lie ahead. The plan of this dissertation report is as follows:

Chapter 1: Introduction. I start with a brief background, then lay out the rationale of the study, and outline the research questions. The chapter ends with the plan of the report.

Chapter 2: Theoretical Framework. I present the theoretical framework guiding the study, and situate it in the current research.

Chapter 3: Methods. I start with the study design. That is followed by a description of the setting and the participants. Then I present how I see my role as a researcher in this study. After situating myself in the study, I move on to a description of data collection procedures followed during fieldwork. The chapter ends with the section on data analysis procedures.

Chapter 4: The Study Site. To give the reader a sense of the place where this study was conducted, I present the study site through multiple frames of reference. I successively present the status of human development, with a focus on education, at the national, state and district levels. Then I present a portrait of the village of Rajkheda where the school where I conducted the study is located. From village, I sharpen my focus at the school giving the readers a sense of the general daily rhythm, infrastructure, resources and constraints of the place. This is followed by descriptions of the teacher professional and school science discourses that influenced the teaching-learning of science in the 8th grade.

Chapter 5: Students: Outside school. This chapter focuses on students' lives outside the school. I describe the sort of family backgrounds most students in the 8th grade came from. That is followed by a portrait of their everyday activities outside school. A descriptive analysis of their experiences with the material world comes next. In the next section, I present my analysis of their multiple representations of scientific knowledge. The chapter ends with a description of students' views on schooling and school science.

Chapter 6: Raghuvanshi's science classroom: A portrait of a science teacher as a bricoleur. As the chapter name suggests, this chapter presents a portrait of Raghuvanshi's teaching of science to 8th graders. A start with a description of his teacher script that acts as a template for his teaching practice and the role of students. To give the readers, a sense of this science periods, I present the daily routine I happen to observe in science periods. The next section describes how he worked with the existing resources and constraints to enact his teaching script. The classroom discourse is analyzed thereafter. Since students in his class did more than learn science, I also analyze the discursive underlife I happen to make note of while observing the science periods. To situate Raghuvanshi's teaching in the extant professional discourse, I then present a portrait of another teacher's teaching as a study in contrast.

Chapter 7: Students in the science classroom. In this last of the 'findings' start with an analysis of the different forms of students participation in the science period. That is followed by an analysis of students' response to school science discourse.

Chapter 8: Discussions. In this last chapter, I integrate the different themes that emerged from the analysis of the data and discuss the findings of this study. I then discuss the limitations of the study. In the end, I present what I think are the main implications of this study.

Chapter 2
Theoretical Framework

A researcher's research questions and her theoretical lenses intertwine in a mutually constitutive relationship. The way research questions have been posed predispose them to be illuminated by a limited range of theoretical perspectives. Similarly, our theoretical perspective bring to the foreground only certain categories of research question as meaningful and researchable, pushing to the background other, and perhaps equally legitimate research questions. This study focuses on students at the margins of the Indian society, and seeks to understand their engagement with school science discourse on one hand, and with objects and phenomena of the material world on the other.

Erickson (1986) exhorted educational researchers to make the familiar *strange*, commonplace *problematic* and invisible *visible* by paying close attention to the lives and meanings that people living those lives make for them. With the research task that I gave myself, a sociocultural perspective appears most suited to guide my research. It is sufficiently powerful to unravel the complexities of events that occur in a classroom (Ball, 2002; Hicks, 1996). Language, culture and learning are the threads with which the fabric of events in classroom (and elsewhere) are woven. Like, Gutierrez (2000), I too find a sociocultural perspective of learning and human development, most "useful in making sense of the interconnectedness of language, culture, and learning." Also, and perhaps what is equally, if not more, important, I believe such a view on human life is imbued with a emancipatory potential that sees "people as actively engaged with the environment" (Holland, Lachiotte, Skinner, & Cain, 1998), thereby allowing them some scope for enacting their agency in changing their lives for the better. Further, as (Gutierrez, 2000) pointed out it is a robust enough theory for helping us visualize learning in ways that make diversity a resource rather than a problem.[1]

The sociocultural Perspective

As Moll (2001) quoting Engestrom pointed out, a sociocultural perspective "is not a fixed and finished body of strictly defined statements-it is itself an internationally evolving, multivoiced activity system." Hence, it is important to avoid the risk of essentializing this powerful theoretical perspective by mapping out the conceptual terrain within which this study was carried out. I start out by laying out my understanding of "cultural" in the socio-cultural perspective adopted for this research study. First, as mentioned above, this perspective views "people as actively engaged with the environment" (Holland, Lachiotte, Skinner, & Cain, 1998). This engagement is mediated by cultural means, i.e. tools and signs (Vygotsky, 1980). Thus, each person is seen as possessing a cultural 'toolkit' of mediational means that act as a resource as well as constraint in her engagement with the world (Wertsch, 1991). In sociocultural theory, the 'world' generally means the social world. In this study, I extend the gamut of 'world' to include the material world of inanimate objects and non-human organisms as well. That is, the theoretical framework of the study attributes a natural impulse to humans that propels them to explore, understand and influence their interactions not only with other human beings, but also with objects and material phenomena of the material world. Sociologists

[1] **It is important to note here that by diversity Gutierrez didn't imply just racial, ethnic, socioeconomic, and linguistic diversity, but also "diversity in the mediational tools, roles, and learning contexts themselves."**

of science have talked about how scientists' knowledge of the material world emerges out of a socioculturally mediated and mutually constitutive dialogic engagement with nature (Gooding, 1990; Pickering, 1993). However, scientists are not only people who engage in such dialogues with the material world. Like Levi-Strauss's *bricoleur* (1966), all of us attempt to explore, manipulate, understand and thus enact some level of (material, if you will) agency over the material world.

The Notion of Culture

Now, I realize that *culture* is one of the most complicated terms in research with myriad of meanings, interpretations and usages (Gallego, Cole, & Cognition, 2001). The fact that I see human engagement with the immediate world as mediated through cultural means implies that I attach a semiotic significance to these tools. That is, the concept of culture I adopt in this study is, like Geertz (1973) a semiotic one. This notion of culture moves beyond treating culture as "inherited goods" or as discreet and more or less coherent "ways of life" to seeing culture as a "web of significance" human beings weave for themselves in which each node and strand is imbued with symbolic meanings that are interpersonally negotiated through linguistic discourse (Gallego, Cole, & Cognition, 2001; Geertz, 1973; Ratner, 2000; Rosaldo, 1989). That is, as Bruner (1996) so pithily summarized, culture is all about "human transactions of all sorts, depicted in symbols." Giving the rationale for a semiotic approach to culture, one that is most pertinent for my research questions, Geertz (1973) explained that the "whole point is … to aid us in gaining access to the conceptual world in which our subjects live so that we can, in some extended sense of the term, converse with them."

Thus, culture is not something that is 'out there' to be studied directly, however, as Gutierrez (2000) says, "we can study how people live culturally as they participate in their daily lives." Thus, in this constitutive approach, culture is not a transcendent notion spanning spatial and temporal contexts, but a contingently emergent feature of situated action in a social setting. That is, individuals do not just reproduce culture, but also continually critique, interpret and produce and transform it as they engage in dialogic encounters with the social and material world (Barton, Ermer, Burkett, & Osborne, 2003; Giroux, 1997; Gjerde, 2004). What I find most promising in this standpoint, a feature most relevant for my study that focuses on an underprivileged section of India, is that it "forces us to confront the concept of culture ... as an uneven, incomplete production of meaning and value, often composed of incommensurable demands and practices, produced in the *act of social survival* (emphasis mine)" (Bhabha, 1994). This, I believe, preserves hope, and as Bhabha further adds, "an aura of selfhood, a promise of pleasure" to even the most disadvantaged people in this world.

Circulating Discourses

A semiotic perspective also allows me to take a discourse-centered approach to culture. As Urban (1993) argues, if culture is revealed in publicly accessible signs, then actually occurring instances of discourse(s) in an event come across as one of the important categories of such revealing signs. Mediational (and thus cultural) means that people use to negotiate work reveal their contingent and situated picking and unpicking of the elements of the circulating and accessible discourses. Depending upon the extant power relations and ideological positioning, a person has available to him a limited menu of circulating discourses to author her contingent response to the world. These available discourses, then in Bakhtinian terms, constitute an ephemeral and local space of authoring a response to what the world directs at the person. This authorship as (Holland, Lachiotte, Skinner, & Cain, 1998) aver, "is a matter of orchestration: of arranging the identifiable social discourses/practices that are one's resources (which Bakhtin glossed as "voices") in order to craft a response in a time and space defined by others' standpoints in activity, that is, in a social field conceived as the ground of responsiveness." These circulating discourses actually act as both resources and constraints – constraining action as much as enabling it.

As a web page on Foucault and discourse at http://www.marxists.org/reference/archive/hegel/txt/discours.htm states, the term discourse has become embarrassingly overloaded in human sciences. Thus, if only for the sake of clarity and conceptual parsimony, I take help from Cherryholmes (1988) in defining discourse broadly as "what is said and written and passes for more or less orderly thought and exchange of ideas." Of course, as Cherryholmes further adds, discourses are not composed by randomly choosing words and statements; they are rule governed and regulated as they are produced by bodies of historically situated rules that Foucault labeled as discursive practices (p. 2).

Thus, a science classroom can be seen as a discursive site animated by several circulating discourses that act as contingent and local resources and constraints for the teacher and students alike for engagement in the social work of teaching and learning. (Holland, Lachiotte, Skinner, & Cain, 1998) express similar ideas, albeit in a Bhaktinian way, when they claim that "the equation of the means of expression and social force-the notion of voice-works both ways. It positions persons as it provides them with the tools to re-create their positions. The fields of cultural production that circumscribe perspectives become in Bakhtin's handling, spaces of authoring." Though a myriad number of discourses can be identified to be present as part of mediational toolkit of participants in a classroom, for the analytic purposes of my study, I focus on a few that seem particularly relevant to understand (scientific) literacy events in a classroom as they appear to be most important in constituting the 'space of authoring' for both the teacher and the students. These are: (a) the *professional discourse* that guide, constrains and enables a teacher to teach according to the extant and socio-historically situated discursive practice of teaching; (b) *school science discourse* that enters the classroom through the prescribed syllabus and textbook, and constitutes the ontological and epistemological form and content of the disciplinary subject of science taught to students; (c) *out-of-school discourses* that pertain to daily lives of students and teachers outside the classroom and school; and (d) the *classroom discourse* that (under)determine the general ebb and flow of events in a classroom.

Thus, if I use the metaphor of interacting bodies in a force field, then a classroom can be likened to an open system comprising two types of interacting 'bodies' – the teacher and the students - that are embedded in a force field. This force field is multidimensional with each dimension representing a discourse present and contingently available to the participants in the classroom. The system is open in the sense that outside discourses can enter the classroom and influence the constitution of the force field of the system. The interaction between the teacher and a student is partially determined in a mutually constitutive manner by their locus in the force field as the locus determines the nature and extent of discourses that work upon a body and thus, also, are available to it. Thus, their loci positions the interacting bodies ideologically and also (under)determines the power relations between them. However, the teacher and the students are not inert bodies totally governed by the surrounding force field of circulating discourses. They have an internal dynamics of their own arising from their inherent intentionality, desires and personal histories. This internal dynamics can, in certain contingent cases, cause a shift in the locus of a body, thereby changing the nature of interaction between the teacher and the taught.

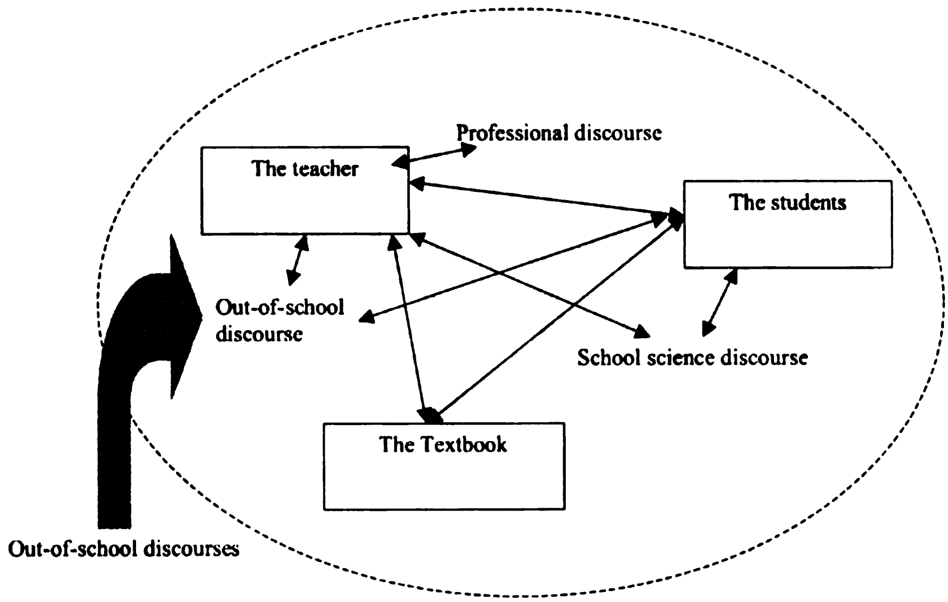


Figure 2.1: A science classroom – force field analogy

Discourses present in a classroom vary in the nature of constraints and affordances they offer to a student or the teacher. Some discourses are easy to make ones own, and put to creative use. Other discourses demand conformity and rigidity, and don't submit to appropriation that easily. As Bakhtin (1981) says,

> The word in language is half someone else's. It becomes 'one's own' only when the speaker populates it with his own intention, his own accent, when he appropriates the word, adapting it to his own semantic and expressive intention. ... And not all words for just anyone submit equally easily to this appropriation, to this seizure and transformation into private property: many words stubbornly resist, others remain alien, sound foreign in the mouth of the one who appropriated them and who now speaks them; they cannot be assimilated into his context and fall out of it; it is as if they put themselves in quotation marks against the will of the speaker" (pp. 293-294).

Highlighting this difference between different "words", i.e., discourses, Bakhtin (1981) wrote of discourses being internally persuasive and/or authoritative. Characterizing an authoritative discourse, Bakhtin says,

> The authoritative word demands that we acknowledge it, that we make it our own; it binds us, quite independent of any power it might have to persuade us internally; we encounter it with its authority already fused to it. The authoritative word is located in a distanced zone, organically connected with a past that is felt to be hierarchically higher. .... It is a prior discourse. It is therefore not a question of choosing it from among other possible discourses that are its equal. It is given (it sounds) in lofty spheres, not those of familiar contact. Its language is a special (as it were, hieratic) language. It can be profaned. It is akin to taboo, i.e., a name that must not be taken in vain. . . " (pp. 342-343).

In contrast, an internally persuasive discourse according to Bakhtin is a creative and productive discourse as it, "awakens new and independent words, that it organizes masses of our words from within, and does not remain in an isolated and static condition. ... the essence of the internally persuasive word, such as that word's semantic openness to us, its capacity for further creative life in the context of our ideological consciousness, its unfinishedness and the inexhaustibility of our further dialogic interaction with it. ... we can take it into new contexts, attach it to new material, put it in a new situation in order to wrest new answers from it, new insights into its meanings, and even wrest from it new words of its *own*" (pp. 345-346). Bakhtin admitted the possibility of a discourse being both internally persuasive and authoritative. Thus, each discourse can be thought of as having a locus on an authoritativeness vs. persuasiveness two-dimensional continuum (refer Fig. 2).

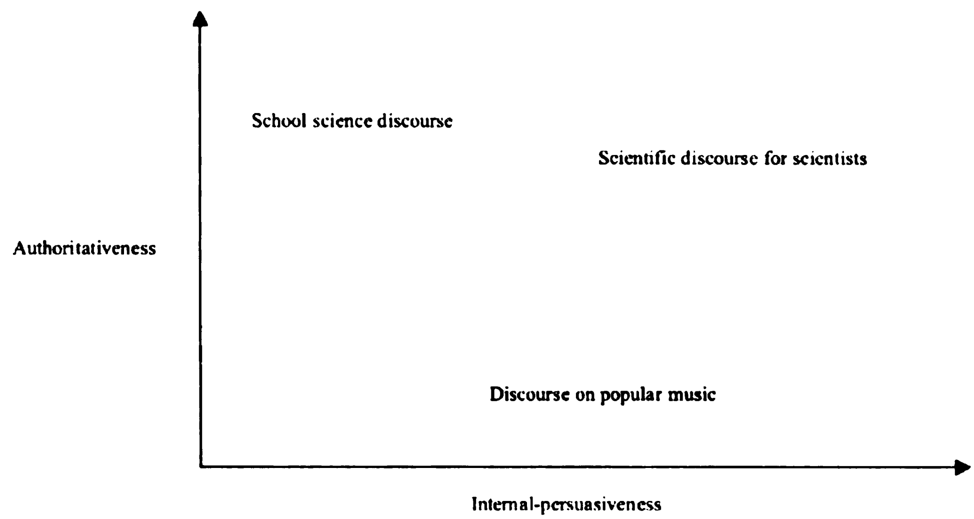


Figure 2.2: Discourses – a dimensional perspective

As the diagram shows, in a classroom some discourses, such as school science discourse, may have a low value of internal-persuasiveness, but a high value of authoritativeness. While some other discourses, out-of-school discourse on popular music for instance, are highly internally persuasive but lack authoritativeness. Scientific discourse for scientists or for students who learn science meaningfully may be high on both authoritativeness and persuasiveness.

As discussed above, a science teacher, depending upon the ephemeral and shifting characteristics of a literacy event in the classroom, makes a situated contingent use of the discourses available to construct her teaching practice. For one event, the school science discourse may dominate her utterances, but some other event the confluence of moderating factors may be such that out-of-school discourse may become prominent in her interactions with the students. According to Bakhtin (1986), "Any concrete utterance is a link in the chain of speech communication of a particular sphere. ... Each utterance is filled with echoes and reverberations of other utterances to which it is related by the communality of the sphere of speech communication.". Thus, as he adds further, "However monological the utterance may be (for example, a scientific or philosophical treatise), ... (it) is filled with dialogic overtones, and they must be taken into account in order to understand fully the style of the utterance" (p. 92). Likewise, it can be assumed that the utterances of a teacher, or a student for that matter, even if dominated by one discourse will almost always have traces, or "dialogic overtones" of other discourses circulating in the immediate discursive context. Though, of course, it is possible that the dialogic overtones may not be obvious or even observable to an observer or to another participant in the classroom.

Teaching as Performance

The theoretical perspective of the study conceptualizes teaching practice through the generative metaphor of "teaching as performance" (Pineau, 1994). This is done so as to highlight the process of teaching as against its end-result. Butler (2004) giving a performative perspective on gender called it "a kind of a doing, ... a practice of improvisation within a scene of constraint. Moreover, one does not "do" one's gender alone. One is always "doing" with or for another, even if the other is only imaginary. What I call my "own" gender appears perhaps at times as something that I author or, indeed, own. But the terms that make up one's own gender are, from the start, outside oneself, beyond oneself in a sociality that has no single author." Likewise, teaching too is a performance enacted in front of and in relationship with others (students). It is also a kind of "doing" that is part of a daily practice, but still carry a contingent admixture of spontaneity and thinking on one's feet – in other words "a practice of improvisation within a scene of constraint". Thus, a teacher *is* as teacher *does*. A practiced performance needs a script - a sort of normative sociolinguistic pattern of interactional exchange between the performer and the audience that can act as a common resource by all participants to interpret the activity of others and to guide their own participation. According to (Gutierrez, Rymes, & Larson, 1995), in a classroom setting, such patterns collectively constitute the *teacher script*.

With an implicit concurrence of the students, a teacher performs in the class according to her *teacher script*. The teacher script, thus, shapes the ongoing dialogic events in the classroom by (under)determining: (a) how a lesson is supposed to progress during the class; (b) how the teacher and the students are supposed to interact and behave while class is in progress; (c) what and whose voices are to be legitimized and included in or de-legitimized and excluded from the classroom discourse; (d) the power and sociocultural relationships in the official space; and (e) the construction and legitimization of the situated identities of both the teacher and the taught.

Students also have a role and are indeed expected to participate in the teacher's script. For instance, the teacher-student interaction in initiation, response, and evaluation (IRE) discourse pattern is a common feature of most teacher scripts (Burbules & Bruce, 2001; Mehan, 1982). Of course, the control of the teacher script over the communicative events in the classroom is never so severe and deterministic as to foreclose any contingent improvisation by the teacher or the students. Expert teachers often deviate from the teacher script to take advantage of the emergent and transients 'teaching moments', or let students take the ongoing dialogue in the classroom in unscripted yet productive directions. Students too on their own initiative can find, on opportune moments, enough wiggle room, ambiguity, indeterminacy in the teacher script to improvise upon their given roles in the classroom.

Further, as Lampert says, "students come into the classroom with multiple purposes: making friends, protecting themselves, arranging dates, earning spending money, and so on" (2001). Thus, apart from learning science, students in a classroom have several other ongoing agendas, concerns, intentions and activities that are unrelated or only tangentially related to the "official" business of the class, and belong to students' out-of-school discourses that enters the classroom along with them. These elements often get excluded from the dialogues constructed by the teacher script in the classroom. However, they do engender and contribute surreptitious sidebar conversations, furtive exchange of notes, quick meaningful glances, comments sparked off by something the teacher said or did, and umpteen other communicative exchanges that populate and sustain the discursive *underlife* of the classroom (Gutierrez, Rymes, & Larson, 1995).

Students as Learners

According to the sociocultural perspective of the study, learning and human development are seen as happening in terms of their evolving participation in the sociocultural activities of their communities (Lave & Wenger, 1991; Rogoff, 2003). Reflecting a consensus view in sociocultural theory, Lave & Wenger (p. 35) say, "In our view, learning is not merely situated in practice - as if it were some independently reifiable process that just happened to be located somewhere; learning is an integral part of generative social practice in the lived-in world. ... Legitimate peripheral participation is proposed as a descriptor of engagement in social practice that entails learning as an integral constituent. Further, learning through engagement in a social practice happens either under adult guidance or in collaboration with more capable peers (Vygotsky, 1980). Thus, children in all societies come to acquire a rich though locally and socioculturally situated "funds of knowledge" about the world through engagement in different social practices in their daily lives outside school (Moll, Amanti, Neff, & Gonzalez, 1992).

The nature and content of this knowledge varies across different cultural communities. Rogoff in her study of children's lives in different cultural communities found significant differences in the extent to which "they are allowed to participate in and observe adult activities" (2003). Comparing children from a farming community in East Africa with middle class American children, she reports that 4 year old children from the African farming community, "spent 35% of their time doing chores, and 3-year-olds did chores during 25% of their time. ... In contrast. middle-class U.S. children of the same ages spent none to 1% of their time doing chores, though they did spend 4% to 5% of their time accompanying others in chores (such as helping the mother peel a carrot or fold laundry) (p. 136). Thus, as Rogoff further reports, the Aka kids of Central Africa, when they are 7 to 12 years old, can hunt and butcher large game animals, trap porcupines and grow food plants. In contrast, most American kids may not even know how to hold a butcher's knife properly and safely, though they may know a lot about manipulating symbols and images on a computer screen or understanding a subway map.

Thus, students entering a classroom aren't *tabulas rasas,* but possess homegrown experiential knowledge about the world, and know effective ways of sense making and communicating this knowledge to other members of the different communities of practice of which they are legitimate participants. Under propitious circumstances, these valuable mediational means get revealed in students' dialogic engagement with the school science discourse. As (Warren, Ballenger, Ogonowski, Rosebery, & Hudicourt-Barnes, 2001) noted, "...in the science classroom children's questions and their familiar ways of discussing them do not lack complexity, generativity, or precision; rather, they constitute invaluable intellectual resources which can support children as they think about and learn to explain the world around them scientifically."

Science Learning in Schools

Traditional school science discourse recontextualizes science as it exists in scientific research communities into a crystallized, secure, fixed body of knowledge comprising concepts, generalizations, and procedures that children can learn, teachers can teach, and administrators can use to govern both the teacher and the taught and themselves (Popkewitz, 2002; Sharma & Anderson, 2003). An unfortunate consequence of this process of recontextualization is that school science discourse often gets far removed from the daily lives of the students, and what students learn in science classroom contributes little in furthering their abilities to understand, influence and manipulate the material world they live in.

However, there are also teachers who are confident of their content and craft knowledge, cognizant of the generative potential of students' own discourses and knowledge systems, and sensitive to the learning needs of their students. Such teachers are often able to use students' own voices and intellectual resources to co-construct, in active partnership of students, a rich, productive social heteroglossia and dialogic interaction of school science discourse with students' out-of-school discourses. Researchers have researched and talked about this kind of meaningful learning using different metaphors. For instance, Gutierrez et al used the construct of "third space" to denote the discursive site where dialogic interaction of different discourses, official as well as unofficial, takes place (1995). Dyson's ethnographic research highlighted the importance of enacting "a "permeable" curriculum that allows for interplay between teachers' and children's language and experiences" (1993, p.1). And in a similar vein, Heath (1983) has talked about the back-and-forth translations of knowledge between the scientific and the community knowledge domains, that teachers as cultural brokers between communities and classrooms can undertake in their classrooms to help students become ethnographers (and thus learners of personally meaningful and useful knowledge) in their own communities.

The Issue of Human Agency

As elucidated earlier, the theoretical framework of the study takes a discourse-centered approach to culture and social practices. A discursive standpoint is often seen as denying possibilities of enactment of human agency as all human thought and action are assumed to be determined by discourses (Ahearn, 2001; Cherryholmes, 1988; Erickson, 2004).

That is, an individual human subject is believed to be totally "uttered" by the circulating discourses (Erickson, 2004). However, as both Erickson and Cherryholmes and some other social scientists, such as Bleiker (2003), have pointed out such a view of the influence of discourses over human life is overdetermined and overly deterministic. Cherryholmes (1988) argues that discursive practices are not always as highly integrated or tightly coupled as those studied by Foucault, such as human medicine and law. As Cherryholmes explains, "when discursive practices and speech communities bump into each other, as it were, meanings and rules for proceeding must be negotiated and established. ... Third, anonymous, historical rules governing discourses can be challenged by those not fully socialized to them. ... Fourth, different background institutions will not police anomalous utterances with equal vigor" (pp. 88-89).

Foucault (1988) had once remarked, "I believe in the freedom of people. To the same situation, people react in very different ways". Thus, according to the theoretical perspective of the study, discourses underdetermine human behavior, and social action epitomizes contingent improvisation within a discursive context of constraint. Contingent discursive fissures, cracks and wiggle rooms do transiently appear in everyday social practices that allow people to be contingently creative in their selective picking and unpicking of elements of circulating discourses, and thus, in their dialogic engagement with the world. Butler (2004) perhaps speaks for all of us when she affirms that "the "I" that I am finds itself at once constituted by norms and dependent on them but also endeavors to live in ways that maintain a critical and transformative relation to them" (p. 3).

Thus, like culture, human agency too can be seen as a contingently emergent feature of situated local action. An individual does not *have* agency, but rather under opportune circumstances, she *enacts* or *exercises* agency. Taking a Bakhtinian perspective, the theoretical framework visualizes human agency in terms of a socioculturally mediated and contingently creative dialogue with the world – an engagement that not only shapes the counters and direction of the dialogue, but also influences its outcome. Agency in human actions isn't always discernable to an observer. Further, as Holland et al (1998) quoting Indsen claim, "People do not act only as agents. They also have the capacity to act as 'instruments' of other agents, and to be 'patients,' to be the recipients of the acts of others" (p. 42).

Situating the Study in Current Research

Studies of students' experiences with schooling in India using qualitative and interpretive methodologies have a fairly recent history. There are only a handful of ethnographies, such as Sarangpani's (2003) study of constructions of school knowledge in an Indian village, and Sahni's (1994) sociocultural analysis of literacy in a rural classroom in India, that have attempted to chart this research territory. Ethnographic explorations of science learning in Indian schools have, to the best of my knowledge, not been yet taken. Thus, this study represents an attempt to (partially) fill this lacuna in our understanding of science learning in Indian schools.

Such explorations of students' educational experiences in school settings have been, however, a well traversed territory for educational researchers in America over the past thirty years, and "research has spoken increasingly to the complexity of life that goes on in classrooms" (Ball, 2002). The students that are the focus of this study are on the margins of Indian mainstream. Similar research has been done in other geographical locations, and using ethnographic methodologies researchers have persuasively shown that students who get traditionally marginalized by school science discourse nevertheless possess valuable funds of knowledge about the world (Moll, Amanti, Neff, & Gonzalez, 1992). Further, meaningful science learning experiences get created in science classrooms when teachers not only recognize this rich resource, but also know how to harness it. Here, mention may be made of Barton (1998) who has done extensive research on students who are at the margins of the society using a critical and feminist ethnographic perspectives. She has shown how the culture of power in science education marginalizes students who lack the requisite cultural capital (Barton & Yang, 2000), even though they may inhabit social and cultural spaces that are rich in learning potential and provide them resilience and sustenance (Barton, Ermer, Burkett, & Osborne, 2003). Her work has shown what it may mean to create an inclusive science education for such students (Barton, 1998).

Similarly, Warren and her colleagues have, through their excellent ethnographic case studies of Haitian American and Latino students, have documented the everyday sense making practices of students from non-mainstream backgrounds, and shown their power and usefulness as intellectual resources in science learning (Warren, Rosebery, & Conant, 1994). Moje and her colleagues (Moje et al., 2004; Moje, Collazo, Carrillo, & Marx, 2001) have used a postcolonial notion of *third spaces* to explore the contingent and productive spaces that get created in science classrooms when school science discourse dialogizes with students out-of-school discourses.

Cognate branches of educational research have had an equally, if not longer histories of qualitative and interpretative explorations of educational experiences in school of students from non-mainstream backgrounds. For instance, important signposts of this kind of research in literacy education are ethnographies of communication by Heath (1983) and Dyson (1997; 2003). Heath showed how black community's "ways with words" culturally differed from those of white community and the school resulting in a tilted playing field in favor of kids from white community. Dyson, on the other hand, has shown how popular culture, to which students from minority backgrounds have easy access, can and need to be harnessed to provide rich literacy learning experiences at school.

A perspective on educational experiences of students from non-mainstream backgrounds in a science classroom, from a different context, such as India, can then add fresh insights hitherto unavailable, and thus contribute to a richer, more nuanced understanding of science learning in school settings. Laying out the research agenda for the 21st century, (Ball, 2002) proposed, "ethnographic and discourse studies of local uses of oral and written language, that introduces improved instruction congruent with students' local ways of using language, and development of research-based approaches to preparing teachers for diversity" (pp. 97-98). In a larger perspective, then, this study can be seen as following such a research agenda.

Chapter 3
Methods

This study is an attempt at immersion in Indian science students' worlds in order to understand their actions, words and meanings both within and without school. Thus, two parallel, although intersecting, research themes run through this study. On one hand, this study explores students' engagements with other participants in a science classroom. On another, it tries to understand the nature of their engagement with their immediate material world. The engagement in both contexts is seen as dialogic – you say something to the world and the world responds back to you, and vice versa. Or you do something to the world, and the world does something back to you, and vice versa. That is, dialogues can be verbal (through discourse) as well as non-verbal (through action) (Gee & Green, 1998).

Thus, the study of dialogues in different contexts is at the heart of the study. These dialogues occur in sociocultural contexts with the help of and constrained by circulating discourses. The study attempts to understand these dialogues from an emic perspective. That is, through this study I wanted to understand what the students themselves considered as meaningful and important as they entered in dialogic engagements with the science teacher, their peers, other adults, and with the material world. Research methods need to emerge out of the researcher's questions and theoretical lenses. In light of my research questions and theoretical perspectives as mentioned above and discussed at length in the previous chapters, an ethnographic study design seemed most appropriate. And since the research focus is on dialogues, this study is designed as an ethnography of communication. By making this choice, I am essentially following a fairly established research tradition, initiated by Hymes (1964), that uses ethnography of communication as a framework for conducting and analyzing research of classroom discourse (Gee & Green, 1998; Roberta, Rampton, Leung, & Harris, 2002).

In the sections that follow, I describe the different methodological components of the study.

Setting and Participants

<u>Selecting the study site</u>:

Before coming to United States for my doctoral studies, I used to work with government schools in the Narmada valley region of the state of Madhya Pradesh in India. My work involved developing science curriculum material for schools of that area, organizing and conducting professional development workshops with middle school science teachers of this region. My six-year long association with the education system of this region has played a crucial role in shaping my perspectives on Indian education, but also has left an abiding interest in educational issues of this region. Till 2002, this region was home to an major educational reform initiative that was much lauded by educators for its progressive attributes and potential to make a major improvement in science teaching in schools all over India (Kumar, 2005; Mukherjee, Sadgopal, Shrivastava, & Varma, 1999; Rampal, 2002) . Under this intervention, known as the Hoshangabad Science Teaching Program (HSTP), science teachers taught a learning-by-discovery, learning-through-activity and learning-from-environment based science curriculum at the middle school level. Under bureaucratic pressure and political opposition, this program running in the Hoshangabad district of this region since 1972, was shut down in 2002 ("Education: Dead hand of obscurantism", 2002; Sadgopal, 2002). The traditional state-mandated science curriculum running in the rest of the state was then adopted for schools of this region. Owing to my association with this region and belief in the reform potential of this intervention, I was extremely disappointed on learning about its demise, and often wondered about the kind of science teaching that was now going in the schools of this region.

Thus, when looking for a place to study how students respond to a traditional school science discourse, this region was a natural choice for me to situate my study in. The majority of the students in India, and most of the poor kids, study in government run schools in India. As 72% of the Indian population still lives in villages, such a school is more often than not a rural government school. Though the evidence is limited, these schools are, by and large, reported to offer an inferior quality of education to their students as compared to private schools that are patronized by relatively better-off families (Aggarwal, 2002). Wanting to highlight the iniquitous nature of access to quality education in India, I wanted to base my study in a rural government school. So I contacted my ex-colleagues still working in that region to suggest a school to study. They suggested several schools of which government middle school in village Rajkheda was one. After visiting these schools, I chose Rajkheda school as my study site. The main reasons behind this choice were: (a) the teacher was known to me and was widely respected for his dedication to his job. During the heydays of HSTP, he was a lead teacher who helped other science teachers teach science according to the program's pedagogical principles of learning-by-discovery, learning-through-activity and learning-from-environment. Thus, I could be reasonably certain of accessing sufficient data of interesting science teaching; (b) The classroom environment was free and relaxed with much participation of the students – something that I didn't see happening in other schools suggested to me. Thus, there were greater chances of my recording interesting data in such a setting than in one where fear of the teacher and lack of encouragement to student initiative make students withdraw into their own shells; (c) Finally, the school was located in a village that was close to a town from where I could commute daily. Thus, it not only fitted with my desire to base the study in a village government school, but also was pragmatically convenient.

<u>The study site</u>:

Chapter 4 describes the study site in detail. Here, for readers' benefit and for sake of completeness, I give a brief synopsis of the study site. The study is situated in a village called Rajkheda, wherein I focus on students in a grade 8 science classroom of the government (public) school in the village. This village is in Narmada valley region of the state of Madhya Pradesh, India. Rajkheda is a medium sized (by Indian standards) village of 270 families, and is on the main road linking two towns, Hoshangabad and Pachmadhi, of the district of Hoshangabad. It is a relatively poor village, with 125 families (44.4%) officially classified as below poverty line. The main occupation of the residents of the village is agriculture, and one can see agricultural fields in all directions from the village. The government middle school is the only middle school for Rajkheda and seven other neighboring villages in that region. There is no high school in Rajkheda and students graduating from the middle school have to attend high schools in neighboring towns in order to continue their formal education.

The science teacher of the 8th grade class, Mr. Vineet Raghuvanshi, is a middle-class married Hindu male, and students too come from Hindu, non-tribal rural backgrounds. Agriculture is the main occupation in Rajkheda. Thus, students hail from mostly poor farming, trading or artisan families from the local as well as 7 neighboring villages. The 8th grade class had 49 students on roll of which only 11 were female. Many students were first generation learners of their families, and thus a beacon of hope for their illiterate parents. Students sat in rows on mats in the classroom according to their roll numbers. However, all the girls sat in a row on one side of the classroom. Sometimes, some students did change their places, and teachers didn't object to that much.

Like most other government run schools in Madhya Pradesh, this school too is quite impoverished in terms of material and educational resources. It is a co-educational school, with rather small of student population of only 193 students. The middle school had a total of 4 teachers including the Headmaster who also taught classes along with performing his assigned administrative role as the head of the school. The school has no support staff, and teachers, often with the help of students, perform all the ancillary chores and administrative duties. The entire building has 9 rooms, of which 6 are used as classrooms for grades 1 to 8. Thus, teachers frequently complained to me about the shortage of classrooms. On many days I could see at least one class being held outdoors. The classrooms are typically crowded. The grade 8 classroom had 47 students sitting elbows to elbows in a small 12 x 18 ft. room. The only furniture a classroom has is a table and a chair for the teacher. So the students sit cross-legged on mats, on the floor. The classrooms have few teaching aids and for many students textbooks are the only books that they ever get to read.

In the winter months, the school starts at 11 AM with a combined morning assembly of elementary and middle class students in an open space within the school boundary, in which students sing a common prayer, and general announcements are made by the teachers. After the morning assembly is over, students clean their own classrooms and bring in the furniture for the teacher from the staff room. Thereafter instruction starts in 30 minutes subject-specific periods. There is a lunch break at 1:00 PM of 30 minutes, and the school gets over at 4 PM with another common assembly in which students sing the national anthem before finally heading home.

The school follows state-mandated science curriculum that focused on equipping students' with scientific knowledge in the form of facts, definitions and principles. This scientific knowledge is transmitted through a state-mandated science textbook for each (middle school) grade. The curriculum and the textbook make little attempt to make science relevant to the lives of the students, and rarely harness students own experiences with nature for science teaching. Besides, there is no element of inquiry or even discovery in the science curriculum. The few hands-on activities given in the textbook are to be done basically to illustrate the scientific concepts discussed in the main body of the various chapters comprising the textbook. Further, the textbook is written in an arid, artificial, highly complex linguistic scientific genre that is difficult for students to understand. Student learning is assessed through quarterly summative exams that tests students' abilities to memorize and reproduce official school scientific knowledge.

Researcher role:

I am an Indian citizen who has experienced schooling in India both as a science student and science educator. Further, as mentioned earlier, I was also familiar with the research site and some of its participants by virtue of having worked with science teachers of schools in that area as a science educator and curriculum developer. The teacher was known to me as I had worked with him as a science educator for a number of years. This positioned me somewhat as an ex-insider to the research setting who by virtue of experiences as a doctoral student in an American university had also developed perspectives and acquired descriptive labels that marked me as distinctly an outsider.

It is a typical postcolonial situation marked with considerable cultural and ideational hybridity, hyphenated identities, fuzzy borders and continual border crossings. The resulting ambivalence in my positionality as a researcher did color my perspectives, and influenced the collection and analysis of data. It also endowed my research work with numerous tensions, contradictions and power imbalances. For instance, since I had worked with the science teacher for a number of years in areas of teacher professional and curriculum development, there was a lingering tendency, in the initial phase, with both of us to re-establish that working partnership that we shared earlier. This, in a way conflicted with the intimate yet distanced position that I desired to have in his class as a researcher. For these types of situations, like Luttrell (Luttrell, 2000), the best I hoped to do was to identify these so-called crises of representation in ethnography field notes rather than try to eliminate them.

Data Collection Procedures

The fieldwork for the study was done during the months of December, 2004 to March, 2005. After spending about a fortnight in selecting the study site and reacquainting myself with the region, I shifted to a town close to Rajkheda, and began visiting the school and the village almost on a daily basis. The main components of the fieldwork were as follows:

Negotiating entry into the site:

Owing to my past history of work with teachers in that region, and of association with Eklvya, the organization that ran the Hoshangabad Science Teaching Program (HSTP) in the middle schools, including the one in Rajkheda, negotiating entry into the site wasn't that easy. After I decided that Rajkheda middle school would be the most appropriate study site for this study, I met Raghuvanshi, the science teacher, in Eklavya's office, to request if I could observe his science class. I explained the purpose of my research and then with some measure of trepidation, made the request. To my utmost relief and pleasure, he agreed. However, he said that I shouldn't tell other teachers in the school that I was interested in his class alone. Raghuvanshi suggested that I should observe their classes as well so that they don't feel discriminated against. He also told me that the headmaster of the school, Mr. Mahto, may not be very enthusiastic about my studying his science class, as there was some undercurrents of tension between them owing to their affiliations in different teacher unions. Besides, according to Raghuvanshi, Mr. Mahto had never been supportive of Eklavya's work, though he never protested against HSTP while it ran in his school. Thus, Raghuvanshi advised me that while in school I should pay enough attention to him and do nothing to offend him - advice I conscientiously followed throughout the period of the study.

