Science Literacy in Theory and Practice: A Sociocultural Analysis of Teacher Cognition in a Multicultural Setting

by

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Abstract

Why is it that children of certain sociocultural groups do so "poorly" in science programs - even in those programs that claim to honor diversity and build on student's own conceptual models and theories? This dissertation is a case study that addresses the complexities of teaching science to diverse populations. There is a lot of rhetoric about making all children scientifically literate, regardless of sociocultural position in society, but there has been little work on trying to understand the hidden assumptions behind such efforts. In focusing on notions of science literacy, my work seeks to examine how, in the course of a model science project, a teacher and two researchers brought different assumptions about the meaning of science literacy to the project and produced varying practices. The goal of this project is to move from a view of science teaching as a purely cognitive activity towards a more sociocultural view. With a sociocultural perspective, we can begin to address science teaching in multicultural settings.

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Contents

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"Without love in the dream, it can never come true"
- Robert Hunter

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the children, parents and teachers
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who showed me how hard it is to teach well.

Preface

Science education in the United States is rarely described as taking place within a social context. Most science literacy programs focus on the content of science curriculum or the cognitive abilities of science literacy acquisition within an atemporal and ahistorical processes (though there are exceptions - see Lemke, 1990).

Yet, many troubling questions arise as to what causes the lack of diversity in those who acquire science literacy. These questions motivated my study: why do science literacy programs face continued difficulty reaching more than a handful of students? Why does this breakdown seem to fall along certain class, racial and ethnic dimensions? Is there anything in the way we conceptualize teacher cognition that contributes to these problems. And if there *is* something amiss with our ways of thinking about teacher cognition, what is it and what are the alternatives?

This study proposes that the answers to these questions could be developed within a greater understanding of the social context of learning and teaching science. The purpose of this thesis is to provide a new lens for looking at teacher thinking in science literacy. It is a descriptive case study of one teacher's attempt to implement a new science curriculum including computer technology and a curriculum design heavily influenced by cognitive psychology. This thesis is addressed to researchers in cognitive studies and cultural studies as well as teachers. Researchers and scholars often avoid integrating their theories of mind with those whose daily activities are charged with facilitating the growth of minds. While many cognitive scientists would agree that teachers are valuable for sharing 'real experiences' in the classroom with them, it is rare to see a cognitive scientist look towards teachers as a potential source for new knowledge about the workings of the mind.

On the other hand, sociocultural studies tends to view all communication and social practices as ideologically determined. People use ideologies and cultural models as a basis for individual thought and action, yet few sociocultural studies consider everyday cognition worthy of study. As in cognitive studies, sociocultural studies avoids the everyday, substituting a science of large 'isms' in place of a more detailed discussion of social difference and what people bring to the social order. Too often cultural studies focuses attention on universal, generalizable concepts that transcend immediate social context.

I am not slighting studies that focus on the very real ways that dominant social structures (such as racism and patriarchy) play a role in social relations. But we also need studies that describe and interpret the real ways that people actively and positively seek to interpret and change the social order. This sort of 'popular theorizing" needs to be incorporated into both cognitive studies and cultural studies in our attempts to look at the interaction of larger structures with the local contexts that reproduce them in our daily lives.

To this end, I have relied in this thesis on a theory of *multiply situated subjectivity* that is contrary to the theory of the singular, unified subject presented by both cognitive and sociocultural studies. This bottom-up, context-dependent approach will enlarge the range of possible meanings ascribed to differences in classroom cognition. Understanding diversity is a subject of importance in our rapidly changing society. An explorer of difference must be willing to accept that many categories near and dear to us will be open to questioning. Differences in our culture may include, but cannot be reduced to racial, ethnic, professional, scientific or cultural categories. In approaching difference in cognitive studies, one must bring to the fore the active and embodied nature of differences rooted in social contexts, not ideals of mind or ideology.

Thoughts and ideology are produced through 'practice'. The social dimensions of our thinking are particular and situated, not universal and contextless. Contextualizing practice does require situating them in larger Discourses, but this should be done to demonstrate the discovery of specifics grand theories cannot adequately account. The ethnography of science teaching presented here emphasizes the productive rather than reproductive relationship of individual practices with historically situated Discourses (such as cognitive studies) and various identities (professional, racial, gender and class identities). In this way, I hope to illuminate the relationship of subordinate and dominant ideologies within both teaching and within academic research on teacher thinking.

Structure of the dissertation

Chapter 1 *Background chapter: cognition, culture and communication in historical perspective*. A survey, through review of selected texts, of the debate within western culture on the role of a media technology in cognitive development: written literacy. This review examines the construction of theories of the influence of social context on cognition in various fields (anthropology, cognitive studies and literacy studies).

Chapter 2 *Methods chapter*. Methods for establishing accuracy and validity in social science research are discussed in relation to this study. Epistemological issues in the generalizability of ethnographic description to theory building are also discussed.

Chapter 3 *The research setting*. In this chapter, the research setting and participants in the study are introduced, as well as my entry into the field as a participant observer.

Chapter 4 *Classroom Discourses in Conflict: scenarios of teacher cognition as reasoning between multiple Discourses*. This chapter begins the sociocultural analysis that is at the core of the dissertation and extends through chapters 5 & 6. The focus of the analysis in this chapter are two classroom discussions focusing on the teacher's interactions with the students and a cognitive researcher.

Chapter 5: *Sociocultural Analysis of Teacher Cognition*. This chapter focuses on the teacher's sociocultural models for teaching practice. Larger institutional and social contexts are invoked for theoretical clarity in understanding everyday cognition.

Chapter 6: *The Social Gravity of Cognitive Research: cognitive theory as social practice* . This chapter presents an analysis of cognitive research as social practice guided by sociocultural models. This chapter is similar in intent and structure to the preceding chapter on teacher cognition as a form of social practice.

Chapter 7: *Concluding remarks* . A discussion of the implications this study has for educational research and teacher-researcher collaborations.

The main body of the research (Chapters 3 - 6) flows from description to interpretation and analysis. Chapters 3 is more descriptive than analytical. The main characters of the ethnographic narrative are introduced in this chapter. Chapter 4 ("Classroom Discourses in Conflict") begins to blend description of classroom practices of the teacher and the researchers with analysis of classroom transcripts and research reports. Chapter 5 and 6 are more analytical than descriptive. The practices described in

the previous chapters are explained by the social gravity of Discourses as well as conflict between social groups (as manifest in teacher resistance). Readers may wish to begin with chapters 4,5,6 and 7.

Chapter 1:
Background chapter

Cognition, Culture and Communication in Historical Perspective

Research questions and the relevance of background chapter

Although at the borders of many disciplines, the social study of mind is on the verge of becoming a new discipline: the new cognitive studies. Through an exploration of the research literature I will try to lay the groundwork for research in this emerging field.

The New Cognitive Studies differs from other ways of thinking about cognition. Instead of defining cognition as a tool or technology (like an alphabet, a text book, a computer, sentences, etc.) or a technique (the ability to read and write words or programming a computer), cognition is viewed as including all the social practices surrounding texts books, computers, sentences, etc. (see Note #1 at the end of this chapter). In fact, the new cognitive studies sees no significant division between communication, cognition and culture.

There is no one place one can look for an unified perspective on the social study of mind. The New Cognitive Studies still remains scattered. Elements of this new theory of mind and social practices emerge from anthropology, sociology, neurophysiology, primatology, cultural studies, computer science, cognitive psychology and social (not to be confused with socio-) linguistics. Admittedly, I have only caught glimpses of the contributions of some of the fields, while devoting significant portions of my study to others. Like many other fellow wandering practitioners, my development is necessarily uneven. Hopefully over time, other pieces of the picture will become clearer. The goal of this chapter is to guide the reader through the theoretical background upon which my ethnographic study of science literacy practices is based. I also hope to provide a window to a new and exciting field where many questions are being addressed in unique ways that speak to some of the most pressing social and intellectual issues of our time.

In a sense, this a case study of applied epistemology, where epistemology is advanced not only for the sake of epistemological study of the mind, but also as an attempt to examine the cultural psychologies that empower some and not others. Hopefully, I am not alone in my concern that those of us who participate in the design of

learning environments or technologies have an ethical responsibility to insure that our designs do not contribute to the unequal distribution of power in our society. The ability to communicate, understand and make sense with scientific terms and theories is one of the those many cognitive processes that is bound up in a host of cultural and social processes: Discourses, social contexts and ideologies (Latour, 1987; Fairclough, 1989). The same can be said of the term literacy; it also invokes a similar group of cultural and social processes. Put the two together as in *science literacy* and we are close to what in the Black vernacular is termed "one ball of confusion". The overall goal of my thesis is to try to unravel the "ball of confusion" that is the current state of theories on the role of culture in cognition. What follows is a guide to the literature that informs my work.

Conceptual Framework

Science literacy is more than being able to produce and interpret scientific explanations. An alternative to this commonly held folk theory is a view situating the ability to be scientifically literate within the social practices science literacy is part of. This approach makes it easier to connect scientific practices with the workings of power within the society at large.

The notion that science literacy is a social practice, not an autonomous skill within individuals will be called in this review the *ideological model* of literacy, as opposed to the *autonomous model* (Street, 1984). The ideological view of literacy is crucial, not only as a validity check against cultural bias in the social construction of science literacy, but also as a validity check for units of analysis in cognitive studies that privilege disembodied, autonomous theories of the mind. There is empirical evidence to show that ideologies may indeed play a role in the construction of the mind in cognitive science. Not only should we ask, "what does the science teach when teaching science?", but we must also ask, "what model of mind is the cognitive scientist using when thinking about thinking?". In this sentence, I have paraphrased two important philosophers of thinking, Jim Gee ("What does the English teach?" (Gee, 1986) and Seymour Papert ("You can not think about thinking without thinking about something" (Papert, 1980). In both cases, although in different fields of inquiry, (Gee within social linguistics and Papert within epistemological studies of learning), there is a realization that cognitive studies is inherently reflexive and that knowledge needs to be constructed, not stored or retrieved. Gee asks us to consider that teaching English (as in science) involves more than skills, but also ideologies. Any epistemological inquiry into teaching and learning must include social theory. Papert asks us to consider the subject/object

split so common within cognitive studies as a stumbling block that needs to be overcome. His solution is to make the split a part of the process, thus dissolving the dichotomy between thinking and knowing. What one thinks about has a profound influence on what ones thinks he or she knows.

Ideology

The term 'ideology' requires clarification. It is a misunderstood term that for most North Americans invokes images of bias. It is not uncommon to hear someone dismiss the viewpoints of those they disagree with as, "they are just being ideological". To be called 'ideological' is often misconstrued as being opinionated, advancing a political agenda without recourse to the facts. We often hear news commentators admonishing the 'ideologues' in Washington for their lack of common sense, their blindness to reality because of their slavish attention to ideas.

The way in which I use the term 'ideology', however, departs significantly from the more common usage. While I do agree that there is a connection between 'ideology' and 'common sense', I see this relationship as being more complicated and intertwined than the either-or view that takes ideology to be the opposite of common sense. Rather than dividing common sense into 'ideological' and 'non-ideological', it is more helpful to understand the extent that all common sense assumptions are, to a greater or lesser degree, ideological.

Ideology is the social theory one holds about the distribution of power within society. This social theory can be be theoretical, intuitive, tacit, overt, primary or deferred (Gee, 1990). It involves generalizations about the way power is distributed. When ideology is unquestioned, it adopts the qualities of common sense. For example, institutional practices people draw upon without thinking often are embedded in assumptions that if analyzed, express theories of society. People are used to thinking of ideologies in terms of political ideologies. From this we get the big 'isms': Communism, capitalism, Feminism, etc. But ideology also works on a smaller scale, providing the background common sense assumptions for everyday activities, such as reading the comics page in the Sunday newspaper (or opting for a newspaper that has no comics at all- embodying yet another ideological choice or social theory about the relationships of pleasure, journalism and leisure).

Once we move away from the notion that meaningful human cognition is based more in social practices than in technologies that support them, it is necessary to consider the basis upon which people get their social theories. If we are no longer

interested in the questions generated by an autonomous model of cognition (cognition is in the head), then it is impossible to proceed to newer questions (cognition is social) without raising the issue of ideology. Ideology raises questions about the socially distributed sources of significance used by people in the construction of their social theories.

For example, millions of dollars are spent each year by state school systems on Basal readers while wide-spread reliance on SAT's and other standardized tests as 'objective' measures of cognitive ability continues. This situation speaks to the wide spread use of an autonomous model of cognition as the basis for a social theory of cognition. Yet, very few people question the theory of mind expressed in believing that all children will benefit equally from the same reading material or that from administrating the same test, we can then proceed to rank relative student cognitive competencies. Behind standardization is an ideology that knowledge can be stored (in curriculum) and transmitted to students (in text books) and retrieved when necessary (in tests). Within such a social theory of mind is little room for alternative hypothesis (such as students create knowledge independently of texts that is also worth assessing or that tests are closer to being tests of ways of producing knowledge than they are of assessing knowledge itself). The unquestioned nature of testing in school systems is ideological because it assumes a taken for granted status. Even when testing is seen as problematic, the problem lies either with the students or teachers or the tests need revision. Never is testing itself questioned.

The resistance many people have to discussing ideology in the context of cognition speaks to the success of a dominant ideology (of autonomous cognition) in masking itself as the *common sense* for our thinking about thinking. For example, when pressed, most people will say that the reason why a graduate from community college cannot compete in the job market against a graduate from Harvard Business School is that the community college graduate lacks the proper training or tools. Most people will accept the common sense notion that the difference between these two schools is the 'training' or the 'learning' that happens within them. They may even point to their SAT scores as indicators of differences in imagined preparedness to compete for the same job. Most people will not press deeper into their social theories to register the fact that a lot more is learned at Harvard than the content of the courses. Students also apprentice to social practices usually reserved for a ruling elite. And even if pressed further, and found those willing to admit that a Harvard education is based more on the social practices of one social group, than for others, one will often hear,"yes, it is unfair, but that's the way it is".

But there is a social theory behind the autonomous theory of cognition. All theories of cognition involve social theories that are explanations for the beliefs and values they have adopted and the choice implied by such an adoption, and how such choices are sustained in social relations between people. It does not matter if these choices are well-thought or adopted unconsciously for them to form the basis for an ideology or social theory. In fact, the common sense or naturalness of many social theories are the glue that hold together many contradictions that seems obvious to those outside of a particular social theory. Commenting on ideology, Stuart Hall writes:

> "It is precisely its 'spontaneous' quality, its transparency, its 'naturalness', its refusal to be made to examine the premises on which it is founded, its resistance to change or correction, its effect of instant recognition, and the closed circle in which it moves which makes common sense, at one and the same time, 'spontaneous', ideological and *unconscious*. You cannot learn, through common sense, *how things are:* you can only discover *where they fit* into the existing scheme of things. In this way, its very taken-for-grantedness is what establishes it as a medium in which its own premises and presuppositions are being rendered *invisible* by its apparent transparency." (Hall, 1977).

Another very common social theory and (thus, ideological) model of cognition claims that standard English speakers are 'smarter' than people who speak non-standard dialects. This seems perfectly natural to speakers of both standard and non-standard English . Those who do not speak standard English have two choices. They can either resist this common theory of their cognitive abilities or they can adopt them for themselves, internalizing the dominant ideology that they are cognitively inferior. This happens quite often and one wonders why people would adopt a model of cognition that is not in their favor.

The answer to this question speaks to the ability of the power behind ideologies to naturalize their theories of society. There are very real material and social rewards for adopting the dominant point of view and very real penalties for ignoring them. The way that the standard English issue has become naturalized as the grounding for common sense practices makes it difficult to resist, even if one wanted to. Not only are educational institutions grounded in the myth of the cognitive advantages of standard English (see Stubbs, 1980 for why this is a myth), but newspapers, train schedules, recipes, etc. are all written in standard English. This creates the social practice of associating standard English with 'the way it is', making it harder to see other ways the issue could be addressed. The use of standard English becomes 'mythologized' (Barthes, 1972) and takes on a second order of significance beyond its use function. The dominance of standard English in so many media, makes it difficult to stress social

relations, while making it easier to stress individual agency in thinking about thinking. Such a move is ideological and masks the true relations of power that admittance to Harvard represents: education by and for an elite minority with a disproportionate influence on the distribution of goods in society. It also makes it easier for college administrators to say, "we would love to have more minorities, but we can't find qualified ones".

Thus, the power behind the ideology in Discourse is not repressive but productive (Foucault, 1972). College administrators no longer have to say, "we don't think minority students are good enough". Rather, they can creatively play with the power behind their Discourse to create or produce new subject relations: the minority person who acts like a member of the majority. In this creative move, the power behind the Discourse masks the true source of its ideology (unfair power relations) and appears to be fair by extending the nature of who can count as a member of the dominant culture. By assuring that only members of minority who have successfully internalized the dominant Discourse will arrive at the elite institutions, the social theories beneath the Discourse of these institutions is not threatened. If anything, they are strengthened in that the social theories appear benign, rather than being seen as the representation of the unequal distribution of power they actually are part of.

Hegemony

Another concept important to the understanding of the workings of ideology is hegemony. Hegemony is important because without it, ideology can be seen as monolithic and imposed from above by the dominant groups. As in the example of the non-standard English speaker who internalizes the belief that their way of speaking is inferior, hegemonic relations are based on the ability of dominant classes to "win and shape consent so that the power of the dominant classes appears both legitimate and natural" (Hall, 1977). But because hegemony requires consent, it can never count on complete and uninterrupted power to determine naturalness and must be contested, fought for and won over and over again. Ideological signs are not frozen or static, but constantly moving and up for grabs by the shifting alliances within contemporary societies. There are always ruptures between the sign and the meanings signs are supposed to represent, however fixed they may seem to be in the dominant ideology. For example, the strategic importance of acquiring standard English is not a closed issue. Rather, as we shall see, it is an issue of contested significance between various

members of the African American community (Delpit, 1986,1988; Hewitt, 1986; Gilroy, 1987; Hall, 1989).

"The struggle between different discourses, different definitions and meanings within ideology is therefore always, at the same time, a struggle within signification: a struggle for the possession of the sign which extends to even the most mundane areas of everyday life." (Hebdige, 1979). In this case study, the 'commodity' of a curriculum has both 'legitimate' and 'illegitimate' uses, depending on the social position and theories of its consumers. These objects or commodities can be 'stolen' and 'repossessed' by subordinate groups (in this case African American teachers and their respective subcultures) and used as forms of resistance to re-articulate the contradictions the commodities were supposed to dissolve (Jenkins, 1988). Thus, in this study, we have a curriculum designed to narrow, not widen, the gap between children's acquisition of science literacy being 'repossessed' by the teacher as a sign representing the continuing contradictions and conflicting Discourses felt as real, lived experience inside the classroom.

I agree with Socrates' statement that an unexamined life is not worth living. Following that, I believe that theories that have not stood up to being contrasted with alternative theories are not worth having. At this time, science literacy in North American is problematic (especially for minority groups) because it is undertheorized and unchallenged by alternative theories. In this study, I advance such an alternative reading of science literacy and the cognitive theories used to implement and assess science literacy in practice. My project is ideological and purposely anti-hegemonic in its goals. But it is not the simple exposition of my views, but a more complicated refraction through the prism of observing others attempting to teach, learn and assess science literacy. Cognitive 'styles' that go against the grain of received assumptions and question the surface innocence of everyday life (i.e. challenges to the everyday life of cognitive psychological research on learning) are important sources of knowledge about the intersection of everyday life and ideology. Such challenges reveal everyday practices to be not as transparent as they claim to be and open up a field of inquiry as to the ideological and connotative codes that "cover the face of social life and render it classifiable, intelligible, meaningful." (Hall, 1977). Thus, sociocultural and ideological analysis are crucial aspect of the cognitive studies project, for it speaks to the way in which people make meaning in the world (Bruner, 1990; Lave & Wenger, 1991; Gee, 1992).

In the remaining sections of this chapter, I will survey some of the previous work on the relationship of social construction of mind and the use of tools. The work of L.S. Vygotsky will be a starting point. Not only because of the importance of his theoretical contributions to the study of the sociocultural mediation of thinking by tools and practices (such as texts, decontextualized reasoning, language, literacy, etc.) **but also because ideas borrowed from Vygotsky became the theoretical basis for the science literacy project analyzed in subsequent chapters of this thesis.** Hopefully, after reading this background chapter, the reader will believe, as I do, that there is a strong case for the social construction of science literacy and that this process can be detailed through ethnographic analysis (my use of ethnographic methods is discussed in greater detail in the methods chapter). I hope the reader will appreciate the implicit message in many of the documents reviewed here: ethnographic detail can provide missing links in describing the interface of social to individual cognition.

The review presented here form the core of a conceptual framework which hopefully will be followed by more studies such as this one. Thus, I present the following overview of studies in literacy and the sociocultural mediation of thinking.

Vygotsky's work is pivotal in cognitive studies of the sociocultural mediation of learning. Whereas the field of New Literacies Studies (Luke, 1988, Gee, 1986; 1990) has recognized the contributions of theoreticians such as Bakhtin and Freire who have advanced methods for the social and ideological analysis of literacy, we have as of yet, not promising theoreticians within cognitive studies with a similar analysis of the place for ideology in the study of cognition. This dissertation seeks to push the field of cognitive studies in this direction.

In recent years, cognitive studies have often looked towards Vygotsky for ideas on developing an analysis of the role sociocultural processes plays in cognition. One particularly interesting concept is the Zone of Proximal Development (ZPD), developed by Vygotsky to show that learners can perform tasks normally outside the range of their current abilities - a range which demonstrates the potential for future growth and the acquisition of cognitive abilities (Vygotsky, 1978; Tharp & Gallimore, 1988; Werstch, 1985; Rogoff & Wertsch, 1985; Rogoff, 1990; Bruner, 1990). Both educators and theorists of cognition have been intrigued by the ZPD. However, as we shall see here, there are fundamental contradictions within the Vygotskian enterprise that weakens the applications of these ideals in multicultural settings. The most relevant contradiction for

the purpose of this study is the lack of attention to specifying the role Discourses play in situating meaning created within a ZPD. The sociocultural specificity of interactions within a ZPD are in need of analysis as much as the micro-interactions of the ZPD itself.

There is a discrepancy between standard cognitive theories of the mind and the empirical evidence that sociocultural processes (such as the social distribution of cognitive tools and the prominence of cultural models, cultural models and ideologies in cognition) are the basis for, not the outcomes of, complex cognitive processes (of which science literacy is but one).

Vygotsky's work suggests the mechanisms through which culture becomes a part of each person's nature. A key difference between Vygotsky and Piaget is that Vygotsky saw the development of practical knowledge and speech as interrelated phenomena, while Piaget thought they developed independently. The Piagetian child's "egocentric speech" has no real function in his cognitive activity, while the Vygotskian child is using speech as a tool to mediate his understanding of an activity with the activity itself. This is the meaning of *mediation* in the Vygotskian framework.

The term mediation, as used by Vygotsky, refers to the use of tool systems like sign systems (language, writing, number systems) that are created by societies over the course of human history and that change the form of society and the level of cultural development. Vygotsky believed that the internalization of culturally produced sign systems brings behavioral transformations and forms the bridge between early and later forms of development. Thus, for Vygotsky, in the tradition of Marx and Engels, individual developmental change is rooted in society and culture (Marx & Engels, 1947).

Vygotsky, like many of his young comrades in the revolutionary fervor of the Soviet Revolution, saw the true nature of man as being inherently social. Although, there are some significant differences in his concept of sociohistorical development from that of Marx & Engels, a similar epistemological stance united Marx's critique of the bourgeois tendencies of "civil society" and the bourgeois tendencies of individual psychology (Volosinov, 1973).

One of Vygotsky's basic assumptions about the development of psychological processes is that no single factor and corresponding set of explanatory principles can alone provide a complete account of cognitive development. Instead, multiple forces of development, each with its own set of explanatory principles, are involved. In this account, with the incorporation of a new force in the picture, the very nature of development changes (Werstch, 1985).

The Sociohistorical Method

As mentioned above, the sociohistorical method was influential in Vygotksy's thinking. It was the source of much clarity as well as confusion in his theory. The concept of sociohistoricism was weakest in his attempts to understand social history, and strongest when attempting to understand ontogenesis (individual development). I will show below how, without a rigorous ethnographic framework, Vygotsky and his followers made claims about the importance of literacy in scientific thinking that proved to be extremely biased [through comparison of his work with work done by Scribner and Cole (1981) within an ethnographic framework (this bias will be explored in detail in a later section in this chapter).]

Briefly, Vygotsky constructed two distinct explanatory systems for phylogenesis (development of the species) and sociohistorical development. He believed that sociohistorical development would be best explained through a science of mediated symbol or sign usage, not by mere evolutionary forces of the species. Vygotsky also believed in large cognitive consequences on development from sign usage. In the thirties, Vygotsky along with Luria looked at the changes in higher level cognitive processes that he thought would take place from collectivization and modernization taking place in Soviet Central Asia (Luria, 1976). In this cross-historical research Vygotsky saw an opportunity to observe two historical systems clashing. He and Luria asked literate and non-literate subjects to classify objects and to solve simple syllogisms such as "if toys are nice, and a ball is a toy, is a ball nice?". Their research showed that the literate subjects tended to use linguistic and decontextualized means to solve the problems, while the non-literate subjects tended to use practical experiences as a guide. Scribner and Cole's research with the Vai of Liberia put into question some of Vygotksy's basic findings (see below).

Vygotsky as linguist

Vygotsky was working on some of the central concerns of social linguistics and language acquisition without the benefit of modern linguistic theory. Yet, his ideas were heavily influenced by such pioneers of modern semiotics and linguistics as Husserl, Sapir and Pierce, all of whom he had read. These semioticians and linguists helped him to develop his notion of the indexical, or indicative, which he contrasted with the symbolic function of language.

Vygotsky introduced the notions of the indicative and symbolic functions of speech to cognitive psychology. Without understanding these two aspects of Vygotsky's linguistic theory, internalization becomes a mysterious act. This division of the function of language is surprisingly up to date with contemporary linguistic theory.

Silverstein (1985) divides language functions into two categories similar to those of Vygotsky's in his division of *semantic* and *pragmatic* categories. In his theory, pragmatics refers to the indexical nature of the sign. Its meaning derives from some object or reference in the present setting. Semantics refers to the "context-free meaningfulness" of specific signs, namely the regularities of meaning that do not necessitate reference to context for their specification.

This formulation is very similar to Vygotsky's use of indicative and symbolic function, and this is not surprising, because Vygotsky built his definition of a linguistic sign, especially the word, on work by E. Husserl (Husserl, 1900). Vygotsky said that "it is necessary to distinguish....the meaning of the word or its expression from its referent, that is, objects indicated by the word or expression (1978). Saying "the North American country that had won independence from the British" or " the North American country that lost the war in Viet Nam", might correctly identify the United States. The meaning of these two sentences is different. Vygotsky thought that this aspect of language held the key to understanding child development.

The indicative nature of language, according to Vygotsky, is at the origin of generalizations. During the early phases of ontogenesis, adults regulate their interactions with the child through verbal redirection and transformation of action based on the child's actions. Labeling, one of the earliest forms of communication with children, "enables a child to single out separate elements, thereby overcoming the natural structure of the sensory field...the child begins to perceive the world not only through his eyes but his speech. As a result, the immediacy of natural perception is supplanted by a complex mediated process; as such, speech becomes an essential part of the child's cognitive development" (Vygotsky, 1978).

This social speech, regulated through increasingly sophisticated interactions with people (and words), becomes egocentric speech. Egocentric speech is further along in decontextualization than social speech, unlike pointing or more indexical forms of childhood communication.

To illustrate my point, consider the example of a child trying to get a ball from the top shelf. "Ball" says the child as she reaches for a ball out of reach within earshot of a more competent other (adult or older child), who realizes that the child wants the ball.

Later in the child's development when the child can reach for the ball himself, she may still say 'ball'. This is a pattern that Piaget described as egocentric speech, giving it little relevance in developmental theory. Piaget said that egocentric speech fades as the child's speech becomes more socialized (Piaget, 1926).

Vygotsky's approach was just the opposite, although he acknowledged that Piaget was the first to notice this phenomenon that would become so crucial to his theory. Vygotsky believed that egocentric speech is somewhere between social speech and reflective, conceptual reasoning (scientific thinking). Egocentric speech is, on the one hand, indexical and pragmatic and the other semantic, i.e. relations are constant over utterance events.

"Consequently, the children's adaptive behavior and sign using activity are treated as parallel phenomena- a view that leads to Piaget's notion of "egocentric speech". He did not attribute an important role to speech in the organization of the child's activities nor did he stress his communicative functions, although he was obliged to admit its practical importance" (Vygotsky, 1978).

"In Piaget's theory the essence of human thought is logico-mathematical reasoning, which emerges from action (in the sensorimotor period). Vygotsky saw language, and thus thought, as being social and more multifunctional. And this is the heart of the distinction between Vygotsky and Piaget's view of the relationship of language to thought. For example, psychological theories implicitly or explicitly contain views of language which makes assumptions about the kind of linguistic competence that is attributed to individuals and the kind of cognitive competence that is (implicitly or explicitly) inferred from it (Werstch, 1985).

Vygotsky described egocentric speech as "inner speech in its psychological function and external speech physiologically" (1978). Egocentric speech appears around the age of three. When it disappears around the age of seven, it goes underground, becoming inner speech.

The way in which Vygotsky went about testing his hypothesis was original and completely consistent with his theory. He wrote, "If we replace object analysis by process analysis, then the basic task of research obviously becomes a reconstruction of it's stage in the development of the process: the process must be turned back to its initial stages" (1978). In his own way, Vygotsky's method is very close in spirit to qualitative studies which do not just describe a child's development, but the development of the processes themselves.

To seek the origins of scientific thinking in Vygotsky's genetic method requires searching for and identifying the origins of such thinking in the developmental process. Reflective inner speech is, according to Vygotsky, dialogic in nature, thus it must have

a social origin. Vygotsky's method for research on egocentric speech was based on the following hypothesis: if speech is egocentric as Piaget suggested and has no communicative origins (and thus lacks a communicative function), the amount of egocentric speech will not change if the child is in a social setting where communication is not possible.

Vygotsky and his students (Leont'ev, R.E. Levina, and Luria) made qualitative observations on the amount of egocentric speech among children solving a task (Levina, 1981). In the experimental setting, the dependent variable was the presence of a person who the child perceived as a someone unable or unwilling to help (deaf mute children or speakers of another language). In such a case, the amount of egocentric speech decreased (Wertsch, 1985).

In other experiments, the researchers increased the difficulty of the tasks and saw a correlation with the amount of egocentric speech. In yet another experiment (having established a baseline for egocentric speech in his subjects), Vygotsky isolated the subjects in a setting where vocalization was difficult or impossible (rooms where loud music was in the background, or at a crowded table where many people were talking to each other loudly). Vygotsky found that the amount of egocentric speech also decreased. According to Vygotsky, egocentric speech is the result of the confusion over socially regulated activity mediated through the speech of a more competent other, and the self-regulative aspect of inner speech.

Vygotsky also developed the notion of linguistic context that explains how signs become decontextualized through sign-sign mediation. A good example of linguistic contextualization is the way in which egocentric speech becomes less communicative as it gets more embedded in the self-referential, developing semiotic system.

Research by Kohlberg, Yaeger, and Hjertholm (1968) supports the claim of the social nature of vocalization: the illusion of being understood by others and the presence of potential listeners and interlocutors characterizes the optimal conditions for the use of egocentric speech by children. They found that as children aged from five to nine years of age, the amount of inaudible utterances (low voiced) rose from 0.24 to about 0.50. There was also a corresponding fall in the "describing my own activity" talk. These findings point to the idea that cognition is a socially shared activity and that so-called egocentric speech operates within a social context and is not, as Piaget might suggested, a non-cognitive activity.

Linking social linguistics and cognitive development

This is a good entry point for discussing how social linguistics and ethnographies of communication can clarify the differences and similarities between different modes of communication. For example, in our Western European influenced educational, literacy is thought to be the most evolved semiotic mechanism for decontextualization, while oral skills are not as highly valued. However, both ethnographic work (Heath, 1983; Street,1984) and sociolinguistic analysis of writing and speaking (literacy and orality) point out that the decontextualization process assumed to be supreme in literacy, is not the actual case in practice. It's not that the Discourse of students successful in school is more decontextualized than those of minority students who are failed by schools. Rather, the Discourse of the successful student is sufficiently socially situated within a community Discourse heavily influenced by and knowledgeable of official school Discourse.

The sociolinguistics of literacy offers an alternative way of understanding sociohistorical development through a detailed analysis of the difference between literacy and orality (Stubbs, 1989). The study of the differences and similarities between these two sociohistorical communication systems (literacy and orality) offers a way of understanding the mediational means through which people develop higher cognitive strategies. Not only are all cultures a mix of orality and literacy practices, but the primacy awarded to literacy is itself a social construct that is deeply rooted in an ideology that favors the geographic dialect of a particular sociocultural grouping. Critical theorists can expand the constructionist as well as the Neo-Vygotskian enterprise by providing a more precise description of the *historical* in the socio*historical* method. This is achieved through analyses of the embedded ideologies of gender, geography and history and class.

Critical social linguistics focuses on how language is used in specific social contexts and thereby how it serves as a medium of power and control (Anderson, 1989). Through critical theory and analysis, one adds a great deal of reflexive power to ethnographic description. For example, critical theory together with ethnographic studies of communication help clarify the development of scientific thinking in sociolinguistic communities that are not part of the dominant culture and are "oppressed" by the mainstream through a lack of recognition of differences in their ways of constructing knowledge.

From primitive oral cultures to modern literate civilization: the autonomous model of literacy

My research is situated within a body of work examining the relationship of social context to cognition. In order to frame my ethnographic reading of the sociocultural context for science literacy in a multicultural classroom, I examine the philosophical and ideological history of the debate on the relationship of thinking to literacy. This debate frames epistemological and historical issues particular to classroom-based critical ethnographies of communication.

Given the massive literature stretching from Plato to Freire on the relationship of literacy to learning, I will limit my historical overview to the discussion of a few key works. These works are Levi-Strauss' *The Savage Mind* (1966); Havelock's *Preface to Plato* (1963); Goody's *The Domestication of the Savage Mind* (1977); Ong's *Orality and Literacy* (1982); Papert's *Mindstorms* ; Scribner and Cole's *The Psychology of Literacy* (1981); Street's *Literacy in Theory and Practice;* Freire's *The Politics of Education* (1985) and Heath's *Ways With Words* (1983).

The contrast between "the civilized" and "the primitive" runs deep in human cultures. In the Bible, man's fall from grace is a fall from primitive nature (Eden) into civilization. The primitive/ civilized dichotomy is a hard one to put to rest because it is so firmly ingrained in our culture (Gee, 1990). But the primitive/civilized dichotomy has been effectively challenged by contemporary social anthropologists (Street, 1984). Anthropological and linguistic work has shown that so-called "primitive" cultures have systems of classification as complex as "modern scientists" (Levi-Strauss, 1966). Work by Evans-Pitchard (1937) showed that, in their own terms, the thought processes of witchcraft were the same as those involved in scientific thought and Sapir (1921) work on Native American languages showed them to be some of the world's most complex.

Linguists have also been looking at new forms of the primitive/ civilized dichotomy in "modern" societies. This dichotomy has lived on in a newer guise in the supposedly important distinction between lower status socioeconomic groups and middle class groups. This argument was disproved by Labov (1972). He showed that so-called Black English was as expressive as standard English and contained all the elements usually associated with logical thinking.

Levi-Strauss, Papert, Ackermann and Turkle: From The Savage Mind to The Second Self

Levi-Strauss demonstrated that primitive systems of thought are not as different from modern thought as was commonly thought. In *The Savage Mind,* Levi-Strauss (1966) sought to demonstrate that "there were two distinct modes of scientific thought". He introduced the idea of "bricolage", an important insight which casts primitive man as "tinkerer". Primitive man makes the best of what is available; similar in spirit and different from modern man only by the tools used. Modern man uses *abstract* symbols and tools for the development of higher order cognition, while primitive man uses nature, which is *concrete.*

While a valuable contribution to our understanding of the complexity of primitive societies, Levi-Strauss' anthropology, has not ridden itself of the primitive-civilized dichotomy (it is just recast as formal/ concrete). There is no explanation in the work of Levi-Strauss for how cultures move from the sciences of the concrete to the science of the abstract, nor is there a theory of why certain forms of thinking are privileged over others (Goody, 1977).

The work of Papert, Ackermann and Turkle (Papert, 1980; Turkle, 1984; Ackermann, 1990; Turkle & Papert, 1990) seeks to address the question of the movement of cognition within concrete and abstract modes of thinking. In their work, the computer is described as an object that allows fluidity between the formal and the concrete. Their work shows much promise as a research agenda designed to see if recent technologies such as the computer can "shift the boundary separating concrete and formal" (Papert 1980).

Papert's interest in formal versus concrete distinctions grew out of his own experiences as a child using concrete objects, in his case gears. Later in life, deeply influenced by the genetic epistemology of Jean Piaget, Papert saw the computer as a new medium worthy of exploration for its potential to expand the range of representations, and also for providing a strong case for epistemological pluralism (Papert & Turkle, 1990).

I hope to contribute to discussions of formal and concrete thinking with an investigation into "the framework of thought within which decisions are made in regards to what is legitimized and what isn't and how a particular group succeeds in making its ideology dominant in particular situations" (Street, 1984). My thesis extends these ideas into new areas through a rigorous exploration of social contexts and through developing new units of analysis (from interaction with objects to interactions with ideologies).

The work of Papert and his colleagues focuses on the psychoanalytic and psychological side of how individuals come to view their own cognitive practices, wheras my work stresses sociological, cultural and ideological aspects of this process.

Although different approaches, both research agendas are complementary and not oppositional. My work is encouraged by the spirit of "epistemological pluralism" (Papert & Turkle, 1990) and seeks to understand the appropriation of these ideas within different cultural settings and ideological agendas (for a more complete examination of issues surrounding Logo specifically in regards to the social context of learning see Jackson, 1988).

The Literacy Myth: Orality and Literacy and the transformation from Ancient to Modern Societies

The question of how societies move from concrete to formal modes of thinking has been examined historically and cross-culturally in the work of Ong, Havelock, and Goody (Ong, 1982; Havelock, 1963; Goody, 1977). *In the view of these scholars, the engine driving changes in society from primitive bricolage to sciences of the abstract is literacy.* This claim is not dissimilar to Vygotsky's claim that semiotic systems play a crucial role in sociohistorical and ontological development.

Plato railed against the epic poets, stating that the teller and the audience were "under a spell" (Havelock's *Preface to Plato* , 1963) created by the epic rhythm. Plato's goal was to dislodge power from the epic poets like Homer. Plato felt that in epic poetry innovation in values and ideas were difficult because the hearer identified so much with the poet and the poem-story, and not with the ideas in the tale. Appearing in the political treatise the *Republic*, Plato's attack on poetry as a "crippling of the mind" certainly is not a political theory in the modern sense of the word. But when viewed as an attack on the educational establishment of the time, the real political dimension of Plato's attack becomes clearer.

In *Preface To Plato,* Havelock casts Plato as a cultural prophet who's *Republic* is as much a treatise on literature and its relationship to knowledge as it is a treatise on statecraft. Havelock sees Plato as a crucial figure in the transition from Homer to Aristotle, from orality to literacy:

> In the eighth century we see a new technology of communication become available which provided a second and quite different method of persevering the tradition. It requires historical imagination at first to see how drastic the revolution was, and to understand how it was destined in the end to penetrate and alter every cultural condition and social relationship in Europe. - Havelock, 1963

Epic oral poetry - such as the *Iliad* and the *Odyssey* - had many flaws according to Plato and Havelock. According to their views it was the alphabetization of the Greek

language which allowed for the flowering of Classical Greek culture in the fifth century. Having script-like literacy allowed one to "dump" one's memory into an easily transportable and re-arrangable medium which was superior to oral forms. Communication could be more than heard: it could be an object (text).

Goody's *The Domestication of the Savage Mind* (1977) continues Havelock's interpretation of the role written texts play in the development of Greek civilization and applies it to modern societies. Like Havelock, Goody sees literacy as *the* technology of the intellect and the factor most responsible for the creation of modern societies. Goody believes that it is more useful to discuss differences across cultures as nonliterate/literate rather than pre-logical/logical. Writing is seen as responsible for a variety of changes within a society. Writing is viewed as creating the distinction and subsequent movement from myth to history, the elaboration of bureaucracy, the shift from small face-to-face communities to complex cultures, the emergence of abstract scientific thought and even democracy. In his conceptual framework, the difference between oral societies and literate societies is that "all beliefs, and values, all forms of knowledge, are communicated between individuals in face-to-face contact, whether it be cave-paintings or hand-axes, they are stored only in human memory". From this dichotomy Goody draws all kinds of distinctions between thought processes, cognitive skills and social achievements of oral and literate societies.

"It is clear that the adoption of written modes of communication was intrinsic to the development of more wide-ranging, more depersonalized and more abstract systems of government; at the same time, the shift from oral intercourse meant assigning less importance to face-to-face situations, whether in the form of the interview or audience, of personal service or national festivals in which the renewal of ties of obedience was often as significant as the religious rites." (Goody, 1977)

While Goody acknowledges that characteristics he associates with orality persists in literate, modern societies, - evidence which would seem to contradict the case for strong intrinsic effects of literacy. Goody characterizes these exceptions as "restricted literacy" as opposed to "full literacy".

Ong's *Orality and Literacy* builds on the work of Goody and Havelock by continuing to adopt the great divide theory of sociocultural development. Ong describes the structure of the presentation of ideas in oral cultures. He defines the distinctive oral style as relying heavily on formulaic thought and expression (for easier memorization). Repeated patterns, set phrases or expression (such as proverbs or rhyming structures which limits the possible choices of words at the ends of stanzas, making it easier to store and retrieve ideas from memory). Other characteristics of orality include: a)

additive: (strung together by additive relations like simple adjunction of terms/concepts like *and*) rather than subordinative; b) *aggregative* (clustered elements of thought or expression) rather than analytic c) *redundant* ; d) *conservative* or traditionalist, inhibiting experimentation; e) *restricted to or close to the world of human affairs* ; f) *agonistically toned;* g) *emphatic* and participatory rather than objectively distanced; h) *situational* rather than abstract.

Ong's description of functional literate human beings is telling:

> "beings whose thought processes do not grow out of simply natural powers but out of those powers as structured, directly or indirectly, by the process of writing. Without writing, the literature mind would not and could not think as it does, not only when engaged with writing but normally even when its composing its thoughts in oral form. More than any other single invention writing has transformed human consciousness" - (Ong, 1982).

Ong recognizes that there are possible contradictions in historical, sociological and anthropological evidence suggesting that simply possessing literacy doesn't necessarily eliminate orality. Ong's response to this situation is that "to varying degrees many cultures and subcultures, even in a high technological ambience, preserve much of the mind-set of primary orality". Ong points out that reliance on formulaic elements of a type used in Homer day, still survived in the prose style in Tudor England some 2,000 years after Plato's attack on Homer.

What is relevant about the Havelock-Ong-Goody literature is that claims about the effect of literacy and concepts of "restricted" or "residual" literacy are strikingly similar to characterizations of African American culture. African American culture has a rich oral tradition (enjoyed by African Americans of all classes) which has origins in traditional African languages and in the Creolization process of slavery in the Americas and Caribbean. What is also relevant for my research on the implications of Discourse-based science instruction for children of the Black lower socio-economic class is how similar Ong's and Goody's features are to distinctions made between "scientific" and "nonscientific" explanations.

According to the conceptual framework advanced Ong-Havelock-Goody work, there are "residual" pockets of the orality/literacy split in modern technological societies like the United States and Canada, which may apply to groups with "restricted" literacy (usually lower socio-economic class). Groups usually accorded "full" literacy are usually middle and upper class and have full access to the literacy taught in schools. The legacies of literacy which developed a historical sequence from "primitive/civilized" to "formal/concrete" to "orality/literacy" have come to haunt us in today's efforts to teach

science literacy in today's schools (Lemke, 1982; Graff, 1987; Michaels & O'Connor, 1990).

The false distinction between orality and literacy puts certain Black children at a perceived disadvantage. Science literacy programs which claim to be "discourse based" and which are designed to talk about science in "the ways children naturally come to talk about science" will ultimately fail Black children. The reason for this is a) because what passes as scientific discourse in elementary education is actually folk theory of scientific discourse. This folk theory is based on many of the false assumptions reviewed above and b) that middle class students' discourse is already closer to the discourse desired in school and will respond quicker and thus succeed in these pedagogies and c) lower socioeconomic African American children's school failure will be theorized as "cognitive deficiencies" based on an analysis of their discourse which is also based on cultural models.

In all the arguments presented above literacy was given a privileged position. In the next section, I present an overview of work which challenges the "great divide" theory and develops new ways to conceptualize the relationship of literacy to cognition. As in the previous section, I present a theoretical overview of this literature through the discussion of key writings relevant to my research. These are Scribner's and Cole's *The Psychology of Literacy* ; Heath's *Ways With Words* (1983); Street's *Literacy in Theory and Practice* (1984).

From autonomous to ideological models of literacy

The research of Scribner and Cole (1981) questioned the supposed cognitive consequences of literacy. The claim that literacy leads to higher order cognitive skills is a major factor in keeping cognitive activities separate from (and above) cultural context. Scribner and Cole's research with the Vai of Liberia questions some of Vygotksy's basic findings. They chose a research site in which literacy and schooling were not always coterminous among the Vai. In addition to literacy in English, which is acquired first in school settings, there exists literacy in Vai, "an indigenous script, transmitted outside an institutional setting and having no connection with western style school" (Scribner & Cole, 1981). Finally the Vai in this study had acquired literacy in Arabic, primarily for reading, reciting and memorizing the Qur' an.

Scribner and Cole found that the so-called effects of literacy was bound up in the context of schooling. Their research with people whose literacy developed outside of the context of schooling showed that they didn't necessarily use decontextualized

mediation. This points to the situated nature of learning literacy in school. The literate subjects didn't perform any better than the others in the practical activities, but merely provided better explanations.

Scribner and Cole observed literacy in the absence of facility with decontextualized mediational means and advanced forms of higher mental functioning. And they also observed subjects with the facilities to decontextualize but who did not use advanced forms of higher mental functioning in actual performance. Jean Lave has found similar results in her study of supermarket shoppers who, although "literate" in mathematical algorithms which were decontextualized in form, relied more on contextualized information such as the size of objects when choosing the best buys (Lave, 1988). Scribner and Cole's work also showed that it is not possible to draw a single dichotomy between people who are literate, schooled, capable of using decontextualized mediational means, and likely to use higher mental functions and people who cannot be characterized by any of these terms:

> "It is true that Vygotksy's methods of research and his theory on this issue are at odds, and did contribute to this confusion in understanding his theories. The research that Luria and Vygotsky did in Central Asia focused on the decontextualization of mediational means as an explanatory principle for social history. *The question thus arises as to whether the emergence of intralinguistic contextualization as evidenced in inner speech can serve as an explanation in this genetic domain. Vygotsky made some general claims to this effect, but never developed them in detail.* "(Wertsch, 1985).

As the work by Scribner and Cole points out, Vygotsky's analysis of the interaction of ontogenetic and sociocultural forces in cognitive development is the weakest link in his theory. The social linguistics of literacy offers an alternative way of understanding sociocultural development through a detailed analysis of the relationship between literacy and orality (Stubbs, 1980). Many of the tasks used to measure cognitive flexibility are really in fact tests of the ability to use language in a specific way. They are often tests of explicitness.

Linking ethnographies of communication with sociolinguistics of literacy: Heath and Street

The "decontextualization of mediational means as an explanatory principle for social history" is close to what Brian Street described as the "autonomous" view of literacy. Street challenges the claim that literacy and schooling have any exclusive role in the

development of cognition. Street develops his critique through a discussion of the work of Goody; recent work by Hildyard and Olson (1978); and Greenfield's research in Africa (Greenfield, 1972). Street then juxtaposes historical work by Graff, (1979) and ethnographic work by Heath (reviewed below) to demonstrate that literacy skills are generally not sought unless it is the cultural norm to have "literate consciousness". Literacy follows, rather than causes, economic development. Street's own ethnographic work of literacy programs in a rapidly modernizing Iran in the 1970's grounds his claims in empirical research. According to Street, the diffusion of literacy programs among a population is a causally significant factor in that it promotes literacy as a goal and enhances its attainment, *rather than the other way around.*

Street's study concluded that literacy practices and "consequences" varied; with variations reflecting social, rather than cognitive distinctions. In this respect his work is similar in spirit to the work on the Vai. He found that there was a "commercial" literacy used in the market place which contrasted with more indigenous "Maktab" literacy (the literacy of Mashad, the region of Iran where the research was conducted). These distinctions were further complicated by school-based literacy which differed from the two other forms of literacy and was introduced under the ideological guise of "modernization" and "increased production". Street writes:

> Some of the concepts being developed within what I have called the 'ideological' model of literacy can, I believe, be helpful in avoiding this dilemma and in making sense of the complex overlapping of literacies and ideologies. I will use, for instance, the notion that there is a 'mix' of oral and literate modes of communication, rather than searching for 'pure types' of either. *I shall describe different literacies, rather than assuming a single, autonomous literacy; I shall consider these literacies as embedded in specific ideologies and practices rather than attempting to separate out literacy as such or treat it simply as a technology.* (Street, 1984) - emphasis mine.