Next day, accompanied by an ex-colleague of mine, I went to Rajkheda middle school to request permission from Mr. Mahto to do research in his school and to meet and explain the purpose and nature of my research to all the middle school teachers. After listening to my brief presentation about my research, Mr. Mahto asked a couple of questions, such as why I wasn't studying other schools too. However, he finally gave me the permission. But, after I had spent some days in the school, one day he hinted that it would be good if I got the permission of the District Education Officer too, for basing my study in a school under his jurisdiction. I had hoped that I wouldn't have to do this as on reaching Hoshangabad, I had been told by my friends in Hoshangabad that since the closure of HSTP in 2002, the local education bureaucracy had become suspicious of Eklavya, and maintained a safe distance with their personnel and activities. Thus, I wondered if my association with Eklavya would make getting such permission from the District Education Officer a difficult or even a lengthy process. To obviate the possibility of denial of permission, I approached an officer, the local District Magistrate, who was higher in rank to the District Education Officer, and was known to have a favorable opinion of Eklavya's work. After getting a recommendation from him, I finally approached the District Education Officer. Since I had the backing of his superior, the District Education Officer didn't refuse the permission, but I did have to make several visits to his office to get it. However, once I had a written permission from him, doing fieldwork in Rajkheda middle school was not a problem anymore.

The students welcomed my presence in the school and classroom from day one. As they told me nobody had ever come to study their school, so liked the fact that someone from America had come all the way down to Rajkheda middle school to do a study. According to Bogdan and Biklin, "During the first few days of participant observation, … the researcher often remains somewhat detached, waiting to be looked over and, hopefully, accepted" (Bogdan & Biklin, 1998). However, my experience was totally different. I was a center for curiosity and attraction for many a days in the beginning. Everyday as soon as I entered the school on my bike, students would gather around, closely observing everything I did, and asking all sorts of questions, such as where I did get this old bike from, how does it feel to wear a helmet, where I lived, what would I be doing in the school today, would I be coming to their classroom, would I be interested in seeing their village, and so on.

Inside the classroom, the students were hardly used to a presence of an outsider in the class, especially one who was observing them, taking copious notes while they spoke in the class, and audio and video recorded the class proceedings. For the first month or so, they would try to peep into my field notes and would ask me several questions about what I was jotting down. Sometimes, they would even request me to show them my field notes, and would try to read them. Finding them incomprehensible, they wondered if I would be able to understand them later on too.

My audio recorder was a big distraction for students in the initial phase, and remained so at least for some students right till the end of the fieldwork. I used to place the audio recorder on the floor in the center of the classroom. But in the initial phase of the fieldwork, they would try to shift it around, sometimes closer to where they sat and sometimes away from them. They were fascinated by how it worked. So for a long time, they would try to speak something, such as a cricket commentary or a song, to it to get it recorded. Later, as soon as the period ended and teacher left, they would request that I play it back so that they could hear their recorded voices. It thrilled them no end to hear their own voices. They talked about it with their parents too, so when I visited their homes, often times they and their parents would request that I play that day's classroom recording to them. Hearing classroom proceedings at a different location than the classroom used to be a huge source of amusement for parents and kids alike. Some parents also requested me to record their songs, and thus the audio recorder became the cause for a couple of hastily arranged and impromptu, but delightful nevertheless, music sessions. Thus, the audio recorder acted as quite an icebreaker in at least a couple of homes.

In the initial phase of the fieldwork, I generally let students play around with the recorder as long as they didn't stop the recording. As a result, after some days it lost its curiosity value for most kids, and thus wasn't paid much attention to.

The video camera too was a huge source of curiosity and distraction for all students at least for first the two weeks. The first time, I took out the video camera from the bag and placed it on a tripod in a corner of the classroom, many a classrooms got disrupted for a while as the news got around that there was something to see in the 8th grade classroom. Soon I found myself and the video camera surrounded by lots of children from other classrooms even though Raghuvanshi had begun taking his science period. However, 8th graders were very protective of me and the equipment and did their best to keep students of other grades at a safe distance from the equipment. After a fortnight or so, the students of the 8th grade did get used to being videotaped, and after from making occasional requests to see some of the recorded proceedings, didn't bother much about the camera.

Finding a good place for me to sit and observe the classroom events proved trickier though. The classroom was too small for 49 students and one teacher. Students sat huddled together on the floor. I wanted to sit among the students so as to better observe their actions and participation in the class discussions. The students, however, didn't like my sitting on the floor with them. I was an adult, a guest from America, and was as much respected as the teachers. I was addressed as 'sir', just like the other teachers. No adult, unless he was a local poor laborer or a farmer, sat on the floor in the school. So it went against their sense of propriety to let me sit on the floor amongst them. Raghuvanshi or other teachers didn't have any problems about where I sat. They did ask in the beginning if I wanted to sit on a chair. But when I explained my reasons for sitting among the students, they understood and let me sit wherever I wished. The students though kept on insisting for many days that I should sit on a chair just like their teachers. For many days in the beginning, without my asking they would bring a chair for me to sit on from the staffroom at the beginning of the day. However, I persisted on sitting with them. After a few days they relented too, and would space for me and offer their mats for me to sit on. Though there were many a sniggers among the boys and a feeling of discomfort among the girls, if I chose to sit with the girls. After about a month, I decided to heed their earlier advice, and started sitting on a chair kept in a corner as being a stocky person, I occupied too much space if I sat with them thereby making them more cramped than they already were.

It also took a while to position myself appropriately in the social space of the classroom in terms of relationships with other participants. I wished to position myself more as an interested and involved observer than as a full participant in the discourse community of the classroom. Commenting upon the participant/observer continuum, Bogdan and Biklin (1998), have opined that "Exactly what and how much participation varies during the course of a study". My experience in the field was quite similar. I intended to position myself more as a researcher, and not as an ex-colleague or a potential help to either teachers or students. I had hoped that by "being regularly present, unobtrusively, quiet, and too 'busy' to help children with their work, but never too busy to smile, acknowledge their presence, and say 'hi' (Dyson, 1997)" , I would be able to occupy a low key position inside the classroom and the school. Further, according to (Emerson, Fretz, & Shaw, 1995), "in most social settings writing down what is taking place as it occurs is a strange, marginalizing activity, marking the writer as an observer rather than as a full, ordinary participant" (p. 37). Thus, I had planned on being too busy with writing and observing to participate in the study site. However, this wasn't always possible. While a teacher was around, I was generally able to be a busy observer. However, in the absence of a teacher in the classroom, and this used to happen often, students wanted me to become their teacher. If I was hanging outside the classroom, and some classroom didn't have a teacher, the students from that classroom would come and implore to teach them something, anything, or just talk to them. In the initial phase, I found it extremely difficult to say no to them, and often ended up teaching them something they were having trouble with. Mostly, it was math or English. However, I didn't wish to get too involved in the setting as a participant, and thus, as time passed I became more determined to deny their request. Though if a student approached me individually with a specific request, again mostly it was math or English related, I tried to help. Thus, my positioning on the observer/participant continuum shifted strategically and contingently throughout the fieldwork. Though, following Emerson et al's advice, even when I more of a participant in an event, I tried to "assume the mind-set of an observer, a mind-set in which one constantly steps outside of scenes and events to assess their "write-able" qualities. (p. 37)," an effort in which I wasn't always successful.

Initial observation phase:

Emerson et al(1995, p. 26) advise ethnographers to take note of their "initial" impressions when they first enter their study site. According to him, these initial impressions include "those things available to the senses-the tastes, smells, and sounds of the physical environment, the look and feel of the locale and the people in it … details about the physical setting, including size, space, noise, colors, equipment, and movement, or about people in the setting, such as number, gender, race, appearance, dress, movement, comportment, and feeling tone" (p. 26). For about a week, I didn't take my recording equipment with me to the school, and didn't write down notes while in the school. I just wanted to have a sense of the place at first. Paying heed to Emerson's advice I tried to diligently record my initial impressions lest I should stop noticing many striking things about the site once they became commonplace over time.

Thus, in the initial phase I focused on collecting information and recording my impressions about things, such as:

(a) General design, layout of the school, overall features of the school building, and general transect and mapping of the village;

(b) First impressions and basic information about the school, such as student population, number of classes, number of teachers, general background of the teachers (gender, education, numbers of years in service, whether regular appointee or temporary, caste, etc.), impressions about the school in the community, existence of competing private schools in the neighborhood, what sorts of clothes students and staff wear, administrative details (such as who is the head master, for how long, his relationship with the staff, etc.), general academic performance of the school, non-academic duties of the teaching staff, and so on;

(c) Features of the local community: size, demographic and occupational features, relationship with the school, etc.

(d) Basic information about the 8th grade, such as number of students, gender, caste, class, religion and occupation wise break-up of the class, names of the students, seating patterns, how crowded is the class, decorations adoring the walls, etc.

(e) Occasions for communication (talk, print) between the teacher and the taught and among the students in a regular school/class day. Following Dyson's advice I tried to note, "how the class day is orchestrated, including the sorts of speech and literacy events or occasions that occur and their components" (2004, p. 4). The components include participants, purpose, setting (time/place), mode of communication, mood, message, and generally how interaction occurs.

(f) Student groupings – student initiated or teacher structured – in the class.

(g) Teaching and learning: grossly characterization of the classroom environment, how teachers organize the class and their teaching practices, teacher's way of managing and disciplining the class, , teacher-student relationship, students considered popular by the class, 'star' and problem students, general rhythm of the class proceedings, curriculum material used by the teacher, teaching aids and other resources available to the class and the nature of their use.

(h) Classroom and school events that appear key or significant to me in some respect.

Selection of focus students:

For a finer grained and extended understanding of students' actions both within and without the classroom, I selected three boys and two girls as my focus students. Though, as I explain towards the end of the section, one girl opted out in the later part of the fieldwork. I see these focus students as representative of my 'case' – the 8^{th} grade science class, my selection was purposive and not random or scientific (in the positivistic sense, that is). This is because I wanted these students to be the best possible "guides into and through the social complexities of their classroom lives" (Dyson, 1997). That is, I wanted focal students to not only provide me access to the lives of the students in the 8^{th} grade classroom, but also act as reference points for the events significant to my study (both within and without the classroom). Now, according to Agar as quoted by Dyson (1997, p. 22), inarticulate people with poor recall and reclusive disposition do not make good informants. Further, gaining access to the whole class was important for my study to capture the entire 'case'. Kids have their own peer networks. Thus, if one is friendly with a key member in a peer network, through him one can have an easier access to the lives of many other children.

Thus, it seems important to choose as focal students who are: articulate, willing to talk with me, insightful about the events in the class and beyond, popular with the class, i.e. interact with other students widely, at ease with me following them around and asking all sorts of question, and willing to invite me to their homes. Given the hierarchical nature of Indian society where age is respected and elders feel relatively free to pass judgments on those junior to them in age and/or status, it is quite likely for a child to feel threatened and insecure in the company of a curious adult outsider like me. I was worried that if this happened with my focal students, the quality of my data would become extremely sparse and unreliable. Thus, I very much wanted my focal students to be *confident* kids with whom it is possible to have a friendly relationship.

Of course, there are some drawbacks, to have such a bunch of articulate, confident, friendly and popular kids as focal students. For instance, I ran the risk of not being able to hear the 'voices' of quiet reclusive kids who feel maladjusted in the classroom, alienated from science learning, or feel silenced or oppressed by the extant caste, class or any other criterion based power relations. But since the data collection period was relatively short (about 4 months), and it wasn't feasible to go back to the study site after the data collection period (as I had to head back to United States), I wasn't sure if I would be able to gain the confidence of shy withdrawn students sufficiently early in the data collection period so as to have access to some good quality data. Thus, after considering the different pros and cons of purposive "sampling", I decided to go ahead with it aforementioned pragmatic grounds, and chose five articulate, confident, vivacious, friendly and popular kids as my focal students. These were:

Sarla: She was the eldest daughter of very poor and illiterate parents. She lived in a one-room house with her parents and six siblings. Her parents didn't have any agricultural land. Thus they rented land for farming and also worked as agricultural laborers in farms of other people. She herself worked on agricultural farms whenever she could to support her family. She belonged to a low (*katia*) caste. Bright, vivacious and confident, Sarla was quick to speak her mind. However, extremely weak in math, she struggled with her studies. Because of poverty, Sarla didn't plan on continue schooling after 8th grade.

Raj: He was a cousin of Sarla, and lived in the same *mohalla* (neighborhood) as her. He too came from a very poor landless family, and lived with his parents and a younger brother in a small one-room house with mud floor and walls. Like Sarla, he too was a first generation learner in his family, and like her worked on farms besides continuing his education. During summer vacations he went to work in a brick kiln. Despite being very poor, he went for extra tuitions, and hoped to pass this year after failing for one year. He wanted to continue his education beyond 8th grade.

Narendra: One of the star students, Narendra was one of the most vocal students in the class. He lived in a neighboring village. His parents were illiterate. However, they owned some land and cattle. Narendra lived with his extended family in a bigger house. He belonged to an upper (*purabia*) caste. Though he helped his parents in their family farm, Narendra didn't have to work for money. He too planned to continue studying.

Amaresh: Another good student, Amaresh didn't participate much in class discussions. But I found him easy to talk to both in school and at home. He lived with his two siblings and father in a rented two-room portion that was part of one of the biggest houses in Rajkheda. Narendra's family had shifted to this village some years back from Sagar (a town in Madhya Pradesh). Narendra's father belonged to an upper (*soni*) caste and a family of jewelers. However, Narendra's father for some reason had left his family's traditional occupation, and now worked as a guard in a weighing station close by. His elder brother had left school after grade 9, and now worked as an apprentice in a grocery store in the neighboring town. Amaresh did not work for money.

Amita: She was the sister of Narendra, and a diligent student. As their mother had expired some years back, Amita was the prime caregiver of the family, besides being a full time student of 8^{th} grade. Because of household work, she had to miss school or come late some times. I chose her as a focus student as I thought Amaresh and she would make a good contrast. Initially she seemed receptive to the idea of being a focus student, but later on began avoiding talking to me. One day after some days of insistent persuasion from my side, she finally told me that she didn't wish to talk to me. And I lost a very promising focus student.

Data collection phase:

After about a week of visiting the school daily, I started collecting data as a participant observer in the 8^{th} grade science classroom of the school that was taught by Raghuvanshi. For each middle school grade, the school held one science period of 45 minutes duration (officially speaking) every day. Barring few exceptions, I observed and both audio and video recorded this science period for the 8^{th} grade daily. For most of the days, I also sat and took notes in classrooms of other teachers for this grade. Though my theoretical lenses did influence what I treated as salient and significant, I attempted to record all the events and practices where students could be identifiably seen in a dialogic engagement with others and the material objects.

Categories of data collected:

I interacted with participants in different places and contexts. Each encounter was recorded either in scratch notes or remembered as head notes. The main data categories were:

1. *Ethnographic field notes:* These were composed out of my scratch, head notes, audio and video recordings resulting from (a) participant observation of 8^{th} grade classroom, (b)

visits to students' homes and interactions with their parents and other adults, and (c) casual conversations I had with the participants inside and out of the 8^{th} grade classroom.

2. *Interviews:* I did loosely structured interviews with 18 students of the 8^{th} grade as well as all the 4 middle school teachers. I audio recorded all the interviews. Initially I wanted to interview only focus students. But I found that students liked the idea of being interviewed, and thus many more students wanted to me to interview them. I am inclined to think that this was perhaps because for the first time some adult was asking them about their opinions, views and experiences in a nonjudgmental situation. So I happily interviewed any 8^{th} grade student who expressed his desire. Predictably more boys than girls volunteered to talk to me. Sometimes I had to interview more than one students at a time, as some students insisted on bringing their friends along. I didn't have any questionnaire with me for interviews with either students or teachers. Just some talking points. So, with students I first tried to know:

   a. their personal background and the kind of life they led at home: their daily routine, family, occupation of parents, the household chores they do and other responsibilities they take up at home, their future plans, etc.

   b. their views on schooling: how they valued education, what they liked about their school, what they didn't like about it, ideas about ideal teaching, how Raghuvanshi taught science, what they felt about asking content related questions in classroom, use of study guides to pass exams, usefulness of learning science at school, chapters in their science textbooks that they liked and the ones they didn't like, how was science different from other subjects, etc.

c. things they knew about and could do in connection with agriculture, taking care of cattle, cooking, human diseases, working with electricity and electrical appliances; from whom and how they learned what they knew and could do.

d. new things they learned about different science topics in their science periods that they didn't know about earlier.

e. anything else they wanted to tell me.

It often happened that I was not able to cover all the talking points with some students as I would let them go as soon as I felt that they were losing interest and attention. With focus students, however, I sat more than once to cover all the talking points.

With teachers, I mainly wanted to explore their ideas about teaching, students and parents. Thus, my main talking points were:

a. their personal and professional background.

b. their characterization of students in terms of their motivation to learn and understanding of content.

c. their expectations from students.

d. the preparation they do before teaching a lesson.

e. their conception of an ideal teacher, how close they find themselves to this ideal.

f. positive and negative factors that influence their teaching.

g. value parents and students give to education.

I probed Raghuvanshi much more extensively than other teachers, and tried to know his opinions on things I noticed in his classroom, such as why so few students did homework, why don't many students ask questions in his periods, where he thought students were in their understanding of the topic he was then teaching, how he felt about his science content and pedagogical understanding, etc.

3. *Student artifacts:* science notebooks and examination answer copies of focus students.

4. *Other artifacts:* science textbooks, administrative and policy manual for the teachers.

5. *Photographs* of the village and school.

Transcribing speech data:

The analysis of classroom discourse needed use of speech data along with ethnographic field notes. Now speech data can be transcribed in varied more or less detailed ways depending upon the nature of the arguments one is hoping to make on their basis. On the issue of the level of detail one must present in the transcribed data, I find ourselves agreeing with Gee when he says, "The validity of an analysis is not a matter of how detailed one's transcript is. It is a matter of how the transcript works together with the other elements of the analysis to create a "trustworthy" analysis" (1999, pp. 88 – 89). I found an abridged version of conventions (Ref. Table 1) used by Dyson (1997) in her study of elementary children's social and textual lives, for transcribing classroom talk as appropriate for my analytic purposes.

Table 3.1: Conventions used in the presentation of transcripts

(abc)	Parentheses enclosing text contain notes, usually about contextual and nonverbal information.
( )	Empty parentheses indicate unintelligible words or phrases.
abc	An underlined word indicates a stressed word.
ABC	A capitalized word or phrase indicates increased volume
...	Ellipsis points indicate omitted data.
Conventional punctuation marks	Indicate end of sentences or utterances.
--	Dashes interrupted sequences
..	Two periods indicate a hearable pause.

Data Analysis Procedures

Unit of analysis:

The unit of analysis for this study emerges from the confluence of research questions, theoretical framework and research design of the study. As mentioned at the beginning of this chapter, this study is basically an ethnography of communication which attempts to explore and understand participants' dialogic engagement with the social and material world in different discursive contexts. The theoretical lenses of the study view this engagement as strategic and improvised social action accomplished in real time with the help of whatever circulating discourses the person had access to and could make use at that moment in space and time, and influenced by her intentionality, desires and personal history. If these discourses enable social action, they also constrain and influence it. In other words, a participant's action is assumed to be occasioned not by pervading, ever present and ever active causal relations, but by the transient, contingent coming together of multiple factors at the moment an action takes place.

Thus, the nature of research questions and the theoretical framework goads me to get past the temptation of invoking universals, historical constants and structural assumptions for understanding participants actions and practices, and look at the dialogic or communicative event itself as the basic unit of analysis. A research approach akin to "eventalization" that Foucault attempted in his efforts to understand discursive practices (Foucault, 1988). Hymes too recommended a communicative event as the basic unit of analysis for ethnographies of communication as it enabled a researcher to unravel and understand the "patterning of communicative behavior" in a *speech community*, a sociocultural group that in the theoretical framework of this study, would be more appropriately recognized as a discourse community (Saville-Troike, 1989).

Following Saville-Troike (1989, p. 27), I define a single event "by a unified set of components throughout, beginning with the same general purpose of communication, the same general topic, and involving the same participants, generally using the same language variety, maintaining the same tone or key and the same rules for interaction, in the same setting." Further, defining the boundaries of a communicative event Saville-Troike says, "An event terminates whenever there is a change in the major participants, their role-relationships, or the focus of attention. If there is no change in major participants and setting, the boundary between events is often marked by a period of silence and perhaps change of body position" (p. 27). In keeping with the focus on dialogues in the study, and to highlight the dialogic nature of participants actions, I label these events as *dialogic events*.

In accordance with the aforementioned definition of an event, I analyzed each dialogic event in terms of in terms of:

1. participants;
2. setting of action (time and space);
3. scene (as defined culturally by the participants);
4. purpose of action;
5. Nature of action (form, content, addressivity, etc.)
6. sociocultural means (tools, discourses) used;
7. consequences of action.

Now, I understand that different researchers have demarcated the boundary of an event differently. For instance, Mehan (1982), in her seminal paper, *The structure of classroom events*, takes a communicative event to be a larger unit than Saville-Troike (1989) does. For her, a science period would be a *communicative event*, whereas Saville-Troike would label it as a *communicative situation*. I have chosen to go for Saville-Troike's conceptualization as, I think, it better suits my rhetorical and analytical purposes. Besides, as Gee & Green (1998) say, the size of the unit does not matter, but is more important is to understand what the participants are doing together, i.e. to analyze "the choices of words and actions that members of a group use to engage with each other within and across time, actions, and activity" (pp. 126-127).

Analysis of data:

Classroom data for each class period were first broken up into different dialogic events. Thereafter, each interactional episode was analyzed at two levels:

(a) *socio-linguistic level:* where I looked at how students responded to the official agenda, the teacher's implementation of the official agenda and his response to students' actions; and

(b) *science content or discursive level:* where I focused on the nature of students' utterances in terms of the knowledge and discourses students used by them, science topic, the exigencies that led to their utterances and the effect their actions had on the classroom discourse.

The subsequent steps in analysis based on included writing analytic memos, identification of themes, focused coding, and writing integrative memos (Emerson, Fretz, & Shaw, 1995). Finally, following Emerson et al's and Foley's (2002) advice, rather than presenting a tightly organized analytical argument in a "scientific ethnographic realist narrative style", the results of the study have been written as an analytically thematized narrative tale in a "more reflexive realist narrative style". A tale that not only provides a "thick description" of participants experiences and interpretations, but also weaves in theoretical insights in a dialogic engagement of theory with data. Thus, this paper presents a multivocal ethnography that is resonant with dialogic overtones of both participants' voices and my theoretical commitments.

Chapter 4
The Study Site

To someone who hasn't been to India and hasn't directly or vicariously experienced the life of a student or a teacher in an Indian school, interpreting the results of this study without the benefit of a framing context can be a difficult and even misleading task. This chapter, thus, aims to create multiple frames of reference that will help the reader to situate and interpret the lives and actions of the participants in ways relevant to the research agenda of the study. I start with a perspective on the status of human development, especially education, at the national level and take the reader to successively smaller scales of state, district, village, the school, and finally the 8^{th} grade science classroom. To help the reader interpret the events I observed in the 8^{th} grade science classroom, I also describe the main elements of two discourses that appeared to matter the most in influencing the actions of teachers and students - the teacher professional discourse and the school science discourse.

The status of human development: The National Scenario

It has become a cliché now to call India a land of great contrasts. But clichés do possess the virtue of being largely uncontested. Thus, India, along with China, often comes across in mainstream media and in speeches by politicians as a looming threat to America's prosperity and global dominance. It is routinely put in the front rank of high-growth globalizing countries (*Human development report,* 2005). However, the suicide of more than 25,000 farmers since 1997 in rural India due to indebtedness and entry of transnational corporations in the agricultural sector, a ongoing tragedy largely under-reported in media, tells a totally different story (Shiva, 2004, April 5). As it so happens, the flip side to India's emergence on the global scene remains depressingly stubborn. Indian government admits as much when its own documents report that India's relative ranking on the United Nations Human Development Index has remained at a low of 127 among 177 countries for the last three years in a row, and the incidence of poverty is still at an unacceptable high of 26% of the total population (*Economic survey 2005-2006*, 2006).[1]

Part of the reason for continuing low level of human development in India may be the legacy of colonialism that ended in 1947 (*Human development report*, 2005; Reddy, 2004). In 1951, the first census done in independent India revealed a literacy rate of mere 18% (the female literacy rate was a paltry 8.86%). The gross enrollment ratio – the proportion of children in the 6-14 years age group actually enrolled in elementary schools – was then only 32.1. However, part of the blame also goes to the political elite that took over power from the British in 1947. For instance, the India constitution that was adopted in 1951 enjoined the state to provide free and compulsory education for all children till the age of fourteen years within a period of ten years of its commencement. However, as Govinda, (2002) says, "After the proclamation to establish a mass education system in

[1] It is a standard (though not the only one) practice in India to calculate poverty rate on the basis of head-count ratio which is the ratio of people are not able to have a nationally desirable minimum level of consumption expenditure, based on a standard balanced diet prescribed by India's Nutrition Advisory Committee, to the total population of the region for which poverty rate is being calculated. Only food required for subsistence is considered to calculate a person's consumption expenditure. Thus, a person falling below the poverty line is basically destitute as he/she can't even afford to have two square meals a day.

the country, it took national planners around thirty years to specify distance and population norms for opening new primary schools so that access is not denied to children due to physical distance" (p. 11). Further, according to Govinda, till 1980s, "establishing a school meant no more than posting a teacher to work in the school." Thus, though the number of schools in rural areas steadily grew over the decades, the majority of the Indian population that lives in rural areas, till 1980s, either lacked access to schools or at best managed to get a very poor quality education. For instance, according to the 1991 census the literacy rate in rural areas was mere 44.69%, and only 39.3% of girls in the age group 6 – 10 years, were attending school in rural India, as against the all India average of 45.4% (*Census of India*, 1991). Here it is pertinent to point out that in India the school system, especially at the elementary level, is totally dominated by the government run schools. About 85.3% of the schools in India are government run schools (Mehta, 2005).

Thus, for several decades after India's independence, policy makers failed to appreciate the tremendous demand for access to education even among the poorest sections of the Indian society. Things changed for the better with the adoption of a new National Policy on Education (NPE) at the federal level in 1986. As NPE confessed, "... problems of access, quality, quantity, utility and financial outlay, accumulated over the years, have now assumed such massive proportions that they must be tackled with the utmost urgency. ... Education in India stands at the crossroads today. Neither normal linear expansion nor the existing pace and nature of improvement can meet the needs of the situation" (*National Policy on Education*, 1986). Thus, stressing that "education is essential for all" (p. 4), NPE 1986 advocated "special emphasis on the removal of disparities and to equalize educational opportunity by attending to the specific needs of those who have been denied equality so far" (p. 7).

NPE (1986) led to adoption of several state sponsored programs and initiatives that were aimed to improve access to and quality of education for the people of India. The important examples are: the current ongoing campaign for Universalization of Elementary Education (UEE), the District Primary Education Program (DPEP), Mahila Samakhya project, the Total Literacy Campaign, the Lok Jumbish and Shiksha Karmi projects in Rajasthan, the Bihar Education Project, and the Uttar Pradesh Basic Education project (Roy & Khan, 2003). As a result of these efforts, India's literacy rate rose from 52.2% in 1991 to 65.38% in 2001 – the highest increase in any one decade. In rural areas, the rate of growth of literacy rate, over the corresponding period, was as much as 14.75% (as compared to the 7.2% increase in urban areas). As a result, the rural literacy rate rose from 44.69%. in 1991 to 59.4% in 2001 (*Census of India*, 1991; , *Economic survey 2001-2002*, 2002). Thus, big strides have been made in increasing access to education for Indian masses in the last 15 years. India today has the second largest education system in the world. Aggarwal, (2002) giving an account of Indian education system's gargantuan size reports, "It consists of nearly 610 thousand primary and 185 thousand upper primary schools, about a quarter million non-formal education centers, about 1.87 million teachers and 110 million students study in primary classes in the recognized schools (1997-98). ... The number of students in primary classes in India is larger than the total population of the neighboring Bangladesh" (p. 1). According to the 7th All India Educational Survey conducted in the year 1998-1999, about 87% of rural habitations had access to a primary school within a distance of 1 kilometer – an increase of 21% since 1993 when 6^{th} All India Educational Survey was conducted. An impressive achievement, no doubt.

Table 4.1: India: Education status

No.	Indirect indicators of 'quality' of education	Measure
1	Dropout rate (1998-99) for girls at primary (grade I – V) stage	41%
2	Dropout rate (1998-99) for boys at primary (grade I – V) stage	38.6%
3	Dropout rate (1998-99) for girls at middle (grade I – VIII) stage	60.1%
4	Dropout rate (1998-99) for boys at middle (grade I – VIII) stage	54.4%
5	Pupil-teacher ratio in rural primary government schools (2004)	44
6	Percentage of rural primary schools having an electrical connection (2004)	11.5%
7	Percentage of graduate (all category and regular) teachers in primary schools (2004)	25
8	Average number of teachers in government schools (2004)	3.43
9	Percentage of schools receiving TLM (teaching-learning material) grant in 2003	52%
10	Average number of classrooms in rural elementary schools	2.5

Source for 1, 2, 3, & 4: *7th All India School Education Survey*, 1999
Source for 4, 5, 6, 7, 8, 9 and 10: Mehta, 2005

But what about the quality of education offered in Indian schools? Gauging quality of education offered in schools has been a difficult challenge for educational researchers in India. Little reliable data is available about students' achievement of cognitive and non-cognitive competencies (Aggarwal, 2002; Govinda, 2002). However, on the basis a few school-based indicators alone, such as drop-out rates, it can be easily inferred that the quality of education offered in Indian schools is decidedly not something to be optimistic about (refer table 4.1).

In terms of pedagogy and curriculum material that get used in Indian schools, especially those that are run by government, a few important conclusions can be drawn on the basis of available research. Since, the focus of this study is science education, I'll illustrate my arguments with examples from science education wherever possible. The National Policy on Education (1986) argued for strengthening science education "so as to develop in the child well defined abilities and values such as the spirit of inquiry, creativity, objectivity, the courage to question, and an aesthetic sensibility", and to "enable the learner to acquire problem solving and decision making skills and to discover the relationship of science with health, agriculture, industry and other aspects of daily life" (p. 7).

In the last 15 years, through several initiatives that were mentioned earlier, government has tried to improved the quality of science education by revising textbooks, involving teachers in the process of revision of textbooks, and offering professional development workshops to serving teachers (Dinkar & Smith, 2002; Rampal, 2002). Speaking of government's attempts to measure the success of these efforts, Aggarwal says, "While indicators to measure the access, retention and internal efficiency of the educational system in terms of participation rate, accessibility, repetition rates, promotion rates, dropout rates and input-output ratio have been developed, but little information is available about the learners' achievement of cognitive and non-cognitive competencies" (2002). Since 2005, however, the central government has started publishing a report card on elementary education for each state, and a similar report card is also available for most districts with data from the last three years (*District elementary education report card*, 2005; Mehta, 2005). However, reflecting the priority of the state, the performance indicators are all infrastructure related. The indicators that can speak, even if very inadequately, about the quality of instruction in classrooms are the pass percentages, percentage of students scoring more than 60% in annual exams of students at terminal stages of primary (grade 5) and middle school (grade 8), retention rates, net enrollment ratios, etc. Further, given the large inter-state and intra-state variations in school facilities, quality of teachers and learning outcomes, any judgment on government efforts to improve quality of education on their basis would face serious validity concerns.

But some things we do know that speak to the challenges government faces in their efforts in this direction. First, the sociocultural context in which schools, especially those in rural areas, function is such that teachers command a great degree of authority from and power over their students (Kumar, 2005; Sarangpani, 2003). According to Sarangpani, this authority of the authority almost gets naturalized as a taken-for-granted feature, and is used to not only maintain behavioral control and discipline among students, but also tends to position teachers as knowers and regulators of knowledge construction, and students as passive obedient recipients of state sponsored knowledge. In such an episteme, education reform efforts have to struggle very hard to give sustenance to desirable student attributes as recommended by the NPE (1986), such as "spirit of inquiry, creativity, objectivity, the courage to question, and an aesthetic sensibility".

Second, though efforts to revise textbooks and curriculum were made, often under the impetus of foreign agencies funding reform initiatives, not much effort was directed at deliberations on the curriculum (Dinkar & Smith, 2002). As Dinkar and Smith observed in curriculum and textbook revision workshops, much of the effort was geared at "identifying current difficulties faced by children and teachers" in transecting the extant curriculum, and removing them. Thus, the pedagogical, epistemological and ontological foundations of the existing curricula were by and large left unchallenged.

Third, in order to make education accessible to all sections of the society, the teacher workforce was increased by recruiting less qualified teachers. This has adversely impacted not only the status of teachers, but also the quality of instruction offered to students (Dinkar & Smith, 2002; Kumar, 2005).

Fourth, government bureaucracy maintained a firm control over the curriculum and textbook revision efforts that got eventually mainstreamed. The space for grassroots based organizations and groups to develop alternative and more progressive models of education remained limited (Rampal, 2002). Alternative attempts at intervention in state schools that showed much promise in making a marked qualitative improvement in teaching of science in schools, such as the Hoshangabad Science Teaching Program coordinated by *Eklavya*, were marginalized during this period. Thus the state failed to mainstream their desirable pedagogical and curricular principles (Kumar, 2005; Rampal, 2002).

Fifth, in absence of adequate and commensurate professional development opportunities for teachers so that they could successfully implement progressive pedagogical principles of child-centered and joyful learning, all the fine sounding policy prescriptions remained mere slogans for the teachers (Dinkar & Smith, 2002; Kumar, 2005).

As a result, the science teaching has remained textbook centered (Kumar, 1988). It is pertinent to point here that these textbooks are prescribed by the state, and a science teacher has "no freedom to choose what to teach. She must complete the prescribed syllabus with the help of the prescribed textbook … Resources other than the textbook are not available in the majority of schools, and where they are available they are seldom used. Fear of damage to such resources (e.g., play or science equipment) and the poor chances of repair or replacement discourages the teacher from using them" (Kumar, 1988). In a critique of science textbooks prescribed in government run schools, Koul (1997) pointed out that these science textbooks present, "science in its product form, which is a science that gives prime emphasis to its established concepts, laws, and theories. Both the concept development and questioning manifest this decontextualized form. Very few activities ask students to generate and test knowledge by applying it to new contextual situations". Rampal (2002)makes a similar critique when she alleges that in the curriculum reform efforts initiated by the state, "issues of 'relevance and life orientation' nave not really been addressed. Recognition of local and indigenous knowledge systems, with emphasis on learning in a contextual manner, through the work of most people, engaged in agriculture or artisanal trades, has still not been accepted as a legitimate focus of the curriculum" (p. 166).

We can say that government efforts to improve the quality of science instruction have been successful in terms of better infrastructure and access to formal instruction for most kids. Textbooks and curricula also now have more inputs from the teachers. But as this study shows, the practice of teaching and learning of science in schools still continues along traditional lines. Thus, much remains to be done by the state before it can claim to provide access to the type of science education advocated in national policy documents. One indirect indication of the failure in this direction comes from the reasons children quote for never attending or dropping out of schools (*National Family Health Survey - 2*, 1999). According to this nationwide survey, after cost considerations, "not interested in studies" comes as the most important reason for choosing to stay away or opting out of school system, for both boys and girls. To me, these kids' lack of interest in studies comes across more as a failure of school system to offer an education personally meaningful and relevant to the students, than as a reflection of their competencies.

Thus, it comes as no surprise that there seems to be a general agreement among educational researchers that in an effort to universalize elementary education for all, quality concerns have been given short shrift by the Indian state, and an overwhelming majority of Indian children, especially those from weaker underprivileged sections of Indian society can at best hope to receive a very inferior quality of education through formal education system (Aggarwal, 2002; Dinkar & Smith, 2002; Kumar, 2005; Ramachandran, 2004, July 24; Rampal, April, 2004; Rao, 2000, November 25; Roy & Khan, 2003). It goes to the credit of the current government of India that it has confessed failure on this front. The latest Economic survey, put out by the government of India admits that "It is however important now to shift emphasis and focus attention on the quality of outcome of the various social sector programmes (sic) rather than their quantity or coverage. For example, the quality of education being imparted at the elementary level, rather than just access or only enrolment of children in school, needs to be emphasized (sic) through appropriate modifications in the guidelines and their implementation. ... While universal coverage has been achieved in terms of opening of health centres in most states, the quality of public healthcare services both in the rural and urban areas need urgent improvement" (p. 21).

The Status of Human Development: The State of Madhya Pradesh

Now before I present a portrait of the study site, a brief description of the state of Madhya Pradesh and the district Hoshangabad where this the village Rajkheda is located would be in order. In keeping with the theme of this study, I focus on the status of education of this region. Madhya Pradesh when translated into English literally means central province. The name is befitting as it is located right in the geographic center of India. Till 2000 it was the biggest state of India. On November 1, 2000, it lost that status when its southern region of Chattisgarh was lopped off to make a separate Chattisgarh state. Madhya Pradesh is a Hindi speaking state with rich history and abundant natural resources. It also holds the distinction of being home to about 40% of India's tribal population. Agriculture is the mainstay of the regional economy with about 80% residents depending upon it for their livelihood. Hoshangabad district is in the Narmada valley region of the state. Because of the Narmada river that flows along the northern boundary of this district, this district is blessed with sufficient water resources to make it agriculturally prosperous.

Till the early nineties, Madhya Pradesh lagged behind the national average on most human resource development indicators. It was one of the four big *bimaru* (sick) states that pulled down the human resource development index for the whole nation by several notches.[2] For instance, in 1991, its literacy rate was a paltry 44%, as compared with the national average of 52.2%. The literacy rate among women was only 30%, as against the national figure of 39.2%. Other educational indicators weren't encouraging either. Only 42.8% (*6th All India School Education Survey*, 1993) of the habitations had access to a school within a distance of 1 kilometer, and the net enrollment ratio, in the age group 6 –

[2] The other three *bimaru* states are Uttar Pradesh, Rajasthan and Bihar.

11 years, was just 47.4% (*Census of India*, 1991)[3]. One major reason behind these low figures was that "the norms for opening a school in a village with population between 250 and 300 ignored the scattered and inaccessible habitation pattern of the state, where people live dispersed in small household communities, one to four kilometres (sic) away from the main village. These areas are generally inhabited by socio-economically deprived communities resulting in their needs getting submerged within standardised (sic) norms and strategies. ... Planning was centralised (sic) and so failed to reach out to the needs of the people" (*The Madhya Pradesh Human development Report*, 2002).

Taking cognizance of the severity of the problem, the state government of Madhya Pradesh launched several schemes to achieve universalization of education, the most famous being the Education Guarantee Scheme (EGS) that was launched in 1997. This is a demand-based scheme according to which any community without a schooling facility within a distance of 1 kilometer and having at least 40 children (25 in case of tribal community) can demand from the state a schooling facility, and the state government upon receiving such a request has to provide a school to that community within 90 days. The teacher is chosen by the community, and the community also provides space and some supplemental resources. Whereas the state's role is to train the teacher, provide teaching-learning material, academic supervision, seed money for infrastructure, and salary to the teacher (*The Madhya Pradesh Human development Report*, 2002).

As a result of EGS and other government schemes, the state was able to provide access to schooling to all communities by the year 2002 (*The Madhya Pradesh Human*

---

[3] **Net enrollment ratio is the number of students enrolled in a level of education who belong in the relevant age group, as a percentage of the population in that age group. Thus, a ratio of 47.4% implies that only that percent of the kids in that age group were enrolled (and presumably) attending school.**

development Report, 2002). Other education indicators have also shown a dramatic improvement since early 1990s. For instance, the state has almost managed to bridge the gap between its literacy rate (64.1%) and the national average (65.4%) – representing a decadal growth of about 18.3% (*Census of India*, 2001). The spread of literacy in rural areas has been more impressive as the most of the government schemes were targeted at rural habitations. The literacy rate for women in rural areas increased from 19.2% (the national average 30.6%) in 1991 to 42.96% (the national average being 46.7%) in 2001 (*The Madhya Pradesh Human development Report*, 2002). Similarly, the net enrollment ratio at primary level, i.e. in the age group 6 – 11 years, is now at 89.73% (Mehta, 2005). This indicates a significant improvement over last 15 years. However, access to education does not immediately imply access to good quality education. Besides there are some other important indicators that show that though a lot has been achieved in recent years, the status of education in the state is still far from satisfactory.

For instance, the net enrollment ratio for middle school age group drops to mere 46.13%, i.e. about 54% of children population in the age group 11 – 14 years that should be enrolled in and attending middle school, are out of school(Mehta, 2005). That is an unacceptably high number. Similarly, the dropout rate at primary level is a high 21.4% ("Sarva Sikhsa Abhiyan Madhya Pradesh: Education Profile", 2004). ("Sarva Sikhsa Abhiyan Madhya Pradesh: Education Profile", 2004). In terms of academic achievement, we have examinations results as one major data source. According to this data, 64.71% of girl students managed to pass the 8th grade annual examination. However, the percentage of girls passing with more than 60% marks was only 21.12% percent (Mehta, 2005). The boys were a little worse off than girls in this regard. The poor academic performance of students needs to be seen in context extant learning conditions at school that are by no means conducive to high learning achievements. For instance, the student classroom ratio for middle schools is a high 60 (in fact, in the previous year, it was a shade better at 56), though the teacher-student ratio of 28 was far better 28 than the all schools average of 32 (Mehta, 2005). Also, according to Mehta, only about 7% of the teachers in middle schools had received any in-service training during the previous year, while 55% of the para-teachers didn't have any professional preparation prior to teaching. It is noteworthy to mention here that for some years now, the state government has stopped hiring regular teachers. The ensuing vacancies are being filled by para-teachers that are recruited by local bodies, like local village or the district council. These para-teachers are paid much less for the same amount of work as done by regular teachers who were appointed by the state government, and also do not have the security of tenure. Currently about one-third of the teachers in middle school belong to this category (Mehta, 2005). The government justifies staffing the schools with para-teachers on grounds of economic efficiency, and urgent need for universalization of elementary education (*The Madhya Pradesh Human development Report*, 2002).

Table 4.2: Madhya Pradesh: Education status

No.	Selected education indicators	Measure
1.	Literacy rate (2001)	64.1%
2.	Rural literacy rate for women (2001)	42.96%
3.	Net enrollment ratio at primary school level (2005)	89.73%
4.	Drop-out rate at the primary level (2005)	21.4%
5.	Net enrollment ratio at middle school level (2005)	46.13%
6.	Percentage of girl students passing 8th grade examination (2005)	64.71%
7.	Percentage of girl students passing 8th grade examination with more than 60% marks (2005)	21.12%
8.	Student-classroom ratio (2005)	60
9.	Teacher-student ratio (2005)	28
10.	Percentage of teachers in middle schools who had received any in-service training during the previous year (2005)	7%
11.	Percentage of para-teachers in middle schools without professional training (2005)	55%
12.	Para-teachers as a percentage of total teacher population in middle schools (2005)	33%

The status of human development: The District of Hoshangabad

Hoshangabad district lies on the northern end of the Satpura plateau, and right in the center of Narmada valley. The Narmada River flows along its northern border. In 2001, it had a population of about 1.1 million, which isn't terribly huge by Indian standards. As with rest of the country, the majority of its population, about 61%, lives in villages (*The Madhya Pradesh Human development Report*, 2002). Thanks to adequate sources of irrigation, net irrigated area comprises 78% of its net sown area. ("Hoshangabad - At a glance"). The national average in this regard is 40% (*Agriculture research data book*, 2004). Further, according to the state human development report, this district ranks 14th (out of 48) in the state in terms of human resources development. However, in terms of the gender related development index, its ranking is much worse at 29 (out of 48).

As in other districts of the state (and perhaps the whole country), the state dominates the local education system. For instance, 81% of the schools in the district are government schools which thus account for 75.4% of the total enrolled students from grades 1 to 12.[4] ("District elementary education report card: 2004-05", 2005). In terms of education, the district elementary education report card for the year 2004-05 puts the overall literacy rate at 70% and female literacy at 57.6% (as against the corresponding state averages of 63.7% and 50.3%). By the year 2000, all habitations had at least a primary school within a distance of 1 kilometer, thereby enabling the state to declare the gross access ratio for elementary level in this district to be 100% (*The Madhya Pradesh Human development Report*, 2002). However, in keeping with the trends in rest of the district, the net enrollment ratios for elementary and middle school level were 87.4% and 51% respectively for the academic year 2004-05 ("District elementary education report card: 2004-05", 2005). Thus, by the end of middle school, roughly half of the kids in the age group 11 – 14 years were out of the school system. Other indicators too indicate that despite considerable progress considerable distance needs to be covered before the state can be credited with satisfactorily discharging its obligation to provide access to quality and free education for all. For instance, according to the district elementary education report, as many as 25.9% students at the middle school level were enrolled in a middle school without a building. Pass percentage at 8th grade annual examination for girls was 57.58%, and only 22.71% percent girls were able to get more than 60% marks in these

[4] Primary schools in M.P. start from grade 1.

examinations. Finally, in keeping with the state average, the para teachers comprised about 32% of the total teacher population at the middle school level ("District elementary education report card: 2004-05", 2005). Thus, we see that in overall terms, Hoshangabad is a bit above average in terms of education as compared with other districts of the state.

The State Education System

As mentioned above, the government totally dominates the state education system. However, it allows privately managed schools, and even supports eligible schools with government aid. The 73rd/74th amendments of the Indian constitution heralded an era of democratic decentralization in the state. The local level democratic institutions, like the village and district councils, were revitalized with the infusion of new powers and responsibilities in 1994 (*The Madhya Pradesh Human development Report*, 2002). In the education sector, these bodies were given the responsibility of (a) managing and running schools opened under the Education Guarantee Scheme, (b) construction, repair and expansion of school buildings, (c) provision of equipment, (d) recruitment of para-teachers, (e) implementation of various education incentive schemes. Further, village level village education committees (VECs) have been created in villages with powers to supervise local schools. To assist VEC, local municipal body, such as *gram sabha* and village council *(panchayat),* and the school, creation of parent-teacher- associations (PTA) has been mandated in each village to "supervise and review all development, academic, administrative and financial activities of the school" (*The Madhya Pradesh Human development Report*, 2002). The teachers, as a result, are now pretty accountable to the VEC and PTA for their performance. The state on the other hand, has redefined its role in schools to (a) providing grant-in-aid to private schools, (b) monitoring and improving quality in teaching and teacher training, (c) arranging facilities for physical education and sports, (d) prescribe syllabi for schools, (e) printing and distribution of textbooks, (f) and conducting exams for the students.

Thus, the state has to a substantial extent ceded its traditional power to supervise the day-to-day functioning of the school (which in any case, it could never do in the past) to the local institutions, it has chosen to keep to itself control over the curriculum, teacher professional development and 'teaching-learning material' to be used in the school. Admittedly, there is far greater district level decentralization and involvement of the teachers in in-service professional development and preparation of 'teaching-learning material' now than was the case about 15 years back (Dinkar & Smith, 2002; , *The Madhya Pradesh Human development Report*, 2002). However, the local community is still out of the picture as far as curricular matters are concerned. Curriculum can be thought as consisting of content, pedagogy, learning outcomes and assessment strategies. Till date the local community has no *de jure* role to play in influencing any of these curricular elements. Though it has become customary now to take inputs from teachers in formulation of curriculum and writing of textbooks, the final shape and form of these teaching resources are still decided centrally in the state capital by the education bureaucracy and a panel of curriculum experts (Dinkar & Smith, 2002).

Thus, for each school discipline, the teacher in a government school is given a syllabus that also doubles as a pacing guide. Basically, the syllabus comprises different chapters of the state prescribed textbook that the teacher is required to teach from. To provide supplementary teaching-learning material in addition to the textbook, the state provides for the establishment of a school-based library, and multimedia material equipped computer centers at the local *jan shiksha Kendras* (people education centers). However, the final assessment of student learning outcomes is done through a high-stake examination at the end of the academic year that is strictly based on the prescribed textbook. As assessment usually drives instruction, the use of supplementary material becomes rather incidental to classroom instruction, as I discovered during my fieldwork. The private schools, though, have much greater freedom in choice of curricular material.

The teacher in a government can decide the nature of the annual summative assessment in all years except the terminal ones for each state of schooling. That is, the formulation of exam papers and the evaluation of student responses is done externally (of the school) according to government prescribed procedures at the end of grades 5, 8, 10 and 12. The annual examination is high-stakes in the sense that failure to pass the exam can lead to retention of the student in the current grade. The government schools though follow a general no-retention policy till the grade 5.

When I talk about government schools here, I refer only to schools run by the Madhya Pradesh government. The central government also runs schools in the state. But these schools follow their own curricula, textbooks, teacher recruitment and professional development programs that are different from the state government's. In addition, there also are private schools that are affiliated to national education boards, such as Central Board of Secondary Education or The Council for the Indian School Certificate Examinations. However, the schools following other curricula and affiliated to education boards other than of the state are in minority. Besides, such schools are by and large urban schools. In rural schools, state mandated curricula is the norm.

However, this wasn't the case always. The state for a long time enjoyed the distinction of being a breeding ground of many promising alternative educational interventions, the most famous of them being the Hoshangabad Science Teaching Program (HSTP, for short). As I mentioned in the beginning, till 2001, HSTP was in effect in all the government middle schools and government aided private schools of the districts of Hoshangabad and Harda, and in 13 other school clusters in as many districts of the state. Thus, it covered more than 100,000 students and 2,500 science teachers in about 1000 schools. As mentioned earlier, the program was based on the core pedagogical principles of learning-by-discovery, learning-through-activity and learning-from-environment. This intervention was comprehensive and multifaceted in the sense that it comprised implementation of not only a different science curriculum and pedagogy in schools, but also followed a different paradigm in assessment system, teacher professional development strategies, and bureaucratic structures. It was a collaborative effort by academicians and scientists in several leading universities and science research institutes of the country who were supported in field by Eklavya, a non-government organization with focus on field-based educational innovations. This intervention was guided and sustained by the hope that if it can be shown that science can be taught according to the aforementioned progressive pedagogical principles in even poor, under-equipped, government run mainstream schools, then the state will step up and mainstream the innovations for the entire education system of the state.

It goes to the credit of the state government that it did adopt some elements of HSTP for implementation for the whole state. However, this mainstreaming was done very selectively, and in a piecemeal manner that diluted the pedagogical principles of the program to a great extent. But, what was worse was that the state barricaded the space for innovation for non-government agencies by withdrawing HSTP and its sister programs from the government schools in 2002. In districts Hoshangabad and Harda HSTP was operational since 1978. 24 years ought to be a sufficient time for an intervention to make some place in the teacher's professional discourse, and in public memory. However, to my surprise, when I visited the schools in the district after the program had been shut for just two and a half years, the program had already become part of a distant fading past that showed up in the conversations of teachers and other people only very infrequently. Besides, not many people seemed to miss it. It was almost as if the program never really existed on the ground.

Thus, in 2004, I found the education system in the state in a sort of transition. Long existing alternative interventions in the system had been closed. Many new initiatives had been undertaken, and changes made to the existing structures in the last decade. Some were planned or had been launched only recently. However, there are many things about the system that had been left unruffled too. My fieldwork was, thus, situated in this interesting mish-mash of change amidst continuity.

The Village

Rajkheda is a medium size village located on the road connecting Hoshangabad town with Pachmari, the beautiful hill resort of Madhya Pradesh (refer table 4.3). When I did my fieldwork, this road was being built anew, and thus people were in general hopeful about traveling to neighboring towns with greater convenience and economy of time in near future. The village had one unpaved main street running through it. The government middle and primary school were located on one campus, quite near the entrance of the village and next to this street. By the time I finished my fieldwork, this main street had been converted into a proper road. As I learned this had less to do with the initiative of the villagers, and more with the fact that the village street was to be temporarily used as a diversion while the section of the Hoshangabad - Pachmari road near the village was being repaired.

Table 4.3: Basic government data on Rajkheda

Population	1299
Total number of families	270
Families certified as below the poverty line	125 (46.2%)
Total area	444.291 Hectares
Total cultivable land	394.96 Hectares
Total irrigated land	337 Hectares (85.3%)
Main castes	*Kachi, Katia, chamar, Raghuvanshi, Purabia, adivasi* and *Brahmin*

The fact that 46.2% families (1997-98 figures) were below the official poverty line indicates that Rajkheda wasn't exactly a prosperous village. However, other villages in Hoshangabad aren't doing very well either as the incidence of rural poverty for the entire district is a high 52.8% (1993-94 figures) (*The Madhya Pradesh Human development Report*, 2002). To put this figures in a bigger context, it may be mentioned here that according to national sample survey (NSS) data for the year 1999-2000, the national average of poverty for rural areas is 26.8%, and the corresponding figure for the state of Madhya Pradesh is 37.2% (Deaton & Dreze, 2002).

The prime occupation in Rajkheda was agriculture. The main crops grown were wheat, lentils and soybean. Besides being a village with large number of families belonging to *katia* and *kachi* castes, who prefer to grow fresh vegetables, this was a major agriculture produce of the village as well. If we divide the total cultivable area in the village by the total number of families, then the average cultivable land owned by a family in this village comes to a paltry 1.46 Hectares. Of course, during my fieldwork I came to know many families that didn't own any land at all; most such families worked as agriculture labor on other farmers' lands. Landless farmers are common in this region. For instance, for the entire district, the agricultural laborers comprised 45.3% of the total number of rural workers, whereas cultivators tilling their own land were just 36.6% of the total (*The Madhya Pradesh Human development Report*, 2002). Thus, this figure may not be a good measure of central tendency for landholding per household, but it does give us a rough ballpark figure and an idea of the extent of deprivation in the village.

However, there were certainly some signs of development in the village. Many of the side alleys were paved. The village had electricity, even though it came only intermittently. There was a large overhead water tank right at the entrance of the village that was recently constructed to provide drinking water to the village. However, the water supply network hadn't been laid yet, so the villagers still fetched water from wells and hand pumps. Some people had motorbikes, and I once even espied a car parked within the boundary walls of the biggest house in the village. Under the Indian Tobacco Corporation's *e-chaupal* initiative, one family even had a computer and access to internet. This computer was used to track the bulk prices of agricultural produce on a daily basis. However, as Raj, a student of 8^{th} grade, told me, the family having the computer was an upper caste wealthy and politically powerful family. Thus, as he told me, the lower caste poorer farmers, like his, didn't have access to this useful information.

Though there were a number of brick houses in the village belonging to generally better off families, some of the poorer families I visited lived in small hutments made of mud walls and floors, and clearly lacking any toilet facilities. There was a degree of segregation along caste lines in the village, as I found that all the lower caste *katia* families lived in a separate *katia mohalla* (neighborhood) at the back of the village, whereas most upper caste families had their houses along or near the main street, and right at the beginning of the village. This isn't an unusual thing to occur in Indian villages. Most other villages I have visited in India had this sort of caste-based segregation.

The village had only one little utilities store that also acted as a hangout for adolescents and youth of the village. It was one little shack built of corrugated metal sheets. When I did my fieldwork, cricket matches between India and Pakistan were being played. The owner of the shop used to play the live cricket commentary on his radio. Thus, often there were a small group of people standing in front listening to the commentary and discussing the game. The village also had a public distribution store run by government that supplied essential daily use items, such as kerosene oil and sugar, at reduced rates to the denizens of the village. Just next to the store was a small building, basically a couple of small rooms, that housed the village secretariat office. On walls of the office, were listed the names of the current office holders and village level government workers and the dates and times at which they are supposed to be available at the office. Also on the walls was a citizen's charter, and a list detailing some basic information of all the village level welfare programs.

The School

Rajkheda had only one school building that housed both the government primary and middle schools. The school had a pretty good reputation for studies. As a result, as Dinesh Mathur, the middle school teacher who taught English to eighth graders, once told me that there wasn't a single private school in and around the village. The school was located on the main street, right where the village began. The school premises were bounded by a boundary wall, and had a single entrance through a small gate at the front. The main entrance of the school led to a small open ground on two sides of which were the rooms comprising the school building. The eastern side of the school boundary was incomplete resulting in a big opening. This side opening was in fact as much used to enter or exit the school premises by everyone, including teachers, students and visitors, as the main entrance at the front. The school building was built in stages with little regard for maintaining the architectural continuity over time. Thus, each segment looked different from the rest in layout, design and also the quality of construction (depending upon the amount of funds available for the purpose. Besides, the state department of school education, local village council also gave funds for construction of rooms. The 8^{th} grade classroom, for instance, was built with the help of funds from the village council. Raghuvanshi, the teacher who taught science to the eighth graders told me that when this room was built, the wood used in making the two doors was of very inferior quality. So the doors broke down pretty early. Only their metal frames remained. So now there were no doors, and teachers taught 8^{th} grade students in an 'open classroom'. The room had a single window that too also always remained open because of lack of any window doors.

And since the doors and window were always open, there was always a general and generous exchange of classroom noise between different classrooms.

During the time I did my fieldwork, one of the classrooms was being repaired, and another one was in the danger of collapsing any time so wasn't used at all. As a result, there was a shortage of classrooms in the school, and on many days, especially when the weather permitted, one or more classes had their instruction out in the open. As most classrooms didn't have electricity and couldn't be shut close either because of lack of doors or because doing so would make them very dark places, during winters there were days when they became too cold for students to sit in. Besides, I found that most students never wore enough warm clothes to keep themselves warm. Thus, on particularly cold and overcast days, the students would often request their teachers to hold the class out in the sun where they could be warm and more comfortable.

When I started my fieldwork I was a little surprised to find that both primary and middle schools didn't have a separate room for their headmasters. The headmasters used the staff room as their office space, just like other teachers. The staff room was also used to store desks and chairs for teachers to use in classrooms that didn't have any doors. Every morning, it was students' chore to take a desk and chair from the staff room to such classrooms for teachers to use. The students would also bring them back to the staff room at the end of the school everyday. The school didn't have any separate room for the school library. One day while chatting with 8th grade students, I asked them if they got any books other than textbooks to read. The students told me that there was indeed a library in the school that was run by Raghuvanshi. During lunch break, the kids could borrow books to read. However, they couldn't check out the books for taking home. As there was no teacher in the classroom then, and the students were on their own, I asked them why didn't they get a teacher to lend them some book right then. I was told that it was only because of Raghuvanshi's initiative that this library was functioning, other teachers were not interested in running it. So I found that on some days, Raghuvanshi would lay out a thin mattress (*durri*) on the floor of the verandah in front of the staff room during lunch break. Seeing him doing that students would gather around. Then Raghuvanshi would keep a pile of books on the mattress for them to choose and read during the break. From the excitement among the students and the eagerness with which they picked the books, it was evident that students looked forward to such occasions.

Under the state government's Headstart initiative, the school had also got 3 computers that were to be used to provide students a "computer enabled education … to help the teachers reinforce textual materials and encourage children through interactive learning … and develop computer literacy along with it" (*The Madhya Pradesh Human development Report*, 2002). The computers were used only rarely, and that too more as monitors for showing government provided educational software. The school was required to provide their best and safest room for housing these computers. As a result, the best room in the school was barely used, further contributing to shortage of classrooms in the school.

The classrooms themselves were barely furnished. That is, apart from a chair and desk for the teacher that, in 8th grade at least, was brought daily from the staffroom by the students and taken back there at the end of the day, there used to be no other piece of furniture in the classroom. The students sat on long narrow mats that too were brought from the staffroom at the beginning of the day by the students. There weren't enough mats for all the students, so some students brought their own small rugs made from sackcloth from home. During my fieldwork I witnessed many a struggle among the students for them. For instance, one day Raghuvanshi angrily berated 8th graders on receiving a complaint from kids in the primary school that being bigger and stronger they had forcibly taken mats from their classrooms. Raghuvanshi made the senior students return all the mats they had so taken away. As the mats for the 8th grade class too had been taken away by students from some other grade, most 8th graders had to sit on the bare floor for that whole day. Dusters and chalks used to be another bone of contention between students of different grades. The walls of the classroom were bare with no posters or portraits for students' edification and inspiration. The classrooms didn't have any teaching aids either. If Raghuvanshi wanted students to do or see some experiment, he would bring the kit material from the store room and take it away at the end of the class. Often he would also use his personal items or request students to get them from their homes as the school was seriously under-equipped in this regard too.

The daily routine of the school occurred, with some variations, something as follows. Officially, the school was to start with morning assembly of all the students (primary as well as middle) in the common ground in front of the classrooms at 10:30 AM, and the classes were to start with the first period at 11:00. However, during my entire period of fieldwork, I never once saw the morning assembly or the first period starting at their stipulated times. Though the students started milling around in the ground from about 10:30, the assembly usually started at 11:00, and even later if either the headmaster of the middle school or Raghuvanshi were late. For instance on March 14, Raghuvanshi came to the school very late because of a family engagement. The headmaster, Mr. Mahto, wasn't in the school too. For a long time after the bell for assembly was rung, no teacher tried to impose any order to hullabaloo of the students collected in the school grounds. It seemed as if the teachers present at the scene were waiting for Mahto or Raghuvanshi to turn up and start the proceedings. Finally, around 11:20, Dinesh issued instructions to the students to start their prayers – the most important part of the morning assembly. On most days, students would trickle into their classrooms well after the morning assembly and well into the first period. I noticed that they were rarely admonished or punished for being late.

The official timetable for the middle school organized a day's instruction time in 7 periods with two small breaks of 10 minutes and one big lunch break from 2:10 to 2:40 (refer table 4.4). Each period was to be of 45 minutes duration, except for the last one. The last period was kept for sports and was of 40 minutes duration. However, the teaching rarely followed this schedule. First, the time length of a subject period varied from 20 minutes to more than 1 hour, depending on the time the teacher was willing to spend on that subject that day. The teachers had pretty good understanding among themselves. So if a teacher had to go an errand, official or otherwise, he would finish his period early and leave or even not take it at all. The other teachers then used the extra time to teach their own subjects. Students were totally out of the picture in such changes. So, it didn't really matter if students started losing their concentration in a subject period after a while, if the teacher had decided to teach a long period that day, he would do so. As a result, even the time for lunch break used to keep shifting almost everyday. The official time table was so set that each subject had one period everyday. However, owing to the tradition among teachers of doing all non-teaching official work only during school time, very frequently students in each grade had a period of time during the day when they would be in class waiting for a period to begin and no teacher would turn up to teach them. Sometimes such unsupervised time extended over an hour. Students during this time busied themselves with either their books, casual conversation, and some even slinked out of the school premises to chew tobacco or have a quick smoke on the sly. During these times, if I happen to be outside a classroom and looked available, students from a classroom would approach and implore me to come to their classroom and take a 'class'. Often times it was difficult to deny their request.

Table 4.4: Official time table for 8th grade

Time Slot	*Subject (Teacher)*
11:00 – 11:45	Science (Raghuvanshi)
11:45 – 12:30	Math (Mahto)
12:30 – 12:40	Break
12:40 – 1:25	English (Dinesh)
1:25 – 2:10	Social Studies (Ritesh)
2:10 – 2:40	Lunch break
2:40 – 3:25	Sanskrit (Ritesh)
3:25 – 4:10	Hindi (Mahto)
4:10 – 4:20	Break
4:20 – 5:00	Sports (Ritesh)

I never once saw the last sports period being taken during my entire field work. So the school got over everyday around 4:30 after a common assembly of all the students during which the national anthem was sung by all the students, and announcements were made by the teachers. Predictably, the students were pretty eager about sports and regretted the fact that the teachers didn't organize any sports for them on a regular basis.

Teacher Professional Discourse

Amidst individual differences, I also found some common trends in the ways teachers discharged their professional duties as teachers. These commonalities constituted the professional discourse that influenced teacher's participation in communicative events I happen to observe both within and without the classroom. The most prominent element of this discourse was, of course, the stance teachers took, and were expected to adopt by the local education bureaucracy, towards teaching a school subject.

This aspect was best exemplified to me one day when students of 8th grade were sitting in their classroom waiting for a teacher to turn up. Finally a teacher, Dinesh, did enter the classroom. However, he was also accompanied by the local Block Education Officer (BEO) who had ostensibly come to the school for an unannounced inspection. The officer began by asking kids the reason for poor attendance. A student stood up and told him that some students were absent as they had gone to attend weddings. On hearing this, BEO replied that they shouldn't attend weddings as for each wedding they attend, their marks in exams would reduce by 5%. Then he went on to calculate for them who many % marks they would loose if they attend 2, 3 , 4 and 5 weddings. He enquired from the students if they were being taught on schedule, i.e. if their course work would be completed in time and they would had some days for revision. He also asked if the math course had been completed. Sheela and some other kids said yes. Then he enquired if they will be able to solve a problem if he gave it to them just then. At this, there was an awkward silence among the students. On seeing that students weren't willing to take up the challenge, the BEO acted as if he had scored a point, and said that what was the use of their covering all the course then if, they weren't able to solve math problems. Dinesh tried to impress the

BEO by telling him that he taught English to 8th graders and its course had already been completed, and they would only be doing revisions from now on till the final exams. BEO too then started emphasizing the need for revisions to start as soon as possible. He enquired about science subject, and was told by the students that two chapters remained to be covered. He didn't look very happy about that. Students, especially Sheela, tried to stand up for Raghuvanshi and said that he taught science very well and that he even did science experiments in the class. Dinesh added that each chapter in the science textbook had some *kriyakalap* (activities) to be done in the class. BEO then enquired whether these science experiments are asked in exams. On hearing that they weren't, he compared the present sciende textbooks with Hoshangabad Science Teaching Program (HSTP) books that were used in this school till three years ago. He said that unlike HSTP science, it wasn't necessary to do experiments to 'cover' current textbooks. He emphasized again that there was no need to do experiments in science. Instead students can just read about the experiments from the textbooks. I too was put in bit of a tight spot as BEO then turned around and asked for my opinion. I replied that all teachers including Raghuvanshi worked hard with the kids. I further added that in my opinion this was a good school and that was the reason why I was doing my study here. Interestingly, neither the BEO nor Dinesh asked students for their opinions, problems or their experiences at school. After finishing his spiel, BEO left the room accompanied by Dinesh, and the students were left alone once again to do as they pleased.

As the reader may have noticed, this incident showcases some important ways teachers were expected to, and in fact many of them did, constitute their teaching practices. First, the teaching was primarily geared towards, as the common usage was, 'covering' the course, i.e. the prescribed syllabus. And to 'cover' the course basically meant to teach all the chapters of the prescribed textbook, and then revise the exercise questions at the end of each chapter before the final exams. Textbook was the only curriculum material I ever saw being used in class by the teachers. As I present in more detail in chapter 6, except for Raghuvanshi, all other teachers always stuck close to the text of the textbooks to teach a topic. The knowledge presented in the textbooks was regarded as uncontestable and final. Thus, as I present in greater detail in chapter 6, if according to the social studies textbook the Soviet Union still existed, so it was for the teacher and that is how it was presented to the students. Raghuvanshi did mention referring to other books sometimes while preparing his lessons. But other teachers didn't feel the need for supplementary material. The students, of course, did use subject guides to prepare for the exams.

Second, the teaching was supposed to be primarily test oriented. So it did not matter if the science textbook chapters suggested some hands on activities to be done by the students or to be demonstrated to them. If there were no questions on these activities, then the teacher was supposed to avoid doing them. Raghuvanshi once told me, "I do try that as many kids as possible benefit from schooling. .. And in my efforts, the problem is in aligning with the curriculum because if I try to implement my ideas, I am short of time, and that then influences the implementation of the curriculum. Though I am always aware that I should not focus as much on completing the curriculum as on teaching well. So I "cut" topics, and go ahead. I am always leaving some topics as I proceed." Obviously, as we saw above, the BEO disapproved such a way of 'covering' the course. Raghuvanshi's approach was also different from other teachers as is evident from Dinesh's attempt to impress BEO by his adherence to this expectation. Third, in the incident above, neither the BEO nor Dinesh try to probe what the students felt about the education they got in this school, their experiences or what they wanted their education to be. This was fairly typical of the way teachers in the school constituted their teaching practice. In a highly hierarchical school system like the one I saw in Rajkheda, the agenda was more often than not decided by the person(s) senior in rank, authority or age, and obedience and compliance by juniors was considered virtuous. Thus, students were rather incidental to determining what and how a subject should be taught.

This power relation between the teacher and the taught was also evident in the way communicative exchanges occurred between them. The teacher script enacted by the teachers in the class positioned students in a passive role. The teacher spoke; the students listened. Or the teacher-student dialogue resembled Initiation-response-evaluation (IRE) discourse patterns. Another common form of teacher-student interaction used to be what in India is called the "tu-padh" (you-read) method. In this the teacher asks a student to read aloud a chapter from the textbook. While the student reads, other students listen, and it is assumed that the chapter is being 'covered'. For passages that are deemed difficult by the teacher, an exegesis is presented by him.[5] The room for student initiative in this sort of teacher script was limited. Except for Raghuvanshi, the teachers made little effort to invite, facilitate and legitimize students own voices, experiences, discourses and agenda in co-construction of their own learning experiences in the classroom. Further, only Raghuvanshi took spontaneous and contingent detours from this script or allowed the students to steer the classroom dialogue in unscripted, albeit often productive, directions.

[5] I am using the male pronoun to refer to the teacher as all the teachers in that middle school were male.

A teacher's relations with the students outside the classroom were in many ways a reflection of the way he interacted with them inside the classroom. This is best manifested in the type of errands students were asked to do outside the classroom. There were no custodians for the maintenance and upkeep of the school. Within the school walls, the school community comprised just the teachers and the students. So teachers summarily requisitioned students for any errand that needed to be done in the school. For instance, one day as I entered the village to begin my fieldwork for the day, I found Narendra and a couple of his 8th grade friends standing close to the school wall outside the main gate. The morning assembly was over, but still these kids kept standing outside, and out of the sight of their teachers inside the school wall. Puzzled, I asked them why weren't they entering the school even though they were late. Narendra whispered that if they entered now they will have to pick up trash (*pattal*, *done*) from the ground. At first I didn't understand, but when I looked carefully at the ground inside, I found it was littered with used paper and plastic cups and plates left over by the wedding party that had stayed in the school premises the night before. Neither had the hosts cared to place for the guests some garbage bins or send someone before the school opened to clean the mess, nor the guests had given any thought of not throwing the trash all around. So Narendra and his friends feared that they would be asked to pick up all the trash now. Luckily, as the trash was too much and all around, the teachers didn't ask students to clean the school ground. Though, the students had to clean up their classrooms which had been used for lodging purposed by the wedding party. But this the students didn't mind as it was their daily morning chore. On other days though Raghuvanshi or Mahto did pick up some students before the classes began to clean the school grounds. Thus, as rest of the school stood in gradewise lines and sang their daily prayers, 5 – 6 students would be busy picking up trash from the school grounds instead.

The students did other jobs as well, such as fetching water or tea for the teacher to drink, ringing the school bell, opening the classrooms and staffroom in the morning, fetching stationary and books for the teacher, and repairing classrooms and boundary wall. It did not really matter if the hapless student at that time was busy learning in the classroom, or had to rush home after school. If a teacher needed him at that moment, he or she was requisitioned for the purpose. Further, the students were almost always ordered and never requested to do an errand, and never thanked or shown gratitude for their labor. The students complied with such demands, and didn't show much displeasure or resentment about them. Only once, when some 8^{th} graders were asked to stay back after the school was over, to cut down branches from a tree, and then erect a fence to cover the open gap in the school wall, did I overhear some words of resentment from a couple students.

The teachers of the school together formed a relatively harmonious peer group. All the teachers I spoke to talked well of their peers and praised the help they got from them. Speaking of help he receives from his peers, Raghuvanshi said, "If I talk about our staff here, then I would have to say that I have received their cooperation. Nobody has ever told me not to teach in a particular way … I also receive encouragement from my other colleagues, like, Mehto sir…. For instance, just now, without my asking, he got a box of colored chalk for the school – something that I had been planning to buy myself for a long time. .. So now I quite enjoy teaching geography, and making maps. I use colored chalk for that. .. So like this I get cooperation from the staff. I get help from them too. We help each other. Like both Dinesh and I teach class 6, so he said that I teach geography well and requested that I should teach the geography part of the social studies curriculum, and said that he would cover the civics and history portions. So, this sort of coordination also encourages you to teach better." I also noticed this sort of coordination in the way each teacher picked up the slack for another teacher, in case he wasn't in a position to teach his scheduled period.

There were indeed some undercurrents of tension among them. For instance, Raghuvanshi felt that the headmaster of the school, Mr. Mahto, didn't support him in front of his superiors, such as the principal of the local higher secondary school who also had some supervisory powers over the Rajkheda middle and primary schools. Raghuvanshi was of the opinion that this was so because he and the headmaster belonged to different teacher unions. However, I never observed such tensions coming to the surface and making the teacher group dysfunctional.

Thus, teachers' approach to teaching, his relation with the 'official' text, and with students and with their peers, as I have discussed above, were some of the important elements of teacher professional discourse that I happen to observe during my fieldwork. This discourse didn't always appear as one of the factors that influenced an event in my data. Further, not all its elements were operative when I saw it influencing an event. Or to be more precise, this discourse or its elements didn't always surface in my data.

School Science Discourse

In this section, I present my analysis of the school science discourse the way it factored in students' and the science teacher's actions in the events I happen to observe. As a point of reference, I use the National Curriculum Framework (NCF), 2005 – a document prepared by the National Council for Education Research and Training (NCERT) that lays out a recommended curriculum framework for state level curricula and textbook making bodies.

I should mention here that education being a state subject, curricula and textbooks to be used in government schools run by the state governments are made by state level bodies that are answerable to the state governments. Thus, state governments are not bound to follow the advice tendered by NCERT in designing their curricula and writing their textbooks. However, NCERT being the apex institution in this arena, the curriculum frameworks produced by it do frame the national discourse on curriculum, and also serve as template or reference points for state level curricula making bodies.

For teaching of science in schools, NCF, 2005 makes following recommendations:

1. *Content, process and language of science teaching must be commensurate with the learner's age-range and cognitive reach.*
2. *Science teaching should engage the learners in acquiring methods and processes that will nurture their curiosity and creativity, particularly in relation to the environment.*
3. *Science teaching should be placed in the wider context of children's environment to equip them with the requisite knowledge and skills to enter the world of work.*
4. *Awareness of environmental concerns must permeate the entire school curriculum (National Curriculum Framework 2005).*

Let's consider NCF's first recommendation, viz. Content, process and language of science teaching must be commensurate with the learner's age-range and cognitive reach. The science textbook, and hence the syllabus, for 8th grade has the following chapters (*Vigyan: Kaksha 8*, 2004):

Table 4.5: List of chapters in 8th grade science textbook

No.	Chapter
1	Carbon
2	Compounds of carbon: Fuel
3	Light
4	Pressure
5	Magnetism
6	Electric current
7	Rocks, minerals and metals
8	Metals and its properties
9	Manmade objects
10	Microscopic living world
11	Agricultural practices and implements
12	Useful plants and animals
13	Biological evolution
14	Conservation of natural resources
15	Alternative sources of energy
16	Structure of leaves

Prima facie, this list would appear comparable with the sort of science topics students of this age group and grade would be expected to learn in most parts of the world. For instance, all of the above topics figure in some form or the other in Michigan science curriculum framework at the middle or elementary school level, except for metals that are placed at high school level. However, the content list in itself doesn't tell much because the same content can be taught at different levels of complexity at different grade levels. Also, important is the context in which school science knowledge is imbedded and the ontological nature of the knowledge so presented by the textbook, and thus the school science discourse. Thus, to enable a closer look, I present an analysis of content, process of teaching and speech genre of the chapter on electric current (*Vigyan: Kaksha 8*, 2004). This chapter has been chosen purposively for two reasons. First, I was able to observe the teaching of this chapter from beginning till end. And, second, as the following findings chapters show, most students had an extensive experience of working with electricity and electrical appliances at home and workplaces.

This chapter begins with a review of the concepts of electric charge and electrostatic attraction and repulsion between charges. These concepts were part of the 7^{th} grade syllabus. After that, the sequence of topics is as follows: (a) Nature and sources of electric current: under this topic, after a very concise description of electric current in a simple circuit, there were descriptions of different sources of current, such as Voltaic, Daniel, and dry cells, followed by storage battery, solar cell and dynamo. (b) The next section describes in one brief paragraph the idea that a flowing charge has energy. (c) Electric circuit: the idea of open and closed electric circuits is discussed, and circuit diagrams of such circuits are introduced. (d) Suggested activity involving making a simple bulb circuit. (e) Suggested activity that demonstrates the conductivity of current in different types of water solutions. (f) A two-paragraph section on heating effects of current. (g) Suggested activity to show heating effect of current. (h) A two paragraph description of chemical effects of current. (i) Suggested activity showing chemical effect of current flow in a copper sulfate solution. (j) A one paragraph description of magnetic effect of current. (k) One paragraph description of alternating and direct currents along with their graphical representation. (l) Final section on dangers of and precautions regarding electric current. The chapter then ends with a list of important facts and statements about electric current from the chapter, and a list of questions on the chapter topics.

The very first thing that strikes me about this list of topics is the vastness of its coverage. The chapter achieves the audacious feat of compressing within 7 pages, a total of 8 major concept areas in electricity. As a result, some complex concept areas like the nature of and distinction between get 'covered' in just one short paragraph. This chapter is no exception; the extent of coverage of conceptual areas in other chapters is equally breathtaking. Thus, considering that there are 16 chapters in this textbook, if I add up all the different concept areas 'covered' in all the 16 chapters, the textbook comes across less as a textbook for kids, and more as a compressed science encyclopedia for kids. Further, the reason for clubbing all these topics together in one chapter is not clear. The only thing that connects these disparate topics together is the fact that all of them are electricity topics – an organizing principle that befits encyclopedic compendiums more than school textbooks. Lacking coherence, the chapter abruptly lurches from one topic to another without any smooth and reasoned segue. Thus, for instance, after the section on conductors and insulators, students are suddenly confronted with a section on heating effects of current without any connecting text that would explain to the students the rationale of this transition. Two key criticisms of science curricula in American schools that has emerged from The Third International Mathematics and Science Study (TIMSS) have been that science curricula in American schools tend to be 'a mile wide and an inch deep', i.e., tend to cover too many topics, and lack an organizing principle that would limit the number of essential topics (Schmidt, 2003). From the coverage of topics in the electricity chapter, it is clear that this textbook suffers rather severely on both these counts.

The extensive coverage of concept areas in a chapter, and the fact that there are 16 such chapters in this textbook forces author(s) to attend to each topic only very superficially. The box below presents English translation of the section on chemical effects of current:

Chemical Effects

We have seen before that when *electric current* ("vidhyut dhara") is passed through water, it *dissociates* ("vibhakt") into its two *components* ("ghatak") Hydrogen and Oxygen gas. The *dissociation* ("vibhakt") of *chemical compounds* ("rasayanik yougik") by the action of *electric current* ("vidhyut dhara") is called *electrolysis* ("vidhutya apghatan"). The *chemical compound* ("rasayanic yougik") solution that *dissociates* ("apghatith") is called an *electrolyte* ("vidhutya apghataya"). The two metal plates that are immersed in the solution, through which *electric current* ("vidhyut dara") flows in the solution, are called *electrodes* ("vidhyutagra").

When an *electric current* ("vidhyut dhara") is passed ("pravahit") through an *electrolyte* ("vidhutya apghataya") it *dissociates* ("vibhakt") into its *constituent ions* ("avyavi ion"). *Positive ions* ("ghanatmak ion") get attracted ("akarshit") and flow ("pravahit") towards *cathode* ("rinagra"), and get deposit ("ekatrit") there. A very easy use of *chemical effect* (rasaynik prabhav") of *electric current* ("vidhyut dhara") through which objects can be covered with a thin layer of metal is called *electroplating* ("vidhyutiya lepan"). For example, a layer of Nickel and Chromium can be put on iron so that it does not rust. Putting a layer of gold and silver on cheap metals and expensive articles can make them look beautiful. To observe this let's do an experiment. This experiment needs a carbon rod which can be procured from a used cell or battery (*Vigyan: Kaksha 8*, 2004, p. 37).

(This section is then followed by a suggested activity showing electroplating of copper on carbon rods.)

This section is all there is about chemical effects of electric current in the entire middle school science curriculum. As the reader can see, the author(s) have tried to compress a lot of scientific content in these two paragraphs thereby giving the text some very distinctive features. First, Faced with the task of summarizing a vast body of scientific knowledge on chemical effects of current in just two paragraphs, textbook author(s) chose to focus only on definitions and descriptions of scientific phenomena in their presentation. Owing to differences in discursive contexts in which science is practiced and communicated in a scientific community vis-à-vis a science classroom, scientific discourse, the way it is in scientific research communities, needs to be recontextualized, for the discursive context of a science classroom. One way writers of science textbooks tend to do this is by focusing on the conclusions of scientific studies rather than on the details of the supporting data and arguments. They leave out the painstaking data collection and pattern-finding activities of scientists that led to these conclusions. As a result, scientific knowledge gets presented as a loosely related package of facts, definitions, and sequences of events in science textbooks. We see this happening, rather in the extreme, in the selected text on chemical effects of electric current. For instance, the first paragraph consists of nothing other than three definitions and one sentence description of the electrolysis of water.