Heath's *Ways With Words* (1983) is an ethnographic account of how the use of literacy differs in three communities in the Piedmont area of North Carolina in the United States: a white lower socio-economic community, a black lower socio-economic community and middle class community of urban blacks and whites. Heath's study revealed that the patterns of literacy events were embedded in social activities that reflected *larger sociocultural patterns* .

Heath proved ethnographically that the oral/literate split made no sense in that all three cultures under study used both print and speech. Rather it was the socially mediated relationship between print and speech which really produced differing sets of literacy practices. Members of the different communities were required to respond to

speech and print events differently, although they might possess roughly equivalent levels of reading ability. For some, literacy skills required in school may be rarely required outside of school. For others, rehearsal of the official school Discourse accompanied early apprenticeship to the narrative structures of the community. Heath showed how in acquiring literacy and orality competencies they also become acculturated to a way of making sense of the world.

A good example of the influence of pedagogic practices in the family is the way middle class parent interactions with their children around print activities incorporate interactional patterns used in school. This scaffolding prepares their youngsters for instant recognition of rules for referencing meaning in reading, listening and responding to stories in the classroom. Heath analyzes the bedtime story as an example of the type of literacy event typical to middle class homes.

Heath did not find similar patterns in the Black lower socio-economic class community. Instead she found that written texts were often read or written in groups with their meaning constructed with the help of many participants. The Black lower socio-economic class children were more accustomed to responding to print in the midst of an ongoing stream of discourse. Text was not decontextualized in this case, but contextualized with verbal and nonverbal language. The Black children of Trackton developed connections between situations by gestalt patterns, analogues, or general configuration links, not by specification of labels and discrete features in the situation.

In *Ways With Words*, Heath suggests that in order for non-middle class children to learn participant structures implicit in literacy activities at school, explicit teaching was needed. The parallels of Heath's work and the work of Scribner and Cole on the Vai are striking. Her recommendation that the differences between essayist-style prose and the primary literacy styles of the non-middle class children be identified, taught and practiced is similar to a critique made by Lisa Delpit.

Numerous Black educators, such as Lisa Delpit, have spoken out strongly against "progressive" pedagogies such as the writing process movement saying that the emphasis on meaning over form denies critical help to Black children (Delpit, 1988; Ladson-Billings, 1990). Black children already have the meaning she says: what they don't have is the middle class skills that the middle class kids already bring to school with them. She argues for the deliberate teaching of the "culture of power". As Bourdieu (1984) points out, children are discriminated against in schools by lacking the 'cultural capital'. Delpit's argument is remarkable similar to his:

"If you are not already a participant in the culture of power, being told explicitly the rules of that culture makes acquiring power easier....Unless one has the leisure

of a lifetime of immersion to learn them, explicit presentation makes learning immeasurably easier (Delpit, 1986)."

However aspiring to teach the rules of the culture of power has serious political and personal repercussions. Scollon and Scollon (1981) warned that changing discourse patterns (a strong expression of cultural and individual identity) could result in a loss of identity and the adoption of values at odds with their own belief systems. This is a dilemma that cannot be solved without changing the social structure and the hierarchical nature of the school structure which reproduce dominant social relations. We need to do more than simply teach children the rules of the culture of power, we need to teach them how to *change* the rules of the culture of power.

Conclusion: Plato, Freire and the possibility of emancipatory literacy

I began this review of relevant literature with a discussion of Plato's attack on the epic poets by positioning his critique of orality as a turning point towards a western bias in favor of literacy. But Plato was a critic of literacy, as much as he was of orality. Plato believed that writing was suspect. As Jim Gee points out in his review of Harvey Graff's *Legacies of Literacy* (Graff, 1987), Plato managed to avoid making the crude distinction between speaking and writing, orality and literacy. Plato attacked the epic poets for lulling the Greeks asleep with the drama and the taken for granted traditions of the culture handed down orally, a format which made it hard to question the assumptions. Thus the traditions the epic poets handed down were accepted uncritically.

Plato faulted these oral poets because they could not answer the question, "what do you mean?" Asking an oral poet deeper questions forces the poet out of the "oral sleep" to "re-say his or her own words in a different form, to take them out of poetry and put them into prose" (Gee, 1989). Words then lose their power, Greeks awaken from the "dream state" (Havelock, 1963). Writing down the epic poems, created a space for their critical evaluation. In this sense, print is helpful in that texts could be compared, stored and retrieved at will, aiding the process of uncovering contradictions and inconsistencies hidden by the limitations of aural memory and the rhetoric of oral performance (Goody, 1977; Havelock, 1963; Ong, 1982).

But Plato's critical appraisal of the faults of oral epic forms has a deeper and more fundamental side than that of a critique of a communication medium. The epistemological focus of the challenge to orality, the question, "what do you mean?", is applicable to literacy as well. For Plato, posing that question exposes attempts by poets,

politicians, rhetoricians, etc to make self-interested claims to authority or conservative tradition, whether in print or in speech.

Plato thought writing led the mind to a weakened memory and a tendency towards facile and false knowledge. Once written down, knowledge was no longer outside of itself. Writing encouraged an external crutch. One only really knew, according to Plato, what one could defend in face-to-face dialogue. The text gave the illusion of being explicit, clear, succinct, unanswerable, self-sufficient and closed (precisely the properties grouped under the construction, "decontextualized nature of the written language"). If the Greeks invented the basis of Western Literacy, they were also literacy's earliest critics. Plato, used discursive, expository writing, in which ironically, he attacked writing.

Socrates: I think writing has this strange feature which makes it like painting. The offspring of painting stand there as if it was alive, but if you ask them something, they preserve quite a solemn silence. Similarly with written words: you might think that they spoke as if they had some thought in their heads, but if you ever ask them about any of the things they say out of the desire to learn, they point to just one thing, the same thing each time.

Writing cannot defend itself. It can't stand up to questioning. Plato's epistemology is based on dialogue: when one person can ask another, "what do you mean?" in person. This is a demand for the speaker to re-say what he or she means more deeply felt, to respond to another person's perspective. Once written, the deeply felt knowledge which produced the utterance is lost. Plato attacked politicians and what he called "speech writers" who, together with great orators sought to present sealed world views, impervious to questioning, avoiding real dialogue.

The push for a "re-saying" takes the form of dialogue, and in a way this approach is similar in spirit to Bakhtin's notion of "re-voicing." Bakhtin presents a theory of dialogism, stressing both the open ended nature and the ideologically formed social gravity of meaning. To Bakhtin, the question "what do you mean" is answered in a poetics of placement that seeks to situate epistemology with position, philosophy with voice. A dialogue is an utterance whose address assumes a reply (expected and/or actual). Without this relationship, there is no meaning:

There is neither a first word nor a last word. The contexts of dialogue are without limit. They extend into deepest past and the most distant future. Even meanings born in dialogues of the remotest past will never be grasped once and for all, for they will always be renewed in later dialogue. At any present moment of the dialogue there are great masses of forgotten meanings, but these will be recalled again at a dialogue's later course when it will be given a new life. For

nothing is absolutely dead: every meaning will someday have its homecoming festival. (Bakhtin, 1979, as translated in Holquist, 1990).

Plato envisioned a 'homecoming' where meaning would be re-invented, but by whom? A democratic forum or an elite leadership of the self-selected? Plato who saw dialogues as the only true path to knowledge, wrote his dialogues down, but warned that his writings and others of this sort were not to be taken "literally". These written dialogues should be compared to "writing" that is "written together with the knowledge of the soul of the learner, capable of defending itself, and knowing how to keep silent in relation to the people it should."

Plato's understanding of literacy was prophetic of the future struggles over the ideological consequences of literacy. Plato and Socrates were revolutionaries against the social order of their time. Plato's *Republic* is a manifesto for a perfect society. As mentioned earlier, a good portion of the *Republic* is an attack against the epic poets. Plato's strategy was to develop refined forms of Socratic reasoning, and to use it to attack Homer's power base by asking them, what do you mean? He also used this strategy to question the speech writers and the use of rhetoric in speech writing. Plato realized that part of the problem with print is that it could get into the wrong hands. It could "re-said", "revoiced", in other words, reinterpreted too freely. Separated from its author/authority, a text can not be properly "corrected", as it could in dialogue.

In the *Republic*, Plato's solution to the problem is the installation of a hierarchy with "philosopher-kings" like himself at the top. These "philosopher-kings" would grant access to different levels in society based on individuals passing "examinations" in the form of dialogues with philosopher-Kings who would have all the political power.

But there are several problems with this plan, the least of which is the undemocratic nature of who decides what is correct. Plato's solution for that was to situate power within a small circle of elite initiates who would be the only ones allowed to read the texts. Also the texts were to be written in an esoteric way so that only the initiated could read them and they would restricted to a small number.

Many of these aspects of Plato's *Republic* have been realized most frequently through history. So is literacy emancipatory or is a tool of hegemonic control? In Plato, we see the roots of both. On the positive side, Plato wants us to interrogate all utterances (written or oral) by re-voicing or re-saying them in dialogue. One must reach to retrieve the author, the authority of the voice, to distinguish between correct and false interpretations. One must engage the text in dialogue to ensure that the text is not

overridden by the lazy or self-interested. But the drive to privilege some interpretations over others is the creation of authority; hence a dilemma arises.

We can not lapse into relativism, because then what the text says can be anything and then it says nothing at all. But we know there is an empirical world out there and so not all interpretations should count as much as others. But whose to say which interpretation of the empirical will be accepted? Plato took the route into an authoritarian corner in his *Republic*. This legacy is continues today in the universities and in the school-based literacy which still holds much authority in Western culture.

There is a radical alternative to the authoritarian side to Plato's dilemma: the use of emancipatory literacy for religious, political and cultural resistance to hegemonic discourse. Like Bakhtin (1986), and in some ways Plato, Freire's view of literacy demands a reading of the world. Although developed within the context of campaigns for literacy within the Third World, Freire's emancipatory pedagogy has implication for schools in North America. It is no accident that Freire, like Plato has published some of his dialogues in book form (Freire, 1985), bearing out Bakhtin's dialogism.

Freire's view of the "correct way of thinking" moves us away from universalizing the interpretations of texts towards an engagement with one's historical moment: moving oneself from an object of history to subject. Freire's pedagogy is one of learning to ask questions. This is a radical epistemology because it is less interested in certainty and generalizability.

However as in all theories of learning, Freire creates his *Republic* as well. There is escape from the incorporation of a world-view or ideology in literacy nor is there a way of avoiding the relativity of meaning. It is then preferable to announce clearly what one's ideological stance is in literacy theory and practice. The ideological view of literacy expects no intrinsic cognitive consequences from literacy apart from the social context of its use. Literacy is part of a cultural package perpetuating power, helping to shape work habits which are required for industrialization, (or post-industrialization in the case of the new literacy crisis: scientific and technological literacy).

The literature on school-based literacy shows that the ideology of these practices is often left implicit, thus empowering those children who already know the implicit assumptions, and disempowering other children for whom the rules are never made explicit until it is time to be evaluated, and by then it is too late (Cazden, 1987; Michaels, 1981; Heath, 1983). Thus, the study of science learning and literacy is not just a study of science and literacy, but a study of the social contexts in which these practices are embedded. My thesis is about uncovering theoretical assumptions in science literacy and its realization through ethnographic analysis of classroom discourse.

Note #1

There are numerous texts that represent the autonomous view of cognition. At the core of this view has been the digital computer. Briefly, the computer has informed the autonomous view of cognition by providing a metaphor for the mind based on the manipulation of symbols. Cognition is viewed as the manipulation of mental *representations*. Thus, the autonomous view of cognition seeks to study the way the mind represents the world. Cognition is seen separate and apart (and possibly 'above') social structures. The mind is seen as a tool or machine: cognition is the result of structures in the mind (that are constructed or innate to biological development). Noam Chomsky, John McCarthy, Herbert Simon and Marvin Minsky are generally considered 'the founding fathers' of cognitive science. Cognitive scientists of this orientation are interested in examining the structures of the mind, rather than how these structures may be implicated in broader social and political struggles. See Gardner's *The Mind's New Science: A History of the Cognitive Revolution* for an extensive review of the early developments in cognitive science. Emphasizing information processing and procedural thinking, the computer was used to model human cognitive practices, such as memory (Simon, 1981; Newell & Simon, 1981). Folk psychology or cultural models were suspect and were to be overcome in getting to the real workings of mind (Fodor, 1975, 1987; Stitch, 1983).

For a critique of this position within the development of cognitive science specifically see Herbert L. Dreyfus & Stuart E. Dreyfus, *Mind Over Machine: The Power of Human Intuition and Expertise in the Era of Computer* (New York: Frees Press); Lucy Suchman's *Plans and Situated Actions* (1988); Jean Lave's *Cognition in Practice* (1988); Francisco J. Varela, Evan Thompson and Eleanor Rosch's *The Embodied Mind: Cognitive Science and Human Experience* (1991); Jim Gee's *The Social Mind* (1992); Jerome Bruner's *Acts of Meaning* (1990). The basic theme that runs through these critiques is that cognition, when observed in humans, looks nothing like a digital, serial computer. These researchers point out the socially situated and distributed nature of cognitive practices and question the notion that cognition happens 'in the head'. While certainly the brain is a part of cognition, its place has been stressed to the determent of another plausible theories of mind: meaning is not in our heads, but in the world.

Chapter 2: Methods

Methodology is, at this historical juncture, problematic for both media arts and sciences and cultural studies. Both fields are in a period of formation and resist generic definition, thus making every discussion on methods a contribution to an on-going debate. Methodological discussions within the arena of epistemology and learning are especially prone to become theoretical discussions because learning is such a diffuse and wide-spread phenomena that is cultural as much as it is theoretical. Thus, epistemologists of learning must take into account the wide range of theories, including their own, and as a result, they must include a justification for their analyzes which theorists of natural sciences need not do.

Adding to the complexity of the issue of methodology within epistemological studies is the struggle to deal effectively with cultural issues than span a wide range of institutional, social and historical practices. For instance, a sociocultural approach to epistemology and learning avoids simplistic analyzes that reduce the interaction of a teacher and a piece of software to the interaction of one person and a commodity. Rather, it seeks to situate the interaction within an agency model that accounts for ways the ways in which social and historical formations influence the parameters for thought.

To this goal, there can be no advanced work, or reflection that can be privileged in the writing of epistemologcal research, rather advanced reflection must be constantly checked and revised for its sociocultural specificity. It is inappropriate to uncritically adopt methods from other research disciplines. What the important questions are and how they will be answered in a specific research project must be left open to question. This means that no research method can be privileged nor can any be dismissed outright. In this study, I draw from a range of methods from different disciplines, and I use them creatively to answer the questions raised by my inquiry.

From anthropology, I have used participant observation and interviewing as methods for contextualizing the practices of small groups (Black teachers working with progressive education ideologies and cognitive scientists researching their particular theories of the social). From the sociology of education, I have used ideas about the social organization of schools and their possible relationships to institutions outside schools. From the philosophy and sociology of science, I have borrowed theories and research methods for situating the cognitive practices of scientists within sociocultural context. From discourse and textual analysis, I have used methods for describing the way in which language is a tool for creating and maintaining private and public identities. From cultural studies, I have inherited an interest in exploring the everyday

life of cognitive practices with a political commitment to examine how social order both "constraints and oppresses the people, but at the same time offers them resources to fight against those restraints (Fiske, 1992)."

This is an ambitious way to proceed, but sociocultural analysts have little choice if they are to move towards contextualizing cognitive practices in a way that comes close to capturing the richness of cognition in practice. Martyn Hammersley (1992) writes that "decisions should flow from commitment to general methodological principles, instead of being made on the basis of those epistemologcal, methodological and practical assumptions that are most reasonable in the particular research context (including the capabilities of the researcher)." Following this train of thought, I present in this chapter, not the justification and results of one particular method (say, ethnography or discourse analysis) but the usefulness of particular methods in my overall goal of developing a description of the sociocultural mediation of cognitive practices in teaching within multicultural settings.

Two concerns should be at the heart of any discussion of methods: the validity of the claims of the research and its generalizability to situations outside of the case. Such a discussion is relevant whether one used survey, experimental or qualitative methods to obtain an analysis.

Establishing validity in social science research

What do I mean when I use the term validity? In my conceptualization of the term, I have tried to avoid lapsing into a positivist or 'naive' realism concerning the relationship of research claims to reality. At the same time, I also want to avoid the philosophical problems associated with a relativist or radical constructionist viewpoint (Ackermann, 1992; Scheffler, 1967). My position is somewhere in between these two extremes. On the one hand, I agree with the relativists that all knowledge is constructed and that there is no direct correspondence between reality and our descriptions of it "for the obvious reason that we have no independent, immediate and utterly reliable access to reality." (Hammersly, 1992).

In breaking with naive realism, one does not have to abandon the notion that there is an independent and knowable phenomena outside of our personal and social constructions. However, what we do have to break with is the idea that validity is based on *certainty*. The obsession with certainty hides us from the possibility of being able to discover the contextual richness of knowledge. Social scientists are becoming increasingly facile at checking the basis for their assumptions. This strategy avoids the

relativist view that all knowledge is equally based on arbitrary, constructed views. Freed from the naive realist claim that all knowledge must be certain and without any doubt, the social scientists can make a claim that is 'more or less' true depending on how the claim is used. In fact, too much certainty can drown out the relevance of an observation to others by providing a summary of details that is neither desirable nor usable by participants in the settings.

It has become common place in recent years to pose the issue of validity within qualitative studies as if such studies demanded a special set of criteria (Lofland, 1971; Shatzman and Strauss, 1973). However, a new direction in qualitative studies is gaining momentum. This direction sees no intrinsic differences between quantitative and qualitative studies in terms of establishing criteria for validity. Although one used to think only in terms of validity in quantitative studies, what may be required is a shift in terminology. While not wanting to revive the slightly stale debate between paradigms, I recognize that many of my readers may be confused by my terminology. Thus, I present the following brief, but functional translation of terms between what has been known as quantitative and experimental methods into qualitative and interpretative methods (Guba & Lincoln, 1985):

Qualitative = Quantitative as in:

Credibility = internal validity

Transferability = external validity

Dependability or accuracy = reliability

Confirmability = objectivity.[1]

Achieving the maximum amount of each of these states within social science research is what a concern with validity should be orientated towards. Of course, these neatly separated terms look different in actual practice and are more interdependent than this simple list implies. For instance, it is impossible to have credibility without dependability, but one could have dependability without credibility (Kirk & Miller, 1986). A claim could be made that in a social setting a certain activity takes place every time people meet in that setting. However, the meaning the activity has to the participants is not something one could make a valid claim about based only on the observation that it occurred regularly. The activity may turn out not to be meaningful at

[1] My decision to adopt these terms is based on their acceptance among many researchers in the community of qualitative researchers who produce case studies. See Mishler, (1990) for an exemplary discussion on the role of community dialogue in the social construction of validity in social science research.

all (depending on the purposes of the observations). This is a case of dependability without credibility. But if one wanted to make a claim that event X has meaning Y, one would first have to 'prove' that event X is indeed a member of the class of events we claim it is, and that it is a part of the social setting under study. In this case, we have credibility that includes, but is not based solely on dependability. In this chapter, the discussion of dependability and confirmability will integrated into a discussion of credibility. Transferability will be discussed in the concluding section of this chapter.

Credibility in ethnographic research

Concern over possible bias in participant observation is understandable. Indeed, it might be all too easy for an observer to record, detail and analyze nothing but their own biases. One of the most persistent questions asked of participant observation studies is to what extent one can be sure the findings are not simply a report of the observers opinions, thoughts or biases.

Addressing this issue begins with the acceptance that concern with observer bias should be a concern for all scientific endeavors, be they in the laboratory or in the field. Dealing with threats to validity is an aspect of scientific research in general (Hammersley & Atkinson, 1989). Qualitative researchers have developed means for minimizing observer bias and assuring that credible findings will be produced. These include: triangulation of data sources; member checks; triangulation of methods; and longitudinal time frame for field research.

Triangulation of data sources (contextual validity)

"**Contextual validation** takes two main forms. First, the validity of a piece of evidence can be assessed by comparing it with other kinds of evidence on the same point. The second kind of contextual validation comes to evaluate a source of evidence by collecting other kinds of evidence about the source...to locate the characteristic pattern of distortion in the source." (Diesling, 1972)

In the first sense of triangulating sources, other means are used to make sure one's source is accurate (checking dates, etc). For example, an informants recollection is verified through other sources. In the second sense of the triangulation of sources, one can establish a pattern of biases or falsification through contextualizing the source.

Example #1 from the data:

In attempting to contextualize Lenny's (the teacher in this study) classroom practices, I interviewed the cognitive science researchers (Murray and Olson) about their views of Lenny's practices. Their descriptions of Lenny were often at odds with Lenny's self-descriptions, so this had the interesting effect of allowing for triangulation of their own self-descriptions within a cognitive science framework. This is a good example of the holistic nature of building reliable descriptions and theory building in ethnographic research. In order to accurately explain or understand Lenny's actions, I continued to build new theoretical frameworks for analysis.

Moira Inghilleri, a visiting graduate student from the University of London, wrote a paper based on the same research project (Inghilleri, in press). Although we shared our data with each other, it was necessary for her to interview Lenny separately (I am grateful to her for sharing her data, as well as for her insights into Lenny's cultural and ideological models for classroom activities). Inghilleri added additional triangulation in her assessment that Lenny's concern with the conflicting nature of Discourses in the classroom were a crucial factor in the sociocultural context of his classroom. When researchers reach similar conclusions separately, this is a sign of the rigor of a working hypothesis.

I also interviewed the school's principal, and conducted informal interviews with Lenny's fellow teachers whom I got to know in my visits to the school. From these other sources at the Sandy Heights School, I was able to situate Lenny's place in the school's institutional Discourse.

Theoretical sensitivity to the sociocultural issues raised in the analysis of the conceptual frameworks of African American teachers was raised through both personal reflection, as well as through the research literature in sociocultural studies (Foster, 1991; Delpit; 1986; Henry, 1991). Using the research literature to develop theoretical sensitivity is a form of triangulation in theory building (Glaser & Strauss, 1967; Strauss, 1987).

Attention to theory is not trivial. As Paul Willis (1980) points out, there is no untheoretical way to see an object. My surprise at Lenny's actions was a catalyst for a reorientation of my theoretical perspective, and this surprise was based on interacting with the data: I could not adequately present a new perception of Lenny's actions without a new social theory. This is a case against the *naive realism* so often characteristic of ethnographic accounts, which claim that new insights 'emerged' from the data. New insights can only emerge from the interaction of theory to research practice. Thus, in my discussion of the evolution of my relationship with Lenny in

Chapter X, it was crucial to include my theoretical position at the beginning of the project and to show how it changed. This is what is meant by claiming reflexivity is an essential part of ethnographic analysis.

Example #2 from the data:

Analysis of transcripts of student oral tests (in the form of assessment interviews) revealed differences among social groups in students' construction of the scientific discourse that they were supposed to master (on why the seasons change). This indicated differences in students' appropriation of science literacy. Although extensive ethnographic data about the students' sociocultural background (communicative practices at home and in the community) was not available, it can still be said that differences in the Discourse strategies the students brought to the interview task was very likely influenced by resources available to the students outside the classroom. This claim rests on the fact that classroom opportunities for apprenticing Discourse practices and strategies for scientific literacy were severely limited or nonexistent for the students interviewed except for one student. This student came the closest to mastering the literacy task both in classroom discussions and in the interview.

While it is difficult to say exactly where outside this class, the student learned the Discourse that was privileged by the teacher, it was clear that this particular students' facility with this Discourse prepared her for extensive practice of the science literacy within school. Within the classroom she was privileged (e.g. she was allowed to do activities in which only one other student participated; a student with similar sociocultural background. This data helped to correlate the teacher's theories of sociocultural difference with actual classroom practices of students and teacher.

Member checks (verification by others)

A member check is when "data, analytic categories, interpretations, and conclusions are tested with members of those stake-holding groups from whom the data was originally collected (Guba & Lincoln, 1985)". This is a test of the credibility of the researcher's depiction of the multiple realities through verification with member's of the group studied. A summary of an interview can be shared with a participant, or researcher and participant can sit together and watch a videotape of an activity. The participant's accounting of the activity viewed or described by the researcher should not be significantly different from the researcher's account (this does not preclude an agreement to disagree).

Examples from the data:

Although it may appear from the interviews that in many of my discussions with Lenny we 'disagreed' a lot, this was actually a benefit in terms of member checks. The frankness of our discussions helped us to eventually 'agree' on a description of Lenny's theories. The difference between an argument and a civil discussion is culturally constructed and, thus, models of decorum in ethnographic interviews are relative (Goody, 1978). The fact that Lenny and I were both African American males with a certain amount of empathy (real and imagined) was exploited extensively by this researcher. That we did not have the distance typical of relationships in classical ethnography allowed me to openly question Lenny. It also allowed me to test my theories of Lenny's thinking and practices with him throughout the project.