Second, the extent of nominalization of scientific terminology in the text is simply mind blowing. Some bit of nominalization is inevitable because of recontextualization of science from scientific research communities to a science classroom, but, certainly not to the extent as seen in the text above. There are 13 technical terms in these two paragraphs. Each such term compresses within itself so much of concrete referential information, links to direct experience, observable properties, material particularities, and relations among material objects that is largely invisible to the students. As a result, school science discourse as constructed by this textbook in the classroom becomes so much more abstruse, alien, far removed from the experiential base of the students, and thus far more inaccessible for use in furthering ones agency over the material world.

Third, the text comes across as a canonical story that provides an authoritative account of the world. As a result, the school science discourse emanating from the textbook is an authoritative discourse that does not aim to persuade, but "demands that we acknowledge it, that we make it our own; ... we encounter it with its authority already fused to it. ... it demands our unconditional allegiance" (Bakhtin, 1981, p. 343).

Fourth, this section stands on its own in the whole chapter, and in fact, the whole book. It does not build upon the preceding section which was on heating effects of current, and does not contribute to the following section on magnetic effects. Also, it uses scientific phrases, for instance, positive ion, that enter the text all of a sudden, and vanish likewise from following pages. It reminds students of electrolysis of water. But there is no mention of this phenomenon in the preceding text of this chapter or the preceding chapters of the book. Electrolysis of water is something that student learn about in grade 7. So without teacher's help a student may not recall or remember where she may have encountered this phenomenon before. Thus, this section comes across an isolated disconnected piece of text. Unfortunately, the entire book is strung together from such disconnected texts.

Finally, the speech genre of the text is totally alien for the students. Even for non-technical actions, objects and processes, instead of using simple everyday words, the text uses archaic, Sanskrit-based words, like "vidhyut dhara" (electric current), "vibhakt" (dissociate or break), and "pravahit" (flow). Nobody uses these words in everyday discourse, except, perhaps for humorous purposes. As Bakhtin realized such words resist appropriation, they remain alien and if used "sound foreign in the mouth" and "put themselves in quotation marks against the will of the speaker" (Bakhtin, 1981). Thus, whenever the context was congenial, students avoided using the speech genre of the science textbook for purposes of communication.

They also barely understood it. This became clear to me one day when Raghuvanshi while 'covering' the topic of magnetic effects of current, asked students to read the activity (*kriya-kalap*) that demonstrated magnetic effect of current from their textbooks. My notes for the day recorded this event as follow:

> *Students started reading. Most of them were reading aloud so that created quite a din in the classroom. ... After a while, Raghuvanshi asked them what they understood after reading from the book. Ramesh replied that they had to connect ends of a wire to a cell. Raghuvanshi not satisfied asked again that what was one supposed to do in that experiment. I found that nobody volunteered to explain. Then Raghuvanshi asked students to identify the equipment needed from the diagram and the description of the experiment in the textbook. Some students could identify wire and cell. ... He then explained what was one to do in the experiment, and then asked if needle would move once current was flowed in the circuit. Students again apparently had no clue as no one responded to Raghuvanshi's question.*

Thus, though students could read the text, they could barely comprehend it. The best they could do was to memorize it so that they could pass the exams by regurgitating it on the answer sheet for the examiners. And this they certainly did as their responses to questions asked in the exams show. Based on my past experience of working with students in India, I feel that after some years of experience with such textbooks many students simply stop believing that the text contained in these books is actually meant to be understood.

Now, let's come to the second recommendation by the National Curriculum Framework (NCF) about science teaching. It recommends that "science teaching should engage the learners in acquiring methods and processes that will nurture their curiosity and creativity, particularly in relation to the environment." For this happen, teacher should not only engage students in scientific inquiry in the classroom, but also create contexts for the students to do meta-level reflections on the knowledge constructed through inquiry and the processes they used to do so. Also, the primary context of scientific inquiry has to be the immediate environment of the students. However, the way the science textbook presents science to the students, NCF's aforementioned recommendation seems difficult to realize in practice even for the most determined teacher. First of all, the textbook is the only window to science that both the teacher and students in the Rajkheda middle school had access. However, the textbook presented itself both to the teacher and the taught as the repository of the final uncontested knowledge of the material world. Because of the way this knowledge was inscribed in the textbook, students could not directly access it with much success without the mediation of the teacher. Thus, the textbook tended to position itself as the fountainhead of scientific knowledge, the teacher as the interpreter and conduit of this knowledge and students as passive receivers. Such subject positioning encourage lecture driven and IRE based instructional practices wherein students do not learn to learn. Neither does their sense of curiosity and wonder about the world find legitimate avenues of expression in the classroom. Instead, what students learn is to strategically mask their curiosity, and work the system for their survival by memorizing the science text.

Also, it seems that author(s) of the textbook either do not believe in the NCF vision of science teaching or think that it is a far fetched dream in currently existing conditions. I say this because the way activities are written in the chapters, they become superfluous. In each activity description, the results of activity are already described so that even if a student does not do an activity she can know what is supposed to happen if that activity is done.

NCF's third recommendation is that "science teaching should be placed in the wider context of children's environment to equip them with the requisite knowledge and skills to enter the world of work." Students of the school, as the following chapters show, were young productive members of the local economy. Their work at home, farm and other workplaces had given them rich experiential knowledge of the world – a knowledge that let them exert considerable level of material agency over the world. They could make mud stoves, hammer iron sickles out of hot scrap iron, draw electricity from high voltage overhead cables for their homes and so on. However, they, like the rest of us, were also keen to further their abilities to understand and control material objects and phenomena for their functional purposes. Thus, they actively looked for and appropriated mediational tools that let them further their material agency from wherever they could. A science classroom is then a natural and obvious place to build ones mediational toolkit about the material world.

A science classroom can indeed become such a place if the science teacher encourages students to bring their experiences, knowledge and discourses from outside the school into the classroom, and uses them to situate school science in the daily lives of the students. School science discourse can be of great help in enabling the science teacher create such learning contexts. However, the author(s) who wrote this textbook didn't belong to the local region, and thus were perhaps unaware of the local contexts of students of Rajkheda. Besides, even if they were aware, it is doubtful they could create situated and personally meaningful learning contexts for students of Rajkheda as this textbooks was written for the whole state, and thus assumed a student that didn't share much resemblance with the type of students that the 8th grade of that school had. For instance, as I show in the following chapters, most students knew how to construct electric circuits using alternating current. However, the science textbook assumed that students didn't know much about circuits. Besides, school science discourse represented by this textbook was an authoritative one that didn't acknowledge students as creators of their own knowledge, and co-constructors of learning experiences in the classroom. As a result, school science discourse provided the teacher with very little opportunities to translate NCF's third recommendation into reality.

The textbook has two chapters, *conservation of natural resources* and *alternate sources of energy*, that raise environmental issues of depletion, destruction and pollution of natural resources, and energy shortage, and pose them as environmental concerns for students. Such concerns are, however, missing from other chapters. Further, the way environmental concerns have been raised in chapter make them remote from the everyday life of the students. There is no effort to help students connect their everyday experiences with water or electric energy shortages for example, with the larger picture. For instance, in the chapter, conservation of natural resources, the problem of destruction of natural resources is presented as a general problem facing the mankind with no illustration of how this problem could be playing out in the lives of people in a certain area. As a result, the solutions suggested are also equally general in nature, such as we all should consume less resources. One important role science curriculum can play is to help students evolve into active citizens that are concerned about their own environmental problems and capable of doing something about it. However, there are no suggested projects or even examples in these two chapters that encourage students to look at their own environmental problems in the neighborhood and search for a collective solution.

In its fourth recommendation, NCF desires that "awareness of environmental concerns must permeate the entire school curriculum". As I presented above, such concerns are extremely patchy in their appearance across the two chapters on conservation of natural resources and alternative sources of energy, and are missing altogether from rest of the chapters. As a result, these concerns do not influence the character of the science curriculum in any major way. As a result, school science discourse doesn't really help a teacher much in making these issues relevant to the lives of the students.

Thus, we see that the school science discourse in the 8th grade classroom at the Rajkheda school was geared for a kind of science teaching very different from the one recommended by the NCF. That is, if a teacher, such as Raghuvanshi, taught in ways that matched NCF, then it was not because of the extant school science discourse, but in spite of it.

Summing Up

This chapter prepares the stage for the following findings chapter by creating contexts at multiple scales within which the results of this study can be interpreted. Starting from a national perspective, this chapter takes broad look at the state of human development, especially the status of education, at succeeding smaller levels of state of Madhya Pradesh, the district of Hoshangabad, and finally the village of Rajkheda in which the study site was located. Then a perspective on the school is presented in terms of its resources and constraints, daily routine, and the elements of teacher professional and school science discourses that I found contingently operational in the events I happen to observe in the 8th grade classroom.

Chapter 5
Students: Outside School

The research questions of this study are directed at understanding students' participation in science periods taught by Mr. Raghuvanshi. However, to have a better and more grounded appreciation of what students did or did not do in school, it is important also to understand their lives outside school. In this chapter, I attempt to do just that. Starting with a portrait of their family background, I narrate their daily life activities focusing on the depth and range of their experiences with their immediate material world. I then describe how the knowledge students accrued from these experiences got revealed in events occurring both within and without classroom in different ways in accord with the contingent factors that came together momentarily to influence the event. However, some broad trends in their knowledge representations could be discerned, and thus are presented here. Towards the end, I present an analysis of important themes emerging out of data that reflect students' attitudes towards education, school science and their science teacher.

Students' Family Background

As mentioned in the previous chapter, about 46% (1997-98 data) of Rajkheda families fell below official poverty line. The neighboring villages that sent students to the middle school in Rajkheda didn't look any different from Rajkheda, and thus can be assumed to be having similar poverty levels. The official poverty live being pegged very low at Rs. 368 per month (about $8 per month) for rural areas (2005 figure, after adjusting for inflation; source: http://www.indiaresource.org), it doesn't take much affluence for rural families in India to ease out of official poverty, and still leading impoverished lives. Considering the low level of human development indices for the region, as reported in the previous chapter, it would be fair to say that most of the students in Raghuvanshi's class came

from poor to very poor families. During the course of my fieldwork I visited homes of six students in four villages including Rajkheda, and chatted with their parents. As is obvious from the brief profile of the parents of these students given in the accompanying table 5.1, they came from families with poor socio-economic backgrounds and low levels of literacy. I didn't select these families on the basis of a random sampling exercise. However, considering the high levels of poverty in the village as mentioned above, the fact that only 5 out of 49 students in grade 8 were from the upper castes, and the average landholding in the district in

Table 5.1: Focus students' background

Student	**Caste**	**Family Profession**	**Parents Educational Background**
Raj	Scheduled caste (Katia)	Landless laborers	Both parents Illiterate
Sarla	Scheduled caste (Katia)	Landless laborers	Father educated till grade 5; mother illiterate
Ganesh	Not known	Farmer	Father been to college; mother not known
Narendra	Other backward caste (Gujjar)	Farmer	Both parents illiterate
Mahesh	Scheduled caste (Lohar)	Ironsmith	Both parents Illiterate
Amaresh & Amita	Upper (Soni)	Night watchman in a weighing station	Father educated till Grade 10; mother not alive

which this village fell is mere 9.2 acres (1998-99), it can be assumed that these families were fairly representative of the type of families students in grade 8 hailed from.[1]

Ritesh Shrivastav, the teacher who taught social studies to grade 8, was of the opinion that, "Parents that are educated have a good attitude towards education. Parents who are uneducated are more concerned about their work. They don't pay attention to their kids education. They think this is some "extra" thing, when they should realize that it is the "main" thing." However, all the parents I met, and especially the ones that were illiterate or barely literate, were eager to get their children educated. Education offered hope for a better tomorrow. Mahesh's father, a poor ironsmith in the neighboring village of Ajneri, said, "I am illiterate, and have lived my life, but Mahesh has still a life to make, and if he becomes educated then he will be able to do many things, such as getting bank loans or opening up a shop." Sarla's mother expressed her worries to me about her daughter not passing the annual examination for grade 8. Thus, I was told that Sarla was woken up as early as 4:00 in the morning so that she could study for her exams. And according to Sarla's both parents, they also had their kids study in the evenings. Most students I talked to told me that they were woken up early by their parents in the morning so that they could study for a while. Besides, all the parents I talked to, except for Amaresh and Amita's father, sent their wards to extra tuition classes in the morning just before school. Mr. Soni, the father of Amaresh and Amita, had a monthly income of mere Rs. 1500 ($32.48), and thus was perhaps too poor to afford tuition.

Like Sarla's mother who worried if her daughter would pass grade 8, I found that even illiterate parents had a sense of how well their students were doing at school. However

[1] The average size of agricultural farm in United States is 444 acres (source: United States Department of Agriculture on web @: www. usda.gov

they had limited means to help their children do well at school. For instance, consider Raj's family. Raj lived in a one-room shack made of mud walls and thatched roof with his parents and a younger sibling. Raj's parents were illiterate and extremely poor. Talking to them was a sobering experience as I realized how helpless they felt in their pursuit to ensure education for their kids. Raj's father confided to me that he was very worried about Raj's younger brother who was in 5th grade and still didn't know how to read and write. Being illiterate obviously they couldn't help their son academically at home. When I inquired if they ever went to school to enquire what sort of education their kids were getting at school, Raj's father bowed his head down and uttered "no" softly. None of the parents I talked to ever went to school to talk to teachers about how well their kids were doing. As Raghuvanshi said, "an illiterate person does not have the courage to go to the teacher and talk to him about his kids' education, like asking him why are you teaching this, and why aren't you teaching that? .. Yes, how can he say that? He can never say that." Being illiterate or barely literate, most parents weren't able to help their children academically at home either.

When Raghuvanshi and I went to Narendra's house to meet his parents, his grandmother who lived with the family told Raghuvanshi that since theirs was not an educated family (Narendra's father was an illiterate farmer), it was up to Raghuvanshi to make sure that he did well at school. Narendra's grandmother's request thus in a way corroborates the reply that Raghuvanshi gave to me when I asked him about parents' attitudes towards education of their kids. He said, "Parents .. I agree that they want their kids to get educated, and .. want to send their kids to schools to get them educated. .. But after they get educational materials for their kids, they think that now it is their kids job to study, and the teachers' responsibility to teach them." Thus, I found that most parents in general maintained a distance from the school and the teachers they sent their children to. There were exceptions, of course. Members of the dominant family of Patels in Rajkheda, for instancce, thought nothing of entering the school to have a chat with a teacher. In fact, one day I saw one person (younger brother of ex-*sarpanch* of the village[2]) belonging to this family entering the school premises to give a sound verbal thrashing to a kid who he thought had a fight with his son. After scolding that hapless kid who was cowering in fear, he angrily complained to the teachers who had gathered at the scene, and demanded that the father of that kid be summoned right away to apologize for his son's putative errant behavior. The poor illiterate denizens of the village, on the other hand, kept to themselves and came to the school only when called by the teacher.

They also refrained from making any criticism of the school or the teachers to me, and preferred to blame their children instead for their poor academic performance. As Sarla's father said, "village kids do not like to study." A sentiment shared by Mahesh's mother who said that her son was more in playing games with his friends than in studies. Their circumspection in criticizing the school with me may partly have to do with my ambiguous positioning as a researcher and as someone closer to teachers in profession, and socio-economic standing.

Students' Lives Outside School

In my conversations with students of the 8th grade, one of my several queries always had to do with the life they led outside the school. As I mentioned in the chapter on methods,

[2] *Sarpanch* is an elected head of the local village council – the *gram panchayat*.

some students, especially girls, were not willing to talk about their life outside school with me. However, the ones who did agree painted a rich portrait of their everyday activities of outside school.

Through them I came to know that most kids of their age (13 – 16 years), especially those belonging to poorer families, led a pretty busy life as productive members of the local village economy. Before and after school, they helped their parents at home, farmland and/or in their family profession. For instance, Raj who came from a family of landless agriculture workers, told me that he was then helping his parents harvest sweet potatoes from an agricultural farm they had taken on contract from the landowner.[3] During forthcoming vacations in the summer, he planned to join his uncle to work as a wage laborer at a brick-making factory close by. He said he had been working in this factory during summer vacations for the past five years. Likewise, Mahesh's father was an ironsmith who worked from his home. Mahesh told me that he helped his father, and could make iron sickles on his own. On visit to his home, his mother confirmed that she and her husband let Mahesh make small farm implements. Mahesh's father also moonlighted as agricultural labor. Following his father's lead, Mahesh told me that in his spare time he also worked as a hired labor on wages. When I asked him what sorts of jobs he did, he replied, " All types .. If somebody needs labor, I go there. If soybean is being harvested I go there." It seems that students hailing from comparatively better-off families were not required to contribute as much to the family's income or work. For instance, when I asked Narendra if he helped the family in growing crops, he replied, "No sir, not that much. Nothing special." Narendra's family owned agricultural land and lived

[3] I got to take with me delicious baked sweet potatoes, when I went to his home to meet his parents.

in a better looking house than his poorer peers like Raj and Sarla. However, Narendra too, as he told me, helped in household chores, such as cutting fodder for and feeding the cattle the family owned. Similarly, Deepak, who belonged to a relatively well-to-do family with father having a side profession as a priest, admitted not helping his family in cultivation of crops.

Most students I talked to also helped their family in household chores. I could also see some gender-based division of labor, especially in case of household work. For instance, though some boys reported that they could make food, cooking was primarily a girl's domain. Boys helped in taking care of cattle, filling up water to drink, and helped in maintenance and running of agricultural and other implements and appliances. In case of poorer families, however, the gender division was less marked as all members had to work out of sheer economic necessity. As a result, everybody had to do at least little bit of everything for the whole family to survive. For instance, Raj's both parents used to be at work when he returned from school around 4:00 PM. So, as Raj told me, he usually cleaned the house and washed the utensils, which are traditionally women's jobs, after returning from school, while his both parents were away working on somebody's fields. On her return from work, her mother then cooked food for the family. Likewise, Sarla, being the eldest daughter of poor landless agricultural workers, not only cooked evening meals for the whole family, but also worked as a productive member to add to the family's income. While talking about the 'weak' condition of her family, she told me, "Sir, in grade 8, I went to fields to do weeding and harvesting of soybean. And now after the examinations are over, I'll go to harvest wheat."

All this non-academic work was done by these kids in addition to the full time responsibility of being students in a middle school and teenagers with active social lives. They had to find time during the day for not only hanging out with their friends, but also to prepare for the approaching annual examinations on which their academic future depended. Thus, most kids I talked to mentioned getting up early in the morning, in some cases as early as 4:00 AM, to study before the hustle-bustle of the daily routine started. It mustn't have been easy for them. Speaking of his difficult morning routine, Raj said, "You see, ever since this month of January started, I have been getting up very early in the morning, getting up at 4:00 in the morning. It was difficult for the first week. I used to tell my mother to wake me up, but I just wasn't able to open my eyes. But after a few days, it was possible to wake up so early. After getting up, I go to toilet. I wash my face and hands so that I don't fall asleep again. And then I sit separately on a bed to study. I study till about 6 O'clock. Then I again wash and freshen up again. Then I drink tea around 7:00, and then head for tuition classes." After coming back from his tuition classes, Raj took a bath and had his early lunch and then headed for school that started at 10:30.

Of course, doing all this extra work besides being a full time student wasn't easy and sometimes led them to miss their classes. For example, one day when I was walking back from Sarla's house to the school, Sarla's younger brother, Ramji, accompanied me for some distance. School was about to start, so I asked Ramji if he was accompanying me to the school. He told me that he wasn't going to the school but to the village government public distribution supply shop to get kerosene for the house. I asked him when would he come to the school then. He said he wouldn't be going to the school as he had to feed the cattle that day. Similarly, sometimes girl students too had to stay back to take care of household chores as I learned one day when I asked Amaresh why her sister, Amita, who was in the same grade as him, was absent that day. He told me that she was cooking food and had got late doing that so she couldn't come. I then asked if their mother made her finish cooking before she could leave for school. Amaresh replied in a subdued voice that their mother was dead. So Amita, still in her teens, had already become a fulltime caregiver for the family in addition to being a student of 8^{th} grade. Whenever I went to Amaresh and Amita's house to meet their father, it was always Amita who did the welcoming chore, like offering water to drink and making tea for all, for the guest, i.e. me. My impression that girls in Raghuvanshi's class often had to work a lot at home got confirmed several times during the study. For instance, once I was having an informal conversation with Beena, Uma, Mukta and Amita. It was lunch break and we were chitchatting about sundry things. During the conversation I remarked, "I have been talking to both boy and girl students. It seems girls do not get time to study at home because of all the work. And sometimes they are even not able to come to school because of all the work at home." All the girls wholeheartedly concurred with my remark said almost in unison, "Yes sir! That's true! We hardly get any time to study at home." Of course, like boys, girls from better off families were .. well, better off in this regard. Uma, who hailed from a relatively prosperous and upper-caste (Brahmin) family of the village, admitted that though she knows how to cook, she doesn't have to as there are other people at home to do the cooking. She further added that she cooks food only now and then when need arises.

Students' Experiences with the Material World

As a result of their active engagement with paid and unpaid work at home and workplace, most students of 8th grade had accumulated years of rich experience of either working with many material objects and phenomena relevant to their daily lives, or had closely observed adults working with them as legitimate peripheral participants in native discourses surrounding them (Lave and Wenger, 1991). It is not possible for me to give a complete and extensive account of the range and nature of students' experiences with Nature. However, in this section I attempt to give the reader an idea of the wealth and diversity of their experiences through an account of the kind of things they did or were able to do in the daily life contexts of working with plants, cattle, electricity and cooking. This section, thus, sets the stage for talking about the nature of knowledge representations that students produced in different contexts and how these knowledge representations relate with the nature of experiences students had with the material world as part of their daily lives.

As I mentioned above, almost all 8th grade boys I interacted with during my fieldwork, either worked on or had opportunities to closely observe adults working on agricultural farms and homestead vegetable gardens. The only exception I came across was Amaresh whose father neither owned agricultural land nor worked on it. As mentioned earlier, he worked as night watchman at a weighing station close by. Amaresh's elder brother too, after quitting school in 10th grade, worked as an apprentice at a grocery store in the neighboring town of Pipariya. So, perhaps, he didn't have as many opportunities to work on farms as his other classmates. As reported earlier, most girls belonging to poorer landless families also had to work on farms.

As a result of their agricultural work, these students had rich experiences with plant life in all their life stages. They knew how to plant agricultural crops, grow and tend them, and harvest them when they are ripe. For instance, consider a part of conversation I had with Narendra on agriculture:

Me: But you surely know a lot about agriculture. Right?
Narendra: Yes sir.
Me: Do you know what is done and not done to grow wheat?
Narendra: Yes sir, before sowing wheat, the entire field is irrigated. Then there is something called "rakhad" that is ...
Me: What is that?
Narendra: 'Rakhad'.
Me: What is this?
Narendra: It is a powder.
Me: What does it do?
Narendra: Nothing, it just has some manure and keeps the soil wet.
Me: Ok.
Narendra: So that is spread throughout the field while plowing the field. Then wheat is sowed. Along with wheat, we put a manure called DAP, and the seed is sowed. The wheat grows up in 15-20 days. Then we irrigate the crop. Thereafter we have to irrigate the crop 3 times. Then one day 'bal' comes out.
Me: Your father had given water just a few days back.
Narendra: Yes. Now water has been given enough times, we wouldn't have to give any more water. .. We have finished with it just yesterday.

As we can see in this conversation, Narendra speaks pretty confidently about the different things a farmer needs to do to plant a wheat crop in that region. Unlike many other students, his knowledge, however, sprang more from close observation of adults than from his direct participation. As he admitted when I asked how did he know so much about agriculture, "I often go to the field. ... I see and sometimes when I go at night, I don't come back, and spend the night there in the field. … There is motor there, so I go there sometimes .. just to keep guard." Raj, however, worked in the fields, and thus his experience with plants wasn't vicarious like Narendra's. In the conversation fragment I produce below, he educates me about how wheat crop is harvested:

Me: How do you cut it (wheat crop)?

Raj: For cutting, first we select an auspicious day – a Monday or a Tuesday. That day, we just go in the evening, and just cut one fistful of wheat. We tie and keep it safely. And then the next day we start cutting wheat.
Me: So do you cut by your hands?
Raj: We cut it by sickles.
Me: And I have seen some harvesters here too.
Raj: Yes, there are harvesters too. Harvesters are used because they finish up in one day. Sickles are used because then thresher allows us to make hay for feeding cattle.
Me: You get hay when you cut wheat with sickle or when you use a harvester?
Raj: You don't get hay when you use harvester.
Me: Really? Is that so?
Raj: Yes. When you use harvester everything else comes out from below. So you end up getting nothing. When you cut wheat by a sickle, and then break it up in thresher, then it throws out hay from one side.
Me: From thresher?
Raj: Yes, from thresher.
Me: Then it must be a disadvantage to use a harvester?
Raj: Yes, your losses are great with a harvester. With harvester, a lot of wheat gets lost by spilling. You just wait and see, when harvesters are used here, you will see that a lot of wheat is lost in the field when harvester is used. You will find lots of kids, everybody picking those grains scattered by the harvester in the fields.
Me: Then what is the point of using a harvester? Why do people use it then?
Raj: People who have lots of land do that. Harvesting becomes manageable then. When a lot of wheat is produced. Big people do it. That is why.

It is clear from this piece of conversation that such detailed and nuanced knowledge of comparative advantages of using a harvester versus harvesting the standing crop through the traditional, low technology way could come to Raj only through years of observation as well as direct experience with harvesting of crops. Sarla too explained to me in similar terms the different things a farmer needs to do to grow crops. When I asked her how she came to know so much, she said, "Sir, I learnt it being observing others. By seeing how my father does things."

It is possible, though, that these kids were still not allowed to have experience of some agricultural operations, especially those that were hazardous in nature. For instance, spraying of insecticides on crops is done usually manually with the help of a spray gun and a canister of insecticide carried on ones back in that part of India. It is a risky operation as there is always a danger of exposure to powerful noxious chemicals. Mahesh told me about many different operations that he did on agricultural fields. But when I asked if he had ever sprayed insecticides, he said, "No, I have never put pesticides."

Besides working on farms, another important chore both boys and girls reported doing at home was taking care of cows and/or buffaloes owned by the family. As I understood listening to students' descriptions of their daily routines, feeding and giving water to them used to be primarily their responsibility. Milking them was something adults took care of, though some kids, like Raj, knew how to do it. It seems that through years of tending to them, students had accumulated a much experience about these domestic mammals. I had an inkling about the depth of their experience when I heard them talk about the various diseases cows get afflicted with and the homegrown remedies that are then used to cure them. For example, consider the following segment from a conversation I once had with Raj:

Me: And you know, cows sometimes get sick.
Raj: Right.
Me: So what types of diseases does it normally catch?
Raj: They catch cold .. And you know, their hooves. They also catch the disease of hooves – "baiga". You have seen there hooves, right? You know their hooves become like this (Shows me with his hands). ( )
Me: So how do you treat a cow? For instance if it catches a cold, then what do you do?
Raj: Then it has be fed "auta".
Me: you mean porridge.
Raj: No, of garlic, and it has 1 kilo of ("khilwara"). This big, and fruit of ("peda"). That and "saunf", "aijwayun", and garlic is grounded into a paste and dissolved in water. The cow is made to drink that. And if its stomach has bloated then feeding her leaves of (gajra) cures it fine.
Me: And if it is suffering from loose motions, then?
Raj: Then one should make a paste of "chedchitta", and feed that.
Me: What?
Raj: "Chedchitta."

Me: OK .. that should be fed.
Raj: Right.
Me: And if you treat a cow, and still it doesn't get well, then what do you do?
Raj: If it is serious, then a doctor has to be called.

Thus, as we see above, Raj not only knew the symptoms of two of the most common diseases but also had a detailed knowledge of how to prepare the homegrown medicines to cure them. Other students too impressed with their experiences with cattle. For instance, when I posed similar questions to Narendra, I got equally detailed responses. As example, I present below a similar segment of a conversation with Narendra on this issue of diseases of and cures for cows:

Me: and if your cow or buffalo falls sick do you what needs to be done?
Narendra: Yes sir, if it catches cold, then they must be made to drink mustard oil. And if it "phoks", then hay and "bhant" must be fed to them.
Me: Hay and ...?
Narendra: "Bhant".
Me: When do you give that?
Narendra: There are 7 grains, right? (I nod) wheat, gram, and so on. They are all mixed to make a mixture, and then it and hay must be fed to the cow.
Me: When should it be given? What is "phok"?
Narendra: That means that it is excreting loose shit.
Me: Oh, Ok. So if a cow falls sick, you do all this. But if it is very sick then what you do?
Narendra: if it is very sick, then we ask a knowledgeable person. And if he asks us to put "dima", then we put "dima" to the cow.
Me: what is "dima"?
Narendra: It is a sharp thing which is heated and the cow is poked with it.
Me: How does that help?
Narendra: That gives energy to the cow, and since it gets a shock, it gets ok.
Me: Does that bleed then?
Narendra: No sir, it doesn't bleed. Only the outer skin gets burned.

Here again we see an impressive display of experiential knowledge, a native, unofficial pathology, arising out of years of tending to sick cattle of the family. What is also remarkable in these two pieces of data is the fact that both students also recognized the limits of their knowledge, and knew when to ask for advice of a more knowledgeable person, usually the local veterinarian. These experiences can potentially serve as a solid foundation for building rich learning experiences for students in science. However, as the reader will see in the following chapters, this wasn't always feasible. In the next two chapters, I present the varied contingencies in which such rich experiences that kids had outside school, did or didn't get leveraged for the sake of their learning of science.

As I mentioned above, cooking was something that most girls, and some boys, had to at home, albeit to varying degrees and sophistication. Experiences with the family hearth were, however, not restricted to just cooking food. As I discovered one day during a visit to Sarla's home, having the responsibility of preparing meals for the family also included making and maintaining earthen stoves (called "chullah" in Hindi) on which food was cooked using fuel wood. Elder sisters in the family also made toy earthen "chullah" for their little siblings. I often found little kids cooking pretend food with beautifully made and decorated toy "chullahs" in evenings outside their homes. Through years of making these stoves, these girls in 8^{th} grade had acquired a rich experience of working with different types of clay and an appreciation of the thermodynamics of cooking food on such stoves using wood.

To give the reader, a flavor of the richness of their experience that they accrued while making these stoves, I present a portion of a very interesting conversation I had with Sapna and Sarla when I had gone to Sarla's house to meet his parents. Sapna was Sarla's cousin and lived in a house right opposite Sarla's. In between their houses was a dirt track barely wide enough for a small bullock cart to pass through. So when I reached Sarla's house in the evening, I found Sapna making a "chullah" in the open courtyard in front of her house. Seeing me, she stood up and greeted me. Curious to find out what she was doing, I struck up a conversation with her. Sarla saw me chatting with her cousin, and joined us. After returning to my lodgings, I noted the relevant segment of this conversation in my field notes as follows:

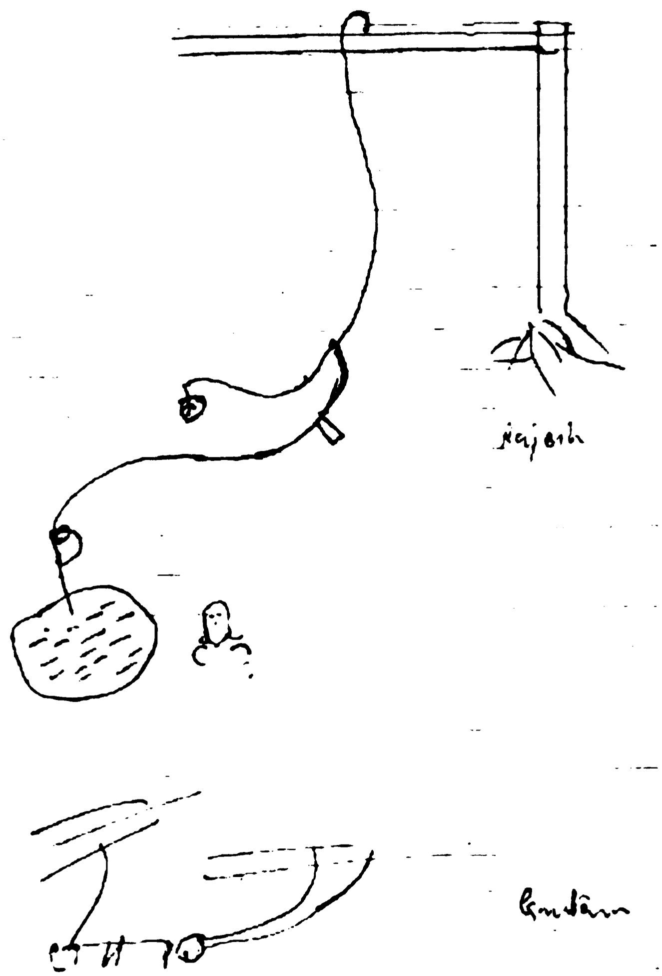
> *When I inquired how a "chullah" was made, Sapna said that it was girls' job. When I insisted on being told, both Sapna and Sarla explained to me how a chullah was made. They said that first they strain the soil to take out small pebbles, then soak it in water, then knead it after mixing it well in water. Then they mixed hay in it, and again kneaded it for about 30 minutes. When I asked why they did that. I was told that that was done so that "chullah" didn't break when it dried. I was told that "chullah" could be made with black as well as yellow soil. Sapna said she was painting the new "chullah" with red mud because it looked good. If she didn't paint it with red mud, it would have looked black and not so good. Red mud was brought from a red mud pit close to the village. Then with the help and support of wooden planks, the base and three sides of the "chullah" were made. After that it was left to dry, and its surface was smoothened by rubbing it with pieces of earthen baked tiles that are used in construction of roofs here. When I inquired about the height of the "chullah", Sarla said that it was usually roughly equal to about one palm and couple of fingers length, though the height varied. But she added that usually "chullah" weren't taller than this. When I asked whether these "chullah" gave too much smoke. Sarla denied, and said that it gave smoke only when the fire was extinguished. When I asked how long does a "chullah" last, Sarla said that one normally "chullah" lasts for about one year. But she made about 3 - 4 "chullahs" in a year. I then asked her if fire got dimmer because of deposition of ash. Sarla replied that when that happened they would take the ash out. The "chullah" had a small platform with raised edges in front. Sarla told me that was for making "baati" and roasting sweet potatoes on hot embers. I told Sarla that I had seen "chullahs" in which there were small thin parallel iron rods inserted a little above base. Sarla agreed that there are "chullahs" of this sort, and this was done so that ash fell to the bottom and thus didn't cover the burning wood. I asked where she had seen these type of "chullahs", Sarla said that she has had them in her own house. When I asked why they hadn't put iron rods in this "chullah" then, Sapna replied that that was because they didn't wish to go around asking others for these rods.*

This conversation shows the depth of Sarla and Sapna's familiarity with the materials used for building the earthen stoves. Through experience they had became aware of properties of the different types of clay. They knew that locally available clay cracks up on drying, but when mixed with hay, this property can be changed to their advantage. They had also developed an appreciation that height of the stove matters for its proper working. Through apprenticeship of observation and their own experiences, these girls had also come to know that basic design principles that were compatible with not only local culinary practices but also the thermodynamic constraints imposed by nature. Through these girls and other students I also came to know about the different types of food they could or had to cook at home. Once I got to eat a delicious meal prepared by Sarla. It seems likely to assume then that time spent in the family kitchen had given these kids immense experience with different kinds of food materials, their physical and chemical properties, mixing and separation of materials, effects of heat on materials, and so on.

To some extent I expected students in such a rural setting to be having such rich experiences with farming, cattle and cooking, and a situated yet functionally powerful everyday knowledge about the material world that arose out of such experiences. What I had not expected was to find that students in 8th grade, especially boys, also had extensive experiential knowledge of high voltage (220 volts) AC electricity and electrical appliances. Their knowledge couldn't have had its source in school science as it didn't provide students with any opportunities to explore AC electric circuits. The source, as I discovered, was the important role of an ability to work with household electric lines and appliances in their daily lives. As I mentioned in the previous chapter, the village had electricity. Electric bulbs lit the homes of even the poorer denizens, TV sets and music cassette players were not uncommon, and electricity run pumps were used to draw water from wells for irrigation of agricultural fields. Villagers needed electricity, and it was available, at least for a few hours everyday. However, it was also costly - for many families, that is. Besides, electricity consumed is rather laxly monitored by state electricity boards in India. Thus, I found that using electricity by making an illegal "direct connection", as villagers called it, to the nearest power cable supplying electricity to the neighborhood was common. Actually, this is a rather widespread phenomenon in India. Studies on India's power sector show that, as much as 21% of the electric power generated in India got lost during transmission and distribution of electricity (Dosaani, 2004), and as much as 37% of reported electrical consumption in the rural areas may be contributing to this extraordinary transmission & distribution losses in India (Kannan and Pillai, 2000). Thus, many students through apprenticeship of observation and by trying it themselves had learned out to make such "direct connections" safely.

showing Their deep experiential knowledge about making such potentially dangerous high voltage connections got revealed to me during one freewheeling discussion I once happened to have with a bunch of students in their classroom. The fact that there was no teacher in the class then and students were largely left to themselves, probably encouraged them to participate more freely than usual. During this conversation I asked them if they knew how "direct connections" are made to get electricity from electric poles. Raj said yes. I then asked if he could draw a diagram to show me how that is done. Using a page of my notebook and with helpful suggestions from other students, Raj drew a diagram in my notebook, and explained how wires are connected to the electric lines between the poles, where switch is placed, how "joints" are made in wires, and how one wire is connected to the ground for "earthing" (Pic. 5.1). As he drew, he also told me in detail how a wire is "earthed" – the pit that is dug and the chemicals (water, coal and salt) that are put into it along with the wire attached to an iron rod. He and other students sitting there were aware that not all electric lines carry current – two carry "phase", but one is earth line.

Picture 5.1: Circuit diagrams showing "direct connection."



Raj thought that one wire was of "phase", and the other didn't carry current. But when I asked him about the third wire, he didn't know for sure, but told me that two wires were of use, and the third one wasn't. Ganesh thought that two carried current, and one didn't. Ganesh also told me how electricity can be brought to a house through two types of circuits one with "earthing", although without a switch and one without "earthing", i.e. by simply connecting the two ends of the connection to the two phase wires. To explain his circuit, he drew the circuit diagrams in the space below Raj's diagram (Pic 5.1). I asked Raj if Ganesh was right. He said yes. Ganesh also said that if connections were made to just one line, then bulb would not light. It would light only when connections were made to different lines. I learned from them that most houses in Rajkheda village get electricity this way.

Students, especially boys, were also able to do simple repairs of electrical appliances, often using soldering iron to accomplish their job. Consider an excerpt from a conversation I once had with Dheeraj, a student in R's class:

Me: What all things can you do related to electricity? Can you connect with the line?
Dheeraj: Yes sir.
Me: And can you repair some things?
Dheeraj: Yes sir.
Me: What all things can you repair?
Dheeraj: Sir, things like "tape" (cassette player in local lexicon) and "torch" (flashlight).
Me: Really?
Dheeraj: Yes sir.
Me: so you have ever done soldering?
Dheeraj: Yes. .. If there is loose connection anywhere, I can set it right. If some bulb holder is not working, I can repair that.

Praveen, in fact, went one step further. He reported to me, "If somebody in the village comes, then I do "welding-shelding" and using "ranga" (solder) can "solder-volder" things."[4] As I learned, many times their knowledge arose from having to solve a problem in their household circuits and appliances all by themselves. As Deepak told me, "Sir, we have a tube well, when its fuse blows up, I have to go to repair it." Repairing a fuse in a 220 volts AC current is dangerous, but not that complicated. One just has to replace the burnt out fuse wire with a new one. Sometimes, however, the problems were more complex working knowledge of AC current and circuits. For instance, Deepak told me how he once repaired a fan that was not working. I reproduce the conversation we had below:

Deepak: No sir, what happened once was .. there was a "fault" in the wire. So, I checked it with, what do you call it .. a ("series") .. it was a long wire ..
Me(Interrupting): What? What did you use to check?

---

[4] It is common usage in Hindi to add a rhyming (nonsensical) word at the end of nouns and action verbs. Thus, welding in Praveen's sentence was uttered as "welding-shelding" and solder as "solder-volder".

Deepak: Sir, don't we call it .. a "tester".
Me: Oh, yes, right, right.
Deepak: So I checked the wires with it .. where the "cut" in the wire was .. it was lighting there ("liss raha tha"), but was not lighting ("nahi liss raha tha") in the other wire. Then I checked in the middle, it was not lighting up, so I replaced that bit of wire, and it started working.

Thus, we see in this conversation, how Deepak when confronted with the problem of a nonworking fan figured out the problem through a "tester" and solved it by repairing the gap in the circuit. Students also got to learn about electrical circuits from the adults in their family and village. As Raj told me, "When people in my locality repair electricity, then I usually observe them. If somebody opens a TV, and repairs it. Then I observe that too, and learn which wire is connected to where .. ."

Thus, as I have shown in these examples, students through active participation in daily events and activities in the local village economy and their homes had accumulated a rich experience of working with plants, domestic animals and inanimate objects and phenomena. This experience yielded them a robust and functional knowledge of the world around them. However, as I show in the following section, the expression of this knowledge was very much context dependent.

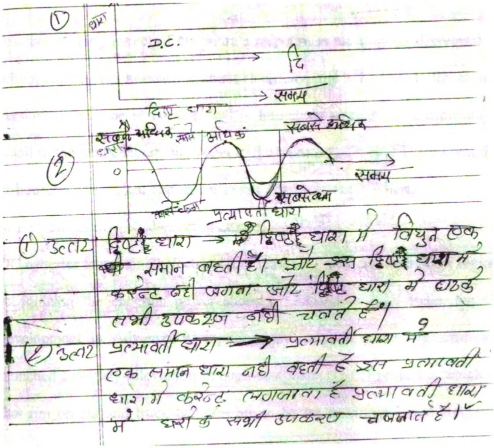
Understanding Students' Representations of Scientific Knowledge

During my fieldwork I was able to observe students expressing their knowledge of the material world in many different contexts. They revealed their knowledge through the various chores they did during the course of their daily existence as natives, solutions they came up with to solve practical problems they encountered in their work outside school, their participation in classroom discussions with their science teacher, homework done in their notebooks, answers to questions asked in the exams, responses to questions asked by me in one-on-one interviews, and so on. In each event of this nature, their knowledge representations depended very much on the situated manner in which they choose the discursive resources to construct their responses, the dialogue they were entering into or participating through their knowledge representations, the purpose, and their audience.

For instance, consider the following page from the science notebook of Narendra, in which he used to write his homework. On this page Narendra has answered the following question:

Describe direct and alternating currents with the help of diagrams.

Picture 5.2: A page from Narendra's science notebook



The two graphs shown in the page above are time versus amplitude graphs for alternating and direct current. The text of the answer translates in English as follows:

> *1. Answer: Direct current ("disht dhara"): Current flows uniformly in direct current ("disht dhara"). And it does not give us electric shock and home appliances do not work with direct current ("disht dhara").*
>
> *2. Answer: Alternating current ("pratyavarti dhara").: Current does not flow uniformly in alternating current ("pratyavarti dhara"). It gives us electric shock. All home appliances run with alternating current ("pratyavarti dhara").*

As a speaker of Hindi would know, "disht dhara" and "pratyavarti dhara", the terms used by Narendra to denote the two types of current, belong to a lexicon that doesn't circulate outside of school science textbooks and students' notebooks. In everyday language people in that region refer to these currents as "AC current" and "DC current". Similarly, the phrase for uniformly, "ek samaan", used by Narendra is more commonly found in textbooks than in everyday conversations.

Another striking aspect of Narendra's response is the implicit disavowal of out-of-school experiential knowledge about electricity, and adherence to the school science version of the type of current used in household circuits. As I explicate in greater detail in the next chapter, according to the science textbook, "The current that is used in household electrical appliances is not direct current." Whereas, owing to shortage or non-availability of alternating current from electricity lines, use of car and truck DC batteries to run small electrical appliances is pretty common in the region. In fact, recognizing the endemic power shortage problem in rural India, the Center for development in Advanced Computing, an Indian research organization, recently launched a poverty-alleviation-through-computers type of project in which computers that run on car and truck batteries are to be set in village based computer centers (http://news.zdnet.com/2100-1040_22-5700701.html) . Thus, when this issue was discussed in the class, students were very reluctant to accept what the textbook said. During the discussion many students, including Narendra, insisted that the TVs in their homes ran on truck batteries (which supplies only direct current). However, when Narendra had to answer the question given as homework by the teacher, he chose to ignore his experiences with electricity outside the school and retold the science textbook version, viz. "home appliances do not work with direct current."

In the example given above, the dialogic overtones are much muted, and the response is constructed using primarily school science discourse and school science knowledge. Students in the school used their class notes and homework written in notebooks to prepare for exams that tested not what students understood about the material world, but the extent to which they were able to remember school science knowledge given in the textbook. Thus, one can understand why Narendra chose to ignore his out-of-school discourses and knowledge to construct the aforementioned response.

However, as the (rhetorical) context changed, so did students' knowledge representations as revealed through their utterances. The reader saw one contrasting example in the slice of conversation with students about "direct connections", that I presented earlier in this chapter. The discursive hybridity and the free borrowing from different knowledge sources is conspicuously present in this rhetorically effective response that was intended to show me how a "direct connection" is made. Students drew on their elemental knowledge of circuits, most probably garnered from school science, and added in their experiential knowledge arising from observation and practice to draw for me two alternate circuit diagrams for such connections. School science, in India or elsewhere (such as U.S), generally eschews high voltage alternating current circuits to teach about how currents flows in electric circuits. But this conversation and the circuit diagrams they drew revealed to me that through their experience with high voltage alternating current household circuits, the students had indeed come to have a pretty sophisticated understanding (for their age) of current flow in circuits. Further, the conversation revealed their awareness of many aspects of alternating currents that school science barely, if ever, touched upon at this grade. For instance, they were aware that alternating current have "phases", and only two of the power lines supplying current to a neighborhood, the ones that in their discourse on electricity carry "phase", carry current. The textbook barely mentioned "earthing" as a safety precaution. But, as the discussion uncovers, the students actually knew how to "earth" a household circuit. This knowledge, of course, never got revealed neither in their notebooks nor in their answers to questions in the examinations. Further, use of English terms, like "earthing", "direct connections", "phase" and "joints", shows their familiarity with out-of-school discourse about electricity that circulates among electricians and people knowledgeable about electrical appliances in rural areas. In the next two chapters I show more examples which showcase how students, in a manner befitting a *bricoleur*, dipped into and selectively picked from available circulating discourses to jerry-rig responses that were sensitive to contingent rhetorical context of the event.

Students' knowledge representations didn't always get revealed in dialogues with other people. They also got revealed in their dialogue with the material world. For instance, when I saw Sapna making "chullah" (earthen stove) from clay or when I observed Govind and Moti making a simple bulb circuit from a students' bracelet, a bulb that they had brought from home, and a battery they borrowed from me, I was essentially seeing them engaged in an intense dialogue with the material world. The material object they crafted represented their knowledge in a material form – a knowledge that was intimately sensual, implicit, and in no need of conscious articulation for its rhetorical effectiveness. One look at the "chulllah" Sapna made was enough to convince me that she knew a lot about clay and thermodynamics of firewood based cooking.

However, the rhetorical diversity of the knowledge representations that students produced could not sufficiently mask some common trends that I was able to observe nonetheless. First, their representations of the material world were far richer in experiences than in scientifically accurate patterns and explanations of those experiences. Second, being deeply and primarily experiential, their knowledge of the material world was more functional in nature. It enabled them to manipulate the material objects and phenomena for their everyday purposes, but didn't help them much explaining why the material world behaved the way it did. When pressed for explanations, they often produced tautological ones. For them, if a thing behaved in a certain manner, it was because it was its nature to do so. Thus, their knowledge of the material resembled craft knowledge in terms of being more implicit than explicit. Lastly, material phenomena were largely understood in terms of sequence of observable events. That is, their representations by and large manifested ignorance of unobservable (to naked eye) reasons and mechanisms of material phenomena.

Students' Views on Schooling and School Science

I was curious to know how students in R's class viewed schooling and school science. Thus during interviews and informal chats with them I probed them on these matters. An analysis of their responses revealed the following major trends:

All students professed liking their school. The main reason they gave was that in this school, they were taught well. So, like Bhagirath, other students too would say, "sir, 'padhai'" (a Hindi word that in different contexts mean teaching, education, and learning), when I asked them what did they like best about this school. As regards their impressions about the individual teachers, it was evident that almost all of them liked Raghuvanshi's teaching, though they mentioned different reasons for their liking. For instance, Deepak liked the fact that Raghuvanshi didn't teach that much from the book because that way he was able to understand science better. Uma, on the other hand, mentioned that Raghivanshi never beat students for their failings and misdemeanors. Some students also mentioned that he made science interesting and cracked jokes in class as reasons for liking him.

Students valued education mostly for being necessary for getting jobs or setting up a trade. As Kishen said, "By getting educated .. we can get a job, we can go anywhere, we can go to offices …" Like Kishen other students also mentioned that education would help them get along in the world by enabling them to conduct financial transactions, read written information on products and public notices, enabling them to travel, be better farmers, etc. For these pragmatic reasons, almost all students I talked to recognized the importance of knowing mathematics, Hindi and English. They considered it necessary for surviving as productive adults. Students approached me many times with the most sincere request that I tell them some easy way to learn English.

Though science wasn't considered as important as mathematics, Hindi and English, most students I talked to valued science for the knowledge about the world it provides. When I quizzed students about what sort of things they learned from science, most examples pertained to plants and agriculture. When I asked Yash why he liked science, he replied, "Sir, I like science subject the most ... because through it we come to know many crops, such as what are the different things about it, and what sorts of diseases inflict them and what is their treatment." Interestingly only a few students mentioned electricity in this context. A couple of the students, such as Narendra and Raj, were, however, of the opinion that though science provided knowledge about the world, they would not be seriously disadvantaged if they didn't study science at all. It was also interesting to note that Mukta valued science for its language which she found to be very different from the everyday language.

Interestingly, all except one student liked learning science. The reasons they gave were: (a) Raghuvanshi taught well, he worked hard to make them understand science well; (b) they did experiments; (c) it was easy; (d) they learned about agriculture, etc.; (e) he didn't teach from the book; (f) Raghuvanshi didn't beat students, and students weren't afraid in his class; (g) and he used humor in teaching them. Kishen was the only student, who said he didn't like science. He said, "sir, in science .. my mind really gets blown off .. I don't know what happens but I just can't put my heart into science." Though he also readily admitted that he liked Raghuvanshi's teaching.

When asked why students seldom asked questions in the science class (and of other subjects too), the most common response was that they felt shy or were afraid of being made fun of by their peers and/or upbraided by their teacher in case they made a mistake. For instance, consider a segment of a conversation I once had with two students - Rakesh and Ramesh.

Me: Tell me .. why don't you ask questions in a science class?
Rakesh: Just like that .. Sir, boys laugh, that's why.
Me: Because boys would laugh?
Ramesh: They would make fun.
Rakesh: Yes, they would make fun.
M: What? .. If you can't understand, then they would make fun of you?
Rakesh: They laugh also when if we answer in the class.

It was also interesting to hear from as many as three students, Yash, Narendra and Ganesh, that they did not ask questions because questions about the natural world did not come to their minds anymore. A couple of students also felt that asking non-course and related-with-natural-world sorts of questions may derail the official agenda of the teacher, and classroom was not an appropriate place for asking such questions.

Summing Up

It was my intention to challenge in this chapter the conventional wisdom, often reflected in teachers' and even parents' comments, about students from rural families and their parents not being interested in education. In this chapter, I showed how keen the rural parents were to see their kids acquire education – a desire that was matched by the efforts made by students to succeed at school. Besides being students of 8th

grade, these kids were also important contributing members of the local rural economy and their families. They were legitimate, and not always peripheral, participants to multiple discourses that constituted rural life. And, as presented in this chapter, this participation had yielded to them a rich wealth of experiences about objects and phenomena about the natural world. This was an immensely powerful resource for learning of science that, as I present in the next two chapters, got harnessed only partially and sporadically in science periods.

Chapter 6

Raghuvanshi's Science Classroom: A Portrait of a Science Teacher as a Bricoleur

Raghuvanshi was certainly not an ordinary run-of-the-mill teacher. Much of what he did in his science class was different from what I saw happening in classes led by other teachers. However, he was also not a heretic by any means in terms of his teaching practice. He did by and large use the professional and school science discourses in his teaching of science – discourses that had legitimacy in the school and approval of the local government education bureaucracy. However, his enactment of the teacher script carried an unmistakable stamp of his ideas, beliefs and personality, and unmistakable evidence of contingent improvisation under constraint. In this chapter, I present an analysis of Raghuvanshi's teaching of science. As a study in contrast, I also present a brief portrait of another teacher's enactment of teacher script.

The Teacher Script

To fully appreciate Raghuvanshi's tactical enactment of the teacher script, it is worthwhile to first recapitulate the main elements of the teacher professional and school discourses that were elucidated in greater detail in Chapter 4. As I showed in that chapter, the school provided bare minimum resources to a science teacher. He had to teach science to a class full of more than 40 students packed in a small room with the help one book (the science textbook approved by the state textbook board), one blackboard and a handful of chalk pieces. The science textbook represented the science curriculum. Except for a pacing guide that specified chapters to be covered each month and government published textbook, teacher did not have access to any other curriculum resource to teach the state mandated science curriculum for VIII grade. The teacher was expected to cover the curriculum by strictly following the textbook, and 'doing' all the chapters. As was shown in Chapter 4, government education officers overseeing the implementation of the curriculum measured a teacher's professional competence by the number of chapters he had taught to his students. The local Block Education Officer, as I mentioned in Chapter 4, was pretty displeased by the fact that Raghuvanshi had still to 'do' two more chapters. The fact that students got to learn science through experiments in his class only served to mark Raghuvanshi down in the officer's eyes. According to the Block Education Officer, it wasn't necessary to do experiments in class to cover the science textbook. As my review of school science discourse in Chapter 4 shows, experiments were indeed presented in the science textbook in a way as to make them totally superfluous. Passing in exams didn't depend a bit on whether students ever got to do cookbook type of lab activities or lab demonstrations given in the textbook. Further, experiments were suggested in the textbook but only as illustrations of scientific principles, facts and theories, with their results given alongside. So a student could learn what would happen if these activities were done, without doing them.

Further, as I present in greater detail in Chapter 4, the absence of scientific inquiry was complemented by an emphasis on having students memorize scientific facts, definitions and explanations in the name of science learning. Science textbook presented to the students as sole authoritative canon presented science as turgid prose in a genre that was barely comprehensible to the students and often left a native Hindi speaker like me, with some experience of writing in Hindi, flummoxed. The science textbook and hence the science curriculum made little effort to connect school science with students lives and experiences, and offered little opportunities for inclusion and legitimization of students' voices in the classroom discourse.

According to the professional discourse of teachers that I inferred from teaching practices of teachers, a few of teaching practices were much preferred over others. First, the teachers often resorted to initiation-response-evaluation (IRE) teacher-student exchanges to teach a topic. Then, I also got to see the (in)famous "you read" teaching practice, in which a student was asked to read aloud text from the textbook, and everybody listened. The teacher, now and then, interrupted the student reading aloud to translate in everyday language what the text meant or to elaborate on some point presented in the chapter. Preference was to be given to individual seatwork rather than group work. Lastly, it was considered important to teach-to–the-test. Questions that were likely to be asked in the final annual examination were identified, and a considerable time was spent in detailing their answers to the students. No formative assessment was done, and the sole purpose of summative evaluations was to grade student performance and determine students' future, in terms of promotion to the next grade. Summative evaluations were of the nature of paper and pen tests largely designed to test how much and how well the student had memorized the official scientific canon as presented in the science textbook.

Finally, both the teacher professional and school science discourses stipulated a marginal role for students in construction of their own learning experiences. They were expected to be subservient to the teacher, and participate in their learning largely through passive listening and obedience to teacher's instructions. They were not encouraged to question, probe and explore but rather to memorize and regurgitate official text on demand.

Daily Routine in Raghuvanshi's Science Period

Before I lay out in detail the different ways in which Raghuvanshi enacted his teacher script, it would be useful to get a sense of the daily rhythm of events in his classroom that I got to observe during the course of my presence in the school. In the paragraphs that follow I will attempt to construct from my field notes a typical science period thought by Raghuvanshi to 8^{th} grade students.

Though there were small variations now and then, throughout my study period, I found Raghuvanhi's class having a predictable recurring pattern of events and practices. A typical science period started with roll call of students taken by Raghuvanshi. He called out their roll numbers, and students responded by standing up and saying "yes, sir!" in English. It usually happened that while Raghuvanshi was taking roll call, a few students would enter the classroom. They did that often by first asking, in English, permission to enter. They would say, "May I come in, sir?". Raghuvanshi would respond, "Come, in." But it also happened sometimes, often when he had already started teaching, that they would just slink in and occupy their place on the mat unobtrusively. After roll call was done, Raghuvanshi called students to show their "homework". Only a few students (usually not more than three) got up and show their notebooks in which they did their homework to Raghuvanshi. While Raghuvanshi checked their homework, these students stood there, listening to various comments Raghuvanshi made while going through their work. During this time, the rest of the students either chatted with their friends, opened their books or notebooks and read them, or tried to finish their homework (sometimes by borrowing somebody else's notebook). After Raghuvanshi was done with this daily routine, he made some general announcements, if there were some to be made, and then would start his teaching for the day. Sometimes, students chose this moment to seek clarifications on some procedural issues pertaining to the classroom or the school.

The teaching often began by his asking students, often in English, to close their books and notebooks. If he was teaching a chapter that was to be continued from the last class, he would start by reviewing what the class had done in the last science period. This was generally done in the instructional sequence of initiation-response-evaluation (IRE). Thereafter, Raghuvanshi posed a question for students to consider and respond. Sometimes, he would do this by asking students to discuss the question amongst themselves in small groups. He would give students about 5-10 minutes for this discussion. Students were left free to form groups as they desired. These groups were always monolithic in terms of gender – girls formed their own groups and boys had their own.

After review of last lesson was done, Raghuvanshi would start teaching the topics he intended to cover that day. He roughly followed the sequence of topics laid out in the concerned chapter of the science textbook. However, brief detours, often at the initiative of students, were also taken at times. Unless Raghuvanshi wanted to use the textbook specifically for some purpose, students weren't allowed to open their textbooks while lesson was being conducted. Teaching usually proceeded as a concatenated series of teacher talk and Initiation-Response-Evaluation (IRE) exchanges that sometimes evolved or transformed into animated whole class discussions with eager multivocal exchanges between the teacher and the taught. Whenever the contingent constraints and affordances of the teaching situation made it possible, Raghuvanshi complemented his teaching through IRE exchange and classroom discussions with hands-on activities done in the classroom. After covering the topics that Raghuvanshi had intended for the day, he signaled the end of science period by giving some questions to students to be done as homework.

Improvising under Constraints

After having a sense of the daily rhythm of events & practices in Raghuvanshi's science period, it seems apposite to examine how Raghuvanshi worked with the existing and contingently emergent constraints and affordances to create learning opportunities for his students. That will set the stage for understanding the nature of classroom discourse that Raghuvanshi helped create in his science class.

As mentioned earlier, the science textbook was the only curriculum resource available to Raghuvanshi save for a pacing guide that laid out chapters of the textbook that were to be taught in each month of an academic year. As indicated in the previous section, Raghuvanshi more or less faithfully followed the sequence of content as presented in a chapter in the science textbook to teach a particular topic. However, for most of the topics he never referred to the textbook while teaching a topic in the class. As Raghuvanshi told me, "My expectation is always that when I am teaching, their complete attention should be on me. It is for this reason why I ask kids to turn over their books or keep their pens in their bags." Having focused the attention of the students away from science as presented in the textbook, Raghuvanshi was left free to improvise upon and enact the teacher script in his own way. Thus, as I show below, he taught science topics as he understood them taking frequent detours from the prescribed sequence or allowing students to lead the class discussion in directions interesting to them.

For example, the textbook has only one chapter on electric current. In that chapter there is one paragraph on two types of electric current – direct (DC) and alternating current (AC). Content wise, it is a very densely packed paragraph that describes, with the help of two small current vs. time graphs some theoretical differences between these two types of current. It gives no examples of how and the usual voltages at which these currents are used, makes no attempt to connect this content knowledge to students' lives, and provides no openings for students to add their own experiences with these two types of currents. In fact, this paragraph even makes statements that contradict students' experiences with electricity. For instance, it states that, "The current that is used in household electrical appliances is not direct current." However, owing to shortage or non-availability of alternating current from electricity lines, use of car and truck DC batteries to run small electrical appliances is pretty common in the region.

Raghuvanshi, on the other hand, devoted one whole extended class period of 1 hour, as against officially stipulated 45 minutes, to discuss these two types of currents and how the differences between the two play out in the daily lives of his students. The textbook presumes that students don't know that there can be different types of current and proceeds to educate the students about them. Whereas, Raghuvanshi right from the beginning of this science period not only invited students to bring in and share their knowledge and experiences with different types of current with the whole class, but also allowed them to lead the class discussions in directions more compatible to their interests.

Consider an event from this science period given below:

Raghuvanshi:: Till now, .. you have seen how many types of electric current?
No response for a few moments. Students sitting quietly (well, almost; some whispering could still be heard).
Ramesh Singh stands up, and says: The "current" that flows in wires.
Raghuvanshi:: Yes.
Ramesh: The "current" that flows in wires.
Raghuvanshi:: Which type of wire?
Ramesh: The "line" wire.
Raghuvanshi:: The "line" wire. So this is "line" type of current. That you call .. "bijli" .. or "electric" .. "line". This is one type of electricity. .. Is there any other type of electricity ("bijli")? .. The one that is flowing in your electric poles and wires. That is one type of electricity. It is Ramesh Singh's opinion that one type of electricity is that which flows in the wires on electric poles. Is there any other type of electricity?
No immediate response from the students.
Raghuvanshi: writes on the blackboard: (1) The one that flows in wires hanging on electric poles.
Raj and Baghirath exchanging sidebar conversations and smiles.

As we see here, instead of proceeding to tell the students what the different types of current are, Raghuvanshi starts by inviting students to share their knowledge of different types of currents that they may have come across in their daily lives. Further, when Ramesh responds to Raghuvnashi's invitation with an answer using terms from out-of-school discourse on electricity, like "line" and "current", he not only accepts them but also legitimizes their usage in classroom by re-voicing them himself for the whole class. The student's contribution is duly acknowledged by writing it on the blackboard. The discussion then proceeds as follow:

Raghuvanshi: asks again: Is there any other type of electricity that you may have seen or experienced? Or in your homes, you may have used it.
Raj exchanging sidebar conversations with Rakesh now.
No response from students for a while.
Raghuvanshi:: There is one in your homes, and you use it. You use it often.
Ramesh raises his hand once more.
Raghuvanshi:: One "minute", let the others think about it too. .. Let other answer too. You have already given one answer.

Ramesh pulls his hand down.
No response from students.
After a while, Raj raises his hand and says: Sir, may I tell you about one?
Raghuvanshi:: Yes, speak up.
Raj stands up and says: Sir, the electricity from a "generator."
Raghuvanshi:: The electricity from "generator".
Raj: We can run tube wells from this type.
Raghuvanshi:: Ok. .. He says that there is an electricity from generator.
Some students speak "generator" in a low voice.
Raghuvanshi: writes "electricity from generator" on the BB.

Thus, not content with just Ramesh contributing his ideas about different types of electric currents, Raghuvanshi asks the students again to think of types of electricity that they may have "seen or experienced". These repeated invitations do result in more participation from students. In fact, when Ramesh volunteers again to share his ideas, Raghuvanshi asks him to wait and let other students contribute too, which as we see above, they finally did. Raj comes forward with his idea about electricity from a "generator" as being another type of current. Raghuvanshi again deviating from an I-R-E type of exchange, doesn't immediately evaluate Raj's contribution as right or wrong, and legitimizes it by accepting it and writing it verbatim on the blackboard. The students obviously had plenty of experiences about electricity to share, but were hesitating to do so. But as a result of Raghuvanshi's repeated exhortation and Ramesh and Raj's participation, the hesitation dissolves and many more students jump into the discussion making it highly animated and multi-vocal, as I present below:

Bharatjee: Sir, "battery" – the one that can run a TV.
Raghuvanshi:: Yes, the electricity from a "battery".
A student: Sir, TV can be run on it.
Another student: Our TV runs on it.
Raghuvanshi:: Yes, a TV can be run on it. Now which type of battery?
A student: sir, "kisan torch".
Raghuvanshi:: The truck battery.
Another student: sir, tractor.
Now more students say: "kisan torch".
Raghuvanshi:: Can TV run on the battery used in "kisan torch"?

Many students: YES SIR!
Raghuvanshi:: Ok, now tell me if the electricity from "kisan torch" is different from the electricity from a truck battery?
Most students listening to Raghuvanshi attentively now.
Some students say yes.
Narendra shouts: No, they are the same.
Ramesh Singh raises his hand, and says: Should I say something?
Raghuvanshi:: Yes.
Ramesh: They is a difference between them.
Raghuvanshi:: They are <u>different</u>? Tell me more.
Ramesh: One is of 3 volts and the other is of 12 volts.
Raghuvanshi:: No, the voltage can be more or less. Just like, these wires on poles .. (some students start chatting) .. Listen to me .. Listen. .. The electricity that is flowing in wires on poles .. There is one which is flowing in those big wires that are near the temple there ..
Students: Yes sir.
Raghuvanshi (continuing): And there also are poles that are here. .. The ones that are standing in your village. .. Now, the electricity is these two types of poles .. is it of different types or the same?
Some students: It is of the same type.
Raghuvanshi:: It is of the same type, right?
Students: Yes sir.
Raghuvanshi:: Similarly, electricity that flows in your "kisan torch" and the one that flows in your battery .. are they of the same type or different?
Students: THEY ARE THE SAME.
Raghuvanshi:: You mean this big type of battery.
Students: Yes sir.
Raghuvanshi writes on the blackboard: (2) The electricity from "kisan torch" and "battery".

As we see in this lengthy event, students had a rich experience with household electricity, and were aware that all electric currents that flows in the appliances they used weren't the same. In this event, we also see that after they got over their initial hesitation because of Raghuvanshi's encouragement, they were eager to share their experiences with the whole class. In contradiction to the claim made in the textbook that "The current that is used in household electrical appliances is not direct current", students knew that batteries can be used to run such appliances. Raghuvanshi accepted and legitimized this homegrown knowledge. He deviates from an I-R-E interactional pattern, and encourages a much lengthier discussion on this topic than what the school science discourse warranted, as is reflected in the condensed, abstruse, and remote way this topic was presented in the science textbook.

Each chapter of the book had some exercise questions at the end. Raghuvanshi often avoided referring to them or asked students to answer them for homework. At the end of a science period, he gave his own questions for students to answer as homework. Raghuvanshi rationalizing this predilection told me, "I do not give questions from the book because I know that there are books like MBD and .. GPH, that have answers to those questions. .. That's why I give the questions that I have made myself. The questions are always about things that I have taught that day – the things that I have "targeted" today for learning by kids. My questions are always related to this fact."[1] Since Raghuvanshi often didn't teach from the textbook, it is easy to understand why he chose to have summative assessments different from those prescribed by the school science discourse. But that does not imply that Raghuvanshi, unlike other teachers, did not prepare his students to succeed in the annual final examinations on which their fate as students depended. I observed a few instances when Raghuvanshi stressed that students write answer of some "I-M-P" (short for "important") questions because of their likelihood of being asked in the exams. He sometimes also pointed out science content that had greater chances of being asked in the exams. For instance, consider this event that occurred when Raghuvanshi was teaching the chapter on rocks, ores and metals:

> *Raghuvanshi: In our Madhya Pradesh, iron mines are found in the Chattisgarh area ... from where iron ore is extracted. Now the iron ore we get ... what is its chemical composition? What is the name of the iron ore we get?*

---

[1] **MBD and GPH referred to by Raghuvanshi here are test preparation guide books that were popular with students.**

(NO response from the students)
Raghuvanshi: You read the first line ... look into your books.
(Students start looking into their science textbooks.
Raghuvanshi: Look into 'Extraction of iron ore'.
A student: Hematite.
Raghuvanshi: Yes, iron ores are ... number one hematite, and the other magnetite, and the third one is iron pyrite. (writes on the BB) ... Remember these names. These are also asked in exams. ... So the chemical formula of hematite is ...
Gautam: Fe_2O_3.
Raghuvanshi: And of magnetite?
Students: Fe_3O_4.
Raghuvanshi: And pyrite?
Students: FeS_2.
Raghuvanshi: These you will have to remember. Iron is always asked about in the exams.

However, the textbook didn't always remain at the periphery of classroom discourse in Raghuvanshi's classroom. As the event given above shows, I got to witness a few occasions when contrary to my expectations, Raghuvanshi asked students to either refer to some particular text in the textbook. A couple of times I even found him asking students to read aloud some sections from the book, a teaching practice much favored by other teachers of the school. It is difficult to see any clear pattern in when Raghuvanshi chose to refer to the textbook and when he consigned it to the margins. For instance, one might presume that a teacher is more likely to take a greater support from the textbook in content areas where (s)he was not very confident of her/his understanding of the subject matter. But, in Raghuvanshi such reasoning didn't always hold. Raghuvanshi confessed to me, "I have a good understanding of Physics and Chemistry topics, but I feel some lack of understanding in Botany and Zoology." However, as we see in the event given above, Raghuvanshi chose to depend upon the textbook while teaching about ores and metals. Likewise, while teaching electricity when Raghuvanshi came to the topic of dynamo, he asked a student to get up and read aloud related text from the textbook for the benefit of the whole class. Perhaps, these deviations from expected behavior only show that events are caused by a contingent confluence of multiple factors arising out of then extant constraints and affordances of the teaching situation. A search for definite and definitive causes is often as elusive as it is misleading.

However, science isn't or rather shouldn't be taught with the help of a textbook alone. If the learning goals aim for student learning science with understanding and motivation, just as in scientific communities, dialogue with peers have to go hand-in-hand with dialogue with the material world through experiments and other activities(Anderson, 2003; Sharma & Anderson, 2003). As mentioned earlier, textbook did mention some experiments and activities to be done by the teacher, but only as demonstrations and applications of scientific facts and theories given in the accompanying text. Even if students do not get to do scientific inquiry to learn science, experimental demonstrations can do much to help students learn and maintain their interest in science. However, the state education department didn't really expect the teacher to demonstrate or let students do these experiments. As Raghuvanshi told me they neither got sufficient funds to buy equipment and supplies needed for the purpose, nor did they get the type of professional development opportunities that would enable them to perform these experiments and activities with students. However, Raghuvanshi was not to be deterred. Being a resourceful person, he had managed to collect and preserve some science equipment over the years, much of it dating from the time when the government schools of the area followed a learning-by-doing and discovery oriented science curriculum. He used this equipment to demonstrate or let students conduct experiments whenever the teaching context was amenable to such improvisation.

For instance, the chapter on electricity describes different types of battery, such as voltaic cell, dry cell and Daniel cell. Raghuvanshi, however, went one step further, and with the help of students made an improvised Daniel cell in classroom out of a copper vessel (*lota*) that is used in Hindu homes in religious rituals, a water purification candle, and chemicals. He then made a simple circuit connected with the Daniel, and showed that the cell was generating current by showing the effect of current on a magnetic needle put close to the connecting wires of the circuit. Now, Daniel cell is a type of battery invented by Englishman John Daniel in 1836, that for some reason is still taught in Indian schools, even though most students never get to see them in their lives. As a science student I too had read about Daniel cell, but had never had seen it made right before my eyes till that day in Raghuvanshi's class. Like me, students were also thrilled to see this simple yet elegant demonstration. They probably had a better appreciation of a Daniel cell than I had as a student when I just had to memorize its construction and diagrammatic representation for passing the exams.

As I have shown, the school didn't provide many resources to a teacher to support her/his teaching. However, teachers in a school form a community of practice that can be a source of much support to a teacher. Though I didn't see teachers collaborating to co-teach a class or helping each other with teaching ideas, I did find one instance of Raghuvanshi seeking help of another teacher to teach a topic. One day, when I was helping some grade 8 students with math problems in the absence of a teacher in the classroom, Dinesh Mathur, the teacher who taught science to the 7th graders, but English to the 8th graders entered the room to announce that in place of Raghuvanshi sir, he would be teaching the chapter on biological evolution to them as Raghuvanshi sir had asked him to do so. Now, as reported earlier, Raghuvanshi didn't feel comfortable with his content understanding in Life Sciences. Thus, as Raghuvanshi told me later, he had requested Mathur to teach this chapter in place of him. This event indicates that Raghuvanshi was willing to move himself out of the teacher role temporarily if that made better science learning among students possible. I found that Raghuvanshi and Mathur collaborated in this manner in other grades too. It is possible that other teachers in the school too helped each other out by agreeing to chip in with their help in academic areas of their expertise for their peers. Certainly, all the middle school teachers I talked about the cohesiveness of the small community of practice they had in school, and appreciated the help they got from their peers. Such peer collaboration does not find mention in 'The Charter of Education' *(Siksha ka charter, 2003)* - the only official policy document the teachers of the school had. The professional discourse of teachers did not and could not account for every contingency arising in the day to day work of a teacher. There existed wiggle room where capillaries of discursive power ran dry, official voice was silent. In such in-between spaces, local actors, like Raghuvanshi and Mathur, could author their own improvised responses to meet the local contingencies and circumvent the factors that otherwise would constrain their teaching practice.

Raghuvanshi was often in the habit of using simple instructions in English. Thus, for instance, if he wanted a student to wipe clean the classroom blackboard, he would instruct a student to "clean the blackboard" in English. Likewise, throughout the science period, students got to hear and respond to instructions, like "show your homework", "take out page 47", "close your books", and so on. Students seeking to enter the class would often ask permission by saying "May I come in, sir?" to which he responded by uttering, “come in”. When he took roll call, students responded to their roll number by getting up and saying “yes sir!”. I found this insertion of English in the daily classroom discourse pretty interesting and often wondered if Raghuvanshi’s teaching craft knowledge had anything to do with it. My questions on this issue got answered during one of the lengthy conversations I had with him. He told me that he recently attended a “Sanskrit training” camp in which the “trainer” required all the attending teachers to communicate in Sanskrit only while they attended the camp. As Raghuvanshi said that experience, “helped me to incorporate some things in my teaching that I had long desired, ... Like, I now give many instructions in English, like I tell them to “open your book”, “close your book”, or “take out your homework”. .. Or “clean the blackboard”. I use these instructions, so they (students) have also started learning them.” Raghuvanshi’s desire and insistence on inserting English in the daily classroom clearly indicates his attempts to harness whatever extant resources to enrich his teaching practice.

Thus, as we see in this section, Raghuvanshi worked with the contingent resources and constraints in his teaching situation to enact in his own version of the teacher script – an enactment that was marked with contingent improvisation and was suffused with his own intentions, personal history and positionality in local time and space. However, the portrait of Raghuvanshi’s teaching is still incomplete as I still have to delineate the contours of the classroom discourse Raghuvanshi sought to create in his science periods with the help and/or hindrance of the abovementioned resources and constraints of this teaching situation. In the sections that follow, I attempt to do just that, and then perhaps the reader will have a fuller measure of Raghuvanshi as a bricoleur engaged in selective picking and unpicking of elements of the teacher professional and school science discourses and authoring his own personal and unique performance.

The classroom discourse

Looking at the patterns of events and practices in science periods, one can piece together major elements of the classroom discourse in science periods. Understanding these elements sets the stage for an examination of the different ways students responded to school science as taught by Raghuvanshi – a key focus of the next chapter.

As I mentioned above, the teaching for the day actually began only after Raghuvanshi was done with checking the notebooks of the few students that came to him to show their homework. In sharp contrast to the way text has been presented in the science textbook, and the way other teachers of the school taught, Raghuvanshi invariably started his teaching with a string of questions about the topic that were posed to the students. Often, he asked students to get together in small groups to discuss the questions among themselves before reporting their answers to the whole class. Thus, for instance, on January 24, 2005, Raghuvanshi began the chapter on sources of energy by first asking students in English to "stop writing, and close your books", and then gave them the following question to discuss in small groups:

> *"Urja sankat ko dekhte hue, aaj humne kin sroton ka upyog karna shuru kar diya hai? Aur agle samay mein humein kin sroton ka upyog karna chahiye?" (Keeping in view the shortage of energy, which resources of energy have we started using today? And which sources of energy should we use in future?)*

Raghuvanshi also wrote this question on the blackboard. Similarly, on March 2, 2005, Raghuvanshi started the topic of dangers of electricity by asking students to discuss among themselves in small groups what are the dangers of electricity, its causes and precautions one can take to escape these dangers. Evidently, through these questions, following a sort of learning cycle approach, he sought to establish the main problems of his science lesson for the students (Anderson, 2003).

As can be noticed above, I found that Raghuvanshi encouraged student-student exchange in the classroom. For instance, Raghuvanshi also asked students to get into groups in order to do experiments. Not always, but it seems that this happened whenever he had sufficient kit supply to make it feasible. For instance, he had sufficient bar magnets in his kit supply. So while teaching the chapter on magnetism, he asked students to form 4 groups, and gave one pair of bar magnets to each group for exploration of magnetic properties of attraction and repulsion. The students were told to find out the answers of following questions through their explorations:

Q.1 Iron is ______ when brought near North pole.
Q.2 Iron is ______ when brought near South pole.
Q.3 South pole is ______ when brought near North pole.
Q.4 North pole is ______ when brought near South pole.
Q.5 North pole is ______ when brought near North pole.
Q.6 South pole is ______ when brought near South pole.
Q.7 There is ______ between like poles.
Q.8 There is ______ between unlike poles.

Such group discussions and explorations did much to engage students in productive content related dialogue with each other. I also found that sometimes Raghuvanshi also encouraged student-student dialogue by echoing and throwing back a students' comment for consideration to the whole class. This sort of re-voicing of students by the teacher put students' voices in the center of an emergent heteroglossia that was mostly as productive as it was unscripted. For instance, consider this student-teacher dialogue that occurred when Raghuvanshi was teaching the chapter on magnets.

Raghuvanshi: OK, you guys also have magnets of your own?? All of you have seen magnets? You have seen the school ones that I showed you, but you also have magnets in your homes.
Students: Yes, sir.
Raghuvanshi: What do you think they must be made of? What is it – wood, cloth, stone, sand?
Mukta: Sand.
Raghuvanshi: Sand, eh?
Ramesh: It looks like iron.
Raghuvanshi: So it is like iron? Does everybody agree with this?

Here in this excahnge, we see Raghuvanshi re-voicing first Mukta's and then Ramesh's response for the whole class to consider. Through such re-voicing Raghuvanshi often engendered vigorous classroom discussions in which he was just one another, albeit an important one, participant. I saw such discussions very rarely in class periods taken by other teachers.

Sometimes, dialogue among students led to a light hearted banter that did much to enliven events in science periods, and establish a sense of conviviality in the classroom. Consider the event given below:

Raghuvanshi:: So if the motor is on, and if there is a drop in current, then ...
Raj: Sir, that thing will automatically shut the motor off.
Raghuvanshi:: Yes, so it also stops the engine on its own. ... So there is a new thing now. What would we call it? .. Auto .. Auto switch?
Raj: Yes, auto switch.
Dhanraj: Auto! .. There is an "auto" that runs too.
Raj: Sir, please write "switch" along with "auto", otherwise Dhanraj would think that we talking of the "auto" that runs. (Students laugh).
R (while writing on the BB): A-U-T-O S-W-I-T-C-H. ( ).
Raj: Sir, Dhanraj was talking of the auto that runs on the road.
Mahesh: Sir, there is one Mahindra auto too.
Students laugh.
Raghuvanshi:: Mahindra auto .. and .. Vespa auto.
Students: Ganeshji's auto, automatic pump, ..

This dialogic event occurred during classroom discussion on electrical safety, in the event of houses not having the safety of fuse wires installed in the household circuits. This discussion saw a strong participation by students who infected and invigorated the discussion with their ideas and experiences of working with such circuits in their daily lives outside school. Raj, as we see in this event, brought in the idea of using "auto-switches" that automatically switch off circuits in the event of current fluctuations. In the villages in this region, people prefer the shorter moniker "Auto" instead of "Auto-switch" in their everyday discourse on electricity. However, "Auto" (short for Auto-rickshaw) is also a name for a three-wheel scooter that is used as taxi in cities of India. So, Dhanraj commented on the homonymic nature of this word, prompting banter and humorous digressions among students. I found that Raghuvanshi tolerated, and most times didn't even hide his enjoyment at such gentle teasing and repartee among students. In fact, once when Raj jokingly complained that Sapna was laughing at him, Raghuvanshi replied in good humor that Raj should let her laugh as he was making her happy by letting her laugh at him. However, assuring Raj at the same time, he said, "You said nothing wrong. Whatever you said was good. And if somebody felt like laughing because of what you said, then it is all the better." Thus, the classroom events in science periods weren't always dull and dreary like other class periods, continually punctuated as they were with healthy and humorous interludes.