In the following excerpt from a memo is a record of an exchange between Lenny and I early into the project. In this excerpt, Lenny has taken the initiative in socially situating his theories of learning and minority education:

> Lenny then asked me if I had read an article in the New York Times about two Black schools in the same Brooklyn area that had very different programs and school size. They both had mostly Black students and each had a Black principal. I remarked that the smaller more "Afrocentric" school had better results. "Yes, but only on standardized tests", he countered. I wondered what he was getting at. I responded that the smaller school seemed, according to the article, to foster higher levels of self-esteem and confidence in the ability to learn. Lenny said, "Yes, well the other school had more immigrants. It was more like our school".

Moments such as the one presented above occurred frequently throughout the building of our research relationship. As a result of these exchanges, I began to see the relationships between ethnicity, race, identity and communication in a non-mechanistic way. These member checks allowed for further theoretical elaboration and the development of new research questions. Near the end of my involvement with Lenny, I was able to share with him my developing theories in a quite open manner. For instance, I was able to say to him, "Some people might say that your teaching practices are "racist". How would you respond to that?" Lenny would then detail for me his theories on race and ethnicity and why he felt the ultimate result of his actions was actually "anti-racist".

Because Lenny was an unapologetic defender of his practices and critic of others, member checks with this informant was not difficult. In this study, epistemological issues were raised concerning the usual construction of the informant as passive observer. Ethnography's obsession with creating an object out of the other was one

growing out of a desire to know whether difference resulted from a position of inferiority or superiority (Clifford, 1987). Ethnography as a 'genre', then, should be aware of its historical complicity in the politics of domination through representation (particularly with regards to the Third World).

Wanting to avoid the pitfalls of traditional ethnographic representation of subjects, I maintained a critical distance from the tendencies of others (and myself at times), to deny the validity of the very active living present voice of my informant. This was a critical distance which, although difficult to maintain at times, paid off immensely in my sociocultural analysis of the science literacy project's epistemology.

Triangulation of methods

"Once a proposition has been confirmed by two or more measurement processes, the uncertainty of its interpretation is greatly reduced. The most persuasive evidence comes through a triangulation of measurement processes" (Webb, 1966). The triangulation of different methods can imply either different data collection methods (interview, questionnaire, observation, testing) or different designs. In this section, I will discuss the triangulation of observation, ethnographic interviewing and discourse analysis.

Example from the data:

The pattern of triangulation of methods in this project began with participant observation. During the academic term from September through March, I visited Lenny's classroom every week during science lessons (which averaged about twice a week). I also observed at various times during the school day, and week, when science was not taught. I went to lunch with the children. I talked to Lenny and other teachers in the park during recess while they watched the children play. The classes' time in the computer lab was another site of frequent observation. All the videotapes used for analysis were of science classroom activities. The science lessons were usually held at the end of the day and were followed by snack, clean-up and preparations for leaving.

There were days when Lenny might cut a science lesson short to deal with a discipline issue or class business (taking student book club orders, preparing for school outings, etc.) Sometimes the end of a science lesson and the beginning of a lecture on classroom behavior would be hard to distinguish. I have tried to capture the intricacies of classroom Discourse in my analysis in chapter X.

After observing a particular pattern in classroom Discourse, I would ask Lenny why he thought it was occurring. These questions were asked during informal

interviews after a classroom observation and in extensive formal ethnographic interviews taking place in his home. In the interviews, I would try to link Lenny's actions to a wide array of possible interpretations. He would agree with some, disagree with others. The interviews were then transcribed. I can testify to the fact that transcription, while grueling, is a necessary form of data collection that should be done by the analyst, instead of 'farmed out to hired hands'. Transcription is a form of interpretation (Ochs, 1979).

The original transcripts included every audible utterance from the tapes. Every stutter, pause, and broken sentence was transcribed as text. This was necessary in order to capture as much detail as possible about the co-construction of meaning. It was helpful to know, for instance, that occasionally a response would begin before the response of the other participant in the dialogue had ended. How people read each cues are important for the co-construction of meaning.

In post-dialogue analysis, having these cues recorded was also helpful in determining the beginnings and endings of sections of Discourse as the participants see them. Although the transcripts in the body of the dissertation have been cleaned up for readability, knowledge of these context dependent co-construction cues aided me in my decisions as to how to break the transcript into smaller units for analysis.

From these units, I coded the various sections for patterns and trends in the dialogues. Simultaneously, new ideas encountered in the sociocultural research literature helped me to situate the project within a larger theoretical framework than standard cognitive science. I was able to make connections not only between Lenny's theories, but also between his theories and other critiques of progressive pedagogies (Bernstein, 1990; Bourdieu, 1984). Additionally, critical ethnographies of culture, class, identity and ethnicity from the United Kingdom (Hewitt, 1986; etc.) helped to set an example of how to discuss cultural processes and social reproduction at the same times.

As my theories of Lenny's practice evolved, I would present them to him along with my questions. Eventually the gap between my questions and answers narrowed. My confidence in my representation of Lenny's theories grew due to the triangulation process of moving between between classroom observation and interviewing.

Besides interviews, I used memos a great deal. Memos helped to document the migration of my ideas through various wrong turns and blind alleys. Memos were also helpful due to the fact that Lenny and I had many phone conversations where I could not take notes directly or record the conversation. I encouraged Lenny to talk to me about his ideas whenever he wanted to, even if it was not the most ideal time to record his

ideas. Often I would write a memo after hanging up the phone with Lenny or after I got home after having spent a day in the classroom when I had more time to think about what occurred. However, one maxim of field research was definitely true: if something is important and you missed it, it will happen again. If it does not happen again, it probably was not that important, so don't worry about it.

Longitudinal time-frame

Prolonged engagement in the field is the investment of sufficient time to achieve certain purposes: learning the culture, testing for information in the field and building trust. This is important for establishing checks against observer bias. Too short a time in the field before testing for information will not likely give the researcher the opportunity to be sure that what is meaningful for the researcher, is equally meaningful for the culture at large.

A researcher should deal with personal distortions, hopefully, before going into the field. A good way to check on this is to record, before beginning to observe, one's feeling about the site, expectations, etc. in a memo. This will also act as a marker for knowing how one's thinking has changed within the course of fieldwork. If fieldnotes and subsequent interpretations are not very different from the early memo, then the researcher is alerted to possible biasing.

Building trust is important because, being a stranger, it takes time for respondents to trust and share important data with the observer. Building trust is a developmental process and there are no easy prescriptions for gaining trust, but prolonged engagement is a pre-requisite for establishing trust and rapport.

Prolonged engagement is more than being in a research setting for a long time. Researchers should also be aware of their perceptions of the setting can become routinized, making the strange familiar. Once the *pervasive* qualities of the research setting are known, the researcher should be looking for multiple perspectives and atypical situations.

Examples from the data:

My theories of Lenny's cognitive practices evolved over the months. I kept an open mind for possible alternative theories to explain what I was observing. For example, when Lenny's self-identity as an African American conflicted with my theoretical models of the relationship of ethnicity, race and identity and teaching practice, my own theories underwent re-evaluation. As a former African American teacher, I had to make sure that my own personal stake in understanding these relationships were not

undermined by personal bias. I wrote many memos and talked with other African American teachers and researchers.

For example, a discussion with an African American researcher of African American teachers at the 1990 AERA conference in Boston was helpful; communication with an African Canadian researcher doing a dissertation on African Canadian teachers and a fellow African American graduate student at MIT all helped to socially situate my own interpretative framework. I also visited the classroom of an Afrocentric teacher in another city for purposes of comparison.

For this process to contribute to my understanding of Lenny's thinking, a long period of observation and analysis was required. My final analysis would have looked quite different if my thinking had been 'frozen' at an earlier stage of its development. The long period of engagement with the research setting forced me to work against the possible 'normalizing' of my interpretive framework by making sure I had considered all the alternative explanations. While certainly one can continue to generate alternative hypotheses and theories after leaving the field, validity is increased through being able to interview subjects and change research strategies while in the setting under study. This gives the researcher the advantage of coming to see subjects react in situo to developing theories.

When proposing an analysis of a classroom teaching situation, it is possible to learn as much from the 'tools' in the environment (that the informant uses to explain the theory) as from the words themselves. For example, one afternoon, Lenny and I were discussing the school work of a child in his class after school. Lenny, in making a point about literacy, went and pulled out an English composition this student had written. Such actions helped to situate use of essayist text as an indicator of school-based literacy as a social practice, not only a theory in literacy studies.

Of course, member checks cannot be used as the basis for validity, only for accuracy of descriptions. It is possible in adversarial situations that researcher and informant disagree on whether or not an event took place or whether or how an action's intentionality should be interpreted. It is unsound practice to give priority to members' versions of social settings just because they live or work there and researchers do not. However, these factors can be used as *evidence*.

Transferability

Most educational researchers want to understand what happens in learning contexts in order to improve them. To this goal, the use of causal explanation is crucial for one

cannot simply change surface structures: one must identify and change deeper causal structures.

The use of ethnographic research for causal explanations can be problematic if the researchers, after identifying and explaining causal factors in social settings that are carefully contextualized, proceed to link these causal elements out of context. There may be a tendency, as a result of a strong identification of causal explanation with experimental methods and quantitative analysis, to generalize notions of causality developed within the local, contextualized methods of qualitative research.

This can be avoided by being clear about the difference between the relationship of quantitative and qualitative research to generalizability. The burden of proof in terms of generalizability rests as much with those seeking to apply a qualitatively derived causal explanation as it is for the original researcher. The original researcher cannot know in advance the sites in which the research will be applied. The original researcher should include within his or her own account sufficient contextual data to make those who apply the particular causal explanations developed locally, aware of how similar or dissimilar the two comparison sites are. Simple statements of direct connections can be misleading. The very methods qualitative researchers use to insure the internal validity of his or her own research are contrary to clean generalizations. It is better to recast the question of generalizability as one of *transferability* (Guba & Lincoln, 1985). Even if one is reasonably sure that the two sites are similar based on ethnographic evidence, it is advisable to carry out a small study to be sure.

In case studies, such as this one, the issue of the relevance of a small sample (such as one classroom and one teacher) to broader concerns is a natural and understandable concern. However, one must be cautious at applying double standards when thinking about the validity of case studies. There is a clear and present danger that we reserve such questions of validity for small, rather than large case studies. Is a nation-wide case study of notions of gender and its effects on the education of women scientists more (or less) relevant than a case study of one classroom in an all-girls school? It all depends on the uses to which we will put the findings of the study and the amount of detail needed. There is not one already formulated answer to this question. The case study is one of several research strategies to chose from (others include the survey and the experiment). There are no distinct methodological issues for the case study. All the criteria of validity reviewed above apply to all social science research, whether it be experimental, survey or otherwise.

There are trade-offs and interconnections between research methods that, when recognized, make qualitative research seem less mysterious. True, most case studies

differ from experiments in that the researcher is unable to construct in advance all the independent and dependent variables. However, once inside a setting, the researcher is able to conduct 'quasi-experimental' procedures for developing theories and alternative hypotheses. One example of 'quasi-experimental' design is purposeful or theoretical sampling (Guba & Lincoln, 1985; Glaser & Strauss, 1967).

"The criteria of theoretical sampling are designed to be applied in the on-going joint collection and analysis of data associated with the generation of theory. Therefore, they are continually tailored to fit the data and are applied judiciously at the right point and moment in the analysis. The analyst can continually adjust his control of data collection to ensure the data's relevance to the impersonal criteria of emergent theory." (Glaser & Strauss, 1967).

While this form of sampling differs from experimental and survey samples in form, it is no different in its application in insuring validity. Additionally, researchers can draw upon statistics about the population to which the generalization or transferability is to be made. For example, in this study, I drew upon statistics about the small number of Black students entering the science professions to build an argument that my case study is representative. I also drew upon surveys of the literature in both teacher research and cognitive studies to make the case for the paucity of information concerning African American teachers and their cognitive strategies and the need for descriptive studies of this kind. In fact, some case studies are conducted because of their atypical nature. This was certainly a factor in my selection of African American teachers within progressive education settings as a particular area of inquiry.

In assessing the claims of transferability in social science research, one can test claims of causality from a case study against claims of generalizations based on survey and statistical evidence.

Example from the data analysis:

There is qualitative (literature reviews), as well as statistical and demographic evidence that 1) cognitive psychology is and will remain for some time the dominant paradigm in educational research (and thus must be contextualized as a research practice); 2) the schools of North America are becoming increasingly diverse and 3) future membership in democratic institutions of this continent will depend increasingly on a fair amount of scientific literacy. These are institutional and demographic trends that can be generalized. In terms of the transferability of this case study, details explored here will have to be examined in light of the outcomes of these trends. Thus, if in future

decades, that cognitive psychology fades and is replaced by sociology as the dominant Discourse in schools of education; the United States becomes less, rather than, more diverse; and the United States reverts from an advanced capitalist society to a rural, agrarian one, then my findings will be less relevant.

As Martyn Hammersly points out:

"While case studies do not involve manipulation of variables, it is possible to use the comparison of existing cases to make reasonable judgements about causal relationships. Furthermore, it is often not feasible or ethical to carry out experiments in social science research; and the findings of case study research are likely to suffer less from reactivity and therefore may involve higher ecological validity than experimental research" (Hammersly, 1992).

Conclusions

Attention to method in epistemological studies is crucial. The development of knowledge about a research setting must change not only what we seek to learn or know about something, but must also change the learner or the knower. As Foucault writes in his introduction to *The Uses of Pleasure: The history of sexuality, part two:*

"After all, what would be the passion for knowledge if it resulted only in a certain amount of knowledgeableness and not, in one way or another and to the extent possible, in the knower straying afield of himself? There are times in life when the question of knowing if one can think differently than one thinks, perceive differently than one sees, is absolutely necessary if one is to go on looking and reflecting at all. People will say, perhaps, that these games with oneself would be better left backstage; or, at best, that they may properly form part of those preliminary exercises that are forgotten once they have served their purpose. But then, what is philosophy today - philosophical activity, I mean - if it is not the critical work that thought brings to bear on itself?" (Foucault, 1985, p. 8-9) This commitment is shared in my philosophical investigation of the construction of meaning around science literacy texts.

Chapter 3: Description of the research setting

Common to traditional cognitive psychology is a notion of science literacy as a singular, unitary Discourse. This dissertation, in contrast, seeks to understand science literacy as reasoning between multiple voices or Discourses. The multiplicity of Discourses reflects the distribution of power within society and the conflicts of identities and values that result from these differences. In the classroom, teaching science literacy is more than teaching the Discourse of science. Science literacy also involves the sociocultural context of its use, as well as social position of the producers of science literacy texts and theories of social relations embedded in various systems of meaning. The results of a year-long ethnographic case study of a science literacy project in a fifth-sixth grade classroom is the context for this approach to analyzing teacher theorizing and practice.

In this chapter, two points about science teaching in multicultural settings will be explored 1) teacher as a mediator between different Discourses (see section below for how the term 'Discourse' will be used in this chapter); and 2) how differences between the idealized subject positions in one 'Discourse' and the actual multiply situated nature of the cognitive strategies of teaching, creates the potential for acts of resistance by the teacher and students. Using ethnographic methods, I will blend ethnographic information and discourse analysis to analyze the way in which traditional cultural models of science and science literacy (represented here by the Discourse of cognitive psychology) mask important information about the potential of sociocultural context to transform science teaching. I believe, as a result of this study, that it is time to abandon the 'folk theory' that science and science literacy are only one set of representations, theories, data, practices, etc. Such cultural models are making it extremely difficult to identify how science literacy is currently practiced in schools, and how science programs are transformed by sociocultural context.

My use of ethnography is an attempt to unmask the sociocultural context of science teaching in multicultural settings by reversing the usual configuration of scientist in the center and non-scientist in the margins. I hope to make the 'voice' of a particular teacher recognizable, not as a source of mistaken ideas, but as the beginnings of an alternative epistemology of science literacy. It should be obvious that schools have historically failed in their mission to provide the basis for science literacy to a diverse range of students. My work is an attempt to broaden this commonplace criticism of schools into

a larger cultural critique which integrates the various Discourses, and to show how their interaction co-constructs differential access to science literacy.

Discourses

Throughout this chapter, I will use the term 'discourse' in a somewhat different manner than it is commonly used (to express oneself in oral communication). My different use of the term will be signalled by the use of the capital 'D', and is best summarized by the following quotation from social linguist, Jim Gee:

> A *Discourse* is a socially accepted association among ways of using language, of thinking, feeling, believing, valuing, and of acting that can be used to identify oneself as a member of a socially meaningful group or 'social network', or to signal (that one is playing) a socially meaningful 'role'. (Gee 1990)

The four principal Discourses present in the science literacy practices and theories of the teacher in this study were: 1) Science (i.e. the Discourse of astronomy); 2) Cognitive psychology (the Discourse of the instructional design); 3) Pedagogic or Instructional Discourse of the classroom's institutional setting, and 4) the sociocultural context of the classroom (including issues of ethnicity, language and class). Transcripts of classroom discussions and teacher interviews will be presented as examples of how these Discourses are used in the production and interpretation of science literacy texts and practices.

Since people rely heavily on cultural models to manage their movement through various Discourses, my analysis will attempt to bring a cultural analysis to the interpretation of how the teacher constructed meaning in this classroom. Moreover, instructional practices (which includes classroom management) are not only the creation of individual teachers, but are also socially constructed. Contrary to the focus on the individual as the producer and interpreter of texts, the focus of this chapter is on the way various socially and historically defined Discourses speak to each other through individuals. Although Discourses assume that when we use them, we do so by being totally inside a particular Discourse, this is never, in reality, the case. Human beings are members of various Discourses at the same time and thus are never totally socially and cognitively 'of one mind', but rather, of several.

In this case study, I examine the conflicting Discourses at work within a science literacy project meant to explain the mechanics of seasonal change to a classroom of fifth and sixth graders. I identify the four principal Discourses that were involved in the cognitive processes of the teacher, who is the focus of this study, through ethnographic

methods. Social context is seen as including resources provided by the institution of schooling and the Discourse of a particular curriculum to teachers and students. There is added complexity in that people within institutions have histories and their own interpretative frameworks which interact with each other.

Sociocultural mediation of cognition

Analysis of sociocultural mediation of cognition emphasizes cognition in cultural, institutional and historical perspective (Wertsch 1991). Sociocultural 'meaning' will be analyzed through a framework focusing on the use of cultural models as resources for using texts, contexts and interactions in the production and interpretation of communication. Utterances can have multiple meanings depending on the cultural models of the receiver and the sender. Because we are often unaware of our use of cultural models, they take on ideological implications. That is, we can often use our cultural models uncritically, taking them to be 'the way things are' (see page X for more on ideology). Cultural models are not, however, entirely negative. They are functional in that they off-load important cognitive tasks in communication to socially distributed and agreed upon cultural codes. If we had to decide on the codes every time we communicated, communication would be too cumbersome to be worthwhile. Yet by using cultural models, we get functional communication at a price: all models are inherently ideological. Cultural models represent a series of choices, a world view (Gee, 1990). Agreeing upon a cultural code makes one a member of group or "thought collective" (Fleck, 1935; Douglas, 1986). As Bakhtin (1986) noted, "the topic of the speaker's speech, regardless of what this topic may be, does not become the object of the speech for the first time in any utterance; a speaker is not the first to talk about it ." (p.93)

When a person is multiply situated between cultural models of Discourse, resistance can begin through the addition of subjectivity to the reading of the text. In some cases, a reader may read a text in such a way that he or she does not perform an action implied by a particular text. This difference in responding to a text could be viewed as an act of resistance. In this chapter, I give a sociocultural analysis to one teacher's act of resistance.

For subjectivity to acquire the quality of resistance, the resisting reader, within a particular act or reading, pushes imposed systems of meaning towards an alternative reading that does not conform to the dominant system. Despite its rhetoric, the ability of psychology, (and its subdiscipline, cognitive psychology) to totally dominate classroom

practices is not complete. Subordinate subcultures not only exist, but actively refuse to be passive readers or subjects by aligning their readings with their own alternative sociocultural norms and theories (Fiske, 1990; Jenkins, 1988). In this case, we have a teacher who applies his own resistant reading to science literacy texts' textual ideology. His reading is based on his theories of sociocultural difference and how these work against lower socioeconomic Black children. The goal of this approach to studying cognition is to clarify the need to 1) incorporate sociocultural issues into cognitive studies and 2) argue that sociocultural approaches must take into account the way that cognitive strategies are often based on ideological theories of mind embedded in everyday practices.

Structure of the chapter

This analysis begins with a description of two institutional frameworks for thinking, or 'voices': 1) the research setting (schools and classrooms) and 2) cognitive psychology. This description will proceed from the conceptual framework laid out above. The use of the term 'institutional voice' refers to the concept that when one speaks about science literacy, astronomy (the content of the project) or multicultural education, one is not discussing a subject for the first time, but is discussing the subject in a context of previous words and actions.

The Design Experiment: goals, social contexts, people and designs for learning

In the summer of 1989, two research scientists (Randy Murray and James Olson) joined together with a group of teachers to initiate a "teacher-researcher" collaboration under the heading "Design Experiments". The stated goal of a design experiment was the implementation of several designs in different settings. It was proposed that educational researchers can "begin to construct a systematic design science" of education (Murray, 1989[2]) to guide the successful implementation of new technologies and teaching techniques. Based on the idea that there has been "remarkably little systematic knowledge or accumulated wisdom to guide the development of future innovation", the goal of the project was to develop a "methodology for carrying out design experiments and to study different ways of using technologies in classrooms and school".

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[2] All the names of researchers, teachers and researcher centers and funding agencies have been changed in this dissertation. References to papers written by researchers in the project will use psuedonyms.

The Design Experiment (DE) was a collection of many projects under one heading. The seasonal change study was but one of several projects (see Appendix C). The seasonal change component included a project using drama as a form of science literacy (also with a focus on seasonal change); a project using the 'Itakura-Hatano' method for introducing children to the discourse of scientific inquiry through classroom debate; and a shadow data project that combined various pieces of software (some tools, some simulations) with observation of seasonal patterns in shadow length and day length.

The main focus of this chapter is neither on the DE itself or the drama activities, but on the 'Hatano' method and on the shadow data project, and on how these were appropriated by one teacher in theory and in practice. However, at some points in my description and analysis, it will be advantageous not to separate the 'Hatano' method from the Design Experiment because they both are products of the Discourse of cognitive psychology in which they originated and remained situated throughout the project.

The seasonal change study created by Olson was a science literacy project whose epistemological approach to multicultural education was founded on a Neo-Vygotskian sociocultural view of language and culture. This pedagogy provided for the acquisition of science literacy within 'activity settings' where children of 'linguistic minorities', as well of those of the 'linguistic mainstream' would learn the discourse and interactional practices of science alongside more 'competent others' in a 'zone of proximal development' (Vygotsky, 1978). Astronomical theories of seasonal change formed the core of this particular science literacy effort. During the course of the project these concerns were grouped under the term 'sense making'.

Why seasonal change was used as a context for studying cognitive change

Seasonal change is well known for being a hard concept to grasp for adults, as well as for children. Researchers (Michaels & Bruce, 1989; Horowitz, 1989) have recently focused on the depiction of seasonal change in classroom talk and textbooks as one possible source for the difficulty most Americans have in mastering this subject which is taught in most school curricula. In the United States, students generally encounter this subject between fifth and sixth grades. It is fair to say that being able to give a reasonable scientific explanation of seasonal change is often used as a measure of basic science literacy. Seasonal change is one of these 'facts' that you see written about as an indicator of the health of our schools. In this way, seasonal change is part of a

science literacy myth (literacy is what books you read or what facts you know, rather than the purposes these books or facts ever play into your life).

There were other reasons why Murray and Olson chose to center the project on the field of astronomy. Significant among these reasons is the wide spread social concern on the health of the nation's science instruction that inspired previous research on the failings of traditional school science to teach 'scientific literacy' effectively (references). Certainly these concerns have also played a role in this project. But while concern over the health of our nation's schools was certainly a factor, there were other more specific reasons that attracted the interest of these particular cognitive psychologists. Traces of the institutional' thinking of cognitive psychology exist in the selection of specific areas of research.

There has been great interest in describing cognitive processes that to lay observers seem mysterious and unclassifiable (Piaget, 1969, Vygotsky, 1962). Concepts such as *assimilation, accommodation, internalization, appropriation,* etc have helped us to get a better handle on how the human mind works and grows. This success has led to a situation where cognitive psychologists have felt confident that concepts developed in the laboratory or clinical interview can be applied to solving the practical problems of schools and education. Thus, a professional, as well as a social interest (i.e. interested scientist versus concerned citizen) was a motivating factor for this particular set of cognitive research concerns. Seasonal change as a pedagogic issue attracted the cognitive scientists precisely because it was such a difficult subject to teach and learn.

Description of the instructional / learning Discourse of the educational institution

Instructional / learning Discourse

The Sandy Heights School (SHS) is a combined elementary and intermediate school (combined in one building) with grades from k-8. SHS was founded in 1972 as an publicly supported alternative school; one of several across the country begun in this period. In the 1980-81 school year, SHS merged with The Paine School, another school in the Sandy Heights neighborhood. At the time of the merger the SHS moved to its present site. The Paine School was not an alternative school and when the two schools merged, according to its principal, the SHS abandoned its alternative pedagogy for the first years of the merger in order "to insure that all the students started out on an equal footing".

Ten years later, many of the original teachers have slowly re-introduced progressive pedagogies now that a basic culture for learning has been established.

Thus, the typical SHS classroom is a mix of traditional and progressive pedagogies. This point about the history of the culture of the school was the manner in which DE contrasted a supposedly 'progressive' SHS with another school that was juxtaposed as being more 'traditional'.

The Discourse of Progressive education

SHS teachers cannot be classified as 'progressive' in the strict sense of the word. By progressive education, I am referring to the educational movement that flourished in this country from the late 1880's to the early 1930's and had a renaissance in the United States and Canada in the late 1960's and early 1970's (Luke, 1988). The goal of the original progressive education movement was to center education around the needs of the whole child in mind, body and spirit. Clustered mostly in Northern urban centers, this movement of schools was closely tied to correcting the social ills of a rapidly industrializing society (Dewey, 1916, 1963; Counts, 1932). The two themes of the individual and the society were interdependent.

In the progressive education pedagogy, learning is seen as experiential and children are expected to learn from doing. Similarly, teachers are expected to approach their jobs as 'researchers' learning from children and experimenting with various curriculums. Teachers and textbooks take a back seat to direct experience which was seen as being a more vital source of learning.

Play, work, and art are all seen as part of a continuum, and not separate parts of the child's day. Work is not to be imposed by the teacher. Rather, children are expected to pursue their own studies following their interests. A sense of purpose within self-initiated activity is crucial to not crush the developing whole child. An integrated curriculum was the vehicle to carry all these ideals to practice; so that language learning, mathematics, social studies and art could all be integrated in a curriculum where students ran a grocery store for a few weeks, a task most youngsters would find exciting. Also basic to the progressive pedagogy is an ideal of teaching democracy through practice. It is believed that students learning within a democratic classroom (where their needs are addressed) would develop an appreciation for democracy far beyond what any civic textbooks could teach them.

Cultural Contradictions and sociocultural issues in progressive education

As in other systems of meaning, progressive education is rooted in a particular time, place and mission. Progressive education took its contemporary situation as the starting point for the alternatives it presented. The American Progressive movement was part of an international progressive movement that celebrated both individuality and a growing recognition that environmental factors played as great a role in developing minds and bodies as did individual traits. Muckrakers such as Sinclair Lewis and other reformers believed that cleaning up the social environment would allow individuals to flourish. This ideology was a form of scientific rationalism (Popekwitz, 1987).

Sociocultural setting and classrooms

Currently (May 1991) SHS has 395 students, 19 classrooms and 21 teachers. Children of color (Asian -, African-, Native-, Latino- Americans) comprise 54% of the school, with Euro-American children making up the remaining 46%.

Among the children of color, the largest (and only) group of linguistic minorities are Haitian-Americans. Haitian-Americans comprise all 86 children in the transitional bilingual program. The 18 Latino American children, the 13 Asian-American and the 1 Native American children are all monolingual English speakers. The interest in working with linguistic minorities was part of the decision process in the selection of the Sandy Heights School as one of the school sites.

The teaching staff is also ethnically diverse. Teachers of color comprise 40% of the staff, while white teachers make up the remaining 60%. All the teachers of color are either African American or Haitian-American except for 1 Latino-American and 1 Asian-American. As mentioned above, teachers in SHS vary in the ways they use progressive education methods in their teaching. The teachers of color tend to fall more on the 'traditional' as opposed to 'progressive' end of the pedagogic spectrum. My assessment is based on an informal survey of teachers and discussions with the principal.

The teacher who is at the center of this study is an African American teacher who certainly falls within this generalization. I ascertained this view through interviews with the staff, parents and the teacher himself. This teacher, Lenny Douglas, is a well-respected colleague in a staff that supports diverse teaching styles. The staff recognizes that all teachers and pedagogies have plusses and minuses and is more focused on keeping a dialogue about education going than on defending particular philosophies. Lenny is one of the more 'traditional' teachers in the school, but since the school does not define itself as exclusively progressive, Lenny's teacher-centered style is not seen as a problem in general.

Bilingual education in the SHS

The Transitional Bilingual program serves the Haitian-American population. Because of the history of the underdevelopment of Haiti, many children arrive in the United States without having previously attended public schools. The majority of children speak Haitian Creole which they can neither read nor write, and for good reason, for there has been little written literature in Creole until very recently. The language of power in Haiti is French and a Creole dictionary was not published until the early 1980's. The overwhelming reason for this lack of print literacy is underdevelopment. The literacy situation in Haiti is due not only to a lack of written materials but also because of extreme levels of poverty (malnutrition is not an uncommon experience for Haitian children). In addition to a lack of text literacy, Haitian children of various ages come to the States without knowing the names of colors, how to tell time, etc., thus highly unprepared for the forms of literacy demanded by school.

The goal of the Transitional Bilingual program is to mainstream Creole speaking children after three years of their arrival in the program. Until this year, it was the only one in Sandy Heights. Although the budget for the program comes from the Sandy Heights Central budget, not the SHS budget, primary responsibility for the educational objectives of the program is the SHS staff.

They are many complications to realizing these goals, most beyond the scope of this study. However, the reader should be aware that in addition to differences in literacy practices, Haitian children in the SHS more often than not have nontraditional family structures. For example, the father of a family may arrive in the States first, securing a job, and sometimes starting a new family before sending for his children in Haiti. Other differences might be that a child is sent to live with an uncle or a relative he or she hardly knows. This is not true for all cases, and intact families do arrive together.

Discourses in contact: Teacher-researcher collaboration (the Discourse of the instructional design meets the instructional Discourse)

In this section, I will examine the instructional or pedagogic practices as theorized within the conceptual framework of the researchers. Since the researchers were not directly involved in instruction, this will be an examination of the theories underlying the theory of instructional design in light of their commitment to teacher-researcher collaboration. The theories of the researchers were formed as part of the Discourse of

cognitive science studies of learning. In the arena of teacher-researcher collaboration, these theories came face to face with the theories of the teachers. In the course of describing how the theories (and in a following section their practices) of teacher-researcher collaboration are mediated by sociocultural factors, I will show how, speaking different Discourses, the participants shared words in conversations, but not their meanings.

Researchers' theories of collaboration

Early in the project, teacher involvement was seen as crucial to the success of the project. Rather than dropping an already formed curriculum on the laps of teachers, it was decided that the participating teachers would work together with Olson and Murray in the summer before implementing the curriculum. It was also decided that a design team of 'experts' in astronomy and curriculum design would begin working with the researchers in addition to the teachers. There were, however, crucial differences in the way the principal investigators (PI's) interacted with the teachers and the design team. The principal investigator writes the grant proposals that secures the funding for research (usually, but not always) from a government agency. The teachers (one of whom is the focus of this particular ethnography of teaching practice) met with the PI's and the design for two weeks, while other members of the design team worked on developing most of the curriculum before the teachers arrived on the scene. The role of the teachers in this 'collaboration' was to work on how the curriculum would be taught in their particular classrooms.

James Olson and Randy Murray are two cognitive psychologists interested in the social context of cognition. These two well-known and respected scientists pioneered the recognition of social processes in cognitive studies. Randy Murray's writing on cognitive apprenticeship has been most influential in research on learning processes by providing an alternative model to the social organization of learning. James Olson has also been a major voice in the growing interest in social context of learning.[3]

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[3] For an excellent introduction to how the ideas of internalization, appropriation and the zone of proximal development (that first appeared in the writings of Vygotsky and Luria in the early part of this century) are being appropriated by contemporary cognitive psychologists see *The Construction Zone* (Newman, Griffin & Cole, 1989). Olson, along with others represents a new interest in Vygotsky by cognitive psychologists dissatisfied with the focus on the individual in mainstream educational psychology (see also Wertsch, 1985; Tharp & Galimore, 1988; Rogoloff, 1990; Martin, 1985).

Randy Murray was the principal investigator for the Design Experiment. He coordinated activities in a number of schools with other researchers in different sites. James Olson brought to the project a science discovery/ progressive education curriculum on astronomy (although Murray supported its use by the teachers). I have decided to call this the Shadow Data Project (SDP). This project was combined with a method of leading classroom discussions developed by two Japanese cognitive scientists, Hatano and Inagaki. For the purpose of this thesis, their method will be referred to (as it was in practice) as the 'Hatano Method'. There are conflicting reports from these two researchers and Lenny (the teacher in this case study) as to how much of the DE was designed to incorporate the Hatano method.

Briefly, Randy Murray and James Olson claim that the use of the Hatano method was to be for a limited time only and not to be used as a general guide for classroom discussion. That was not the understanding of the teacher who felt this *was* the model to be used for all classroom discussions. I will return to this issue later in the chapter on the teacher's theories. Since this is primarily a study of what happened and not only of intentions, I will foreground Hatano as it was foregrounded in actual practice: a pedagogic discourse for classroom discussions on seasonal change.

Researchers' theories of instruction: The Hatano method and the shadow data project

There has also been a considerable body of cognitive science research in education in Japan exploring the 'social context of cognition' (Miyake, 1986; Inagaki & Hatano, 1983). Giyoo Hatano and Kayoko Inagaki have written many articles on "how a collective attempt to acquire knowledge takes place and how such knowledge gets to be shared" (from an article by Hatano and Itakura distributed to DE team and teachers). This work is based on observations in Japanese classrooms using a sequence of "hypothesis-experiment-instruction" for generating "constructive interaction" in the sciences and mathematics. According to the authors, their observations yielded evidence that "a large number of members of a group can be involved in enduring coherent talk about a target issue. Moreover, the group may generate "respectable" cognitive products, for example, a plausible explanation, which any individual is likely to produce."

Hatano and associates' interest in collective forms of decision making dove-tailed nicely with those of Olson and Murray. Murray is cited in a text of Hatano and Inagaki

(1989), which shows that the interest was certainly mutual. During the summer and fall, teachers in the project were introduced to the Hatano method of leading classroom discussions in the sciences, and strongly encouraged to try it. Hatano himself visited the Sandy Heights area and the teachers were invited to a meeting where videotapes of a Japanese classroom were shown. The reason for the close fit between researchers from different nations has to do with the international nature of cognitive psychology Discourse. Like most traditional scientific Discourses, cognitive psychology spends considerable energy building units of analysis from an internationally agreed upon set of common texts. For example, Vygotsky's concept of the *zone of proximal development* is rapidly becoming a standard concept in the canon of cognitive psychology research exploring social context, the way *ego, Id and Superego* did for Freudian psychology.[4]

Basically, the 'Hatano' method, (originally developed by K. Itakura for Japanese elementary and high schools) includes the following procedure:

1) students are introduced to a problem that has three or four possible answers;

2) students are asked to select an answer for themselves individually;

3) student's choices are tallied and put on a blackboard;

4) students are encouraged to explain and discuss and or defend their answers with one another;

5) students are asked to choose one of the possible answers again. They may change their answers;

6) students are allowed to test their predictions or refer to a text. (Hatano and Inagaki, 1989).

The teacher's role is one of facilitator who "tries to stay as neutral as possible" during the ensuing discussion: "Thus, although she (or he) has control over what kind of activities students are engaged in, none of the members of the group is taken as more capable by status *other than the interaction: information flows horizontally.* " (Hatano and Inagaki, 1989). (emphasis mine). The discussion of what would be the best among alternative answers (Step 4) is to be grounded in the "context of empirical confirmation" (Hatano and Inagaki, 1989). This is a process, rather than a product orientated approach where "the group is not expected to perform the task efficiently. Rather, its members are expected to *acquire knowledge, since this is a method for learning science, above all for learning basic concepts and principles in science.*" (Hatano and Inagaki, 1989).

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[4] Of course, the actual social history of the institutionalization of Freudian terms is more complex. I offer this simplified summary for the sake of argument.

The teachers in the DE used the Hatano method in many of the classroom discussions that took place with the entire class. In a memo to the teachers dated August 9th, Murray wrote:

"One possible activity is to have the students predict and discuss a la Hatano whether at midday the sun produces no shadow, a shadow pointing north or a shadow pointing south.....I've enclosed a description of an activity to determine the earth's tilt from shadow data."

There were considerable differences however in how the Hatano method was applied in practice between Japanese and United States classrooms. For instance, in the Japanese studies, the core problems were never as complex as seasonal change. In those studies, the questions were on topics like the conservation of weight when sugar is dissolved in water. Another difference was that in the DE the class was divided into small groups, which was not necessarily the case in Japan.

The theory and practice of the small group structure was also a source of contradiction in informant reports. While everyone agrees that it was Olson who suggested the use of small groups, the participants don't all agree on the theory that explains small group practice in the DE. Murray, Olson and Lenny have different versions of why the small groups activities were proposed in this project. Lenny used them because he thought that was what Olson and Murray wanted. Although advocating small group work, Olson theoretically gave only the pragmatic reasons of classroom management for their use in the project. This rationale which obviously contradicts other 'more central' theoretical concerns, points to a pattern through out the project: a dysfunction between theory and practice. Olson wrote in an e-mail message to me in response to follow-up questions, after the project ended:

"I'm interested in small group work because it is a practical way of getting work done in the classroom. I'm more centrally interested in how the culture develops within a small group. I think that small groups are quite limited because they do not have direct adult support usually. I am influenced by the sociocultural theorists in this area (the Construction Zone is still the thing I would like to point to as what I think of classrooms).

Of course, there were other differences besides small groups and the content of the hypothesis-experiment-instruction (the differences between Japanese and American classroom cultures more likely than not was a factor).

Seasonal change does share some of the characteristics of the typical H-E-I question: it *is* a question with many possible alternative answers (the most common one is the distance theory: earth is closer to the sun in the summer and farther away in the winter). However, setting up a 'context of confirmation' is much more difficult than

dropping a sugar cube in the water. The Hatano data, like most reports written in the Discourse of cognitive psychology, is weak on ethnographic description.

The goal of the shadow data project (SDP), however, was to create a "context of confirmation" in a technologically-enhanced learning environment (Newman, Goldman, Brienne, Jackson & Magzamen, 1989). The activities of the SDP basically were as follows:

1) students track the changing length of shadows with a measuring device (shadows are longer in the winter, shorter in the summer). This must be done on the same time of day.

2) students graph the changing lengths and determine a pattern. At the same time, data is collected daily on the length of the day (time between sunrise and sunset) and the maximum and minimal temperatures.

3) Through telecommunications, children would communicate with classrooms in Japan and New York City and compare shadow data. Day length and temperature data could also be accessed through newspapers and manipulated with data bases.

In addition to these activities, the curriculum text, "Daytime Astronomy" (EES, 1971) and the teacher's manual to the simulation software, *Sunlab Teacher's Guide* (Smallberg, 1990) were given to the teachers. Isaac Asimov's text *How We Found Out The Earth Is Round* (1972) was also used as a text to be read to students to ground them in the historical precedents for their shadow data collection experiments. In this text, Asimov describes how Greek astronomers discovered the world was round through observation of natural events such as lengths of shadows, the sun's position in the sky, and the movement of stars in the night sky.

The meaning of the term 'social context' in the Discourse of cognitive science of education

Olson and Murray's research interests were based on their claim that previous research in cognitive processes in education focused almost exclusively on student's appropriation of models of motion and mechanics. In this project they wanted to shift the focus away from building models of representations and appropriation by individual students towards the communicative functions of science practice.

Olson was particularly interested in the perceptual issues that makes seasonal change a hard concept to grasp. Olson theorized that our everyday working model of the sun-earth relationship is geocentric (Olson and Benson, 1990), which makes the

heliocentric model of seasonal change hard to grasp because it is counter-intuitive. As a cognitive psychologist, Olson was interested in how to teach students this counter-intuitive explanatory system. Technology was seen as a tool for facilitating these social processes.

Olson described *sense making* as "the coordination of data about the world with a theoretical model that explains it. We propose that this differentiation between model and data is the critical element of scientific explanation that students must master but that the instantiation of this differential in classroom interaction is problematic especially for students who do not use the rhetoric of science talk" (Olson & Benson, 1990). Olson's concern is that in classrooms, theories and hypothesis are disassociated from the data, and this is a major factor in non-mainstream children failing to acquire scientific sense making discourse. In the study of seasonal change, students were supposed to build theories and hypotheses in the context of interaction with data that was supposed to create 'a conversation with the data'.

As background to this use of the 'social', they cite narratives of well-known scientific discoveries such as Crick and Watson's collaboration on the discovery of DNA as empirical evidence that the building of scientific models is as much a social construction as an individual one. They fault the theories and methods of previous attempts to teach science for lacking this appreciation of the social nature of science. They also put much emphasis on technology as being a tool that might enable students and teachers to finally be able to control and manipulate communicative processes. Indeed, many of the new directions in computer science applications point in this direction. Electronic mail and computer fax machines are the tip of the ice-berg of an impending media revolution of future linkages of computer and communications technologies (Kobayashi, 1986; Negroponte, 1970; Brand, 1987). The SDP was partially a 'formative evaluation' of the use of these forms of media technology in classroom science instruction.

The Design Experiment begins: institutions and the everyday world of teacher-researcher collaboration

In this section, we will start to look at how the four different discourses dialogued with each other. The four principal Discourses present in the science literacy practices and theories of the teacher in this study were: 1) Science (i.e. the Discourse of astronomy); 2) Cognitive psychology (the Discourse of the instructional design); 3) Pedagogic or Instructional Discourse of the classroom's institutional setting (progressive

education) and 4) the sociocultural context of the classroom (including issues of ethnicity, language and class). The participants, members of different discourses with different, conflicting loyalties and goals, began at an early stage of the collaboration to impart meanings to each others' actions from inside each one's Discourse.

The Design Experiment development team was composed of teachers from the three schools and of academics meeting for a week in July 1989 to 'design' the curriculum for the coming fall. The researchers on the team covered an impressive array of academic disciplines: a cognitive scientist, a curriculum designer, a technology specialist, an astrophysicist, and a drama specialist. The science curriculum that emerged from this week was focused on "the astronomical relations between the sun and the earth that cause the seasons. The unit emphasized data collection, making models, graphing data, and explaining the data in terms of models".

As mentioned earlier, collaboration with the teachers was a goal of the summer workshop. Murray and Olson hoped that the teachers would not simply do as they were told, but would take 'ownership' of the project. Two of the teachers (Jan and Dorothy from the Patton School) put together an outline of the curriculum following the workshop. However, from this outline, it was clear to Millie Solomon (The Drama PI who left), Randy Murray and James Olson that the teachers from the Patton School were appropriating the curriculum's progressive goals within a more traditional pedagogy Although Millie Solomon, a professional curriculum designer and staff developer, urged the other two PI's (Olson and Murray) to reconsider giving so much control over to the teacher, they resisted that suggestion. Murray wanted to 'take on' the idea of teacher-collaboration. Lenny also had explicit ideas for how to implement the curriculum, and he too was urged to write up a curriculum or at least a summary of his teaching plans for the SDP (which he never did).

Reliance on curriculum and lesson plans varies between schools, teachers and content areas. A teacher fluent in a content area with experience may forego any set plans, relying instead on situated actions. Some schools may require lesson plans, regardless of the experience of the teacher. Standardized tests and curricula also play a role in deciding whether or not a teacher relies on a written plan of action. In this case, there were two crucial differences between the Patton School and the SHS teachers regarding the use of lesson plans and curriculum.

First, the teachers from the Patton School were required to teach science, while Lenny was not. The SHS school had an 'official' science teacher and the Patton School did not. At the time, this was not seen as a negative factor, although it was clear early

on that Lenny squeezed the science lessons into time that usually were used for other things.

The second difference between sites was that Lenny was an ex-engineer who had worked for NASA in the 1960's. He was extremely confident in his command of the content of the project. The other two teachers, as is the case with most elementary school teachers, were not as fluent in the Discourse of science, so the curriculum helped them sequence the SDP in a way that made them feel more secure. They could use it as a map to figure out where they were and where they were going.

Early signs of conflicting Discourses

My first meeting with everyone together was on September 18th, 1989. This meeting began a series of afterschool meetings with the teachers, cognitive psychologists and ethnographers (there was another ethnographer in another school). These meetings, held on weekdays afterschool hours, lasted for approximately two hours and were held every three weeks or so. In a field note, from September 18th I wrote:

> There was a lot of active and continuous talking amongst the people who were there. Teachers were Lenny Douglas, Sandy Heights School; Jan Page and Dorothy from the Patton School; Merril Jones (principal of the Patton School); Paul Gilligan, fifth grade teacher (in a school that was eventually de-emphasized as a research site in the project).
>
> I met Lenny Douglas whose classroom I'm doing the ethnographic research in. He teaches a mixed grade classroom (fifth-sixth grade). He was very inviting to me
>
> The researchers were Millie Solomon, Sarah Michaels, Randy Murray, the drama teachers from Emerson, and myself. Christine, the astrophysicist from Harvard was there.
>
> Lenny Douglas bought in some samples of drawing made by the children in his classroom, as well as some videotapes of himself teaching. (excerpts from fieldnotes)

I made a personal note recording the impression I got from Lenny's description of his classroom that the Sandy Heights School was similar to a progressive school I had taught in, so an empathetic relationship was already developing:

> **Personal Note:** Sandy Heights sounds like an alternative school situation not dissimilar to the alternative schools in New York City.

The purpose of this meeting was to set the context for the beginning of the SDP. The first 45 minutes was on business logistics and the second half-hour on what was needed to be done on the following Thursday (the fall equinox). Murray talked to the group about the Hatano type of experiment. He wanted the students to predict which way the shadow would be facing at noon. This was because he felt "that most people think the sun is over head at noon". The sun in the temperate zone is never at the zenith, even at its highest point in the sky on the summer solstice. If the sun was directly overhead, there would be little or no shadow. But the sun is actually always a bit to the south of the zenith in the northern hemisphere. The sun moves up and down in relationship to the southern horizon as the earth revolves around the sun during the year. The length of the changing shadows can be used as 'data' that the sun's position in the sky is changing. Thus children would be asked to make a hypothesis, test it empirically, and then debate the issue in class (hypothesis-experiment-instruction).

Teachers were also told that the "sun shadow measurement should be done at noon for a telecommunication link-up." This was for future calibration with other telecommunications sites of shadow and day length. In the same field note, I wrote:

> This Thursday is the equinox and Olson designed an experiment where the students would take measurements of the length of shadows cast by a stick for fifteen minutes before and after midday (on the equinox that would be 12:42 pm) every fifteen minutes in groups of four). Lenny Douglas summed up the project for him in these three ideas:
> - find true north
> - shadow lengths to compare
> - enter data into database

Also present at this meeting was Helen Clark, a researcher who had studied children's explanation of seasonal change. She was concurrently doing research in the SHS with the Hatano method in a different classroom. Helen asked the teachers not to be evaluative of the children's explanations during the Hatano Experiment (Helen Clark's relationship to the project is explained in chapter 6).

It was also said that the Hatano Experiment shouldn't be introduced as a study of the season's. That would be pre-mature. Murray also had prepared a multiple choice test on seasonal change that he wanted the group to look at and comment on.

We decided that if a child did not know an answer we would instruct them to leave it blank, rather than guess, because we wanted to be sure that we had an accurate picture of the child's knowledge, not a lucky guess. This 'test' was a multiple choice question and answer test similar to standardized tests in traditional science classrooms. This test

would be given to the students as a 'pre and post- test'. These pre- and post-tests were not used systematically in any subsequent analysis of the project.

The administration of the tests was inappropriate because they violated a sociocultural approach to learning and teaching in two crucial ways: 1) by tacitly accepting the tests as meaningful indicators of knowledge (other than knowing how to take a test); and 2) by giving the students the message that somehow, somewhere, despite all the emphasis on process, a product was expected. This had the unfortunate effect of focusing students on getting the 'right answer'. As Courtney B. Cazden (1980, p.596) writes,

[B]ecause of the nature of language itself, tests may aggravate more than they help. They will almost certainly reinforce the view that language can be developed as a set of measurable subskills ready for assembly and integration at some later time. They will almost certainly aggravate the already serious imbalance between means and ends - an imbalance between too much drill on the component skills of language and literacy and too little attention to their significant use.