Though it was infrequent, Raghuvanshi wasn't shy either of using humor as a pedagogic tool to interest and motivate students his class. Humor often lies in transgression of cultural and linguistic boundaries. So, when Raghuvanshi inserted out-of-school discourses in the classroom discourses, or did something that was unexpected for a teacher, students couldn't help being tickled. For instance, while telling students how they can reverse the effects of electrolysis by reversing the polarities in the experimental set-up, Raghuvanshi uttered the typical (Indian) magic incantation: "*Jai kali culcutte wali tera wachan no jaye khali*" to dramatize the results of the experiment. As was to be expected, students just loved it and there were smiles all around. Raghuvanshi also had a fetching talent of using the most evocative analogies to drive home a point – a pedagogical content knowledge that he used most effectively. Consider the event I give below. In this event, Raghuvanshi is talking about an adaptation leaves of some water plants have that let such plants survive in water.

> *Raghuvanshi: ... So it (the leaf's surface) is smooth, green and what else does it have on its surface .. I mean, what must be happening, why doesn't water stay on its surface? .. What must be on its surface? .. (no response from students) .. that is, it is very smooth. Thus, on it .. oily or wax like substance is there on its surface. This wax like smooth substance does not let water .. stay on the surface of the leaf (students chime in with Raghuvanshi). .. Why is it not letting water to stay on its surface? .. If it stayed then what would have happened? .. (no response from students) .. After all, it is submerged in water from beneath, and so if it also gets submerged from the top then what would have happened? .. (no response from students) .. Then it would not have been able to give out excess water. How would it have given out water if its upper surface had not been open to air? That's why, God or the plant itself has made such an arrangement that .. it made the upper surface smooth.*
> *Students: Yes sir.*
> *Raghuvanshi: That's what it says to the water – "Don't sit over me. I won't let you do that. As it is I am living in water day and night, and on top of that if you climb onto my head, then what will happen to me!?"*
> *Students laugh.*
> *Sheela (laughing): Yes sir.*

The image of leaf admonishing water must have been rib-tickling one indeed for these students. Especially, if in other classes they got nothing but dour authoritative instruction from teachers. The transgression of boundaries by the teacher encouraged students to do the same. As a result, I frequently got to observe events wherein students brought in their everyday discourses in the classroom discourse. Raghuvanshi gave legitimacy to such attempts and welcomed the ensuing hybridity.

His tolerant attitude towards hybridity of discourses was revealed to me one day when the science period had just started. Raghuvanshi had checked some students' homework, and was to begin teaching for the day. Seeing a smile on Raghuvanshi's lips, Rakesh asked him why was he smiling. Raghuvanshi laughed and said that he was smiling because of the way Dhanraj had used hybrid language ("*kichdi basha*") in his homework. R told the class that we all use hybrid language ("*kichdi basha"*), but Dhanraj had gone one step ahead and mixed languages within a word. Raghuvanshi then gave an example of how we all use hybrid language. He spoke a sentence in a Hindi-English hybrid: "*daily use mein hum ek mixed basha bolte hain*", and asked students to identify English words in this sentence. Students quickly pointed out the English words "daily" and "mixed". Raghuvanshi then told the class that in his homework, Dhanraj had written "Aluminum" as L'mineum' (letter 'L' followed by 'minium' in Hindi). Raghuvanshi wrote "L'mineum" on the BB to show how Dhanraj had concocted this hybrid word. Students could easily read and understand what Raghuvanshi had written. Sheela then pointed Raghuvanshi's attention towards the name 'Dhanraj' written on one of the classroom walls, with white chalk, mixing in a variety of ways English, Hindi as well as symbol "+" - "+raaz", "+raj" ('raj' in Hindi), and "+raj"). R seemed amused after reading them. Surprisingly, he didn't tell Dhanraj or any other student to wipe them off. However, Raghuvanshi ended this brief digression by saying that such usage was good for laughs and for fun sake, but Dhanraj should desist from using such language in exams lest he should get zero from the examiner.

Thus, in the event mentioned above, we find Raghuvanshi endorsing hybridity while at the same time reminding students to be mindful of the communicative context. Whenever the confluence of different factors contributing to an event made it possible, students, encouraged by the openness of their teacher towards out-of-school hybrid discourses and knowledge, suffused the classroom discourse with heteroglossia that was marked with productive intertextuality and acceptance of differences in meanings and genres. This aspect of Raghuvanshi's science classroom is explored in greater detail in the following chapter as it focuses on students' actions. Here, in keeping with the focus of the chapter, I wish to highlight Raghuvanshi's actions that helped co-construct this heteroglossia.

First, whenever he could, Raghuvanshi tried to situate school science in the lives of his students. More often than not that meant going beyond or around the prescribed curriculum. But there were exceptions too – occasions when he followed the professional discourse, and treated school science as presented in the textbook as the sole authoritative fountainhead of knowledge in the classroom. To illustrate the contingent and shifting nature of Raghuvanshi's teaching practice, the way he taught the chapter on electricity is an apposite case in point. The reader will remember from the previous section how Raghuvanshi tried to situate the classroom discussion on alternating and direct currents by first asking students to narrate their experiences with different types of current. That set the stage, as we saw, for the entire discussion on this topic to stay grounded in the daily life experiences of the kids. As a result, students' knowledge abstracted from their experiences with household electricity could not only be a part of the classroom discourse, but could also gain due legitimacy – something that school science discourse just did not provide for. For instance, if Raghuvanshi had not made effort to situate this discussion in the lives of students, the home grown knowledge that some household appliances can indeed, and are in fact, run on direct current would have been de-legitimized by the rather categorical assertion of the science textbook that "The current that is used in household electrical appliances is not direct current."

But, even with the chapter on electricity, Raghuvanshi did not always attempt to bring students experiences to the foreground in classroom dialogues. I observed eight science periods in which Raghuvanshi taught electricity. Each of these periods was focused on one topic of electricity (refer Table 6.1).

Table 6.1: Electricity Lessons

Date	Main topic	Situating topic in the lives of the student
Feb 9	Magnetic effects of current	No
Feb 10	Static electricity	No
Feb 15	Sources of electricity – chemical batteries, solar cell & dynamo	Only while discussing chemical batteries
Feb 16	Conductors and Insulators	Yes
Feb 18	Heating effect of current	Yes
Feb 19	Chemical effect of current	No
March 1	Alternating and direct current	Yes
March 2	Dangers from current & electrical safety	Yes

As can be seen in the accompanying Table 6.1, there were a few occasions, such as when Raghuvanshi taught solar cell and static electricity, that he did not attempt to connect the topic with the lives of the students. To teach electricity generation through solar cells and dynamo, Raghuvanshi deferred to the professional and school science discourses and based his instruction solely on the textbook. He read aloud from the book, translating the text in simpler everyday Hindi, made constant references to it, and even asked a student to read aloud the text for everybody – practices that constituted important tools of the trade for other teachers in the school. For the topic of static electricity, he didn't refer to the textbook at all, basing his instruction on static repulsion and attraction experiments he did with the students. However, in order to teach magnetic effects of electric current, he first asked students to read an experiment suggested in the textbook, and then demonstrated that experiment to the whole class. Thus, we can see that though Raghuvanshi tended to situate school science content in the lives of his students, there were occasions when he followed the school science discourse and didn't make effort to enrich school science with the daily life experiences of the students.

The tactical nature of selective picking and unpicking of the circulating discourses that we saw above correlates rather well with the nuanced and apparently contradictory nature of Raghuvanshi's thinking on this issue as it got revealed to me during the couple of lengthy conversations I had with him on his ideas and practice of science teaching. Raghuvanshi was of the firm opinion that, "...the things that we teach should match their interests too. So we should know what are the interests of a student, and then we should encourage him to learn according to his interests. And then he can learn a lot." Further, Raghuvanshi believed that a teacher "should have full faith in the capabilities of his students ... that kids too have immense potential for lot of learning, if only we teach them properly." Thus, guided by confidence in the learning abilities of his students and a desire to align his teaching with their interests, Raghuvanshi tried his best to situate school science content in the everyday experience of his students. However, talking about his image of an ideal teacher, he commented, "Well, it is this thing that ... the objectives that are determined for us, ... the most important, "basic" things in our curriculum – we should understand that it is essential to teach them first. First, you teach them, and then come on to other things .. *Basically* (word uttered in English), what is most essential should be taught first." Raghuvanshi never once complained about the science curriculum or berated the content or form of the science textbooks he had to use. In fact, when I asked him about the main ideas of the chapter on metals that he was then teaching, Raghuvanshi added after talking about the main ideas that "In this book, the effort is to .. those properties have been *entered* (word uttered in English) that can be done by the kids. Activities have also been included." Such comments and the fact that Raghuvanshi taught topics like solar cell that were required by the precribed curriculum, but had little to do with the daily life experiences points towards Raghuvanshi's acceptance and conformity, if only partial, to the professional and school science discourses.

Being a reflective practioner of his craft, Raghuvanshi was, however, aware of agonistic relationship between concern for students and compliance with school science discourse. I asked him how far he thought he was from his image of an ideal teacher. Raghuvanshi gave a little laugh on hearing the question and responded, "I think I am very, very far from that ... And in my efforts, the problem is in aligning with the curriculum because if I try to implement my ideas, I am short of time, and that then influences the implementation of the curriculum. Though I am always aware that I should not focus as much on completing the curriculum as on teaching well. So I *cut* (word uttered in English) topics, and go ahead. I am always leaving some topics as I proceed."

I found a similar pattern of contingently shifting confluence of competing tendencies in dialogic exchanges between the teacher that the taught in the science period. As mentioned in the section on daily routine in Raghuvanshi's class, the teacher script as enacted by Raghuvanshi positioned him at the center of the dialogic exchange with students at the margins. Teacher talk and teacher initiated and controlled Initiation-Response-Evaluation (IRE) exchanges was the general norm in science periods. However, as I present in greater detail in the next chapter, this script was neither set in stone nor indifferent to the intentions and actions of students. The roles of the teacher and the students in this script were contingently and continually negotiated between them. Consider an event that occurred in a science period in which the main topic for the day was heating effects of electricity. Before this event, Raghuvanshi had talked about melting points of metals being high or low, and a student had mentioned fuse wire as a substance with low melting point.

> *Raghuvanshi: In the main switch cut-out "fuse wire" is used. Now this "fuse wire" ... "FUSE WIRE". What is this? ... In our houses, if there is any problem, of the electric sort, or if something happened outside the house because of which suddenly lots of current flows into wires, then what happens?*
> *Mahesh: It blows then.*
> *Raghuvanshi: Then what happens (repeating the question).*
> *Students: Sir, it blows.*
> *Narendra: it melts.*
> *Mahesh: a "blast" occurs.*
> *Raghuvanshi: When electricity is more, what happens ...? The "fuse wire" melts. Why does it melt?*
> *Students' response unclear.*
> *Raghuvanshi: No, what happens then? What is it that happens there? If voltage is high, then what does that do?*
> *Mahesh: Sir, that "fuse wire" becomes very thin.*
> *Rakesh: (Sir, one phase goes off.)*
> *Raghuvanshi:: So what happens to the wire? Do they heat up? The "fuse wire".*
> *Students: Yes, sir.*
> *Raghuvanshi: So fuse wire heats up and then melts.*

Here, as can be clearly seen, students are conforming to the teacher script and playing their ascribed subordinate role in the IRE exchange. Students do not take any initiative in terms of asking questions or offering their own and unsolicited comments. They merely respond to Raghuvanshi's questions and instructions. However, earlier in the same period, the roles had got re-negotiated when Raghuvanshi was discussing with students coils of metals or alloys of high melting point used in electric stoves and heaters. Bharatjee then mentioned about coil being there in bulbs too. Raghuvanshi agreed and wanted to talk about the filament in a bulb. But suddenly Raj smiling heavily got up from his seat, moved to the next row of students and looking out points to a halogen bulb hanging outside the classroom said, " sir, this one that is lighted up there also has one."[2] Raj's initiative then triggered off the following dialogue:

Raghuvanshi: Yes, what is it called?
Narendra & Mahesh: MERCURY!
Baghirath: No sir, it is not Mercury.
Many students talking at once offering their opinions about what it is called. Of them Sapna's voice is the loudest.
Sapna: Halogen!
R (speaking slowly): H-a-l-o-g-e-n.
Narendra: No sir, it is Mercury.
Raghuvanshi:: Yes, this one is Mercury. Mercury gives out a yellow colored light.
Rajesh and Meer Saheb: Sir, it is there on 'Chaugadda' and also in 'Itwara bazaar'.[3]
Raghuvanshi:: No, Mercury doesn't give yellow light..
Mahesh: Sir, it gives blue .. or green.
Raghuvanshi:: Mercury gives a milky white light. Like the one our tube lights give.
Students: Yes sir.
Raghuvanshi:: Yes, that is Mercury .. And the yellow color, I think, is .. yes, Sodium lamp. It is the Sodium ones .. The ones that give yellow color. .. Sodium lamp.
Mahesh: Sir, the ones that are in Pipariya give yellow.
Raghuvanshi:: Yes the ones that give yellow .. There are yellow .. but there are milky ones too. The ones that are installed on Jhanda Chowk .. they give totally milky white light.[4]
Students: Yes sir.
Raghuvanshi:: They are mercury lamps. .. And the ones that are fitted on street lampposts ..
Students: Yes sir.
Raghuvanshi:: The ones that give yellowish light are Sodium lamps.
Mahesh: Yes sir, that's right.

[2] This was a halogen lamp hanging on a wire outside that had been left by hosts of the wedding party that had stayed in the school the night before. The bulb was still lighted up as it was jury-rigged through a 'direct' connection from the main wire supplying electric power to the school.
[3] 'Chaugadda' and 'Itwara bazaar' are two famous and busy markets in the neighboring town of Pipariya.
[4] 'Jhanda Chowk' is the important city square of the Pipariya town.

Thus, we find here that Raj's initiative triggered an animated discussion in which the teacher script was abandoned for a while, speaking roles changed and dialogue proceeded in a rather in an unscripted manner rich with multiple voices and discourses. In contradistinction with a typical IRE exchange, Raghuvanshi wasn't the only initiator or evaluator, nor students were the only ones responding to the other person's initiative. For a while, everyone was at the center and the periphery of the classroom discourse at the same time – positioned equally in a dialogue among equals.

And that's how I observed much of the dialogic exchange happening in Raghuvanshi's class – linked periods of authoritative teacher talk and IRE exchanges that repeatedly and ephemerally evolved into a multivocal heteroglossia – thick with intertextuality, and acceptance of difference. The fact that students took content-related initiative in the in Raghuvanshi's classroom is remarkable. First, because I saw a complete lack of initiative in class periods of other teachers. And second, because this happened despite the reluctance among students, as shared with me by many students, to be seen as taking initiative in the classroom.

Now, making causal links is risky and can even be misleading. But certainly at least some of the contributing factors for an event or a practice can be identified. The analysis of transcripts of science periods indeed suggests some important contributory factors. First, the way Raghuvanshi enacted his teacher script, students felt encouraged to contribute their voices, discourses and experiential knowledge to the ongoing dialogues in science periods. For instance, as we saw in events analyzed earlier, he often began instruction on a topic with questions asked to the students. Students were many a times encouraged to discuss these questions in small groups.

Second, as I showed in the case of the chapter on electricity, Raghuvanshi more often than not tried to situate science content in the lived experiences of his students. Third, analysis of communicative events in science periods showed that student initiative was more often than not acknowledged and legitimized by Raghuvanshi. Out of 39 events that had students taking science content-related initiative in science periods, I found that Raghuvanshi didn't privilege only four such attempts. As we saw happening in a few events given above, he tended to acquiesce to students' attempts to influence and take the content-related classroom discussions in unscripted directions. My analysis shows that as a result, students were able to substantially influence events in science periods in about 64% of the cases where they took some initiative to do so.

Fourth, as I showed in the event where Raghuvanshi reacted to Dheeraj's hybrid spelling of the word 'Aluminum' in his homework, Raghuvanshi was comfortable with hybridity and accepted presence of multiple discourses in classroom dialogues. He used both the local vernacular and official Hindi as presented in the science textbook in his teaching, mixed English phrases in his instructions and comments, and actively translated between different discourses while teaching, especially when he borrowed text from the textbook to make a point. For instance, while asking students to refer to the text about Alternating and Direct currents in the textbook, Raghuvanshi mentioned, "Now you can open your books, and .. page 38 .. "dhist dhara" and "pratyavarti dhara". ... (students open their books) .. Have you understood now? Let me tell you what it is called in English because in the book English words are also used. "dhist dhara" is called "direct current". D for "direct" and C for "current", so in short we will say "DC current". .. (Raghuvanshi points to the graph of AC in the book) And this is called "pratyavarti dhara", or in English it would be "alternating current" (students practice speaking out this English word). Raghuvanshi also translated students' discourse into science discourse. For example, consider this brief dialogue:

Lal Saheb: Sir.
R: Yes.
Lal Saheb: Should I say something?
R: Yes, speak up.
Lal Saheb (stands up): Sir, in TV and radio, there is an "elumeetur" that's why they can run. The bulbs don't have it, so that's why they would not light up.
R: "Elumeetur"?
Lal Saheb: Yes sir.
R: "Eliminator"? Yes it is called "Eliminator". "E-L-I-M-I-N-A-T-O-R".
Some students try speaking "eliminator".

In everyday discourse, the electrical appliance *eliminator* has got transmuted to *elumeetur*. Thus, we find Raghuvanshi re-voicing this term in English and letting students practice speaking it. Similarly, when Sapna used an everyday expression – *alag-alag* – to indicate magnetic repulsion between like poles of two magnets. Raghuvanshi then re-voiced her answer in scientific terms, by mentioning the term used by textbook – *vikarshan*. In such events, I find Raghuvanshi not only allowing entry of out-of-school discourses and knowledge sources in classroom discussions, but also dialogizing them with school science discourse. This teaching practice comes across to me as a contributing factor to vibrant heteroglossia that I saw contingently emerging now and then in his classroom. I have presented some events in this chapter that showcased this dialogizing of discourses in the events. In the next chapter, instances of this heteroglossia are examined in further detail to show how students actions too contributed to its contextual and ephemeral emergence (and dissolution).

Finally, except perhaps Mathur, Raghuvanshi had a greater tolerance for an active underlife and general lack of overt discipline in the classroom than the other two teachers of the middle school. Many times students would walk in late and he would pay little attention to the late coming student. Loud rhythmic chanting of multiplication tables by children from elementary classrooms that wafted in through the open door and window often merged with the background noise of student chatter to transform the classroom into a vocally vibrant public space where often much seemed to happen besides the official business of imparting and receiving education. Predictably, periods of high activity coincided with transitions or lull in teaching in the science period, such as when Raghuvanshi gave homework at the end of the class or transitioned from one activity to the next. Much of the underlife comprised students having sidebar conversations, and passing books and other stuff among themselves. But sometimes, students also tried to communicate with students outside the classroom through the open door or window. Raghuvanshi, however, discouraged such behavior through mild reprimands. Actually, I never saw Raghuvanshi threatening any student with any punitive action for their actions in the classroom. Unlike other teachers, he never beat or threatened to beat his students. At most they received a mild verbal reprimand for their behavior unruly behavior. Besides, his reprimands mostly were addressed to no one in particular but to the class as a whole. Many students I talked to listed Raghuvanshi never giving corporeal punishment to them and their consequent lack of fear in his classroom as two important reasons of their liking science as a school subject. Thus, students were visibly more relaxed and acted more naturally in science periods as compared to other subject periods. As Dheeraj said, "there is no fear of doing anything in Raghuvanshi sir's class." However, I also never saw open defiance and gross indiscipline in science periods. Raghuvanshi only had to raise his voice to put the class back on agenda and greatly reduce activity in the discursive underlife. Perhaps, mutual respect among the teacher and the taught, Raghuvanshi's engaging manner of teaching, and traditional cultural norms of interaction between a teacher and a student worked to keep students' underlife in the classroom within healthy limits. It seems safe to conclude though that Raghuvanshi's lack of emphasis on enforcing overt discipline and compliance among students and the resulting construction of a relaxed and convivial classroom learning environment may have spurred many a student to add their often hesitant voices to the ongoing dialogues in science periods.

A Study in Contrast: Ritesh Shrivastav's Classroom

The nature of Raghuvanshi's enactment of his teacher script can be better appreciated in light of how other teachers in the same school taught. Thus, in this section, I present a brief portrait of Ritesh Shrivastav's classroom. Ritesh Shrivastav taught social studies to the 8th grade. He had a good opinion of himself as a teacher as he unabashedly admitted to me that he felt he was close to the image of an ideal teacher he had in his mind. He added though as an afterthought that he did still keep trying to come closer to that ideal. He wasn't very articulate about describing his image of an ideal teacher, but did say that, "well, the ideals are just that one must do ones duty whatever it is. .. Also, all topics should be taught in as much "detail" as possible. Then it is "clear" to the kids. .. So, kids should be taught in as much "detail" as possible."

A tall imposing man that he was, Ritesh Shrivastav maintained a stern visage in the class. In response to my question about his expectations about how students should behave in his class, Shrivastav told me that "students should take interest in whatever subject is being taught to them. .. They should have an inclination towards the subjects." Taking interest in studies probably meant being a good listener as that was pretty much of what students were allowed to do in class. Any sidebar conversation among students was strongly admonished. Students told me there was a general fear of him as he had the reputation of beating students for their misdemeanors and infractions. Thus, I found that while Shrivastav taught, students in his class kept silent - their heads down and trying or pretending to read the textbook.

As for the teaching practices he favored, three clearly stood out during my study period. First, teaching a chapter meant asking a student, mostly it was Amaresh who was picked out, to read aloud the chapter from the beginning for the whole class. So while Amaresh read aloud the chapter, rest of the class listened. Though, of course, I could see them looking sideways now and then and exchanging glances with their friends. When I asked him what kind of preparation he did before teaching a chapter, Shrivastav replied, "I need to prepare. .. I have to look at the chapter and see which terms will be difficult for students so that I can get them to write their meanings. .. So I have to look it up a bit." Besides, identifying difficult terms he felt he didn't need to do any other preparation now as he has been teaching this subject for the last six or seven years. In keeping with how he prepared for his teaching, Shrivastav's academic input in the class didn't go far beyond translation of academic official Hindi terminology into simpler everyday language. And thus, Shrivastav would interrupt the student reading aloud the text frequently to either explain the meaning of some term he thought was difficult for the students or to re-voice a passage or a couple of sentences in the text in a slightly simpler but similar language for the benefit of students. He particularly emphasized the content he thought was important for students from the point of view of examinations marking such content as "I.M.P" (short for "important"). The contrast with Raghuvanshi's class is striking as never even once during my entire study period did I witness students asking a content related question or making a content related comment in class. If students had any questions, they were almost always of procedural nature.

Second, unlike Raghuvanshi, Shrivastav followed the school textbook strictly to cover the social studies curriculum. Never once did I see him abandoning it even momentarily or improvising upon it. The textbook represented the final authoritative word, even if it was outdated and incorrect. For instance, the book had a chapter on India's foreign policy. This chapter, long after the demise of Soviet Union in 1991, still stubbornly mentioned it as existing. And that's how it was taught to the students – still existing and as one of the two super powers in the world. Further, the chapter also talked of India as one of the leaders of the Non-Alignment Movement and as following *Panchsheel* (meaning five moral principles in Sanskrit) principles of co-existence among nations (of 1950s) as a component of their foreign policy. There was no mention of India's foreign policy in a uni-polar post 9-11 and increasingly 'flat' world. Evidently this chapter had been written many, many years back and hadn't been revised since. But, Shrivastav didn't deviate a bit from the text and endorsed every word of it for the students.

Third, after a chapter or a portion of it had been read by one and listened to by all, Shrivastav dictated answers to exercise questions that were at the end of each chapter. A couple of times he started with questions first, and then came to the reading of the textbook. Questions, he thought, were important from the point of view of exams, were declared as "IMP". So while he dictated, all the students, sitting cross-legged on the floor and their shoulders hunched over the notebooks in their laps, hastily scribbled down what the teacher said.

Thus, I found an enactment of teacher script in Shrivastav's class that was in sharp contradistinction with Raghuvanshi's. While Raghuvanshi enabled students, albeit in a contingent and context dependent manner, to play an important role in the co-construction of their learning experiences, Shrivastav denied them any meaningful role. While Raghuvanshi worked to create conditions for contingent enactment of student agency, Shrivastav's teaching didn't allow such conditions to congeal, even if transiently. Other two teachers, headmaster Mahto and English teacher Mathur, enacted the teacher script differently from Shrivastav and in their own way. But none of them did as much selective and contingent picking and unpicking of circulating discourses and improvisation in their enactment of the teacher script as much as Raghuvanshi. And lastly, but most importantly, none of them made learning as much personally meaningful to a student, as Raghuvanshi did.

Summing Up

It would be naïve to think of Raghuvanshi as a mythical hero who having little weakness of his own was able to surmount daunting odds to teach science in ways that educators and policy makers advocate. His teaching practice had several shortcomings of which he too was aware. Also, as the analysis in this chapter reveals, many times he chose to teach in pretty traditional, non-student friendly ways. However, what was certainly remarkable about his teaching was the way he was able to contingently circumvent his own limitations and negotiate the existing constraints and affordances to create apposite conditions for learning of science in ways that were personally meaningful and relevant to this students. As a skilled bricoleur, he seized contingently emerging opportunities to exercise of his own agency as a teacher. This ephemeral and situated emergence of teacher agency enabled him to contingently and selectively pick, adapt and improvise on circulating discourses of his profession and school science to craft a teaching script that offered many opportunities for students to learn science in ways that went beyond the limitations of the extant school science and professional discourses.

This agency manifested itself in many different ways and contexts. For instance, as we saw in this chapter, he followed the curriculum, yet found opportunities to deviate from it or improvise upon it to make school science more relevant to students' daily lives. Whenever it was feasible, he scrounged around for kit material to do fascinating science experiments with students even though the extant professional discourse didn't encourage this practice. Thus, through a tactical re-use of the prescribed curriculum he was able to help engender contingent opportunities for himself and his students that enabled both the teacher and the taught to move beyond its limits and make school science more relevant and meaningful to their lives.

Likewise, though I-R-E type of interactional exchanges dominated in science periods, there were also many occasions when by a contingent enactment of his teacher agency, he was able to open up ephemeral spaces where students' agency could be exercised. He helped actualize, although in an contingent and thus inconsistent manner, conditions that made it possible for students to take initiative, change the nature and form of classroom dialogues, and animate the classroom discourse with their voices, out-of-school discourses and knowledge systems.

Thus, Raghuvanshi's enactment of the teacher script stamped with his own personality, history, ideas and beliefs showed unmistakable evidence of situated improvisations and enactment of teacher agency for sake of better science learning. This enactment of teacher agency was very much depended on the transient confluence of different factors defining that moment in space and time. As a result, it got revealed to me only inconsistently and under opportune circumstances. In contradistinction, Ritesh Shrivastav, who taught social studies to the same class, enacted the teacher script in ways that were relatively more consistent in adherence to the extant circulating discourses of the profession and the school subject and lack of contingent improvisation upon them. Unfortunately this also translated as consistent denial of possibilities of greater participation of students in co-construction of their learning experiences.

Chapter 7
Students in the Science Classroom

All the students I spoke to liked Raghuvanshi and the way he taught science. However, their participation in the classroom discourse varied considerably within and across subject topics. As mentioned in the methods chapter, to evaluate how students participated in the classroom discourse and responded to school science, I took an dialogic event in Raghuvanshi's science class as the basic unit of analysis, and analyzed a total of 469 episodes that occurred in 11 class periods of Raghuvanshi's teaching science. An interactional episode is one where participants can be identifiably seen as engaged in a dialogic and socioculturally mediated action in a social context such as a science period taught by Raghuvanshi. A class period consists of a sequence of connected dialogic events wherein each event is demarcated from the preceding and succeeding ones in terms of participants, setting, topic, and nature of action (form, content, addressivity, etc.).

I was interested in understanding not only how students participated in the classroom discourse and responded to the teacher script in the science classroom, but also how students' agency gets enacted in the way they responded to the school science they encountered in Raghuvanshi's classroom. Thus, each interactional episode was analyzed at two levels:

1. *socio-linguistic level:* where I looked at how students responded to teacher's enactment of his teacher script, and his response to students' actions; and

2. *science content or discursive level:* where I focused on the nature of students' utterances in terms of the knowledge and discourses students used by them, science topic, the exigencies that led to their utterances and the effect their actions had on the classroom discourse.

In this chapter, I present the main results of this analysis. The attempt is to showcase interesting patterns that the analysis revealed at both levels – patterns that help us understand the nuanced, contingent and improvised ways in which students with all their knowledge and experience of and interests in the material world respond to teacher script and school science discourse in Raghuvanshi's classroom.

Different Forms of Student Participation in the Classroom

As discussed in the previous chapter, Raghuvanshi's class had a predictable familiar daily rhythm to it. Almost every day, the science class started with roll call of students. First, homework of students who volunteered to show was checked while rest of the class waited. The teaching began shortly thereafter and almost always ended with the giving of homework to students. In the previous chapter I also showed how remarkably relaxed the learning environment in Raghuvanshi's class was, especially if we compare it with that of other subjects. Students not only felt more freer to participate in classroom discussions, but also in the discursive underlife. Raghuvanshi didn't spend much time in managing the students overtly. He tolerated students' sidebar conversations as long as they didn't threaten to overwhelm events related to classroom discourse. Further, Raghuvanshi actively encouraged students' participation in the classroom. However, as this section will show, despite all the encouragement by the teacher, students responded to the

Table 7.1: Student participation in science periods (Topic: Electricity)

Category of Events	**Frequency**
Events with students-in-action (taking initiative)	54 *(25 events with content-related initiatives (9% of total no. of total number of events)*
Events with students responding to teacher instructions and questions and conforming to the teacher script	165 *(90 events where students responses include their out-of-school discourses and knowledge (32% of total no. of events))*
Events with students taking initiative to inject a non-content related element in the classroom discourse	14
Events with students taking initiative in the discursive underlife	38
Events with students responding to teacher instructions and questions with a non-content related response	7
Episodes with Teacher-in-action on non-science related issues	3
Total Episodes examined	**281** *(in about 41% episodes, students either took content related initiatives or responded with their out-of-school discourses and knowledge)*

classroom discourse contingently, calibrating their responses in accordance with the constraints and affordances of the social situation of the moment. The major categories of their response as thrown up by the socio-linguistic discourse analysis of the interactional episodes are as follows:

(A) Following the teacher script: For much of the class time (61% of the 469 episodes studied), I found that students sat in the class rather passively either listening to Raghuvanshi or participating in the IRE (initiation-response-evaluation) exchanges or classroom activities as instructed by him. Except through compliance, there was little evidence of student initiative to influence events pertaining to teaching-learning of

science. As a result, teacher-student dialogue unfolded more or less according to the teacher script. Students in these dialogic events opted to conform to the teacher script by: (a) using or adding their out-of-school discourses and experiences in their responses to teacher's instructions or questions; (b) using or repeating statements from school science; (c) responding to teacher's procedural or instructional routines; or by (d) just silently listening to what the teacher had to say.

For instance, one day Raghuvanshi was teaching chemical properties of metals. After reviewing with the students the chemical properties of metals that were covered the day before, Raghuvanshi came to the topic of the influence of acids on metals and nonmetals, and initiated the following IRE sequence with students:

> *Raghuvanshi writes "The influence of acids on metals and nonmetals" on the BB, and then turns around to ask: Do you know what is an acid ("amla")?*
> *There was no immediate response from the students.*
> *Raghuvanshi sits down on the chair, and asks again: Acid ("amla").. what is it? .. Keep the pen down, keep it down. . Do you know anything about acids? .. Eh? .. "Amla" means?*
> *Dheeraj: "Acid".*
> *Raghuvanshi: Acid. That's the English name. Do you know its any other properties?*
> *No response from the students.*
> *Raghuvanshi: "amla" means "acid". "Amla" means .. there is a trade name – "tezaab".*
> *Yash: Yes sir, "tezaab".*
> *Raghuvanshi: Trade name ..?*
> *Students: "Tezaab"!*

Here as we see, it is the teacher who asks the question the question that kicks off the teacher-student dialogue. This question, *"Do you know what is an acid?"* first finds no response from the students. But after being asked again in a different way, a student, Dheeraj, attempts a response. He answers Raghuvanshi's question, "Amla means?" by giving its equivalent word in English. This response, interesting in its own way as it provides a glimpse of students' out-of-school discourse on chemicals, is then evaluated by the teacher, and used as a base for furthering the IRE mode of exchange by asking further questions on the issue-at-hand. This episode also shows a rhetorical practice usually linked with IRE exchanges, and indulged in quite regularly by Raghuvanshi. This was to ask rhetorical questions to make sure that all the students were on the same page. In this episode, after telling the students that "tezaab" is a trade name of "amla (acid), Raghuvanshi asks again, *"Trade name ...?"* to which students promptly answered by repeating in unison, *"Tezaab!"*. In episodes where students followed the teacher script, such IRE exchanges dominated much of the teacher-student talk in the classroom.

While students in such events conformed to the teacher script, their participation shows how extensively they made use of their out-of-school discourse and experiences with material world in structuring and giving substance to their responses, whenever the topic resonated with their daily life experiences. An episode that occurred one day when the class was engaged in learning about the heating and chemical effects of electricity manifests this recurrent theme in students' participation in the classroom discourse quite effectively. This episode centers on the question (posed by Raghuvanshi) of why does the fuse wire melt so easily when the other wires in a household electric circuit do not.

> *Raghuvanshi: So why does it melt? Why don't other wires in our houses also melt?*
> *Mahesh: Sir, it is because "current's" influence is first felt by it.*
> *Raghuvanshi: So is that why the wire melts?*
> *Mahesh: Yes sir, it is kept there right in the beginning.*
> *Raghuvanshi: How is it in the beginning? There is a wire from the "pole" to the house too!*
> *Mahesh: Sir, but that wire is thick.*
> *Raghuvanshi: It has nothing to do with wires being thick or thin. Think again. Why does the fuse wire melt? And right next to it there are other wires (which don't melt).*

Mahesh: Sir, "line" (electricity connection) to the house starts right from there.
Raj: sir, a "fault" occurs.
Raghuvanshi: There is indeed a "fault" because of which something happens. What happens to the wire?
Mahesh: (Small explosions occur on electricity poles. Why does that happen?)
Raghuvanshi: Why does it melt?
A Student: what?
Raghuvanshi: This solder ("raanga"). I told you just now. Why does it melt? (pointing to solder wire in his hand)
Narendra (and a couple of other students): Because if its "galnank"(melting point).
Raghuvanshi: Yes, its "galnank"(melting point)is ...?
Students: Low.
Raghuvanshi: So wouldn't something similar be happening in the fuse wire?
Students: yes, sir.
Raghuvanshi: It's melting point too is ...
Students: Low.
Raghuvanshi: That is, because of electricity, because of high voltage, because of this problem, heat is produced there. That is why when you take out the cut-out ...
Students: yes, sir.
Raghuvanshi (continuing): So have you ever touched the plates of the "cut-out"? How is it?
Students: Hot.
Hemraj: "taanti" (warm or hot in local vernacular).
Raghuvanshi: It is "taanti", that is, it is hot. This is our Bundelkhandi language. Right?
(Students and R smile and laugh.)
Raghuvanshi: So it becomes taanti because of high voltage or because of some problem with our electrical appliances. If there is some problem in our radio, TV, or something, or if two wires touch each other, then what happens in a flash? Fuse wire ...
Students: Blows off.
Raghuvanshi: It blows off. And the electricity ...?
Some Students: "fault". "Fault" occurs.
Raghuvanshi: The electricity ... <u>switches off!</u>
Dheeraj: Sir, the wire gets burned.

As we see in this event, students infected the classroom discourse with their voices that borrow liberally from their out-of-school ways of talking about electricity and experiences with household electric circuits. Mahesh had abstracted from his experiences with household electricity an explanation of why fuse wire melts first and not other wires in the circuit. Consequently in the beginning of the episode, we find him engaged in an insistent effort to gain legitimacy for his ideas about the melting of electric fuse wire. Soon other students, Raj, Narendra and Hemraj also, pitch in with their ideas and experiences with electricity. Thus, we get to hear from Raj that fuse wire melts when a "fault" occurs in the circuit, and from Hemraj that plates of the cut-out (the electric fuse) feel "taanti" (meaning hot in local Bundelkandi dialect) to touch. Now "fault" is an English word, but it is also part of the everyday discourse on electricity in the region. Similarly, "taanti" is a word that belongs to the local Bundelkandi dialect. Both, of these terms were certainly not part of textbook Hindi – the genre in which the school science textbook was written. Students working in real-time to fashion a response to the teacher's instructions or questions also made use of school science whenever they could or whenever their out-of-school resources didn't suffice. For instance, in this episode, when Raghuvanshi asked the class, "*Why does it melt? (pointing to solder wire in his hand)*, the students used a school science term, "galanank" (melting point in textbook Hindi) to answer the question. "Galnank", both as a term and as a concept, are not part of the everyday discourse on metals in the region.

Thus, I found that students used their out-of-school discourses and knowledge to construct their responses in about 44% of the episodes where they chose to follow the teacher script without taking any initiative on their own. However, as we saw in the episode above, they also used school science to construct their responses. Let me give another example of this sort. This episode occurred in a science period where the main topic was generation of electricity through different means, such as solar cell, different types of chemical cells, and dynamo. Raghuvanshi's main focus in the classroom discussions that happened during this period was having students realize that in each of the electricity generating devices some form of energy was converted into electrical energy.

> *Raghuvanshi: Here we have the solar "cell". What happens in the solar "cell"? In the solar "cell", which energy got converted? ..Light .. Does light have energy too or not?*
> *Students: yes sir.*
> *Raghuvanshi: So in a solar "cell", light energy gets converted into electrical energy. Now write this completely. (speaking slowly so that students can copy) In a solar "cell", light energy gets converted into electrical energy. (R also writes sentence on the BB). .. OK? But in these three batteries, do they have light energy?*
> *Students: No sir.*
> *Students facing the teacher and most of them paying attention to him.*
> *Raghuvanshi: Light has no role here. In them, it is the chemical energy that gets converted. .. What is it getting converted into?*
> *Students: electricity. (Raghuvanshi repeats with them).*
> *Raghuvanshi: And in this .. the dynamo?*
> *Dheeraj: Magnet ..*
> *Raghuvanshi: What energy is this?*
> *Dheeraj (in a low voice; covers his mouth with his hand while speaking): Magnetic energy.*

In sharp contrast to the episode that I discussed earlier where students made good use of their out-of-school experiences and discourses to influence the ongoing dialogue between the teacher and the taught, in this episode we find students' role reduced to *re-telling* of tiny bits of school science. Evidently, the topic of energy conversion in solar cells and chemical batteries spoke little to their everyday concerns, experiences and ways of talking about the material world. The only discursive resource they could borrow from was school science. This is a recurrent theme that emerges from the content analysis of student participation in the classroom discourse. That is, whenever the science topic veered away from the lived experiences and everyday discourses of the students, they were deprived of important mediational means to participate in and make sense of school science discourse. In such situations, school science was the only resource they could rely upon to navigate events in science periods. In this event, we see that students responses are short, even monosyllabic. In many other events of this nature, students just sat passively listening to their teacher.

However, as I present below, conformity wasn't the only way students related to the teacher script in Raghuvanshi's science classroom. Admittedly, following the teacher's lead and participating in IRE exchanges was what I found them doing in majority (about 61%) of the episodes I analyzed. But whenever the constraints and affordances of the local situation and the resources at their disposal made it feasible, they did the local work of participating in classroom activities a bit differently.

(B) Taking initiative: One day when I asked Lal Saheb why he didn't ask many questions in the science class, he responded, *"Just like that .. Sir, boys laugh, that's why."* As I discussed in the previous chapter, several other students too confessed to me about being afraid, or feeling awkward and shy about asking questions in Raghuvanshi's class. However, during the time I was with them, I got to see many events when, overcoming their fears and misapprehensions, students took initiative in class by asking unsolicited questions or making comments that influenced the ongoing dialogue and often took it into contingent and unscripted directions. Of the total 469 episodes analyzed, in about 17% of them clear evidence of such student action was found. Raising unsolicited science content questions directly or indirectly related to the topic being discussed, adding ones unsolicited comments, views and knowledge to the whole class discussion, taking action or voicing their comments, concerns clarifications on class procedural matters, seeking clarifications on the teacher's or somebody else's comments, and other unsolicited

actions by students that perceptibly aimed at influencing the course and outcome of the student-teacher dialogue in science periods were considered as evidence of student initiative in the analysis of classroom data.

In the following episode, we see students taking initiative to influence the classroom discourse by countering not just their peers but also the teacher with their own understanding of the issue. In the first half of the class period during which this episode occurred, Raghuvanshi wrapped up discussions on a chapter on different sources of energy. The last few science periods had been devoted to this chapter. Student participation in the science period had been mostly passive on these days. Raghuvanshi, sensing students boredom remarked after finishing discussions on this chapter, "We have been doing energy, energy, energy for long. Now let's talk about leaves – something different." Students agreeing with Raghuvanshi responded, "Yes, sir, this energy, energy, energy had gone on for too long. We had got bored of it." Raghuvanshi attempting to segue from energy to plants retorted that it was because of energy that they were alive, and initiated a lengthy but lively dialogue on what makes something living. Excerpts from this dialogue are given below:

> *Raghuvanshi: Now I ask you a question.*
> *Students (Naati and a few others): Yes, sir, ask.*
> *Raghuvanshi: Those things that have energy are called "sajeev" (living things).*
> *Narendra: Sir, wood has energy ...*
> *Raghuvanshi: One minute please. First listen to the question completely, and then answer it.*
> *Raghuvanshi: Living things ... which are they? You have heard this word "sajeev" for a long time. You have known it for long. It is familiar to you. What all things are "sajeev"?*
> *Dheeraj: Sir, tree and ... coal.*
>
> .
>
> .
>
> .
>
> *Raghuvanshi: Just now Dheeraj told us that tree and coal are living things.*

Sapna: Sir, coal is not a living thing.
Raghuvanshi: Why?
Sapna: Sir, it doesn't have any life in it.
Narendra (challenging other students): But after all it is made from living things.
Amaresh in a low voice: But it doesn't grow.
Raghuvanshi (picking up Narendra's utterance): See, he is saying that it is made from living things.
Sapna: Yes, that's true.
Raghuvanshi: So?
Sapna fells silent.
Raghuvanshi: Coal is made from trees. And plant is living thing. And then wood? It is from the tree. You burn it in your homes, you cut it and bring it to your house for burning. Then is wood a living thing?
Narendra and others: It is <u>not, sir.</u>
Raghuvanshi: Why? After all wood is made from tree which is alive.
Narendra and others: Yes, it is made from tree but ...
Amaresh: It doesn't grow.
Raghuvanshi: Listen to him what he is saying. Why is wood not a living thing?
Amaresh: It is not, because it doesn't grow and it doesn't procreate.
Raghuvanshi (to all): Did you listen what he said? Wood does not ...
Students: Yes sir! Wood does not grow and procreate.
Raghuvanshi: Then do you agree with this statement that wood is a living thing? Was he correct or not? (referring to the Dheeraj).
Students: No <u>sir</u>. He was wrong.

As we see in this episode, Raghuvanshi attempting to segue from the topic of energy to plants makes a connection between living things and energy. Narendra sensing the fallacy of this connection, unsuccessfully tried to counter Raghuvanshi's assertion by saying that "wood has energy …". Later, when Raghuvanshi revoices Dheeraj's incorrect statement about coal being a living thing, it sparks an animated and unscripted exchange of ideas and opinions among students. Sapna took the initiative and counters Dheeraj's assertion on tautological grounds that it does not have life in it. Sapna's comment sparks a lively exchange among students in which Narendra playing Devil's advocate counters Sapna's argument by stating that coal is made from living thing. It was an erroneous counter argument, but effective enough to not invite a suitable rebuttal from fellow students. However, Amaresh did counter Narendra on other grounds by observing, *"But it does not* *grow.*" Uttered in low voice, Amaresh's utterance is not picked up and legitimized at first by the teacher. Perhaps, it was not meant to be recognized according to the teacher script. I saw several instances when students responded to the dominant narrative in the classroom discourse *sotto voce* so that only their friends sitting close by could hear and recognize their independent (and often in the minority) take on the issue at hand. Later, Narendra offers his counterargument again, this time in a louder voice, and Raghuvanshi recognizes and allows it to influence the ongoing dialogue.

Thus, we find several things happening in this event. There is clear evidence of student initiative to counter questionable assertions made in the classroom discourse, even if they are from the teacher. This initiative takes the ensuing dialogue in unscripted directions so as to address students' ideas and concerns. However, we also see that student initiative is not always successful in gaining access to the floor and influencing the course and outcome of the dialogue. The teacher acting as a gatekeeper, enacts his own agency in giving or denying legitimacy to students' utterances. Finally, as Amaresh shows through his participation in this dialogue, students calibrated the addressivity of their utterances in a nuanced and measured way to choose their audience.

However, as can be expected student initiative wasn't only or always directed at the school science topic being discussed in the classroom. Through their action students also voiced their intentions on procedural matters, and sought clarifications on procedural matters or on somebody else's comments or actions. In fact, I found that only in about 48% of the episodes that had students taking initiative, was student action aimed at the science topic being discussed in the classroom. As I discuss shortly in the pages ahead, these few episodes gave me a crucial window into the ways in which students were making sense of and appropriating school science discourse.

(C) Students in action in the discursive underlife of the classroom: As I presented in the previous chapter, Raghuvanshi's science periods were in general noisier than those of other teachers. Of course, there were time spans too, in most science periods I observed, when I found most students paying attention or participating in the activities pertaining to the classroom discourse. But still, compared to other periods, *underlife* in Raghuvanshi's classroom was often rife with surreptitious and not so surreptitious sidebar conversations, nudges, smiles, and other sundry exchanges among students. Unfortunately, as the classroom was small and fully occupied with more than 40 students on most days, I didn't have the liberty of changing my location in the classroom while the class was in progress. This limitation coupled with inability to attend to and commit to memory or scratch notes all that was transpiring in the classroom, and poor audio recording of the classroom meant that often I was not privy to many of these student initiated exchanges in the underlife of Raghuvanshi's classroom. But I tried to record as many as I could, and of the total of 469 science classroom I analyzed, I find that in about 14% of these episodes, the main activity is happening in underlife, in the form of student initiated and sustained exchanges. These dialogues predictably tended to spike when there was some sort of transition in the period, a temporary lull in active teaching by Raghuvanshi or when the main activity for students in the teacher script mainly comprised copying from the blackboard or taking notes or homework questions from Raghuvanshi.

Most of the times these exchanges were in the form of sidebar conversations both on and off science topic-at-hand in the science period. However, I also witnessed occasions when students indulged in other forms of exchanges, such as talking to somebody from outside the class without teacher's explicit permission, throwing things, such as leaves, at each other, and taking initiative to help a visitor to the classroom without or without explicit Teacher's permission. Sometimes teacher's actions too led to student action in the underlife. For instance, a content-related comment by Raghuvanshi would generate a student-to-student exchange in the underlife of the classroom. This either didn't happen often, or I missed recording it many times. Thus, I could find only 15 episodes (out of a total of 469 examined) of this nature.

Raghuvanshi often ignored student action in the underlife, and asked students to cease them only when they threatened to disrupt the enactment of the teacher script. For instance, once Raghuvanshi espied Raj trying to communicate with some student from another grade standing outside next to the window. Interrupting his teaching, he said, "Hey, no talking! What's the matter?" That was enough for the student standing outside to scamper away, and Raj to get back to paying attention to the teacher.

(D) *Students injecting humor in the classroom discourse:* Students didn't always respond to Raghuvanshi's instructions and questions with an anticipated action according to the teacher script. Though I found this happening in only about 4% of the episodes examined, students some times taking advantage of the contingent ambiguities inherent in social talk, tried to inject an unanticipated and unscripted element, often humor, in the classroom discourse. For instance, one day when a religious sermon by a popular Hindu religious preacher was to be given in the neighboring town, Raj made a mock request to the teacher to be allowed to leave school so as to attend the sermon. Raghuvanshi giving limited legitimacy to the request smiled and replied that that there was no need to go to Asaramji Bapu as he also will be giving them sermons in the class today.

Another episode of this nature occurred one day when the class was discussing conductors and insulators of electricity. The student-teacher dialogue happened as follows:

> *Dheeraj (smiling): Sir, Does current flows through humans or not?*
> *Raghuvanshi: Well, let's find out if electricity flows through human beings or not. Now, in paper?*
>
> .
>
> .
>
> .
>
> *Raghuvanshi: Yeah, that's what I wanted to know if electricity would flow through Peetum Chand. Will it flow through Lalji? Will it flow through Khemraj or not?*
> *Yash (laughing): Yes, through Khemraj it will definitely flow.*
> *Sarla (in a loud voice against lot of student chatter): Yes sir, whether it flows through our arms, let's find this out.*

Here we see how Dheeraj and Yash manage to introduce humor in the classroom by asking questions and making comments about the conductivity of human body and by extension of a classmate of theirs.

Lastly, it also happened, albeit rarely, that the teacher led students into a discussion on some issue that had little to with the teaching-learning of science.

Thus, I observed different forms of student participation in Raghuvanshi's classroom manifesting students' ability and willingness to initiate action as well as to conform to the teacher script. Students gave a situated, contingent and improvised, and thus varied and tactical response to the teacher script. Their response was actively predicated upon the locally extant contingencies, constraints and affordances of the social context and mediational means available to accomplish the work of social talk in a science classroom.

However, a socio-linguistic discourse analysis of the teacher-student dialogue isn't adequate on its own to help us understand how students, with all their out-of-school knowledge of discourses about the things and phenomena in the material world, responded to school science. For that, one will also have look at the social work being accomplished in the classroom from a science-content perspective. And this is what the next section in this chapter aims to do.

Students' Response to School Science discourse

From reading field notes of Raghuvanshi's classroom, it was clear to me that the nature of student response to school science very much depended upon the science topic being discussed in the classroom. Thus, desiring to get a glimpse of what are the sort of science topics interest these students or are amenable for student initiative, I content-analyzed all the episodes that showed student initiative as well as those where students chose to conform to the teacher script in terms of science topic.

If we restrict ourselves to only those episodes during which the main topic being discussed had to do something with electricity, then content-analysis reveals that students took initiative when the main science topic for consideration in the class revolved around issues of electrical safety, conductivity of electricity through different materials, working of an electrical circuit, and electrical lamps. These are all those topics that students, especially boys, had to grapple with in their daily lives as young working adults in farming families. In contrast, I didn't find students taking initiatives in electricity topics like electroplating (chemical effects of current), different kinds of batteries, solar cell, dynamo and electrical charge. In Chapter 5, I dwelt on the nature of experiences with and knowledge of electricity that the students of Raghuvanshi's class had as a result of being young productive members of a rural and agriculture based society. If we recall the findings from the chapter, it becomes evident that the electricity topics in which students showed initiative, were actually the ones that resonated well with their out-of-school experiences with electricity. On the other hand, electricity topics that showed little student initiative, such as electroplating and solar cell, didn't connect that well with their life outside school.

I found a similar pattern in other school science topics, such as plants, chemical properties of metals and energy generation. For instance, even in plants, something that is closely connected with their everyday existence as farmers, students take initiative mostly in discussions that they could relate to, such as different types of leaves and plants found in the area. But, when Raghuvanshi discussed how leaves of aquatic plants adapt themselves to their aquatic habitat, students showed little science content related initiative, and played their part in Raghuvanshi's teacher script. Likewise, students didn't take any initiative when the topic was chemical properties of metals – something they couldn't readily relate to.

Obviously, students' engagement with school science didn't just vary in terms of the science topic, but also, and equally importantly, in terms of exigencies that led to it and the intended purpose of their engagement. In this regard, it seemed important for me to understand what the students were trying to accomplish in events where they take unscripted, unsolicited science content related actions in the classroom discourse. Thus, I analyzed the content-related episodes where students took action in terms of exigencies that led to that action and its intended purpose. Three clear trends emerged from this analytic exercise.

(A) Making connections:

First, students were seen to take content-related initiative, in terms of asking question or making a comment, when the topic was directly connected with their lives. For instance, consider the episode given below. This episode occurred when the class was discussing the different ways household or agricultural electrical connections can be made safe if the electricity is being drawn from the main line through a "direct connection" (as the students mentioned during this class), without using fuse wire in between as a safety precaution.

Narendra: Sir, we can also connect an "MCB".
Raghuvanshi: There is a fuse wire in the "cut-out".
Students: Yes sir.
Raghuvanshi: What?
Students: An "MCB".
Raghuvanshi: M-C-B. It is a new thing that has come recently that is used in place of cut-out or fuse wire. It is called..
Students: M-C-B.
Raghuvanshi: What does it do?
Yashwant: Sir, if there is too much "current", then it "trips".
Raghuvanshi: Yes, it "trips". That is, it stops the "current" on its own.
Yashwant: And, sir, if someone gets a shock then also it "trips".
Raghuvanshi: Are you all listening?
Bhola: Yes sir.
Raj: Sir, another new thing has come. .. "Auto".
Roop Singh: Oh that! That has been long in use.
Raghuvanshi: "Auto"?
Jagdish: ( )
Raghuvanshi: One minute! Let him speak. Go on.
Raj: Sir, it is used in "tube-wells". It is used in "starter" that is used to start tube-wells. If "light" comes, it allows tube-well to start automatically, so that we don't have to go near the "starter". But if "light" is low, it wouldn't start. ( )
Raghuvanshi: So if there is enough "light", it would start on its own. And if it is low then ...
Students (and Raghuvanshi): it would shut-off.

Raghuvanshi: So if the motor is on, and if there is a drop in "current", then ...
Raj: Sir, that thing will automatically shut the "motor" off.
Raghuvanshi: Yes, so it also stops the "engine" on its own. ... So there is a new thing now. What would we call it? .. "Auto" .. "Auto switch"?
Raj: Yes, "auto switch".

Most of the boys in the class worked on farms (their family's or as hired labor) where they either operated tube-wells or water-pumps to draw water for irrigation purposes or observed adults doing so. Further, as I found out during my study, drawing electricity illegally from the main line by making a "direct connection" to it was a common practice, especially among poor farmers, in the villages of the region. Since such connections were made without seeking approval of the local electricity board, the farmers escaped paying the electricity bills, and got this precious resource totally *gratis*. However, getting a "direct connection" also carried a serious danger of electrocution through unsafe connections. Thus, farmers of the rural community of the region had learnt different ways of making such connections safe. Young men of Raghuvanshi's class, being legitimate, and many a times more than peripheral participants to this practice, had acquired much working knowledge about how to make such connections safer. As the topic was intimately connected with their lives as productive adults outside school, in this episode, we find them shedding their inhibitions about taking initiative, and influencing the course and outcome of the ensuing dialogue in a major way.

It is interesting to see how, in this episode, their knowledge of electrical safety and the discourse that accompanies it spills over into classroom dialogues. The science textbook assumed very limited understanding of electrical circuits and safety among its intended audience. In the previous grades, students had only been taught about electrical charge. In the current grade too, there was only one small chapter on electricity that tried to cover too many topics. As a result, the chapter had only one small paragraph on simple electrical circuit, and one small section comprising three paragraphs on dangers of electric current in which the use of fuse wire for ensuring electrical safety was mentioned in a couple of lines. Working with electricity being a big part of their lives outside school, the students, especially boys, evidently knew much more about this topic. And seeing the connection with their daily lives, they were much eager to enrich the school science discourse with their out-of-school discursive resources.

Thus, we find Narendra and Raj taking initiative to inform Raghuvanshi and other students about advanced electrical switches – "MCB" (multiple circuit breaker) and "auto switch". From the class proceeding of that day, it is clear that Raghuvanshi wasn't planning to talk about these kinds of electrical equipment. He only talked about fuse wires for electrical safety. It was students who by taking initiative to about MCB and "auto-switch influenced the ongoing dialogue to proceed in a direction closer to their lives and interests. Evidently it wasn't just these two students who knew about these appliances. It appears to be common knowledge because when Raghuvanshi asked Narendra to repeat the name of the equipment he had mentioned, many students spoke at the same time to repeat the name of the equipment. Similarly, when Raj informed the class about "auto-switch" and claimed that it was a new thing. Ramesh countered it by asserting, "That has been long in use." The students also explained how these safety features worked heavily borrowing English scientific terminology, like current, tripping of electrical circuits, light, starter, auto-switch and MCB. As the reader may have inferred from the passage, “light” was used as another word for electric current. It is a common usage in India probably owing its origin to the fact that in an electric power deficient country like India, in homes electricity is used more for lighting a bulb than for any other purpose. Students’ explanations also show how well the students had understood how these advanced electrical devises worked. As we will see, this robust working knowledge of electricity manifested itself frequently in students’ utterances in the classroom discourse whenever the electricity topic was connected to their lives outside school. As we saw in this event, whenever student initiative seemed relevant to the topic, Raghuvanshi legitimated entry of student utterances into the classroom discourse, and allowed students to shape the ongoing discussion in a meaningful and substantial manner.

(B) Ironing out contradictions:

Secondly, analysis shows that students also took initiative when school science appeared to contradict or say something different about the material world from what students had learned from their outside school experiences and immersion in other discourses. The following episode occurred during a science period where the main topic was the two types of electric current – alternating (AC) and direct (DC). Prior to this episode, Raghuvanshi had discussed with the class how two types of electricity were used in their houses and how appliances that run one type of electricity do not run on the other. The class had also discussed the use of “eliminators” to convert AC to DC, and how magnitude of current in one remains constant while in the other undergoes repeated cyclical changes.

Narendra: Sir, we get a shock from the current on poles, and don't get shock from the battery current.
Raghuvanshi: So don't you get a shock form the current from a battery?
Students: NO SIR.
Narendra: that is just 12 volts.
Raghuvanshi: You don't get the shock because it is just 12 volts. If it becomes 60 or 100 volts, then with it too you will feel a shock.
Students: yes sir.
Raghuvanshi (continuing): .. because the electricity from poles is 220 volts.
Narendra: sir, why then we don't get a shock when we touch the wires after it passes the "eliminator"?
Raghuvanshi: Eh?
Narendra repeats the question.
Raghuvanshi: in the "Eliminator"?
Students: yes sir.
Raghuvanshi: "Eliminator" means that it reduces the current. .. It makes 220 volt current into a 12 or 6 volt current. It changes the current, it makes it DC .. and reduces it too. It does two things. It makes a "cell" like current.

Though Raghuvanshi had covered major differences between AC and DC, he had neglected to address one important difference between AC and DC that students saw in their daily lives. And that is, AC gives electrical shock, but DC seemingly doesn't. It is easy to see how someone may develop this naïve conception since only low voltage DC is used in household circuits whereas only high (comparatively) high voltage AC is used in homes. In this episode, Narendra took initiative to help Raghuvanshi address this naïve conception, and also supplied his own (correct) interpretation that battery current didn't give shock as it was "just 12 volts." Now, while talking about invertors, Raghuvanshi had not mentioned that eliminators, apart from converting AC to DC, also reduced the voltage of the current. By skipping this crucial bit of information, Raghuvanshi had unwittingly created an apparent contradiction about AC and DC, and their capacity to inflict electrical shock on people. That is, if eliminators only converted AC to DC, and the possibility of electrical shock was dependent upon the voltage of the current, then the DC current coming out of an eliminator should have the same voltage as AC and thus, the same capacity to inflict electrical shock to people touching naked wire inadvertently. But that as at least Narendra had realized doesn't happen. Hence the contradiction. Narendra brought up this contradiction for resolution by asking Raghuvanshi, "sir, why then we don't get a shock when we touch the wires after it passes the "eliminator?" As we see in this episode, Raghuvanshi resolved the contradiction by mentioning the fact that eliminator also reduced the voltage of the current.

(C) Making science relevant:

Finally, the analysis shows that on occasions when the main topic was close to students' lives, but the way it was being approached in the class reduced its relevance for the students, students responded by taking initiative to influence the ongoing dialogue in the classroom so as to make it germane to their out-of-school experiences or life situations. As an illustration, consider the episode given below:

> *Raghuvanshi: So is there anything we can do to avoid this danger? If there is too much current, then wires in our homes get hot .. There was no fault. But because of too much current what happens is that ..*
> *A student: A "fault" occurs.*
> *Raghuvanshi: No, the wire melts. Right?*
> *Students: Yes sir.*
>
> .
>
> .
>
> .
>
> *Raghuvanshi: So what can we do to avoid this danger? If there is too much current .. it happens sometimes.*
> *Bhola: "Fuse wire", sir. Of low melting point.*
> *Raghuvanshi: Yes, we should use a fuse wire of low melting point. So tell me, is he correct in saying this?*
> *Narendra: Yes, sir.*
> *Raghuvanshi: Can we use any "fuse wire", and from anywhere?*
> *Students: NO SIR.*
> *Raghuvanshi: So, of what type?*
> *Students: Of low melting point.*
> *Raghuvanshi: Of low melting point, and of precisely the gauge that is needed there.*
> *Students: Yes sir.*

Narendra: Sir, what if someone has a "direct connection"?
Raghuvanshi: Even if there is a direct connection, then also you can think of some solution. That is, if you connect wires directly, what precautions need to be taken?

.
.
.

Raghuvanshi: Come on tell us what needs to be done to avoid this danger if wires are connected directly?
A student: Sir, we should connect a "grip" to the wire.
Raghuvanshi: <u>What</u> should be connected?
Students: GRIP!
Raghuvanshi: Grip, or what you also call the "cut-out". Or "main switch".

In this episode, we find Raghuvanshi leading a discussion on how fuse wires keep homes safe from electrical fires, "faults" and other dangers. Fuse-wire-based protection is usually installed by the local electricity board while installing a legal electrical connection in a house or a farm. However, since many homes in the villages of this region get their electrical connection illegally directly from the electric poles, fuse wires weren't a very relevant form of protection for the people in the surrounding villages. Though, since using an illegal "direct connection" was fraught with risk of electrocution, the issue of electricity safety was an important issue in the lives of the people. Finding that the discussion was proceeding in a direction not very relevant to the lives of the students, Narendra took corrective action by asking Raghuvanshi, "Sir, what if someone has a *direct connection*?" Everyone in the class, including Raghuvanshi, apparently knew what this phrase in English meant. There were no explanations sought or given on what Narendra meant by "direct connection" and why he asked this question. Raghuvanshi perhaps sensing the importance of this question for the lives of the students, and also recognizing that students may have lots to say on this issue, re-voiced the question back to the students. Narendra's action once legitimized by Raghuvanshi, was immediately taken up by other students. Thereafter, the ongoing dialogue charted an unscripted direction guided by contributions from the students. In this way, Narendra's action succeeded in rooting a school science topic to the lived experiences of the students and their families.

Summing Up

Thus, an analysis of student participation in Raghuvanshi's science classroom both at socio-linguistic and science discourse level reveals interesting and meaningful pointers to students' response to schooling as well as school science discourse in the VIII class of the Rani Pipariya Government Middle School. A sociolinguistic analysis of classroom discourse showed how students accomplished the social work of participating in activities of the science classroom, in a varied, improvised, contingently situated and tactical manner. Though for much of the class time, students sat either passively listening to the teacher and conformed to the teacher script, there were occasions when they took initiative and tried to lead the classroom dialogue in unscripted directions. Sometimes they succeeded in doing so, and sometimes they didn't depending upon the response of the teacher to their initiatives. The analysis also shows that students didn't always restrict their initiatives in classroom discourse to purposes of learning science. Whenever, an appropriate situation presented itself, they also tried to infect the classroom discourse with unscripted utterances that often had humorous overtones. Further, Raghuvanshi's classroom was often rich in discursive underlife. It was tolerated by him as long as it didn't threaten to derail the ongoing science related activities in the classroom.

The varied, situated and tactical manner in which student performed their social roles as students in the classroom bespoke of their contingent enactment of their social agency in the science classroom. The theoretical perspective of the study posits agency in terms of a socioculturally mediated and contingently creative dialogue with the world – an engagement that not only shapes the counters and direction of the dialogue, but also influences its outcome. To an observer, this agency is identifiable in the contingently create aspect of the dialogue, i.e. by the tactical improvisations that participants do in selective picking and unpicking from available circulating discourses to construct their dialogic responses. If the students in Raghuvanshi's classroom had participated in the classroom discourse in a consistently uniform manner, such as by always conforming to the teacher script, their enactment of social agency would not have been observable to me. However, as the analysis in this chapter reveals, students' participation in the classroom discourse was marked by contingent variation and improvisation – a feature of their enactment of their roles as science students that allowed me to observe their social agency. It is also interesting to note that the social agency of students in Raghuvanshi's classroom got expressed in ways far more complex and nuanced than simple opposition and rebellion.

Finally, a science discourse analysis of the class talk reveals how students, as active and knowledgeable agents in the material world, responded to school science discourse. I found that the three main exigencies that gave rise to student action were connectedness of the topic to the lives of the student, need to reconcile their out-of-school discourses and knowledge with school science discourse and desire to influence school science discourse so as to make it relevant to their out-of-school experiences or life situations. In addition, the analysis also showed student action in the classroom discourse resulting from (a) a desire to correct perceived errors in comments made by the teacher or the students, (b) humor or the possibility of it, and (c) a desire to share ones experiences to the ongoing learning process. Interestingly, none of the student actions seem to be driven by pure curiosity about the material world. There was little sense of wonder in the questions students asked. As we saw in chapter 5, this lack of expression of scientific inquisitiveness by students correlates rather well with statements by students to the effect that questions about the world do not arise in their mind now, their valuing education largely for functional purposes, and their general fear of asking questions in the class.

Thus, the analysis shows that students, acting as *bricoleurs*, tried to selectively appropriate school science discourse for their own out-of-school purposes, through their initiatives in science periods. These initiative led to dialogical engagements that shaped the way events unfolded, and often determined their outcomes. In these situated actions aimed at selective appropriation of school science discourse, we can again see a contingent enactment of social agency by students – an agency that sought to extend students' material agency over the material world.

Chapter 8
Discussion and Implications

In this concluding chapter, I bring together and discuss the main themes coursing through this study so as to bring into focus the phenomenon, viz. science learning, that the case analyzed in this study represents. A corollary of Gödel's Incompleteness theorem is that all logical systems, irrespective of their complexity, are intrinsically incomplete. That is, they contain true propositions that cannot be proven from its own defining set of rules. For qualitative interpretive research, I find Gödel's theorem pointing to the inevitable limitations that accompany attempts to "reveal the multiple truths apparent in others' lives" (Emerson, Fretz, & Shaw, 1995, p. 3) through such research. Thus, in this chapter I also discuss what I perceived as the main limitations of this study. Finally, I delineate some implications that this research has for the ways science education in particular and education in general is imparted in schools in India and beyond.

Enacting Agency in a Social and Material world

In this study, human agency comes across as a contingently emergent feature of situated local action. The students or Raghuvanshi did not *have* agency, but rather under opportune circumstances, they *enacted* or *exercised* agency through socioculturally mediated and contingently creative dialogue with the world – an engagement that not only shapes the counters and direction of the dialogue, but also influences its outcome.

(A) Enacting material agency:

The sociocultural perspective views "people as actively engaged with the environment" (Holland, Lachiotte, Skinner, & Cain, 1998). As the study shows, the students of the 8th grade led a busy demanding life. Apart from being students of the local middle school, they also were productive members of the local economy, and thus fully engaged in their local social and material worlds. Rogoff (2003, p. 133) in her study of children's lives in different cultural communities found significant differences in the extent to which "they are allowed to participate in and observe adult activities". Comparing children from a farming community in East Africa with middle class American children, she reports that four year-old children from the African farming community, "spent 35% of their time doing chores, and 3-year-olds did chores during 25% of their time. ... In contrast. middle-class U.S. children of the same ages spent none to 1% of their time doing chores, though they did spend 4% to 5% of their time accompanying others in chores (such as helping the mother peel a carrot or fold laundry). (p. 136). The children in the study site, like kids of the aforementioned African community, worked alongside their parents and other adults. Thus, they worked on farms, tended cattle, operated and helped repair agricultural and household electrical appliances, and cooked food for the family. And as they worked, they also learned about the material world, through direct experience and through apprenticeship and observation from their parents, other adults in the community and their more knowledgeable peers.

As a result of their paid and unpaid work at home and workplace, these students had accumulated years of rich experience of either working with many material objects and phenomena relevant to their daily lives. In the time I spent at the study site, It was not possible for me to have a complete and extensive access to the entire range and nature of their experiences with the material world. But, the data I could gather speak eloquently about the wealth and diversity of their experiences they had garnered in everyday contexts of working with plants, cattle, electricity and cooking.

For instance, as a result of their agricultural work, the students in Raghuvanshi's class had rich experiences with plant life in all their life stages. They knew how to plant agricultural crops, grow and tend them, and harvest them when they are ripe. Their conversations revealed an impressive display of experiential knowledge, a native, unofficial pathology, arising out of years of tending to sick cattle of the family. By years of experience in making *chullah* (earthen stoves), the girls had acquired a rich experience of working with different types of clay and an appreciation of the thermodynamics of cooking food on such woodstoves.

To some extent it is to be expected that students in such a rural setting would have rich experiences with farming, cattle and cooking. What I had not expected was to find that students in 8^{th} grade, especially boys, also had extensive experiential knowledge of high voltage (220 volts) AC electricity and electrical appliances. Their knowledge couldn't have had its source in school science as it didn't provide students with any opportunities to explore AC electric circuits. As I discovered during the fieldwork, the source was the important role an ability to work with household electric lines and appliances played in their daily lives.

In all cultures, kids learn and develop through their evolving participation in activities and discourses of their communities.[1] As Lave & Wenger (p. 35) say, "In our view, learning is not merely situated in practice - as if it were some independently reifiable process that just happened to be located somewhere; learning is an integral part of generative social practice in the lived-in world. ... Legitimate peripheral participation is proposed as a descriptor of engagement in social practice that entails learning as an integral constituent." Because of the situated nature of many of these activities and discourse, the sort of experiences with the social and material world that kids have differ across communities. Thus, for instance, in an American town, a middle school kid may know how to download driving directions from the internet for the family trip, or how to order food through phone. The Aka kids of Central Africa, on the other hand, when they are 7 to 12 years old, can hunt and butcher large game animals, trap porcupines and grow food plants (p. 136). And as we saw in this study, there was no game around for kids in Rajkheda, but certainly they had learned the equally dangerous and important task of rigging a direct electrical connection for their homes and farms from the main line supplying electricity to the whole village.

These experiences of working with objects and phenomena in the material world had yielded them a robust and functional knowledge of the world around them. During my fieldwork I was able to observe students expressing this knowledge in many different contexts. It was revealed in the various chores they did during the course of their daily existence as natives, solutions they came up with ways to solve practical problems they encountered in their work outside school, their participation in classroom discussions with their science teacher, homework done in their notebooks, answers to questions asked

[1] For kids in developed nations with 25/7 multimedia connectivity, there is much larger interpenetration of local and global communities. But for kids in Rajkeda and neighboring villages this interpenetration was still small in significance, and community more often than not was rooted in their local village.

in the exams, responses to questions asked by me in one-on-one interviews, and so on. In each event of this nature, their knowledge representations depended very much on the situated manner in which they chose the discursive resources to construct their responses, the dialogue they were entering into or participating through their knowledge representations, the purpose, and their audience. As the (rhetorical) context changed, so did students' knowledge representations as revealed through their utterances. Though in a different context of children learning to write in an American urban school, Dyson (1993) expressed similar ideas when she said that "writing, like all language use, is always a situated response, an addressing of another in a particular time and place, a motivated making of words for some end." As Dyson found with kids learning to write, for students in Raghuvanshi's class too their situated expressions of knowledge of the material world were their mediators of social action. Through on-the-moment, selective picking and unpicking from circulating discourses accessible to them, the students authored improvised responses that them to survive, negotiate and maneuver their way through their social world(s). As Holland, Lachiotte, Skinner, & Cain (1998) also aver, this authorship "is a matter of orchestration: of arranging the identifiable social discourses/practices that are one's resources (which Bakhtin glossed as "voices") in order to craft a response in a time and space defined by others' standpoints in activity, that is, in a social field conceived as the ground of responsiveness" (p. 272).

However, the rhetorical diversity of knowledge representations that students produced could not sufficiently mask some common trends that I was able to observe nonetheless. First, their representations of the material world were far richer in experiences than in scientifically accurate patterns and explanations of those experiences. Second, their knowledge of the material world was more functional in nature. It enabled them to manipulate the material objects and phenomena for their everyday purposes, but didn't help them much explaining why the material world behaved the way it did. When pressed for explanations, they often produced tautological ones. For them, if a thing behaved in a certain manner, it was because it was its nature to do so. Thus, their knowledge of the material resembled craft knowledge in terms of being more implicit than explicit. Lastly, material phenomena were largely understood in terms of sequence of observable events. That is, their representations by and large manifested ignorance of unobservable (to naked eye) reasons and mechanisms of material phenomena. In a way, these results point to commonality in students' modes of reasoning across different cultures. A study done in Michigan, U.S, on students' explanations on natural phenomena and processes related to carbon cycle revealed similar trends in students' explanations (Hawkins, Sharma, Cho, Jin, & Anderson, 2006). Similarly, Enfield (2005) found greater predilection among second and third graders for doing projects rather than developing accounts.

Egan, (1997) outlined five ways of thinking that, in his opinion, governs an individual's intellectual development.[2] In order of their development, these are: *somatic understanding, mythic understanding, romantic understanding, philosophic understanding* and *ironic understanding*. While reasoning about the material world, students in my study seemed to reflect elements of *mythic understanding*, in terms of their reasoning being largely narrative-based and largely orally communicated, and of

[2] According to Egan these five forms of thought are reflected in intellectual development across history too.

romantic understanding, in terms of it being personal, affective, and containing a mix of both mythic and rational thinking. Bruner (1986) also found similar dependence upon a narrative approach to sense making in people's thinking. Since students' knowledge representations tended to be more action-oriented, contextual, personal, and tacit, I find interesting parallels between their knowledge representations and teacher's practical knowledge as described by Driel, Beijaard, & Verloop (2001).

Thus, I found that students, on account of their busy productive lives outside school, had learned to engage in socioculturally mediated and contingently creative dialogues with the material world. They could construct and manipulate objects, material phenomena, processes and non-human life to their locally situated purposes, and could improvise solutions to challenges posed by local material constraints. In this two-way communication, what they learned from the material world's responses to their actions contributed to their context-bound knowledge about it. This dynamic engagement bespoke of their contingent and situated enactment of material agency.

Harper (1987) did a part ethnographic and part biographic study of an untrained yet expert motor mechanic, Willie, in rural upstate New York. The study showed how Willie through long years of working with, in a sort of dialogue as Harper describes it, automobile parts, tools and materials evolved into a jack-of-all-trades, a Levi-Strauss's *bricoleur*, with a very robust, extensive and proven knowledge of the material world. Willie's knowledge was deeply experiential and replete with useful patterns about how the material world behaved. However, it was also limited in the sense of not being enriched by the powerful explanations that scientific theories provide for our experiences and the patterns we observe in them. Raghuvanshi's students through their own experiences with the material world in their daily lives, had also borrowed, adapted and developed a similar working knowledge. This knowledge, as the study shows, was rich in experience and useful on account of the patterns that students had come to understand about the behavior of electric current and appliances. However, deprived of the explanatory power of scientific models and theories, it was also limited in crucial ways. For instance, the students had a sense of *how* current flows, but didn't understand *what* it was and *why* it flows.

(B) Enacting social agency in science classroom:

Thus, 8th grade students stepped into Raghuvanshi's science class with extensive, useful and situated funds of knowledge about the material world (Moll, Amanti, Neff, & Gonzalez, 1992). There, in order to survive and successfully negotiate their roles, students had to accomplish the social work of engagement in activities of the science classroom. This was an engagement that was mediated by sociocultural mediational tools, such as circulating discourses, in the social setting of a classroom community. The study shows that they performed this role in a varied, improvised, contingently situated and tactical manner.

For much of the class time, students sat either passively listening to the teacher or conforming to the teacher script. Whenever the topic resonated with their daily life experiences, students made extensive use of their out-of-school discourses and experiences with material world in structuring and giving substance to their responses. Students also depended heavily on their out-of-school discourse in taking initiative in the classroom. In a study on use of students' everyday experiences in an American urban elementary science classroom, Upadhyay (2006), came to a similar conclusion, viz. students bring their different funds of knowledge accumulated through their everyday experiences into the classroom, and much meaningful science learning resulted when the teacher integrates students' experiences in her teaching of science topics. Likewise, a study done by Smardon (2004) showed that students sometimes used "the code of the street" to enhance their learning achievements in a science class. These researchers are in good company as some other researchers have also noted the learning potential of such crossing of boundaries and interactions of different discourses in a common space (Gutierrez, Rymes, & Larson, 1995; Heath, 1983; Varelas, Becker, Luster, & Wenzel, 2002; Warren, Ballenger, Ogonowski, Rosebery, & Hudicourt-Barnes, 2001). In language learning, Dyson's work (1996, 1997, 2003) has consistently shown the immense learning potential of permeable curricula that invite students' everyday discourses into the classroom.

But when the science topic veered away from their lived experiences and everyday discourses, the students were deprived of important mediational means to participate in the classroom discourse. In such events, school science discourse was the only circulating discourse they could access to navigate their role as students. However, for students, school science discourse wasn't a discourse that could be easily made ones own, and put to creative use. Speaking of the challenge of appropriating such discourses, Bakhtin (1981) says, "The word in language is half someone else's. It becomes 'one's own' only when the speaker populates it with his own intention, his own accent, when he appropriates the word, adapting it to his own semantic and expressive intention. … And not all words for just anyone submit equally easily to this appropriation, to this seizure and transformation into private property: many words stubbornly resist, others remain alien, sound foreign in the mouth of the one who appropriated them and who now speaks them; they cannot be assimilated into his context and fall out of it; it is as if they put themselves in quotation marks against the will of the speaker." With only limited access to school science discourse and their out-of-school discourses not proving handy, students had narrower *spaces of authoring* their responses on science topics not closely connected with their lives (Holland, Lachiotte, Skinner, & Cain, 1998). Thus, they stuck to the safer strategy of conformity and re-telling of the canonical text, and responding with short, even monosyllabic, responses.

Whenever the constraints and affordances of the local situation and the resources at their disposal made it feasible, they did the local work of participating in classroom activities a bit differently. For instance, I observed several events when leaving aside their circumspection, they took initiative to set off new classroom dialogues, or worked to substantially influence their direction and end result. Sometimes they succeeded in doing so, and sometimes they didn't depending upon the response of the teacher to their initiatives. The analysis showed that students didn't always restrict their initiatives in classroom discourse to purposes of learning science. When, an appropriate situation presented itself, they also tried to infect the classroom discourse with unscripted utterances that often had humorous overtones. Further, there were also, relatively speaking, more opportunities to take initiative in the discursive underlife in Raghuvanshi's classroom. This underlife was tolerated by Raghuvanshi as long as it didn't threaten to derail the ongoing science related activities in the classroom.

The students were aware that school science could provide them with knowledge that was relevant and useful for their social and material lives outside school. The rich hybridity of their discourse on science topics connected with their lives, such as electricity, indicates that as *bricoleurs,* they were eagerly looking to beg, borrow and adapt mediational tools from wherever they could find them - tools that would extend their agency over the material world. Raghuvanshi's science classroom was one such place. And, as this study shows, students, acting as *bricoleurs*, tried to selectively appropriate school science discourse for their own out-of-school purposes, through their initiatives in science periods. Whenever, they could, they used school science discourse to make sense of their daily life experiences with the material world, took initiative to reconcile their out-of-school discourses and knowledge with school science, and tried to influence classroom dialogues so as to make them relevant to their out-of-school experiences or life situations. These were dialogical engagements that shaped the way events unfolded, and often determined their outcomes. In these situated actions aimed at selective appropriation of school science discourse, we can see a contingent enactment of social agency by students – an agency that sought to extend students' material agency over the material world.

Ever since Willis (1977) seminal work in ethnography that showed how working class 'lads' in England resisted and rebelled against the perceived agenda of schooling, there has been a slew of studies purporting to show student or teacher agency largely as resistance and rebellion (Barton, Ermer, Burkett, & Osborne, 2003; Carlone, 2003; Foley, 1991; Gilbert & Yerrick, 2001; Seiler, 2002; Seiler, Tobin, & Sokolic, 2001; Taylor, 2003; Zembylas, 2003). However, like (Niesz, 2003) study, my research with Rajkheda middle school kids also shows that students' responses to school-bound authoritative discourses, such as school science discourse, are far more complex and nuanced than simple opposition and rebellion. Depending upon the contingencies of the moment, students conformed to the teacher script, sat passively listening to the teacher, took initiative to influence the direction and outcome of ongoing classroom discussion, or indulged in surreptitious conversation with their neighbor. Negotiating a science period was social work, and as (Erickson, 2004) says, "the concrete work of uttering/muttering/listening - the practice of social action in oral discourse - is a matter of the use of locally oriented tactics. Talk in interaction may or may not constitute transformative social action but it is always tactical, local social action. Sometimes such action involves small-scale innovation that is no less novel for its being subtle and situated, written upon transcripts that usually remain hidden from panoptical view" (p. 174). This study thus supports Ahearn's (2001) contention that that not only is pure resistance an abstraction as human motivations are always complex and contradictory, but also human responses to hegemony are far more improvised and creative than simple resistance (Holland, Lachiotte, Skinner, & Cain, 1998; Levinson & Holland, 1996).