The pre-test was an implicit admission that the researchers also had an interest in the 'right answer'. However, by refusing to make the product explicit, most students fell through the cracks trying to make a product when all they were practicing was process (Delpit, 1986). Those students who already knew the process, could move on to the product. We will see that this was indeed the case. Lenny, however, was not fooled, and his developing critique, was that, indeed, this science literacy project's hidden agenda would only work for those who could 'find it'.

There should have been a few epistemological and ideological alarm bells going off even before the project started. The researchers might have realized since methods embody theories about leaning, a theory of cognitive apprenticeship is contradicted by a traditional skills based means of assessment. The following excerpt from the Patton School curriculum illustrates this point:

Gravity quiz: "If each stick figure dropped something, in which direction did it fall?" Have students demonstrate with arrow

insert picture:

Another excerpt:
SRA Map and Globe skills kit
"Introduction to Map Reading".

Michael Apple (1983) has written about how teachers become de-skilled and de-professionalized through 'teacher-proof' curricula. Part of this process of de-skilling is a notion of skills which robs teachers of their autonomy. 'Skills' implies that teachers and students are blank slates that will and can use skills the same way in all contexts. An emphasis on 'skills' is what drives the educational establishment's obsession with tests and the ranking of teachers and students. This is not to say that children should not learn skills. Obviously they should. The question is how is this to be achieved? Should children learn literacy skills in isolation from meaningful tasks or in the context of meaningful activities?

The view of 'cognitive apprenticeship' held by Murray and Olson is one that is aware of the 'skills' myth. So why did it happen that they did not see the problems inherent in the teacher's curriculum? To understand this issue, recall the distinctions made between Discourses or institutions in creating meanings. The Discourse of instructional practices of the teachers conflicted with the Discourse of cognitive psychology. While the Discourse of cognitive psychology is very much interested in the theories guiding cognitive development (such as the zone of proximal development), teachers are not usually positioned by the sociocultural context of their settings to question the theoretical assumptions of the "tools" they work with (such as curriculum). Rather, teachers' theoretical orientation usually is to which tools and methods are most effective in completing a task. The everyday world of the teacher is the social context for teacher appropriation of science literacy. For example, the Patton School was a traditional school where students rarely, if ever, began projects. For the Patton School teachers, integration across the curriculum or any of the other hallmarks of progressive pedagogies was not possible. As a result, the teachers from this school were not skilled in implementing the progressive pedagogies envisioned by the project. Yet Murray admitted in a post-interview that while he was aware of the discrepancies between the Patton teacher's theories of learning and his own, he refrained from imposing his view on the teachers, "in the spirit of collaboration". The contradiction here is that 'imposing' one's view on another is not the only alternative to winning someone over to your point of view. Changing paradigms or theoretical frameworks cannot happen in a short one week workshop. Curriculum and staff development works best when it is developed as on going process.

Another rationale given by Olson and Murray for ignoring the theoretical differences between themselves and the teachers was that DE was a formative experiment. Olson described a formative experiment as a research design in which one

added or subtracted different factors in order to try and reach one's goal. In other words, if one wants a certain outcome, one tweaks the experimental parameters until it works the way one wants.

The use of a formative paradigm should not become an excuse to let anything happen, and say, "it is interesting", as if the experimenter was magically detached from the social context of the people in the experiment. In this project, when it became clear that not all the children were being allowed to participate in the project as planned, one had a moral responsibility to question what, in the theories of the experimenter, helped perpetuate this. The experimenter cannot stay outside of a culture that has historically denied quality education to minorities, as a natural scientist stands outside of a test tube of chemicals in a formative material science experiment.

However, the teachers of the Patton School are not the focus of this case study. The relevance of the Patton School teachers to this thesis is to help establish patterns in the social interactions between teachers and researchers. Even though Lenny did not adopt the curriculum of the other teachers, he did not adopt the theories of the researchers either for similar reasons: the hands-off approach (formative experiment) to collaboration between teacher and researchers.

The actual relationship of Lenny to the theories of the researchers, as with the Patton School teachers, were divergent, not convergent. Early in the project, Lenny offered a critique of their cognitive theories by asserting that the sociocultural context of his classroom was not properly theorized. Lenny was concerned that the Haitian-American children in his class would not be able to learn in the student centered investigation envisioned in the project. Again, as with the other teachers' divergent theories, his theories were ignored by the researchers. Only this time, the divergent theories of Lenny were not an attempt to recontextualize the SDP in a skills paradigm to learning, rather, it was an attempt to recontextualize the Discourse of cognitive psychology within the sociocultural context of his particular school (a mixture of traditional and progressive pedagogies).

But unlike the Patton teachers, Lenny quickly developed a critique of the theoretical assumptions of the project. Why did this happen when I have just said that teachers are not usually positioned to make such critiques? I will answer this question in more depth in the chapter devoted to giving a sociocultural reading of Lenny's theorizing. There we will see that the sociocultural basis of his critique reflects his own particular responses to a larger set of social relations in the society at large. Racism played an especially large role in his analysis and sensitivity to the class issues inherent in progressive pedagogies in particular and schooling in general.

Chapter 4:
Classroom Discourses in Conflict:
scenarios of teacher as reasoning between multiple Discourses

In the previous chapter, I described the resources provided by these institutional frameworks for thinking. In this chapter, I will describe the teacher's different reading of the various Discourse as an act of resistance (manifested in his performing different actions than anticipated either in the Discourse of cognitive psychology or the official Discourse of the school). Through analysis of his words and actions in the two classroom episodes, I will give a detailed analysis of the consequences of his resistance on classroom practices. This is followed by concluding remarks on the relevance of socioculturally-situated ethnography in fine-tuning researchers and teachers understanding of resistance as a form of cultural critique.

Now that the stage has been set, it is time to look at the actions of the players in terms of sociocultural mediation of cognitive processes. If I may push a bit further the theatre metaphor, it will be my purpose, in telling this story, to tell it from the point of view of a protagonist: Lenny.

Lenny's task as a teacher was to reason between the multiple Discourses outlined above. He had to reason with 1) the instructional design of the science literacy project; 2) the content area of the subject matter of astronomy; 3) the diversity of social and cultural groupings in his classroom and 4) the instructional / learning practices of his school. In addition, Lenny was also bringing to the situation his own cultural models of all these issues, plus sociocultural issues not addressed in the above Discourses. In fact, the absence of his 'voice' in the above-mentioned Discourses put him in a position of resistance to these Discourses as he simultaneously used them to construct literacy texts for his students and for himself.

One can be 'multiply-situated' in relation to any particular Discourse. For example, a feminist science fiction writer may find herself similarly enthralled with the genre, but repulsed by its historical sexism. In her attempts to reason between her feminist Discourse and the literary Discourse of her choosing in the cognitive activity of writing, she may still produce SF novels, but the absence of her 'voice' in the genre may be resolved by making most of her heroes women. Her re-writing of the rules of the genre can be seen as an act of resistance in terms of power and ideology, although she may have to play by the rest of the rules of the SF Discourse to be recognized by the genre as a writer of SF. Similarly in this case, Lenny has used various Discourses, (Discourses

in which in each case he is positioned slightly differently) to both make sense of and create science literacy texts in the project.

Mediation of instructional design by sociocultural setting and instructional practices: sociocultural analysis of teacher cognition

The first shadow data measurements in Lenny's class took place on September 22, 1989. The class, divided into small groups, went into the school yard and recorded the time, date and length of the shadows at noon. There was little preparation for the students as to the purpose of the activity. Students were told that they were going to participate in a study of seasonal change but the tasks they were doing clearly originated in the adults and not the students. There was a discussion at a meeting with the teachers that acknowledged that while this was not the best way to begin a project, the fall equinox cannot be delayed and the measurements must be taken, even if the students may not know why they were taking them. It was hoped that the students would make sense of the activities later as the project evolved. The project's delayed start was partially caused by the slow delivery of the necessary computers and setting up of the hardware.

One should note how early in the project the Discourse of Science (astronomy) conflicted with the sociocultural context of the classroom and the project's pedagogy. When speaking and acting in the Discourse of Science, one has to calibrate measurements to natural events that do not wait for the rhythms of human society such as when the school year begins. Experienced teachers rarely plan extensive studies the first month of school when children are adjusting to being back in school after the summer vacation. Ironically the beginning and ending of the school year used to be dictated by the seasons. Children were needed to help their families on the farm in a time when North American schooling educated a more rural population.

The Discourse of the physical sciences is not the same as the Discourse of cognitive psychology because the cognitive apprenticeship theory of learning requires students to learn skills within meaningful tasks. The Discourse of cognitive psychology was forced to step aside to allow students the chance to capture the length of shadows on or near the fall equinox. The conflict between the two Discourses made 'learning skills within meaningful tasks' much more difficult to achieve.

All the groups took measurements that day, and the measurements were saved on large sheets of paper. The involvement of all the students in these measurements occurred one other time and then ceased. By December, only two students, Cynthia and

Alberta, were taking regular measurements. These two white middle class girls were also the only students doing the other components of the proposed project: collecting information from around the world about the day length and temperatures in various cities. They were entering this information gathered from newspapers into a database on a computer. All the researchers (including myself) in the project were dismayed at this turn of events, for not only was the teacher not doing the project as planned but it was clear that the same old inequities were surfacing.

While it is easy to 'blame the teacher', I caution the reader not to jump to conclusions, but to understanding (which is not always the same thing!). I learned as I got to know Lenny, that moral indignation can blind us from determining what is really occurring. It is all too easy to try and fit people's actions into what we think they should be doing, and to dismiss them if they contradict our values. It is much harder to focus more on the contextual meanings people derive from social context and practices.

All the adult participants and observers of the project, including Lenny agreed that schools in general were not kind to linguistic minorities. Where we diverged is how much we believed this 'unkindness' to be an expression of one teacher or, alternatively, of a set of social relations. We also disagreed about our responsibilities for critiquing and changing these relations. Implicit in any Discourse is a set of beliefs about the world (ideology). When individuals buy into a Discourse, an entire set of beliefs come pre-packaged within them (see discussion on ideology in chapter 1).

When questioned, Lenny told us that it was inconvenient for him to take the entire class out for shadow measurements at noon because it was their lunch time and their only free period. He claimed that Cynthia and Alberta were the only children willing and interested enough to take measurements, and sometimes this was a chore even for them. The measurements were becoming erratic and the plan of transmitting shadow data across the continents to other sites was clearly in danger of failure. As manager of the time of twenty-five students, he felt that he could not afford to take shadow measurements as frequently as the researchers wanted. He told me that the differences in the shadow length could be useful even when spread over a long period of time. In other words, four measurements a semester rather than sixteen would produce the same pattern.

Lenny also said that the two students doing the measurements were the only students he trusted to 'behave' when taking the measurements on their own without adult supervision. This instructional practice (allowing privileges to those who already knew how to 'behave') extended across the curriculum and clearly was a practice that originated in the sociocultural context of the classroom. This sociocultural context

overrode the implementation of the idealized set of sociocultural the researchers brought in.

No one could claim, however, that they had not been warned by the teacher that the Shadow Data Project was, in his view, not for all his students. Lenny had said loud and clear at the summer workshop and during the early after-school meetings that this curriculum would not work for all of his students. That no one had listened or probed deeply what Lenny meant by that (until it was apparent that Lenny's theories of learning would supersede others) is a problem this thesis seeks to address.

When it became clear how the situation was developing, I asked Lenny why other students couldn't at least enter the data into a data base or use the Sun Lab simulation software that was supposed to supplement data collection, (even if only two students were allowed by him to take on the shadow measurements). He claimed that many of his students, especially the Haitian Creole students were not ready to use computers. He also said that the middle class students were already familiar with computers and many of them already had experiences with modems and telecommunications and 'it would be boring'.

To address this situation, a remedy was initiated within the Discourse of cognitive psychology: circumvent the learning theories of the teacher. When it became clear that only a very small subset of the students would get to measure shadows, data from other classrooms were introduced by Olson. A graph was provided that did part of the 'work' for the students that they were supposed to do themselves. According to the design of the project, the shadow data collected in one location was to be compared through telecommunications. The PI's of the DE were clearly frustrated. Not only were the computers that would allow for the telecommunications late in arriving, but even if the computers were in the classroom, only a very small subset of the students had any data to compare or transmit.

Discourse analysis in sociocultural context

The theoretical basis of cognitive psychology Discourse of this project was to constrain model building through "a conversation between the theories and the data....data is collected as a basis for a model but the developing model guides data collection and predicts new data in a continuous cycle" (Olson & Benson, 1990). According to the researchers the underlying epistemology of scientific reasoning is that "scientific concepts derive their abstract nature from the fact that they stand for as an explanation or account for observed or possible events". It follows then, that Olson

would be concerned that the children were theorizing without being constrained by the data.

In the same paper, Olson expresses concern with the 'serious boot-strapping problem' that exists in engaging children in a 'conversation' when they may lack the 'rhetorical' skills crucial to a free-flowing conversation: "If conversation is the preferred context for mastering scientific sense making, and if the use of an explanatory model is necessary to engage in conversation, then a serious bootstrapping problem exists. The issue is fundamental to development if a Vygotskian approach is taken" (Olson & Benson, 1990).

What Olson fails to mention is the power of sociocultural mediation and the difficulty of relying on 'conversation' or 'talk' as a medium for boot-strapping. The conversations Olson wishes to bring to the classroom are closer to the sociocultural mediation or 'identity kit' of certain students and not others. There is a vast body of research (see background chapter) in which it has been shown that the school-based decontextualized Discourse of science that Olson wants to teach students occurs more frequently in the familial pedagogic contexts of some social groups than others. If as a student, you are learning to have a certain type of conversation while other members of your classroom already know how to have such conversations, then you are not being boot-strapped to the same cognitive task. Those who already have mastered the interactional patterns of the school-based decontextualized Discourse can advance to thinking more about the content area of science, while others are still learning the interactional pattern. This was a major component of Lenny's critique that I will develop in the chapter devoted exclusively to his theories.

Lenny's responses to the curriculum was also an implicit critique of the premises of the Hatano-Itakura method. Recall that this method is based on the premise that "none of the (student) members of the group is taken as being more capable by status other that the interaction, information flows horizontally". Lenny believes that the multiplicity of Discourses in his classroom position speakers vertically as well as horizontally.

Additionally, there is the problem that even those students who have the basic school-based Discourse cannot be expected to respond to school-based Discourse with one voice. School-based science Discourse, like most Discourses, is *heterogeneous* (Bakhtin, 1986; Holguist, 1990). Production and interpretation of school-based Discourse depend on the position of the user and the context of its use. In a multicultural classroom where students from diverse social groups are all engaging with the 'same text', there is a multiplicity of voices and positions (Wertsch, 1991). This is

an issue of sociocultural mediation of cognitive tasks and requires a sociocultural analysis.

While I agree with Olson that it is a goal of any science literacy project for students to engage in 'conversations' with the data, I disagree on what constitutes a 'conversation' and what is seen as 'data'. This analysis will be expanded in the following contrast between how Olson has analyzed a series of classroom 'conversations' in the Discourse of cognitive psychology, and how I have in the Discourse of a social anthropology of cognition.

In analyzing the events of this discussion, I hope to examine how the teacher is positioned between the different Discourses of the project interacted in actual practice. These Discourses are:

1) Science (e.g. physics)
2) Their own science (cognitive psychology)
3) instructional / learning practices
4) sociocultural setting and classrooms

To this end, I would like to focus on two classroom discussions, on January 10 and January 17th. On January 10, the students were introduced to a graphic summary of the shadow data measurements of two other classrooms participating in the project; a classroom in Toyama, Japan and one in New York. In my analysis of a stretch of Discourse from this discussion, I will situate the cognitive strategies of the teacher as reasoning between multiple Discourses. The teacher is doing more than the task of introducing the students to graphed data. The teacher is positioning himself in relationship to the four Discourses. This multiple positioning is not exactly one idealized by the Discourse of cognitive psychology. The Discourse of cognitive psychology is only one of the Discourses the teacher is using in his reasoning. While the teacher is not operating solely within that Discourse, the cognitive psychologists are, and Lenny's use of pedagogic or instructional Discourse that is regulatory of students behavior is indicative of this difference. Lenny is quite cognizant of the sociocultural context which is necessary for its realization (Bernstein, 1990; Inghilleri, in press). Of course, the cognitive psychologists are also reasoning between multiple Discourses and are not 'objectively' applying theory to practice. (See chapter 6 for an explanation of the conflicting Discourse present in the cognitive psychology Discourse).

In the following January 17th transcript of classroom talk, I will show how the teacher has much more on 'his hands' than getting students to produce what Olson called 'sense making' in his examination of the same interchange. This transcript records a

classroom discussion continuing the use of the shadow data graph brought in by Olson. On that day, instead of being asked to develop a theory to describe differences between the shadow lengths of the two cities, students were asked to relate the differences to the overall question of explaining seasonal change using props (a globe of the earth and a smaller sphere representing the distant sun). Each group is asked to present their theory and 'relate it to the data'.

Example 1: January 10

The activity of this day is not one originally designed to be in the project; but one developed on an ad hoc basis. The development of this activity was primarily a result of the cognitive scientist's wish that the class (which was not taking shadow measurements in a systematic fashion) interact with data. However, the teacher was reasoning with a different set of criteria. These issues surface in the stretch of Discourse that follows.

In this transcript, Lenny is introducing the activity described above. But is the activity all that is being introduced? Or are there other social contexts/ subject positions being 'set-up' or defended?

What the teacher thinks science literacy is

1 Lenny: As you know in the past
2 Ah Mr. Burns Please Tom.
3 We've been learning something about the Earth Sun And
4 What we can learn from that in a similar way to how people did
many many years ago before they had all the modern things we have such as telescopes and computers.
5 They could deduce much of what you're trying to do now
6 They had one advantage over you.
7 Student: What?
8 Lenny: They didn't depend on any of these things, they didn't expect
9 So all the things that they had to depend on were tools which were as you know were really simple tools.
10 Ahh we're not talking about that. If you're not talking about this, I don't want to hear it.
11 They had extremely simple tools, a stick, a piece of rope and their minds.
12 That was about it, they didn't have much more than that.
13 There's no calculators, they had no uniform measuring sticks that we think of as uniform around the whole area.

14 But still, they were able to deduce an awful lot of what we know today, way back in those days.
15 You're about to drop a pencil Eva.

What the teacher thinks Olson thinks science literacy is

16 OK We've got some data here similar to the data that you've been taking from New York and Toyama in Japan. The same kind of data.
17 Student: what data?
18 You know the shadow data
[more directives to behavior problems]
19 Alberta: You said we were getting more computers
20 Lenny: We are working on these arrangements already
21 Alberta: How are we supposed to send them the shadow data!
22 Lenny: As soon as we switch CPU's
23 Alberta: We just have to put it all back.
24: Lenny: Shh Shh
25 I have here some data that was taken by some children from those different areas on different days of shadow lengths like you have only James Olson has plotted it out on a piece of paper.
26 Now given this data I'm wondering if you can come up with any explanations as to what its telling you.
27 Student: what?
28 Lenny:Why is it slightly different.
29 What else is there particularly you want them to know Olson?
30 The specific question?
31 Olson: Well there is the particular overall question why are the days getting shorter? And are those two cities different?
32 Lenny: OK. The days are getting shorter and the shadows are getting longer.
33 The data from the two cities are a little bit different.
34 The two cities. Does anyone remember their name?
35 Student: New York and something
36: Lenny: Toyama and New York City.
37: Can I run and xerox some copies so that I can give it to them in groups?

Analysis of sequence

I broke this discourse into two parts. The discourse marker for the two different parts is an immediate change of pitch between sentence 15 and 16. Previously Lenny had been talking in a hushed, 'sermon' tone. The next lines are spoken at a slighter higher pitch and at a faster rate. This pitch change signifies a break between the preceding section and the one that follows. Changes in pitch often signal changes in perspective (Bollinger, 1986; Crystal, 1979).

Also notice how Lenny has a tendency to mark the beginning and endings of sections with imperative or interrogative sentences commanding action or asking for information. The rule against talking out is against 'side talk' (Lemke, 1990). References to side talk are discourse markers that are operational in the social context of this classroom in particular and most classrooms in general (from kindergarten to graduate school). Most teachers/lecturers will not begin to 'address' a group if there is disruptive sidetalk. Sentence 1 is a false start. Lenny has to pause to get a student, Tom Burns back in focus. Lenny begins again in sentence 3. Of course, no teacher can stop all side talk all of the time. There is always some side talk. How pronounced side talk is depends on the social context. In graduate schools, side talk is often reduced to glances between individuals; a glance can signal silently, "did you hear that? I can't believe he said that".

In this classroom, as in many elementary classrooms, there are both explicit and implicit rules for side talk. Side talk, as being used here, includes gestures, focus of attention, etc. that represents, *"My mind is elsewhere and what you are saying is not my focus"* is considered side talk.

Explicit Rule 1) There will be no side talk when the teacher is lecturing.

Implicit Rule 1) Side talk is allowed if it adds to the flow of what the teacher is saying by correcting a mistake or asking a question the teacher was hoping would be asked. The teacher can then decide if the side talk is an attempt to disrupt the lecture.

Implicit Rule 2) Side talk is allowed if after weighing the pros and cons, the teacher decides that disrupting the flow of the lecture to deal with the side talk is not worth stopping. In this case, the teacher often seizes the moment when a major section of the overall discourse organization is completed to address the side talk.

How implicit or explicit the rules are depends on the flow of the talk, the people and the context. The section begins with a false start. Lenny will not continue if all the children are not focused. These sentences 2 and 15 mark the beginning and end of the

first section, which I've labeled "What the teacher thinks science literacy is" (more on that shortly).

In utterance 10, Lenny makes the rules explicit again to a student attempting to interrupt. It is a momentary 'repair' and he moves on.

In sentences 15, Lenny anticipates that Eva will make a possible disruption when she discovers her pencil is gone and circumvents it with his directive to pick it up. But this directive is also a signal that the theme of the lecture has been established enough that Lenny can now pause.

Indeed in the next sentence, accompanied by a pitch change, he begins a new theme, a subtheme connected to the first. In the first section, Lenny is discussing differences between how the Greeks discovered that the Earth was round without computers (Isaac Asimov's book, *How We Learned The Earth Was Round* was part of the curriculum and sections of it was read to this class). In the following section Lenny seems to contrast the use of technology in today's activities with the lack of technology in the past. This occurs in utterances 11 - 14. This section is punctuated by the repairs to side talk and other classroom behavior monitoring:

10 Ahh we're not talking about that. If you're not talking about this, I don't want to hear it.

11 They had extremely simple tools, a stick, a piece of rope and their minds.

12 That was about it, they didn't have much more than that.

13 There's no calculators, they had no uniform measuring sticks that we think of as uniform around the whole area.

14 But still, they were able to deduce an awful lot of what we know today, way back in those days.

15 You're about to drop a pencil Eva.

Lenny also ends this section with a sentence (37) that clearly indicated he is finished the main theme of the text.

The reason why I am taking such an interest in the thematic organization of the text is that the overall cohesiveness of the text tells us something about Lenny's cognitive strategies in relationship to the researcher's goals of bringing the Toyama and New York data into the classroom. Lenny's text has a narrative structure to it. His narrative, like many others, uses binary contrasting elements to give his perspective on the events of the day. He contrasts a "stick, a piece of rope and their minds" with "telescopes and computers". He contrasts "dependence" versus "independence". Independence is an "advantage:

6 They had one advantage over you.

7 Student: What?

8 Lenny: They didn't depend on any of these things, they didn't expect

9 So all the things that they had so all they had to depend on were tools which were as you know were really simple tools.

Dependence is a disadvantage by implication. But why is he telling the students this? I believe this narrative is for the benefit of the researchers. It is a critique and a response to this ad hoc activity that was developed to circumvent his critique of the lack of appreciation of the sociocultural context of his classroom. This critique works by implicitly suggesting that the reason why the class has not been taking shadow data regularly is because Lenny does not believe regularity will lead to understanding the concepts of the science study.

I briefly mentioned his reasons for not being enthusiastic about computers (some students already have them and will be bored; for others, the computer is too 'difficult' for them because they are not ready to work independently). In this situation, Lenny is being 'forced' to do this activity because Olson wants tapes of children in 'sense making conversations'; something he can't get if children aren't having conversations around the data.

When in utterances 25 and 29, Olson is mentioned as both the source of the data and the goal of the activity, Lenny is 'disowning' himself from the activity. His change of perspective, reflected in change of pitch, as well as in the different themes of the subsections, is indicative of his relationship to this activity in particular and to the entire project in general.