The science teacher did much to encourage this contingent and situated emergence of students' social agency. By tactically and contingently selecting and unselecting elements from professional, school science and out-of-school discourses, and improvising upon them, Raghuvanshi was able to open up ephemeral spaces where students' agency could be exercised. This was accomplished by a tactical re-use of the prescribed curriculum such that even though he followed the officially mandated science textbook, there were occasions when his improvisations enabled him to move beyond its limits so as to make school science relevant to students' lives. Concurrently, he also helped actualize conditions that made it possible for students to take initiative and change the nature and form of classroom dialogues. His teaching practices helped students to animate the classroom discourse with their voices, out-of-school discourses and knowledge systems. However, there were also occasions when he followed the professional discourse, and treated school science as presented in the textbook as the sole authoritative fountainhead of knowledge in the classroom. This tactical nature of selective picking and unpicking of the circulating discourses correlated well with the nuanced and apparently contradictory nature of Raghuvanshi's thoughts about following school science and professional discourses and addressing students' interests at the same time. In contrast, other teachers depended rather heavily and consistently on professional and school subject discourses, and thus, enacted their teacher scripts in ways that persistently denied possibilities of greater participation to students in co-construction of their learning experiences.

What did Students Want?

In abstract conversations among policy makers and educators on the nature of schooling the state must provide to its future citizens, it is easy for the voices of these future citizens themselves to go unheard. However, if education is to truly serve the interests of students in government-run schools throughout the country, we must pay heed to what the students and their parents have to say about the kind of education that would best serve their interests. Also, it is only by looking at students' life situations and their motivations regarding education that we can have a better understanding of the different ways they participated in classroom discourse in Raghuvanshi's science periods.

Most kids attending 8th grade in Rajkheda middle school came from very poor families, many with illiterate parents. Contrary to perceptions of some teachers, all the parents I interacted with were eager to get their children educated as education offered hope for a better tomorrow. They tried their best to help their kids succeed at school. They sent them for expensive extra tuition classes despite their extreme poverty. However, their poor educational backgrounds and generally lower social status limited their efforts to their homes. Like working class parents in Lareau's (1989) study on social class and parental intervention in elementary education, the poor farmers of Rajkheda and neighboring villages hesitated to enter the school premises to do something to qualitatively improve their children's educational experiences at school. They further resembled working class parents in Lareau's study in maintaining that it was primarily the teacher's responsibility to ensure that their children get good education at school.

The students too by and large wanted to succeed at school and wanted to get educated. Almost all professed liking their school, and thought that they got good education there. They valued education mostly for being necessary for getting jobs or setting up a trade. They also thought that education would help them get along in the world by enabling them to conduct financial transactions, read written information on products and public notices, enabling them to travel, be better farmers, etc. There might also be cultural reasons, such as desire to be perceived as "educated", that made them value education, but such rationalization on the part of students or even their parents didn't come out strongly in my study. However, in a ethnographic study of lower caste *Dalit* (formerly un-touchables) and Muslim young men in North India, researchers did find participants valuing education as a cultural distinction, as something that would help them getting perceived as moral, civilized, and developed "educated" people (Jeffrey, Jeffery, & Jeffery, 2004).

Though science wasn't considered as important as mathematics, Hindi and English, students valued science for the functional knowledge it provided them about the world, such as pertaining to plants and agriculture. Interestingly only a few students mentioned electricity in this context. Indicating limited value of school science for their everyday purposes, some students were of the opinion that though science provided knowledge about the world, they would not be seriously disadvantaged if they didn't study science at all. However, almost all students liked learning science at school. The reasons they reported had largely to with the way Raghuvanshi taught the subject. These results correlate with that of a comparative study on children's attitudes on interest and enjoyment in science in Northern Ireland and Oman which found that in both cultures an activity-based science aroused greater positive attitudes towards science in students (Murphya, Ambusaidi, & Beggs, 2006). The same study also reported that as school science became less activity oriented in higher grades, students' interest and enjoyment in science declined in both cultures. Thus, it would be safe to conclude that as students explained, Raghuvanshi's teaching practices had much to do with students' general liking of school science.

The study then shows that students came to the school and attended Raghuvanshi's science class eagerly wanting to succeed not only in the scholastic sense of passing the exams, but also in terms of finding and adapting useful mediational tools that would help them make sense of their everyday experiences and extend their chances and scope of exercising agency over the material world. However, students efforts in this direction were continually frustrated and remained limited in extent and scope.

Presenting Levi Strauss's portrayal of a *bricoleur*, Harper (1997) states that, "he "speaks" not only with things. . . but through the medium of things" (p. 21). Likewise, equipped with rich experience with the material world, students' in Raghuvanshi's classroom were ready to have a dialogic engagement with school science with voices that best spoke with real electrical circuits and appliances and through the medium of these "things". However, the stilted, alienated and alienating school science curriculum mandated by the state encouraged an authoritative school science discourse in the classroom that demanded students unconditional allegiance (Bakhtin, 1981); and could only speak in a voice little understood by the students, and largely irrelevant to their contexts and purposes. Raghuvanshi tried his best to overcome these limitations of the prescribed science curriculum by not strictly following the science curriculum. He also encouraged students to dialogically engage the school science discourse with their funds of knowledge, and tried to harness the "the potentially profound continuities between everyday and scientific ways of knowing and talking" to make school science meaningful, accessible and relevant for his students (Moll, Amanti, Neff, & Gonzalez, 1992; Warren, Ballenger, Ogonowski, Rosebery, & Hudicourt-Barnes, 2001). Unfortunately, he could only achieve limited success in this endeavor as he couldn't completely abandon the prescribed science curriculum and textbook and lacked adequate resources and professional support to teach science in ways that would have made it more meaningful and relevant for the students. If a dedicated, committed teacher like Raghuvanshi could translate at best only a partial version of the kind of science education

the national policy documents advocate, it becomes important for the policy makers to create enabling conditions in schools that will help students learn science in a much more meaningful and connected way.

Thus, as some students had reported, school science proved to be of limited use for the students attending the Rajkheda middle school. And by being so, it and the school failed the students in a large measure. Admittedly, as Honig, Kahne, & McLaughlin (2001) argue "many of the factors that shape students' opportunities to learn and teachers' opportunities to teach are beyond the purview of schools." But still there was much that the school and the makers of school science curricula and textbooks could have done to make science education work for the kids attending the school at Rajkheda. For instance, students came to the school with a robust, extensive and proven knowledge of the material world that was deeply experiential and replete with useful patterns about how the material world behaved. However, it was also limited in the sense of not being enriched by the powerful explanations that scientific theories provide for our experiences and the patterns we observe in them. The school could have been a natural site for them to be exposed of these scientific theories, and also to see how their experiential knowledge connects with these theories. Had the school and school science been able to accomplish this feat, the students' engagement with the material world and the scientific knowledge would not only have been more useful to them for their everyday functional purposes, but it also would have closely resembled the way scientists do science (Anderson, 2003; Sharma & Anderson, 2003). Unfortunately, the teacher professional discourse, science curricula and the textbooks made the odds of this happening in a school like Rajkheda very slim. If some meaningful science learning happened, it was largely because of Raghuvanshi's untiring efforts.

Researchers have argued that by being culturally situated, scientific knowledge, like all other bodies of knowledge, reflects the existing gender and racial ideologies of science that seek to deny certain groups, such as women and minority students, from equal access to this body of knowledge (Barton & Yang, 2000; Brickhouse, 2001; Brickhouse, Lowery, & Schultz, 2000). Extending such claims, this study presents the case for scientific knowledge, at least as presented in school science textbooks that are used in government run schools in India, to reflect the class and location (rural versus urban) based differences embedded in Indian society as well. By presenting scientific knowledge as a body of canonical text comprising facts, definitions and narratives about the world, science curricula and textbooks remove at one stroke all the comparative advantages rural kids might have over urban students in terms of experiences with the material world.

Quality and Access

Ever since the adoption of the National Policy on Education (NPE) in 1986, the governments at the state and central level have made sustained efforts to improve both access to education as well as quality of education offered to the masses. The state apparatus has indeed made substantial progress in making elementary education accessible to all. For instance, the region where this study was done, has had universal access to elementary education since 2002. However, access to education alone may not mean much if the quality of education provided in schools remains low.

It is not easy, however, to gauge government's efforts to increase quality of education on the basis of studies done so far owing to absence of reliable data, and focus on measuring 'quality' in terms of students' scores on high stakes tests, and infrastructure-related indicators of 'quality' in government collected data. An argument can be made that there has been some improvement in the quality of instruction because of government's efforts as infrastructure and access to formal instruction for most kids has certainly improved over the years. Further, the textbooks and curricula also now have more inputs from the teachers. However, as this study shows, the practice of teaching and learning of science in schools still continues along traditional lines, and much remains to be done by the state before it can legitimately claim to provide access to the type of science education it advocates in its national policy documents. This assessment concurs with a persistent level of concern among a large number of educators and researchers in India about the quality of instruction, in science as well as other subjects, accessible to an overwhelming majority of Indian children, especially those from weaker underprivileged sections of Indian society. The current Indian parliament is considering a bill to amend India's constitution so as to make right to education a fundamental right of every child in India. Such an amendment is indeed long overdue. However, unless education offered in schools becomes meaningful and relevant for the students, access to schooling alone may not accomplish much in making students studying in government schools like Rajkheda middle school, happy, productive and successful adults in the fast evolving socioeconomic conditions of India.

Limitations of the Study

This study was an attempt at immersion in students' worlds in order to understand how they experienced and perceived the events occurring in their lives (Emerson, Fretz, & Shaw, 1995). Such an attempt is necessarily ambitious as it seeks to capture and inscribe fast-moving events in an hectic, complex social world of which the researcher because of her outsider's status has only limited understanding. As such ambitions are difficult to realize in practice, this study is defined as much by its limitations as by its success in offering the reader a narrativized glimpse into the lives of students in Rajkheda.

A prominent limitation that restricts the scope of this study was poor access to lives and thoughts of girl students in Raghuvanshi's class. I had hoped to better study how science instruction gets gendered in a school like Rajkheda. However, the girl students in 8^{th} grade were now of an age when social norms, especially in rural areas of that region, encourage girls to become wary of contact with outsiders like me. Though there were a few girls that overcame these restraints and offered me as much access to their experiences and lives as the boys, most girls were shy and restrictive in talking with me. In fact, I lost one of my focus students as after a few weeks into the fieldwork she began avoiding talking with me. She was a shy girl – a student of 8^{th} grade along with her brother. Her brother was one of the focus students too. I thought comparing the two siblings would allow me to better understand how gender factors into a student's approach to school science and work outside school. Initially it appeared that with time, I would be able to gain her confidence. But apparently that never could happen, and I lost a great opportunity.

I was in the field continuously for only about 4 months. In retrospect, I think that collecting data in one time slot constrained the depth and quality of data I could access. First, I didn't have much time for making a space for myself in the field, and gaining trust and confidence of the participants before beginning data collection. Second, while in field, I was under tremendous pressure to collect as much data as was feasible. As much of the time went in data collection, I got few opportunities to step aside and pause for a while to reflect at the data, mull over the emerging themes, and do necessary along-the-way course corrections in data collection. Also, once the data collection phase was over, I had to work with what I had because after leaving the site, I could never visit it again for re-checking any facts, finding missing links, or sharing and getting feedback on emerging themes with the participants.

This study is an effort to represent the voices of the underprivileged students and their parents in a village in India. Through this study I wish to speak for them as their voice goes largely unheard in the current discourse on education in India. However, as (Spivak, 1988) reminded intellectuals engaged in such efforts, I run the risk of doing "epistemic violence" to the participants of this study by re-voicing their desires, actions, and meanings through this study. This is so because, as Spivak cautioned, by speaking for them I may be re-inscribing their subordinate position in the society, and furthering their dependence on someone else, an outsider, and a member of a social class that has traditionally oppressed them to speak for them.

Further, as Emerson et al (1995, p. 108) said, "Members' meanings ... are not pristine objects that are simply "discovered." Rather, these meanings are interpretive constructions assembled and conveyed by the ethnographer." Thus, voices of the participants present in this study are more than *in situ* utterances. They have been interpreted, assembled and conveyed by me, and thus contain more than a trace of my own etic meanings, beliefs and agenda. This was necessary to weave a coherent cogent narrative out of a large knotted bunch of disparate little data fragments. As Erickson (2004, p. 196) noted, doing such a study is essentially a "critically realist inferential enterprise." However, any such enterprise is also fraught with the risk that at times the dialogic overtones in the narration may become so loud that the reader may not be able to clearly hear participants' voices. Further, as data collection was perforce influenced, if not guided, by my theoretical lenses and political convictions, it is possible that I may have overlooked or ignored data that on hindsight may come across as salient and insightful.

Lastly, in this study I have presented a detailed 'case' of a middle school science classroom, and through that case I have made generalizations about the 'phenomenon' of science learning. In making this transition, I have depended upon *naturalistic generalization*, that is, on the belief that "if a study gives readers a sense of "being there," of having a vicarious experience in the studied site, then readers may generalize from that experience in private, personal ways, modifying, extending, or adding to their generalized understandings of how the world works" (Dyson & Genishi, 2005). However, any such attempt also involves the risk of essentializing the lives and identities of the participants, and leading readers to make logocentric assumptions about the case.

Implications

Being a qualitative, interpretative account of a case that unfolded in a unique way and is now fixed in time and space, the findings of this study, as Dyson and Genishi (2005) opine, may not be replicable *per se*. However, as they further argue, it can still be read as a concrete instantiation of a more general phenomenon, viz. how science is learned in school settings in India and also in most other countries. Thus, the findings of this study have implications for the way science is and ought to be taught in schools.

As the study shows, kids are naturally desirous of making sense of, interacting with and manipulating their material world. Acting as bricoleurs, they try to adopt and adapt whatever mediational tools available to them for this purpose. Tinkering with the material world, they accumulate a robust body of useful experiential knowledge and ways to make sense of and talk about it. In India, this is likely to me truer of children living in rural areas as besides being students they are also expected to contribute at work in agricultural farms, with cattle, and at home cooking food and doing other household chores. All these out-of-school tasks involve intense and intimate engagement with the material world, albeit always in a social setting. The knowledge that kids gather in non-school settings enables them to accomplish their traditional roles. But because it arises from and is tied down to particular situated experiences and lacks rigor, cogency, and explanatory power of scientifically valid theories and models about the world, their experiential out-of-school knowledge is not of much use in helping them extend and transcend the roles that society has bequeathed to them. Through apprenticeship with a farmer, a rural kid can learn to be farmer – just another farmer, but not a better farmer or something other than a farmer.

For that, an argument can be made that society has provided schools. Of course, many researchers, such as Barton & Yang (2000), Bourdieu (1986), Bowles & Gintes, (1976), Gilbert & Yerrick (2001), Giroux (1997), and Seiler (2002), have shown how effectively schools function to reproduce existing socio-economic inequities and thwart attempts for upward social mobility through education by the underprivileged sections of the society. In the Indian context too, an argument can be made that existing poor condition of schools helps economic and political elite maintain their disproportionate power and control over economic, political and social institutions and natural resources (Madan, 2003, May 31). That may explain the lack of serious commitment towards schooling for the poor that Indian elite has shown so far.

I agree that it is important to highlight the reproductive aspects of schooling, as has been done so well by the researchers I mentioned above and many others. However, excessive, and one-sided focus on the negative aspects of schooling can be counterproductive as well by obscuring the virtues of schooling and extinguishing hopes for peaceful progressive social change. After all, as Anyon (1981) argued, schooling for all sections of society, has not just reproductive but transformative aspects as well. It then becomes the responsibility of the educators and progressives among other stake holders to work towards increasing the transformative aspects of schooling, and whittling down its reproductive aspects. Unwilling to abandon hope, I continue to believe that schools can indeed be places where through apprenticeship of a cognitive sort, kids learn to make connections between with their experiential knowledge and the accumulated knowledge and wisdom of science. Schools can also be natural sites for helping students transition from being just bricoleurs to informed bricoleurs who are capable of extending the range, reach and extent of sources to learn, adopt and adapt useful mediational tools from. Thus, school can be a place where a child can build a future for herself that is better than the present bequeathed to her, and the past that her parents had.

For the vast majority of rural poor eking out a living on a subsistence level and barely managing to physically survive, school and the education it provides is often the only hope for a better future (Rampal, April, 2004). This study recommends a science education that enables rural kids to acquire better tools to understand, question and manipulate the material world around them. This will help them carve out a better life for themselves in their own villages. It will help them become better homemakers, farmers and cattle owners. And more importantly, by encouraging and empowering their innate sense of inquiry, such a type of science education will also help them question the status quo, the existing socioeconomic inequities that work to keep them where they currently are, and work towards bringing about peaceful progressive social change. Thus, as (Barton, Ermer, Burkett, & Osborne, 2003) has also argued, this study recommends a science education in particular and education in general that acts as a force for restoring social justice through peaceful means in a deeply iniquitous Indian society.

But, are rural schools in India really such schools? The study gives much contrary evidence to support a negative response to this question. Kids in rural India, by their intimate relationship with the material world, are uniquely endowed with a rich knowledge and understanding of the world around them. If rural schools are able to harness this tremendous resource for sake of their learning, students can indeed grow up to become powerful agents for change – both in material and social sense. Unfortunately, rural schools in India, as this study indicates, are doing a huge disservice to these underprivileged students by not performing this role. The Indian state and society has accorded high priority to providing universal access to schooling. That is good and worthy of commendation. However, though necessary, easy access to schooling is hardly sufficient to ensure a better future. Unless sustained efforts are made to improve the quality of educational experiences students have at school, kids will continue to face daunting challenges in carving a better future for themselves. Further, hopes for peaceful progressive social change will not get the boost that progressive, good quality education can provide – education that has been long promised in the national policy documents but never delivered. Of course, schools alone cannot carry the responsibility of building a better future. Other institutions, such as family, civil society and democratic institutions, would have to chip in to successfully tackle this challenge. However, in a country where farmers are being driven to commit suicide, and vast swathes of rural hinterland is witnessing violent struggle over control over resources and political power, while urban centers are being recognized and celebrated the world over for being powerhouses of global economy, the cost of letting hopes for peaceful progressive change through better schooling remain muted and flickering can be perilous.

This study encourages other researchers to ask similar questions about schools and science education in other settings. It also supports existing body of research, done in diverse contexts, that shows how science education in particular and education in general can be of great service to students and society if it enables the students to become informed bricoleurs who are able to pick, adapt and adopt the knowledge they need from existing resources so as to transcend the destinies that happenstance of life and history had bestowed upon them.

Of course, what constitutes 'quality' in good quality education is a moot point. The sort of data Indian government agencies collect on schools seem to indicate that government is currently seeing quality of education more in terms of availability of resources and infrastructure, and academic performance in end of the year high stake tests than in terms of the nature of educational experiences students have in the classrooms. While this study agrees that better availability of resources and infrastructure goes a long way in improving the nature of educational experiences in the classroom, it also advocates for more focused attention than hitherto have been given, on improvements in the curricula, assessment, curriculum material and teacher professional development. Otherwise, as Kumar (2005) cautions, "the tendency to link quality with visible indicators and accountability can only exacerbate the problem that the discourse of quality is attempting to address." The nature of changes in these areas can be guided by the existing guidelines as formulated in the National Policy on Education (1986), or the current National Curriculum Framework (2005) as the findings of the study support the prescriptions for science education as outlined in these documents.

However, I am aware that translating visions for science education as sketched out in these documents would be anything but easy and uncontested. Firstly, at policy level itself there are indeed differences of opinions among political parties and in the society at large on curricular issues. These differences are more acute and intractable in social studies than in mathematics or science. However, significant differences on what constitutes quality science education in Indian society cannot be denied or overlooked (Rampal, 2002). Secondly, as the case of Hoshangabad Science Teaching Program illustrates, when attempts are made to translate policy prescriptions into reality, existing socio-political status quo gets threatened. This initiates a oppositional response by the middle class and other groups that seem to benefit most from the existing dispensation, and the issue of what constitutes quality in science education gets problematized at every level of implementation (Mukhia, 2002; Rampal, 2002; Sadgopal, 2002). As I recall from my days of working in this program, people working in this program not only had to counter criticisms of inquiry driven science curriculum in local as well as national media, but also had to respond to more direct challenges from middle class parents they met in the street who viewed such a curriculum as a threat to the future of their children. As Kumar (2005) argues, "the issue of quality cannot be seen in isolation from the socio-cultural context of education." In a deeply divided and highly iniquitous society such as India's, the socio-economic context of education has to be very complex and can only pose serious challenges to any attempt to change the nature of schooling as it exists today. Future efforts would have to carefully study attempts like the Hoshangabad Science Teaching Program, to learn from their successes and failures so as to make more successful and lasting improvements in the quality of educational experiences of students in science as well as other subjects.

This study showcased the efforts of a teacher who tried to create meaningful learning opportunities for his students whenever the existing constraints and resources enabled him to do so. He too resembled a skillful bricoleur who contingently improvises workable solutions from whatever is at hand. His teaching of science shows that even within the existing circumstances, it is possible for a teacher to teach science, at least partially, in a way that is personally meaningful and useful for his students. But then it would be naïve to expect every teacher to have the level of commitment and perseverance that

Raghuvanshi had. The plans for a better science education in schools in India (and beyond) based on such an assumption will not work. What may be workable though is a plan that seeks informed bricolage as a goal for teacher education and professional development (Anderson, 2006), and works to create conditions in schools wherein even ordinary run-of-the-mill teachers feel empowered enough to teach science that has transformative potential for the lives of their students.

Such plans for improving education in government schools must begin from rural and poor areas, if we are to create a socially just society. Here one would do well to remember Gandhi's (1958) suggestion: "Whenever you are in doubt, or when the self becomes too much with you, apply the following test. Recall the face of the poorest and the weakest man [woman] whom you may have seen, and ask yourself, if the step you contemplate is going to be of any use to him [her]. Will he [she] gain anything by it? Will it restore him [her] to a control over his [her] own life and destiny? In other words, will it lead to swaraj [freedom] for the hungry and spiritually starving millions? ... Then you will find your doubts and your self melt away."

REFERENCES

Aggarwal, Y. (2002). *Quality concerns in primary education in India: Where is the problem?* : National Institute of Educational Planning and Administration.

Ahearn, L. M. (2001). Language and agency. *Annual Review of Anthropology, 30*, 109-137.

Anderson, C. W. (2006). *Informed bricolage as a goal for teacher education.*

Bakhtin, M. M. (1981). *The dialogic imagination.* Austin, Texas: University of Texas Press.

Bakhtin, M. M. (1986). *Speech genres and other late Essays.* Austin: University of Texas Press.

Ball, A. F. (2002). Three decades of research on classroom life: Illuminating the classroom communicative lives of America' s at-risk students. *Review of Research in Education.*

Barton, A., & Yang, K. (2000). The Culture of power and science education: Learning from Miguel. *Journal of Research in Science Teaching,* 37(8), 871-889.

Barton, A. C. (1998). Teaching science with homeless children: Pedagogy, representation, and identity. *Journal for Research in Science Teaching*, 35(4), 379-394.

Barton, A. C. (2001). Science education in urban settings: Seeking new ways of praxis through critical ethnography. *Journal of Research in Science Teaching*, 38(8), 899-917.

Barton, A. C., Ermer, J. L., Burkett, T. A., & Osborne, M. D. (2003). *Teaching science for social justice.* New York: Teachers College Press.

Bhabha, H. (1994). The postcolonial and the postmodern: The question of agency. In *The Location of Culture.* New York: Routledge.

Bleiker, R. (2003). Discourse and human agency. *Contemporary Political Theory,* 2, 25-47.

Bogdan, R. C., & Biklin, S. K. (1998). *Qualitative research for education: An introduction to theory and methods.* Boston: Allyn and Bacon.

Brickhouse, N. W. (2001). Embodying science: A feminist perspective on learning. *Journal of Research in Science Teaching,* 38(3), 282-295.

Brickhouse, N. W., Lowery, P., & Schultz, K. (2000). What kind of a girl does science? The construction of school science identities. *Journal of Research in Science Teaching, 37*(5), 441-458.

Bruner, J. (1986). *Actual minds, possible worlds*. Cambridge, MA: Harvard University Press.

Bruner, J. (1996). *The culture of education.* Cambridge, MA: Harvard University Press.

Burbules, N. C., & Bruce, B. C. (2001). Theory and Research on Teaching as Dialogue. In V. Richardson (Ed.), *Handbook of research on teaching*. Washington, DC: American Educational Research Association.

Butler, J. (2004). *Undoing gender*. New York: Routledge.

Carlone, H. B. (2003). (Re)Producing good science students: Girls participation in high school physics. *Journal of Women and Minorities in Science and Engineering, 9*(1), 17-34.

Census of India. (1991). Retrieved. from http://www.censusindia.net.

Census of India. (2001). Retrieved. from http://www.censusindia.net.

Cherryholmes, C. H. (1988). *Power and criticism*. New York: Teachers College Press.

Cochran-Smith, M. (2003). The unforgiving complexity of teaching: Avoiding simplicity in the age of accountability. *Journal of Teacher Education, 54*(1), 3-5.

Driel, J. H. v., Beijaard, D., & Verloop, N. (2001). Professional development and reform in science education: The role of teachers' practical knowledge. *Journal of Research in Science Teaching, 38*(2), 137-158.

Deaton, A., & Dreze, J. (2002, September, 7). Poverty and inequality in India: A re-Examination. *Economic and political weekly,* 3729-3748.

Dinkar, R., & Smith, B. (2002). *Seeking quality education for all: Experiences from the District Primary Education Programme* (Occasional papers): The European Commission.

District elementary education report card. (2005). Retrieved. from http://www.dpepmis.org/Downloads/drc2005/DistrictReportCardVol1/MadhyaPradesh/rptHoshangabad.htm.

District elementary education report card: 2004-05. (2005). Retrieved June 25, 2006, from http://www.dpepmis.org/Downloads/drc2005/DistrictReportCardVol1/MadhyaPradesh/rptHoshangabad.htm

Dyson, A. H. (1993). *Social worlds of children learning to write in an urban primary school*. New York: Teachers College Press.

Dyson, A. H. (1996). Cultural constellations and childhood identities: On Greek gods, cartoon heroes, and the social lives of schoolchildren. *Harvard Educational Review, 66*(3), 471-496.

Dyson, A. H. (1997). *Writing superheroes: Contemporary childhood, popular culture, and classroom literacy*. New York: Teachers College Press.

Dyson, A. H. (2003). School literacy: The view from inside a child culture. In *The Brothers and Sisters Learn to Write: Popular Literacies in Childhood and School Cultures*. New York: Teachers College Press.

Dyson, A. H. (2003). "Welcome to the Jam": Popular culture, school literacy, and the making of childhoods. *Harvard Educational Review, 73*(3), 328.

Dyson, A. H., & Labbo, L. D. (2003). Popular Literacies and the "All" Children: Rethinking Literacy Development for Contemporary Childhoods. *Language Arts, 81*(2), 100.

Dyson, A. H., & Genishi, C. (2005). Making a case matter: On generalization. In *On the case: Approaches to language and literacy research*. New York: Teachers College Press.

Economic survey 2001-2002. (2002). Retrieved. from http://indiabudget.nic.in/es2001-02/social.htm.

Economic survey 2005-2006. (2006). Retrieved. from http://indiabudget.nic.in/es2005-06/esmain.htm.

Education: Dead hand of obscurantism. (2002, May 22). *Economic and political weekly*.

Egan, K. (1997). *The educated mind: How cognitive tools shape our understanding*. Chicago: University of Chicago Press.

Emerson, R. M., Fretz, R. I., & Shaw, L. L. (1995). *Writing ethnographic fieldnotes*. Chicago: The University of Chicago Press.

Enfield, M. (2004). ""It just flies": Joint construction of accounts in elementary science classrooms." Unpublished doctoral dissertation: Michigan State University - East Lansing.

Erickson, F. (1986). Qualitative methods in research on teaching. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (pp. 119-160). New York: Macmillan.

Erickson, F. (2004). *Talk and social theory*. Malden, MA: Polity Press.

Foley, D. E. (1991). Rethinking school ethnographies of colonial settings: A performance perspective of reproduction and resistance. *Comparative Education Review, 35*(3), 532-551.

Foley, D. (2002). Critical ethnography: the reflexive turn. *International Journal of Qualitative Studies in Education, 15*(4), 469-490.

Foucault, M. (1988). Truth, Power, Self: An Interview with Michel Foucault - October 25th, 1982. In L. Martin, H. Gutman & P. Hutton (Eds.), *Technologies of the Self: A Seminar with Michel Foucault* (pp. 9-15). London: Tavistock.

Gandhi, M. K. (1958). *The last phase* (Vol. II).

Gee, J. P., & Green, J. L. (1998). Discourse analysis, learning and social practice: A methodological study. *Review of Research in Education, 23*, 119-169.

Gallego, M. A., Cole, M., & Cognition, T. L. o. C. H. (2001). Classroom Cultures and Cultures in the Classroom. In V. Richardson (Ed.), *Handbook of Research on Teaching*. Washington, DC: American Educational Research Association.

Geertz, C. (1973). *The interpretation of cultures: Selected essays*. New York: Basic Books.

Gilbert, A., & Yerrick, R. (2001). Same school, separate worlds: A sociocultural study of identity, resistance, and negotiation in a rural, lower track science Classroom. *Journal of Research in Science Teaching, 38*(5), 574-598.

Giroux, H. A. (1997). *Pedagogy and the politics of hope: Theory, culture and schooling*. Boulder, Co: Westview Press.

Gjerde, P. F. (2004). Culture, power, experience: Towards a person-centered cultural psychology. *Human Development, 47*, 138-157.

Gooding, D. (1990). *Experiment and the making of meaning: Human agency in the scientific observation and experiment*. Boston: Kluwer Academic Publishers.

Govinda, R. (Ed.). (2002). *India Education Report*. New Delhi: Oxford University Press.

Government of Madhya Pradesh. (2002). *The Madhya Pradesh Human development Report*: Bhopal.

Gutierrez, K. (2000). Teaching and learning in the 21st century. *English Education, 32*(4), 290-298.

Gutierrez, K., Rymes, B., & Larson, J. (1995). Script, counterscript, and underlife in the classroom: James Brown versus Brown v. Board of Education. *Harvard Educational Review, 65*(3), 445.

Harper, D. (1987). *Working Knowledge: Skill and Community in a Small Shop*. Chicago, Il: The University of Chicago Press.

Hawkins, L., Sharma, A., Cho, I.-Y., Jin, H., & Anderson, C. W. (2006). *Developing a Carbon Cycle Learning Progression for K-12*. (Online) Paper presented at the National Association for Research in Science Teaching, San Francisco. Available: http://edr1.educ.msu.edu/EnvironmentalLit/PublicSite/Html/ResearchPapers.htm

Heath, S. B. (1983). *Ways with words: Language, life, and work in communities and classrooms*. New York: Cambridge University Press.

Hicks, D. (1996). Discourse, learning and teaching. *Review of Research in Education, 21*, 49-95.

Holland, D., Lachiotte, W., Skinner, D., & Cain, C. (1998). *Identity and agency in cultural worlds*. Cambridge, MA: Harvard University Press.

Honig, M. I., Kahne, J., & McLaughlin, M. W. (2001). School-community connections: Strengthening opportunity to learn and opportunity to teach. In V. Richardson (Ed.), *Handbook of Research on Teaching*. Washington, DC: American Educational Research Association.

Hoshangabad - At a glance. (Online) Available: http://hoshangabad.nic.in/glance.htm

Human development report. (2005): United Nations Development Program.

Hymes, D. (1964). Introduction: Towards ethnographies of communication. *American Anthropologist, 66*(6).

Indian Agricultural Statistics Research Institute. (2004). Agriculture research data book: New Delhi.

Jeffrey, C., Jeffery, P., & Jeffery, R. (2004). "A Useless Thing!" or "Nectar of the Gods?" The cultural production of education and young men's struggles for respect in liberalizing north India. *Annals of the Association of American Geographers, 94*(4), 961-981.

Kennedy, M. M. (1999). The problem of evidence in teacher education. In R. Roth (Ed.), *The Role of the University in the Preparation of Teachers* (pp. 87-107). London: Falmer Press.

Koul, R. (1997). *Contextualized science: An Indian experience.* Unpublished Ph.D thesis, The Pennsylvania State University, University Park, PA.

Kumar, K. (1988). Origins of India's "Textbook Culture". *Comparative Education Review, 32*(4), 452-464.

Kumar, K. (2005). Quality of education at the beginning of the 21st Century — Lessons from India. *India Educational Review, 41*(1), 3-28.

Lampert, M. (2001). *Teaching problems and the problem of teaching.* New Haven: Yale University Press.

Lareau, A. (1989). *Home advantage: Social class and parental intervention in elementary education.* Philadelphia: The Falmer Press.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation.* Cambridge, UK: Cambridge University Press.

Levi-Strauss, C. (1966). *The savage mind* (J. Weightman & D. Weightman, Trans.). Chicago, Il.: The University of Chicago Press.

Levinson, B. A., & Holland, D. (1996). The cultural production of the educated person: An introduction. In B. A. Levinson, D. E. Foley & D. Holland (Eds.), *The cultural production of the educated person.* Albany: State University of New York Press.

Luttrell, W. (2000). "Good enough" methods for ethnographic research. *Harvard Educational Review, 70*(4).

Mehan, H. (1982). The structure of classroom events and their consequences for student performance. In P. Gilmore & A. A. Glatthorn (Eds.), *Children in and out of school* (pp. 59-87). Washington, DC: Center for Applied Linguistics.

Mehta, A. C. (2005). *Elementary education in india: An analytical report.* New Delhi: National Institute of Educational Planning and Administration.

Moje, E. B., Ciechanowski, K. M., Kramer, K., Ellis, L., Carrillo, R., & Collazo, T. (2004). Working toward third space in content area literacy: An examination of everyday funds of knowledge and discourse. *Reading Research Quarterly, 39*(1), 38-70.

Moje, E. B., Collazo, T., Carrillo, R., & Marx, R. W. (2001). "Maestro, what is 'quality'?": Language, literacy and discourse in project-based science. *Journal of Research in Science Teaching, 38*(4), 469-498.

Moll, L. C. (2001). Through the mediation of others: Vygotskian research on teaching. In V. Richardson (Ed.), *Handbook of research on teaching*. Washington, DC: American Educational Research Association.

Moll, L. C., Amanti, C., Neff, D., & Gonzalez, N. (1992). Funds of knowledge for teaching: Using a qualitative approach to connect homes and classrooms. *Theory Into Practice, 31*(2), 132-141.

Mukherjee, A., Sadgopal, A., Shrivastava, P. K., & Varma, V. S. (1999). *The Hoshangabad Science Teaching Programme.* Paper presented at the Education in the south Asian context: Issues and challenges, Delhi, India.

Murphya, C., Ambusaidi, A., & Beggs, J. (2006). Middle east meets west: Comparing children's attitudes to school science. *International Journal of Science Education, 28*(4), 405-422.

National Council of Educational Research and Training. (2005). *National Curriculum Framework*: New Delhi.

National Council of Educational Research and Training. (1993). *6th All India School Education Survey:* New Delhi.

National Council of Educational Research and Training. (1999). *7th All India School Education Survey*: New Delhi.

National Family Health Survey - 2. (1999). Mumbai: International Institute for Population Sciences.

National Policy on Education. (1986). Available:http://www.education.nic.in/natpol.htm.

Niesz, T. (2003). School reform on the inside: Teacher agency at one Philadelphia middle school. *Penn GSE Perspectives on Urban Education, 2*(2).

Pickering, A. (1993). The mangle of practice: Agency and emergence in the sociology of science. *The American Journal of Sociology, 99*(3), 559-589.

Pineau, E. L. (1994). Teaching is performance: Reconceptualizing a problematic metaphor. *American Educational Research Journal, 31*(1), 3-25.

Popkewitz, T. (2002). How the alchemy makes enquiry, evidence, and exclusion. *Journal of Teacher Education, 53*(3), 262-267.

Rajiv Gandhi Siksha Mission (2003). *Siksha ka charter*: Hoshangabad, M.P.

Ramachandran, V. (2004, July 24). Is Schooling for the poor on the government agenda? *Economic and Political Weekly.*

Rampal, A. (2002). Texts in context: Development of curricula, textbooks, and teaching learning materials. In R. Govinda (Ed.), *India Education Report*. New Delhi: Oxford University Press.

Rampal, A. (April, 2004). Unpacking the 'quality' of schools. *Seminar, 536.*

Rao, N. (2000, November 25). Education: quality with quantity. *Economic and Political Weekly.*

Ratner, C. (2000). Agency and culture. *Journal for The Theory of Social Behavior, 30*(4), 413-434.

Reddy, S. (2004). *Status of learning achievements in India: A reveiw of emperical research*: Azim Premji Foundation.

Roberta, C., Rampton, B., Leung, C., & Harris, R. (2002). Methodology in the analysis of classroom discourse. *Applied Linguistics, 23*(3), 373-392.

Rogoff, B. (2003). *The cultural nature of human development*. New York: Oxford University Press.

Rosaldo, R. (1989). *Culture and truth: The remaking of social analysis*. Boston, MA: Beacon Press.

Roth, W.-M., & Lucas, K. B. (1997). From "truth" to "invented reality": A discourse analysis of high school physics students' talk about scientific knowledge. *Journal for Research in Science Teaching, 34*(2), 145-179.

Roy, M., & Khan, M. L. A. (2003). *Education for all in India: Going up the down staircase ?* (Background paper): UNESCO.

Sadgopal, A. (2002, August, 13). Fatwa on science education. *The Hindustan Times.*

Sahni, U. M. (1994). *Building circles of mutuality: A sociocultural analysis of literacy in a rural classroom in India.* Unpublished Ph.D thesis, University of California, Berkeley.

Sarangpani, P. M. (2003). *Constructing school knowledge: An ethnography of learning in an Indian village*. New Delhi: Sage Publications.

Sarva Sikhsa Abhiyan, Government of Madhya Pradesh. (2004). *Sarva Sikhsa Abhiyan Madhya Pradesh: Education Profile.*

Saville-Troike, M. (1989). *The ethnography of communication: An introduction.* New York: Basil Blackwell.

Schmidt, W. H. (2003). The quest for a coherent school science curriculum: The need for an organizing principle. *Review of Policy Research, 20*(4), 569.

Seiler, G. (2002). *Understanding social reproduction: The recursive nature of structure and agency within a science class.* Unpublished Dissertation, University of Pennsylvania.

Seiler, G., Tobin, K., & Sokolic, J. (2001). Design, technology, and science: Sites for learning, resistance, and social reproduction in urban schools. *Journal for Research in Science Teaching, 38*(7), 746-767.

Sharma, A., & Anderson, C. W. (2003). *Transforming scientists' science into school science.* Paper presented at the National Association of Researchers in Science Teaching, Philadelphia, PA.

Shiva, V. (2004, April 5). The Suicide economy of corporate globalisation [Electronic Version]. *Countercurrents.* Available: http://www.countercurrents.org/glo-shiva050404.htm.

Smardon, R. (2004). Streetwise science: Toward a theory of the code of the classroom. *Mind, Culture, and Activity, 11*(3), 201-223.

Spivak, G. C. (1988). Can the subaltern speak? In C. Nelson & L. Grossberg (Eds.), *Marxism and the interpretation of culture* (pp. 271-313). Chicago: University of Illinois Press.

Taylor, A. R. (2003). Transforming pre-service teachers' understandings of mathematics: Dialogue, Bakhtin and open-Mindedness. *Teaching in Higher Education, 8*(3), 333-344.

Upadhyay, B. R. (2006). Using students' lived experiences in an urban science Ccassroom: An elementary school teacher's thinking. *Science Education, 90*, 94-110.

Urban, G. (1993). *A Discourse-centered approach to culture: Native south American myths and rituals* (Reprint ed.): Univ of Texas Press.

Varelas, M., Becker, J., Luster, B., & Wenzel, S. (2002). When genres meet: Inquiry into a Ssxth-grade urban science class. *Journal for Research in Science Teaching, 39*(7), 579-605.