29 What else is there particularly you want them to know Olson?

This utterance in the context of the thematic cohesiveness of the narrative is *"I will do this activity for you because you want it. Class, it is really Olson, not I, who wants you to do this. If it was up to me, we wouldn't be doing this at all because I knew all along that this project's theory of science literacy will only work for the few middle class children that are already successful in school."*

In a conversation with Lenny on January 23rd, I told him that Olson was becoming increasingly interested in Alberta and Cynthia's work in the project. In response he said:

"Yeah, sure. See, they're competent. What Olson and Murray don't understand is that we've been using technology for years. Using a computer is no big thing. So if

they want to find out about the effects of technology, it makes no difference here. We've always had it".

This interpretation, of course, cannot be known from this narrative alone, but through sociocultural analysis. At this time, I was just as perplexed by Lenny's actions as Olson until I took on the task of interviewing Lenny to try and develop a framework for his theories of the mind. The contrast between the two sections is what Lenny really thinks and the second section is what he thinks he has to do to 'collaborate' with Olson.

Alberta, one of the few children allowed to do the project as planned, is at first allowed to produce side talk. She quickly passes from the safety zone to the danger zone and her side talk is terminated (utterances 19-24). This is because what began as a positive addition ("When are we getting more computers?") was no longer seen as positive when it seemed to be leading to both a critique (you promised and didn't deliver) and an argument without a clear resolution:

19 Alberta: You said we were getting more computers

20 Lenny: We are working on these arrangements already

21 Alberta: How are we supposed to send them the shadow data!

22 Lenny: As soon as we switch CPU's

23 Alberta: We just have to put it all back.

24: Lenny: Shh Shh

Struggles over classroom texts is a theme that also surfaced in my interviews with Lenny. Part of the sociocultural context of the class was not only Haitian bilingual children whom the teacher felt could not handle the curriculum, but also white middle class students who could handle it all too well. These children represented the segment of the school that is most 'at home' with progressive pedagogies. Lenny's instructional practice was an attempt to carefully weave very different Discourse strategies among his students.

In a classroom where diverse Discourses and values may co-exist, as in this case, the background assumptions of the science project that the social processes can be 'recreated' or 'transferred' is undermined by the existence of multiple frameworks or discourses for interpretation. This highlights the 'essential tension' of this project (Kuhn, 1977). On one hand, the project tried to restrain from setting outright hierarchical standards: having the students do the same thing at the same time in a lock-step method characteristic of traditional science education. By not 'telling the students the answers' the project tried to create the excitement of real scientific discovery. On the

other hand, it *did* have a hierarchical ordering of frames of interpretation. It was obvious that the explanation of seasonal change given by the discipline of astronomy was the preferred explanation and that children's 'incorrect' theories would be treated only as a stepping stone to the correct theories.

The strategy of 'not telling students the answers' is an ideology persuasive in progressive pedagogies such as the Shadow Data Project. Lenny appropriated this from the project's early introduction to the teacher of the 'Hatano Method'. On February 12th, Lenny told me that as far as he was concerned "we're trying to get kids to figure it out for themselves without telling them the answers". At the same time, he would confide with me that this strategy would not work for all his students.

We will never get to heart of the matter (teaching science literacy in multicultural settings) by ignoring the social relations in which classroom Discourse is embedded. There was a tension throughout this project for on one hand, saying 'anything goes..it's a formative experiment" and then, on the other hand, having research goals that were not genuinely shared with all the participants in the research. These goals (and values) were not shared because the teacher and the cognitive researchers were members of different Discourse communities.

As a result of this tension, many students are left to flounder on their own because no one says, *"it's more than just presenting your theories; it's presenting them in an acceptable way."* Science literacy is not just about a conversation with the data (one can have a conversations of gestures as in dance). It is a particular kind of conversation. When the attention to the failure of certain student's theories is based exclusively on their rhetoric, and not on the social context of the school, we actually exclude the social context from our theories of learning.

Again, I caution the reader to pay attention to the intentionality and social gravity of the Discourses and institutions rather than individual psychology. Murray and Olson are not 'bad people' in the sense that they deliberately refused to share goals with the teachers. More to the point is that when acquiring a Discourse, one is often quite unaware of the extent to which it excludes and marginalizes other Discourses. In fact it can be argued that this is one of the main purposes of Discourses: to bind separate individuals into working collectively on projects that supersede their individual desires. To get the power of the group, the individual loses a bit of autonomy. The relationship between individual and group autonomy is a fascinating topic that has attracted the attention of many historians and sociologists of knowledge. Let it be said for now that everyone deals with one Discourse or another. If there ever were human beings who

could live without being in groups, they are extinct. So the existence of Discourses is a problem for cognition

Problems are caused when the shared assumptions as to the interpretative framework to use in science are shared by some, but not all of the students. When students' frameworks clash (as they are supposed to in this design), some students' frameworks for interpersonal communication are more in line with the framework of the project than others. Sociocultural aspects of scientific practice begins to generate a dynamic of its own, quite different from the idealized one in the design. In the small group discussions that followed the January 10th transcript above, the student Alberta shares the interpretative framework while the others in her group cannot. Noticeably absent from the design is a notion of how to achieve small group discussions - although much of the curriculum was based on it. It is assumed that small groups operate in a certain way because they are made up of peers, but are they? What makes a student a peer of another? Are there not sociocultural differences that might mediate the interactions in small groups and if so, how does science interact with such a difference?

Part of the original design was for students in other cities (namely New York and Toyama, Japan) to collect equivalent shadow length and day length data and share this data through telecommunications. The differences in latitude of the cities were supposed to spark discussion and shape or constrain developing theories of seasonal change. This design feature was meant to recreate for children the social activity in which scientists move: the exchanging of scientific data. Modern scientific practice is based partially on the existence of communication channels of criticism. Peer review and public forums are essential to the development of objective standards in scientific research. In this project, the rationale for having children compare differing shadow and day lengths was to provoke discussion as to the possible reasons for the differences. The search for a theory that could account for differences in the shadow data was supposed to ground the classroom discussions not only in the data, but to orientate the students towards the communicative or 'conversational' aspects of scientific practice. The evidence was presumed to have the effect of constraining reasoning because theories that could not account for the data would be discounted by the students.

What works in theory or in the science laboratory doesn't always work in the classroom. As we shall see, there were many social processes pulling apart the experiment in complex ways. Unlike the science lab, other criteria that make science 'social' were absent. For instance, in order to share and comment on differences in measurements on the same data, scientists have to be somewhat equal in authority.

Otherwise, a hypothesis for a set of data may be imposed from above and thus forecloses channels for criticism. While this science curriculum valued communication, what was missing was a more complex reading of social construction of scientific knowledge in classrooms.

The social practice of building theories from data (and how that process is mediated by intersubjectivity) cannot be expected to arise from interactions with the data alone. As we shall see in the following scenario, the methods for interpreting data and managing intersubjectivity (correlating what you think you know with what you think others know) are cultural as much as they 'emerge' from the data.

For while the purpose of the activities of the class were to develop theories that specified observable interactions with the natural world, what one makes of such an interaction is a feature of the community values and standards one is in. The weighing and interpretation of 'evidence' is a result of social and historical contexts as much as they are they are the result of social and cognitive needs.

For example, Alberta, alone among the 'side talkers' in the text presented above, displayed any public knowledge of what the 'whole task' was. Her computer question indicated knowledge of how the telecommunications, shadow data and graph fitted together. Alberta's side talk was prevalent over and above the others and the difference is telling. It is not surprising that she had knowledge of the whole task because she, unlike the others, was actually doing the whole task.

But this says less about either her cognitive abilities (described by Olson as academically advanced) or the students who didn't know the whole task and more about the way schools allow children to practice what they come to school already knowing how to do, de facto discrimination against those who don't already know.

Example 2: January 17th

Earlier, I described some of the sociocultural context of the Sandy Heights School through a discussion of its history, ethnic make-up, its stated educational goals and instructional practices for the bilingual students. I also situated 'progressive education' as pedagogy of a particular historical moment and cultural expression. How did Lenny situate himself within this sociocultural context?

In the year I spent observing Lenny teach, I identified certain issues and themes that emerged as significant poles around which Lenny constructed his theories of teaching and learning. These were: family, language, authority, bilingualism, class, racism and

literacy practices. Lenny was a joy to work with for he was an incredibly outspoken and articulate defender of his theories when questioned.

When I first arrived in his classroom, I quickly ascertained that his teaching was not 'progressive' in the way I thought of the word. My early expectations of a certain type of classroom based on the word 'progressive' were soon displaced. Lenny's lessons were often teacher - not child centered. Permission to engage in almost any activity originated in him, unless it was an activity embedded in an already agreed upon schedule (i.e. Haitian-American students could leave without asking for an appointment with a remedial teacher). Permission to go to the computers in the back of the room had to be given, even if it was a spontaneous request. In most of the progressive classrooms I've taught or observed, children often initiate activities, and go to activity centers or special areas on their own (as much as possible).

Lenny's justification for his classroom management style was based on the existence of a diverse range of students. One might say that a tracking system existed, where middle class children received the progressive pedagogy and the other children received varying mixtures of the progressive and the traditional depending on how much of the progressive pedagogic Discourse they mastered. But to call it a tracking system, I believe, is too simplistic, for such a view ignores the social context that surrounds the construction of such a system.

When Lenny argued at the start of the project that the sociocultural context of his class would undermine the project's success, he was speaking from experiences that no one else had: teaching in that classroom to those particular students. Because students remain with a teacher for two years, Lenny had a good sense of who his students were.

Lenny also knew the institution where he taught. Lenny felt pressure from middle class parents to be more 'progressive', but at the same time he disagreed with many family practices of the middle class homes. He often said that while the middle class children knew the Discourse of schooling very well, they were ill-behaved and spoiled. At times, there was a sense of struggle around who controls the floor in the classroom between Lenny and the middle class (in this case white middle class) students.

There was also a struggle between Lenny and the other non-middle-class students. In these instances, there were the types of struggle one would expect in a more traditional classroom: children would be at times verbally silent and visibly angered or resentful of some directive or denial of privilege. The white middle class children on the other hand would continue to negotiate or argue with Lenny when they didn't get what they wanted. Some students would make sarcastic comments in stage whispers or try to undermine Lenny's authority. For example, instead of saying, "you never let me do X",

a white middle class child would say, "You won't let me do X because you think that I can't do X.". The first comment implicitly accepts the teachers' authority. It is an appeal to the teacher to relax authority. The second comment is more a commentary on the interpersonal relationship between the teacher and child. It suggests that the teacher has misinterpreted the child's ability and the fault lies not in the teacher having the final word (and in the view of the child, the wrong word), but in the teacher's ability to detect the true psychological readiness of the child to do X. This focus on the interpersonal is indicative of family relations of the new middle class (Bernstein, 1990). In the following transcript, Tom, a white new middle class child is attempting to present his theories of why shadow lengths differ between Toyama and New York:

Struggle over the globe

1 Lenny: Shh. I need all of you to be quiet and listen. The group over here

2 be quiet and listen to the explanation of this group/

3 each one of you will have a chance so / listen carefully

4 Tom: This {pointing to a small white ball} is the earth remember

5 L: No that can't be the earth

6 T: But this is heavy

7 L: It doesn't make any difference

8 T: Well it does when you're the one explaining

9 L: OK (Tom has to use the globe)

Struggle over theory

10 T: Which one? which theory's first?

11 L: We have to explain why this occurs like that

12 T: I mean theories of shadows? Which one?

13 L: Why

14 T: I don't even know what that means / theories of shadows

Teacher evaluation of student

15 L: Well then Tom you're not ready to explain this data

16 T: I know what the theories of shadows mean

17 L: What does this line mean?

18 T: I don't know

19 Alberta: The daylight of Toyama and New York

20 L: You haven't read your data / sit back down you're not ready

Student evaluation of teacher

21 T: [to his group] We ARE ready / He just thinks we're not ready

22 L: We're trying to explain data first

23 T: I know and we can / I know our theory / I just didn't know what the lines were and I want to say our theory

This exchange is typical of the sociocultural context of the classroom. I broke it up into four episodes: 1) struggle over the globe 2) struggle over theory 3) Teacher's evaluation of student and 4) student evaluation of teacher. Throughout the exchange there is a struggle for control of the discourse from props to theories. This struggle is one over position. The student is resisting the teacher. The subtextual clues of his answers reflect a position of distrust of the teacher's powers of evaluation and empathy. The student's evaluation of the teacher was a correct one. Tom was frequently mentioned by the teacher as an example of how some new middle class children 'go too far' in their attempts to control the discourse of the classroom.

In lines 1-4 the teacher directs the attention of the class to the explanation Tom is about to give on behalf of his group. Tom starts on line 4 by making a smaller object the earth, instead of using the globe. The groups preceding him have used the globe. This move may have possibly been invoked to produce some reaction on part of the teacher or other students. Whatever the motivates, the teacher responded in line 5, "No, that can't be the earth". Tom responds by suggesting that it is too heavy. The implication is that Tom's personal comfort should come before his explanation. The teacher's "ok" in line 9 has a downward shape to its pitch indicating, not an affirmation, but an indicator that the conversation on the comfort of Tom has ended, and that it is time to say something else.

Tom interprets the teacher's 'ok' correctly and continues with the globe. Lines 10 - 14 show that teacher and student are negotiating the scope of the explanation. There seems to be confusion over what theory Tom is supposed to explain. In line 15, the teacher evaluates the student as not being ready to continue. This evaluation is based not only on the student's confession that he may not actually be sure of the task, but also on previous subcontextual clues of a position of resistance (line 8). So "I don't even know what that means" could be read as a evaluation of the pedagogy so far (implicating the teacher's incompetence), or on face value.

Imagine going to a busy restaurant and you are seated by a waiter. The waiter has forgotten to give you a menu. He arrives at your table with his pad out ready to take your order, "What'll it be today?" he asks. Because you are hungry, you snarl, "I don't even know what's on the menu." Of course, its true that you really don't know what's on the menu, but the inflection of your voice is not just a simple statement of that fact. Rather, it is an reflection of your evaluation of the service of the restaurant and the waiter. Most waiters will realize without being told directly you are upset and will apologize immediately and get you a menu. This is the spirit of the exchange presented above.

In line 17, the teacher tests Tom with a question. He fails and is told to sit down. The teacher (appropriating the Discourse of the SDP into his instructional practices) has a set way of what he thinks is the right combination of theory and data. Lenny, based on his reading of the researcher agenda, believes that the theory is constrained by the data. If you can't read the data (represented by lines on a graph) you can't have a theory. But not only does Tom lack the proper Discourse, he has an 'attitude' or a 'position of resistance' that the teacher is also trying to constrain. "He just thinks we're not ready", says Tom. The teacher, according to him, is clearly wrong and he lets him know.

What I hoped to describe in these transcript excerpts and accompanying sociocultural analysis is the way instructional practices (which includes classroom management) are not solely the creation of the teacher, but are socially constructed. This social context includes the resources provided by the institution of schooling to teachers and students. Within institutions are people with histories and their own interpretative frameworks that interact with each other. The social history of the Sandy Heights School where traditional and progressive pedagogies were mixed are also resources in the teacher's decision making.

All of this is also 'data' but unfortunately, while the teacher was well aware of the sociocultural dimensions of his classroom, the Discourse of cognitive psychology in which he was supposedly a 'collaborator' was not quite as aware or interested in data in this form. For this reason, it would be inaccurate to say that if a 'tracking system' existed (and there is good reason to believe it did to some extent), it existed solely due to the teacher.

A 'tracking system' evolved out of power struggles between students, parents and teachers. This is a struggle between the demands of a powerful new middle class and the demands of a much less powerful group of recent American immigrants. There is not comparable data on the similar interactions between the teacher and Haitian immigrants because none of the spokespersons for the small groups came from this linguistic minority. The reasons for this are complex, but the above section of text is indicative of the sociocultural context of the class that was a factor in the teacher's decisions not to make them leaders. In other words, the sociocultural setting of the classroom and the instructional practices of the teacher were in a dialectic relationship, and must not be seen as one coming exclusively from the teacher. Now that I have illustrated some of the social context that shaped Lenny's concerns, I will now return to the narrative of the development of the project.

The Discourse of Astronomy and The Discourse of Cognitive Psychology

At the same time that Lenny was recontextualizing the stated goals of project within the sociocultural context of his classroom, the cognitive psychologists were trying to recontextualize the Discourse of science (astronomy) within a cognitive science Discourse. As described above, seasonal change was chosen as the cognitive problem to solve.

Yet, there was a surprising lack of appreciation of the differences between the goals of a Discourse such as astronomy (managing a range of observations and theories about the known Universe in a variety of interlocking disciplines such as physics, chemistry, geology, biology) and observing conceptual change in children. The Discourses differ in both their 'institutional' frameworks of practice and their 'rhetoric' strategies of communication. And as seen above, the Discourse of instructional practices differs again from both of these. These Discourses represent choices in systems of meanings.

For example, how does one know when someone else knows a theory of seasonal change? There are many answers, depending on the social context. To a teacher in a traditional school it might be when a student can pass a test or use the Discourse of the

textbook. To a teacher in a progressive school, it might be when one can 'discover' the answer for themselves, making it meaningful in one's experience. To an astrophysicist, it might involve some mathematical equations. In comparative planetary geology, a seasonal change theory might include other worlds, like the 'seasons' observed on Mars.[5]

To a cognitive psychologist, making sense of children's explanation of seasonal change has a very different context than the science of astronomy: what is important in an explanation of seasonal change is when conceptual change has occurred. As Neo-Vygotskian cognitive psychologists, the researchers, especially Olson, were interested in finding the right mix between goals originating in adults and the creative process of appropriation of the child. Elsewhere Olson had written that often children and adults enter activities with different goals while they jointly construct the activity. Even when children's goals are not the result of appropriating adult's goals, they are nevertheless, constrained by material and social circumstances.

Children actively use the cultural resources available to them while appropriating adult's activities. So an educational game will be turned into a social activity because children have their own goals. Olson's critique of traditional education is that it all too often favors the goals of the teacher over the goals of the child. Thus, while the cognitive psychologist is in some abstract sense interested in pedagogic practices, the more immediate interest is in cognitive processes.

Olson wrote that a "conversation between the theories and the data" is the basis for theory building: "data is collected as a basis for a model but the developing model guides data collection and predicts new data in a continuous cycle" (Olson & Benson, 1991). In the above stretch of Discourse, the student, Tom, was asked to demonstrate his theory of how the earth's orbit around the sun creates differences in day length around the world. Tom's model was supposed to be 'constrained' by having to stick to the data.

Olson and Lenny produced different readings of the sociocultural dynamics of the classroom. Lenny, reading in the sociocultural context of his classroom, quickly dismissed the explanation because the student was not 'constraining' the model to the data. White middle class students like Tom presented Lenny with many challenges to

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[5] At various times of the year the ice caps of Mars release water and the area around them turn green. It was once thought this indicated life was on Mars, but it appears to be more of a chemical reaction to the melting ice in the soil, rather than any 'life'. No gases indicating life processes on Mars have yet to be found.

authority throughout the school day. While Lenny often encouraged some of this challenging with some students, he admitted in interviews, "it gets out of hand".

Olson's description of the interaction between Lenny and Tom is different from my description. In Olson and Benson (1990) this exchange is seen as illustrative of how "the teacher's definition of the task supported by the graph on the board was not sufficient to communicate the notion of an explanatory model to all the students."

If within the Discourse of cognitive psychology, Olson emphasized a conceptualization of scientific literacy solely as data collection, modelling activities and presentations of theories to other students, it is easy to see how such exchanges between teacher and students can be seen as enough 'data' to build explanatory models of science literacy. The epistemology underlying the approach to data laid out by Olson is problematic. For one thing, it believes that the reason why Tom and the teacher could not agree on the task was that:

"The teacher's set-up of this particular lesson and task definition was clearly aimed at eliciting what we are calling scientific sense making. As we stated in an earlier study (Olson and Zorts, in press) this task definition was often not stated clearly and even in lessons where an explanation of specific data was the stated task, ...the class discussion very often strayed from the sense making task to presenting theories."

Missing from Olson' analysis is a sense of the sociocultural dimensions of the classroom, most notably the teacher. Through ethnographic interviews with the teacher where we discussed the theories behind his teaching practices, I found that issues of power, authority and ideology were also factors in how he set up this and other lessons similar to this one. In my analysis of how Lenny introduced the class to the first part of the task on January 10th, I incorporated Lenny's struggle for a position he felt comfortable with between what he thinks of science literacy and Olson.

In contrast, Olson's does not recognize himself within his narrative as being part of the 'set-up' in his and somehow is not an actor, but an observer, even though it is he who brought about the activity in the first place. That the teacher's definition of the task is 'not clearly stated' has as much to do with the teacher's 'ownership' of the task as it has to do with the task itself. While Olson is looking at the teacher's actions as if they both share the same understanding of the task, potentially powerful differences between them exists in both their ownership of the task and the Discourse the task is embedded.

As Jerome Bruner points out (1990), cognitive psychology has traditionally ignored the culturally shaped notions in which people "organize their views of themselves, of others, and the world in which they live". I have argued the same in my analysis of Lenny's discourse on science literacy. Cultural models were as

much part of his reasoning process as the astronomical theory of the project. There were very strong cultural myths about science at work throughout the project as in the recommended use of the story of the Greeks (as the founders of modern science) or Lenny's fears about overdependence on technology by modern societies where people 'no longer think' because they have 'computers' and other advanced technology. They were not entirely his own theories, but theories shaped by cultural myths (such as romanticism - see Abrahms 1971). They were shared implicitly by Olson who assumed that using Asimov's *How Did We Find Out The Earth Was Round?* (1972) would help ground the students in a sociocultural context.

Conclusions

In hierarchical social structures such as schools, the relationship between resistance and compliance is constantly shifting, depending on the relationship between context and individual agency. Misunderstanding this relationship can have unwanted effects on the communication of scientific ideas, both between researcher and teacher, and teacher and student. When ideas from the academy are resisted by practicing teachers, a problem all researchers have surely faced at one time or another, it is crucial to be able to distinguish between cultural models, scientific theories and the social practices mediating their relation.

Teachers might communicate and agree with researchers on pedagogic goals and theories but in the classroom, they do something entirely different. For example, in after-school meetings with Olson, Lenny (as an ex-NASA engineer) had lively conversations about the astronomical theories in the project. But he felt he could not converse as freely with his students. In making this decision, Lenny was reasoning between 1) his own sociocultural theories of his classroom (which included a class-based cultural critique of progressive pedagogies), 2) the Discourse of cognitive psychology in which the progressive pedagogy was embedded and 3) the Discourse of astronomy.

If one was defining a view of science literacy as the mastery of a specific 'scientific Discourse' without taking into account the social factors surrounding its usage, then yes, on the face it, Lenny was scientifically, literate and anx excellent candidate for teacher in the Shadow Data Project. But Lenny's ability to be 'scientifically literate' in after-school meetings was only one of many forms of address, a point in the continuum of meaning making in science. The goal of

cognitive psychology should be to see how meaning changes context and how context changes meaning.

Recognizing resistance cannot be the beginning and the end of researcher's confrontation of the problem of conflicting world views within schools. Rather, the task of sociocultural analysis of cognitive process in learning and teaching seeks to interpret the multiple layers of meaning that are produced through the collision of multiple Discourses within settings such as classrooms. When researchers design learning environments outside classrooms and then bring them to teachers to use, it is epistemologically shaky to 'fail' teachers, almost in the same manner we 'fail' students because they do not 'state clearly' the tasks we have given them. If there is a gap between the idealized Discourse and the one produced by teachers, it is incumbent upon researchers to question their ideological positions.

In multicultural classrooms where diverse Discourses and values co-exist, as in this case, the background assumptions of the instructional design (that the social processes can be 'recreated' or 'transferred') is transformed by the existence of multiple frameworks or Discourses for interpretation. When this occurs, a space is opened up for resistance. In this case, an African American teacher's 'voice' (being positioned as it was between many Discourses), used this multiple positioning as a place to develop his critique of the project. A different teacher, as unfamiliar with the Discourse of astronomy as Lenny was familiar, would have a different response in the dialogue between the discourses.

One possible outcome of this study might be a further exploration of the use of ethnography to interrogate the cultural models underlying cognitive psychology that has domiated and will dominate educational curriculum for the foreseeable future. Even the new forms of media technology, such as computers, as we have seen, will not be immune to the dialogic and ideological function of classroom communications. Hopefully, cautionary tales such as the one presented here will encourage teachers and researchers to resist and re-voice cultural models that tacitly erase teachers' voices and the sociocultural context that inform them. Not all forms of resistance will be successful or result in the immediate improvement for non-mainstream learners in schools. But if we, as educational researchers, can begin to listen and appreciate the meaning of resistance, we can at least begin to take the voices of teachers seriously.

Chapter 5:
Sociocultural analysis of teacher cognition

Cognitive studies of learning have traditionally focused on assessing cognitive change within one research setting (usually a classroom or an after-school club). This is as true for studies looking at the social origins of cognition, as it is of studies focused on the construction of cognitive processes within individuals. What both approaches to understanding cognition have in common is their limited interest in the social mediation of cognitive activity to activities outside of the classroom. Studies of teacher cognition and instructional practices are not exceptional in this regard. Typically, the goal in these studies is to build models for the assessment of teaching within a site-specific context. The intelligent tutoring system or coaching metaphors that are so often invoked in these studies reduce teaching to reflexive practice based on *on-line* assessment of students' moves (Shulman, 1986; Clark and Peterson; 1986).

While there is some soundness to these models, there is also much information that is lost when we limit consideration of the resources teachers use for on-line assessment to the immediate social context of the interaction. Recent theoretical advances in sociocultural studies, social linguistics and literacy studies call into question commonly held assumptions about the passivity of the reader in the active construction of communication (Bakhtin, 1986; Heath, 1983). By emphasizing what the reader brings to the text, many theorists have called for an examination of the reciprocal nature of the construction of meaning from texts. Developing such an alternative approach to the task of analyzing the interpretation of science literacy texts in practice is one of the major goals of this dissertation.

Instead of an exclusive focus on a teacher's classroom practices in terms of a decontextualized model of ideal interactions, my research moves towards a form of analysis which includes the teacher's cultural models of thinking and teaching. Rather than only assessing actions while teaching, I engaged in an extended dialogue with the teacher over the course of the school year (which continued long after the project ended) about what *cultural models were guiding his teaching strategies*. This is an important, yet subtle difference in orientation to interpreting teaching practice, for it takes us far beyond the immediate context of daily classroom activities. In this chapter, I will present description, analysis and interpretation of data which shows that 1) communication is not univocal, but multivocal and 2) learning environments (including

educational and media technology research in learning, teaching, the construction of knowledge) are, as in most complex cognitive activities, socioculturally mediated. I will identify the presence and absence of qualities in the sociocultural setting of the classroom which changed the meaning of the progressive science pedagogy. A sociocultural approach to mind has meaning, not information processing at the center of its enterprise. The emphasis is away from 'on-line' and towards 'meaning-making'.

In an earlier chapter, I described and analyzed the dynamics of the sociocultural context of a particular classroom, and the role these dynamics played in the social construction of science literacy. In this chapter, I will focus on how socially situated resources for cognition originating outside the classroom shaped this process. What I found in this case study was that individual cognitive actions within the immediate environment of the classroom were mediated by cultural models of cognition *(mediational means)*. This study seeks to make explicit connections between this particular teacher's cultural models of teaching and classroom practice. Linking cognitive theory building with practice required moving from an interpretation of the teacher as individual actor to one of teacher as "actor-with-mediational means within an activity setting" (Wertsch, 1991).

Instead of measuring teacher cognition as the completion of a task at a preordained point in a sequence of events (in this case a curriculum), I looked at what in the sociocultural context (curriculum, content area, institutional context and pedagogic theory) helped or hindered the teacher in performing his tasks effectively.

The emphasis of this chapter will be a detailed analysis of the teacher's resistance to curriculum as a form of cultural critique. It is my contention that the teacher in this study did have such a critique and that this awareness was in conflict with the 'institutional voices' of instructional learning practices of the school, and with the Discourse of cognitive psychology.

The widely held folk theories of western culture are partly responsible for the location of decontextualized reasoning at the center of theories of science literacy (Graff, 1987), while theories of "just plain folks" (Lave, 1988) such as Lenny are destined to exist at the margins. It is ironic that a 'folk theory' of the autonomy of literacy should sustain the unassailability of a scientific theory, while Lenny's efforts to situate the instructional design within a social context was marginalized.

The outlines of the existence of cultural models within the cognitive psychology Discourse become apparent once we contrast idealized subject positions of the teacher with the positions produced in actual practice. An example of a folk theory was the theory that the instructional design was not itself situated within a particular cultural

model of classroom communication. Instead, the instructional design modelled itself as being part of a 'design science' of learning. The term 'design science' came to acquire the meaning of privileged scientific social practices positioned outside of classroom practice. Its pedagogic practice was supposedly the result of the best theories of science learning available within cognitive science. The interactions in the design (such as children debating their theories in class without much intervention from the teacher) were presented as naturalized, dehistoricized, free of any race, class or gendered identity. This is a necessary outcome of the process of reduction which makes it difficult for cognitive science as a field to include itself as an object of reflection. But as Donna Haraway points out:

> "...natural science like the human sciences are culturally and historically specific, modified, involved. They matter to real people. It makes sense to ask what stakes, methods and kinds of authority are involved in natural science accounts, how they differ from religion or ethnography. It does not make sense to ask for a form of authority that escapes the web of the highly productive cultural fields that makes the accounts possible in the first place. The detached eye of objective science is an ideological fiction, and a powerful one. But it is a fiction that hides - and it is designed to hide - how the powerful discourses of the natural sciences really work. Again, the limits are productive, not reductive and invalidating". (Haraway, 1989).

I raise these issues not to invalidate the entire cognitive science enterprise. As Haraway points out, the critique of science should not ignore the value of its self-imposed limits for production. However, it is difficult to imagine a fruitful exploration of ideas currently at the forefront of cognitive science without a critique of its internal values. A shift in values could produce new products with radically different consequences external and internal to the study of minds. What I am exploring through ethnography is the possibility of a new set of values within the study of minds, one that sees sociocultural processes as central, not marginal to cognitive psychology. A cognitive psychology Discourse that sees itself as closer to experimental science than to cultural studies remains unable to divorce its cultural models about the role of the social in cognition with actual practice. Ethnography and cultural studies can call upon a number of sociocultural theories and methods for checking possible threats to validity of psychological accounts resulting from sociocultural bias. Again, this is not to stand in a corner and say, "since science has a sociocultural bias, it is invalid as a practice". What I am questioning is whether some of the practices we see as 'scientific' are only so in the light of an "ideological fiction" of the mind and of scientific practice (Gee, 1992). In the next section, I will discuss the theoretical tools used to try and historicize the individual subject (in this case, a teacher) within social, cultural and cognitive processes.

Voice, addressivity, multivocality and social languages

My ethnographic description of cognitive processes as sociocultural process rests upon the concept of 'voice'. Bakhtin's concept of 'voice' presumes that "an utterance, spoken or written, is always expressed from a point of view [a voice], which for Bakhtin is a process rather than a location. Utterance is an activity that enacts difference in values. On an elementary level, for instance, the same words can mean different things depending on the particular intonation with which they are uttered in a specific context: intonation is the the sound that values makes" (Clark & Holquist, 1984). The concept of 'voice' implies that even when individuals are engaged in 'private' individual activities, they are in communicative dialog with various *others*.

Lenny's response to the 'voice' of the instructional design (cognitive psychology) involved more than just a response to the immediate design goals of the project. The notion of 'addressivity' is important here - the addressee's voice is part of a larger chain of communication, reflected in the production of texts (or utterances). One makes an utterance with the expectation of a *counter word* or response. Knowledge of this produces patterns in any utterance reflecting how the producer of the utterance expects to be responded to. This expected response is not limited to speakers in the same place and time as the producer of the utterance. As Mikhail Bakhtin writes:

"This addressee can be an immediate participant-interlocutor in an everyday dialogue, a differentiated collective of specialists in some particular way of cultural communication, a more or less differentiated public, ethnic group, contemporaries, like-minded people, opponents and enemies, a subordinate, a superior, someone who is lower, higher, familiar, foreign, and so forth. And it also can be an indefinite, unconcretized other" (Bakhtin, 1986).

Lenny and I touched on nearly all of the distant, but relevant interlocutors in Bakhtin's list in the course of a series of interviews based on discussions of his classroom practice. *Lenny's theories were in dialogue with many 'voices' outside the immediate context of his classroom:* cognitive psychologists ("a differentiated collective of specialists in some particular way of cultural communication"); middle class African Americans ("like-minded people"); the sociocultural context of his classroom ("subordinate(s)"; and racism ("an indefinite, unconcretized other"). Issues of *voice* and *addressivity* deal with the question of *who's doing the talking* and *who's being addressed.*

"Voice" and "addressivity" extend the conceptual framework I have been using up to this point of Discourse, subject, interactions and text. With such an integration of ideas from Bakhtin's theory of dialogic discourse, social languages and the New Literacy Studies, we have powerful tools for the analysis of cognition in practice. (Bakhtin, 1986; Gee, 1990; Halliday and Hasan, 1985). My purpose is to show that conflicting Discourses exist within individual subjects, as well as within social settings made up of individuals. This is due to the fact that everyone in modern, western societies are multiply situated with membership and allegiances within a wide range of Discourse communities (social languages) or 'thought collectives' (Douglas, 1986). Thus all speakers and their utterances, except for the most basic, are multivocal.

The Science Literacy Project ends and the ethnographer-researcher dialogue evolves towards a greater intersubjectivity

Reviewing my notes and memos for that year and comparing them to the video and audiotapes of classroom discussions, I felt that my dialogue with Lenny was the most interesting aspect of the project. In the course of the year, my theoretical position moved away from an interest in differences and similarities of orality and literacy towards an interest in more ideological models of science literacy. I began to see how the orality-literacy "split" was itself a cultural model that embodied a theory of society bound up in a theory (some say myth) of literacy (Graff, 1979); also see background chapter).

The following is an excerpt from a memo written in March, about mid-way through the school year. It is an example of my developing theoretical interests and my attempts to work them into my relationships in the field setting. I wrote in a memo:

> I talked with Lenny today after school. I told him that I was doing research on the bilingual issue and would share some of my findings. He said, "oh, so you're still on that", and smiled. "Yes", I responded, "I'm taking your issue real seriously". I told him that I didn't want to talk to him too much about it at that point, and that we should spend some time later talking about it. I did say that the research that I was reading on the bilingual issue stresses that it was not the difference between complex and simple languages that put Creole speakers at a disadvantage in American classrooms, but that rather the difference between orality and literacy. Lenny responded by saying, "I don't think it's orality and literacy. It's the language you spoke...its the whole language experience."

As a result of exchanges like the one presented above, my focus was moving from analyzing Lenny's classroom practices towards coming to understand as a participant-observer, how Lenny's appropriation of the tasks involved seeing the classroom as he knew it - as a lived, cultural experience. The units of analysis were also changing due to a redefinition of the relationship of teaching to research. By re-articulating my position as a researcher in terms of my previous experience as a teacher, I was able to learn new ideas about teaching.

In the excerpt above, Lenny and I were not using the same systems of meaning in our readings of the particular sociocultural context of the classroom. I was trying to speak to Lenny through the Discourse of Linguistics ("I did say that the research that I was reading on the bilingual issue."). Lenny was speaking through the sociocultural context of his classroom, his own sociocultural models and the institutional discourse of his school. He says, "Its the language you spoke...its the whole language experience."

Linguistics as a field of inquiry views Creole as being no different from any other language (although this is a hotly debated issue with linguistics, see Todd, 1990; Romaine, 1988). While I still believe that the Discourse of theoretical linguistics can help us understand much about language in learning contexts, I also believe that use of the Discourse of sociolinguistics, in and of itself, is not sufficient. Through Lenny, I learned that the issue is not a purely linguistic one, but a social one as well. Linguistics treats Creole as an abstract (language) system, comparing it to other language systems. Lenny is thinking about the process of language acquisition, an area where a purely linguistic framework is not as applicable.

In trying to sort out the causes behind our differing interpretations, a shift in theoretical sensitivity began (see methods chapter for more on theoretical sensitivity as a phase in ethnographic analysis; see also *The Discovery of Grounded Theory* by Glaser & Strauss, 1967). It became clear that an examination of the cultural models that formed the basis of Lenny's theories of literacy would give a more comprehensive reading of the social origins of thinking.

Despite my initial antipathy to Lenny's theories of learning, I began feeling that I could not dismiss Lenny's ideas outright. They had a quiet, nagging persistence to them. They reminded me of discussions I had with my mother (also a Black educator). My mother received her Master's degree in Education from Teachers' College at Columbia University in New York City. She was not unfamiliar with progressive pedagogies, but she often critiqued them. When I was studying for my master's degree at Bank Street College, a graduate program based on a progressive approach to learning, she often told me that my graduate training would not work for 'all children'. She

would relate to me her teaching experiences in East Harlem in New York, and how she had to modify her ideas for the African American and Latino American children in her school.

When I started teaching and was able to try out my progressive learning theories outside of the laboratory school of Bank Street, I continued to have extensive conversations with my mother about the dilemmas I was facing in the multicultural settings where I was teaching. Remembering these conversations, a strange feeling of" deja vu" became associated with my conversations with Lenny. Perhaps this was a similar experience to what bell hooks describes, writing from the perspective of a radical black feminist scholar, about her intellectual debt to her grandmother:

> Her memory stands as a challenge to intellectuals, especially those on the left, who assume that the capacity to think critically, in abstract concepts, to be theoretical, is a function of class and educational privilege. Contemporary intellectuals committed to progressive politics must be reminded again and again that the capacity to name something (particularly in writing terms like aesthetics, postmodernism, deconstructionism, etc.) is not synonymous with the creation or ownership of the condition or circumstance to such terms refer. (hooks, 1990 - p.112)

Not knowing yet how my interactions with Lenny would form into a case study by the end of the school year, Lenny had become the main focus of my research interests. Conceptualizing the cultural models underlying teacher cognition in multicultural settings seemed to be an appropriate task. It was time to become more 'marginalized', to end my reliance on the Discourse of academia and to reach out to Lenny as a legitimate producer of knowledge. The summer following the end of the Shadow Data Project, I interviewed Lenny in his home (the site of the previous interviews) for many hours. As in the revelation bell hooks describes, that those outside the academy are legitimate producers of knowledge, I shifted to listening to Lenny on his own terms.

This is certainly unmarked territory for the individual researcher as well as for the field of educational research on teacher thinking in general. The goals and theoretical issues in teacher cognition generally originate in the center, rather than on the margins of power and influence. A theoretical framework that situates itself on the margins of this Discourse will look very different from what we are accustomed to as readers and producers of educational research Discourse. Undergoing such a process of decentering can be disorientating at first. But it is a necessary process to understanding the relationship between cultural models of science literacy and actual practice.

An example of disorientation that occurred early in our dialogue was my initial negative reaction to Lenny's self-description as a BASP (Black Anglo Saxon

Protestant). It was only as I began to learn about his life history through interviews that I began to change my frame of interpretation. Lenny grew up as one of the few African Americans in a small town in New England. New England has a much lower percentage of African Americans than other areas of the United States. Initially, Lenny's description of himself as a 'BASP' was not credible for me as I struggled to make sense of his contradictions. But through time, I redefined my own 'voice' as not being representative the voice of all African Americans, but one of many possible African American voices.

I began to see how individuals adopt multiple, and sometimes conflicting voices or subject position within multiple Discourses. Lenny helped the process in his honesty and willingness to have his ideas interrogated. The qualitative difference in our voices presented an opportunity for me to construct a sociocultural model of his 'voice'. Our difference was a chance for me to analyze why there were differences at all. Since I could no longer take for granted that we were speaking with the same voices, then I had to figure out why Lenny was doing what he was doing.

I found myself in a position which many contemporary anthropologists are finding themselves: creating ethnographic texts that complicate, rather than simplify. The good part of this story is that accepting this complexity undermines the illusion that we all share the same world. Recognition of alternative epistemologies is a challenge to the social order. Ethnography becomes a vehicle of political change through recognizing alternative epistemologies. Ethnography can help us change the core around which we construct a center and the surrounding walls that create a periphery.

> "The cultural critic becomes, in effect, a reader of cultural criticisms, discovered ethnographically, rather than an independent originator of critical insight. [T]he idea of the ethnographer's function as uncovering, reading, and making visible for others the critical perspectives and possibilities for alternatives that exists in the lives of their subjects is an attractive one. It is a function that anthropology has been performing aboard, and it should be a style of cultural criticism it could perform at home" (Marcus & Fischer, 1986, p. 133).

In the rest of this chapter, I will try to 'uncover' Lenny's perspectives. In doing so, I use ethnographic description as a means for raising new theoretical questions.

Setting the stage for dialogue between between researcher and teacher: from margin to center

In my first memo, written about Lenny, I wrote:

> Since the beginning of the project, Lenny has been reminding us that he feels that he has a wider range of skills in his classroom than the project assumes. We assured him that he could go at his own pace, that he did not need to adhere to a fixed schedule (which isn't entirely true..more on this in my memo to be written on the difference between astronomical time and school time), and that he could do the curriculum in any way he thought was better for his kids. Lenny did not feel this alone could address the problem of "skill levels" in his class. That's when I started probing deeper in order to get a sense of what he meant by "skills problems".
>
> - From Memo 1

When I asked Lenny why he thought that the middle class children were able to talk more easily about astronomical concepts than non-middle class children and why the non-middle class children lacked these 'skills', he said:

> It's a combination of reading and language. Starting out with kids with parents talking about the constellations. Having a slight bit of knowledge about astrological symbols and where they came from. In whole language and living experiences, some of them get this information. Their parents take them to the planetarium. They take them to the Smithsonian Observatory. They have open house there. How many minority parents even know it? That it exists?

In this passage, Lenny is presenting his theory of pedagogic discourse within the broader context of social relations within North America. What he is saying is that there are critical pedagogic contexts that take place outside of school, and that these involve socialization into culturally specific systems of meaning. His question, "how many minority parents even know it (about the open house at the observatory)? That it exists?" links social practices with his theories of instruction.

In the same December interview, Lenny consistently talked about how the sociocultural context or Discourse of the institutional setting affected his reading of the science literacy project. I asked Lenny, hypothetically, what he would change in his classroom if he was given free reign in changing his classroom Discourse.

> Lenny: I am still *constrained* to teach skills. Because the parents are going to constrain me. *Remember, it's not me. It's the parents.* (emphasis mine). The parents say "does my child know how to add

> and subtract, multiply and divide?" "Can they spell?" "Do they know anything about geography?" They ask about these skills. I've got to teach those skills.

Lenny's comment, "it's not me" is very telling. It explains Lenny's institutional constraints within conflicting social relations between himself and demanding White middle class parents. He uses the word 'constrain' to describe his relationship to them. Lenny believes that if school restructuring remains only at the level of the classroom, this would not satisfy parents.

As I became more familiar with Lenny's theories, I began to interrogate them. These interrogations often took the form of challenges. At first, these challenges occurred mostly off the record and were centered on educational issues facing Black Americans. On several occasions after observing a class or putting away my field notes, I would, talk casually about the merits or demerits of Afrocentric education (placing an emphasis on the ties between African and African American communicative styles at the center of pedagogic practice) or the fate of our children in a school system run by others. Most of the time in our early discussions we would not agree on much. I would end up pushing and challenging Lenny on many of his theories of learning.

However, Lenny took my challenges very seriously because a) I was an African American whom he perceived to be similar to himself and b) my challenges came from my own teaching practice (or instructional or learning practices) instead of remaining exclusively within the realm of cognitive psychology. Recall the concept of addressivity used above. Lenny's resistance to the instructional design was partly based on his theory that the cognitive psychologist lacked contextual knowledge of the classroom. Lenny could not as easily dismiss my questions about his teaching practices.

As a former teacher, I had taught in a school similar to the SHS in both its progressive orientation and multicultural student and staff composition. As an African American, my participation in the Discourse of progressive education gave me enough shared cultural experience to emerge in a dialogue with Lenny not just as an ethnographer of cognition but as a former colleague. In another memo, I wrote:

> I had a conversation with Lenny tonight on the phone. It was a very intense conversation on a number of levels: a) we got to discuss some real differences between ourselves on theories of language and cognitive development b) I had to ask Lenny some hard questions on why he wasn't collecting data or doing much of any of the activities with the children. While some of the conversation was difficult, it was necessary.

As you may tell from this memo excerpt, I was having difficulties interpreting Lenny's theories. At the same time, I was becoming familiar with the writings of Lisa Delpit (1986, 1988) on the 'silenced dialogue' of progressive African American educators. There seemed to be some convergence with Lenny's critique of the progressive pedagogy of the Design Experiment and Delpit's arguments with the progressive pedagogies of the writing process movement. Delpit's work, while only just beginning to bring attention to the contradictions of progressive Black educators, remained a crucial document in my trying to seek new frames of interpretation for Lenny. My encounter with her work was important because 1) it gave a socioculturally specific voice to anxieties and questions that I felt while teaching 'progressively' in a multicultural contexts and 2) it gave me a rationale for wanting to avoid making my conversations with Lenny a 'silenced dialogue'.

Dialogue, confrontation and the development of socioculturally specific (African American) intersubjectivity

In the sequence of events described above, one can see a developing intersubjectivity. As progressive Black educators, our intersubjectivity was not a random event. It was shaped by our shared goals and dilemmas. We both sought a deeper understanding of the tensions inherent in adopting an institutional 'voice' instructional practices that were progressive on the one hand, but on the other hand silenced our own 'voices' as Black teachers in multicultural settings. I had experienced a similar 'tug-of-war' between the various Discourses in my teaching practice.

When I taught, some aspects of progressive pedagogies in my classroom became problematic for parents of the more capable readers. These parents felt that their children spent too much time tutoring other children in reading. When I explained to them that it was the philosophy of the school that children learn through doing as much as from instruction, they were not satisfied. They wanted special projects and activities like book reports. Eventually I had to capitulate because these parents threatened to withdraw their children from the classroom and I was also committed to diversity. And these threats were not only from White middle class parents, but also Black middle class parents.

The following excerpt is from an interview conducted after the project ended. The excerpt comes from a longer exchange between Lenny and myself on why it is hard to find progressive educators within the African American community. I take one turn in the conversation (utterance 2), the rest is Lenny's talk. I broke this section into chunks that I feel follows Lenny organization of the talk.

1 Lenny: When we go for a minority teacher in our school, *one of the criteria is you have to have three years of teaching in an open classroom.*

2 Isaac: That limits a lot of people, right?

3 L: That's right.

4 How many minorities are you going to find, number one.

5 How many minorities who are reared in a family where that kind of openness was allowed.

6 That would say, "I want to go to school and learn how to teach in the same manner", ok

7 You don't find this.

8 It's scarce as hen's teeth.

There are many conflicting 'voices' present in Lenny's discussion on the relationship between progressive education, African American teachers, and the family as the sites and agents of pedagogic Discourse and the constraints of institutions.

In the first utterance, he is re-voicing the official Discourse of the school where he works, "when we go for a minority teacher in our school, one of the criteria is you have to have three years of teaching in an open classroom."

My reply (utterance 2) is a check to see if my assessment of Lenny's train of thought is correct. He confirms that, yes, I am correct in assuming that this qualification limits the number of applicants for teaching in his school. He continues this train of thought, by saying minority teachers are hard to find in general (utterance 4: "how many minorities are you going to find, number one"). This statement and the following, "how many minorities who are reared in a family where that kind of openness was allowed" is not the official Discourse of the school, but rather Lenny's *response* to that voice. These two utterances (4 & 5) are meaningless by themselves, but make sense in the context of the re-voicing of the school's institutional Discourse at the beginning. If utterances 4 & 5 were the official discourse of the school, then the policy would be futile and unnecessary.

The two contrasting (and conflicting) themes of the first utterance, (on the one hand about looking for a minority teacher and on the other hand, the school's three year rule), are evidenced in the structure of the utterance. The italicized clause is in the voice of the institutional Discourse, while the rest of the sentence is Lenny's voice. Bakhtin called such an utterance a 'hybrid construction': "an utterance that belongs, by its grammatical (syntactic) and compositional markers, to a single speaker, but that actually contains mixed within it two utterances, two speech manners, two styles, two 'languages', two semantic and axiological belief systems" (Bakhtin, 1981). At play here are Bakhtin's notions of voice, addressivity, dialogicality and social language.

In utterance 6, Lenny re-voices what he imagines to be the missing voice in most African American teachers, the desire to teach "progressively": "I want to go to school and learn how to teach in the same manner". Lenny's voice creates meaning in dialogue with the 'missing' voices of African American teachers. He attributes the absence of this voice to conflict between pedagogic practices at home in utterance 5 ("how many minorities who are reared in a family where that kind of openness was allowed"). Lenny places the typical African American teacher outside the Discourse of progressive education.

Utterances 7 & 8 merely verify and check what has already been said. We can make sense of these closing statements as summaries. In this interpretation of Lenny's talk, we can uncover the multiple situatedness of his cultural models and how he uses this model to situate himself as an African American teacher in the school culture. We can also see that his use of cultural models involves making choices as to which voice has priority in specific contexts. His access to some of the core cultural experiences of being a Black teacher, speaks to his attribution of the sparse distribution of like-minded peers to social relations rather than individual agency. This social knowledge also conflicts with his position as a member of the school culture where he is accepted as a peer. Lenny's cultural model does not necessarily lead him to a critique of 1) the school's policies, 2) progressive education or 3) African Americans. Instead, he offers a critique of the social relations in which all three sociocultural groups are embedded, and which shapes their relationships to each other. Within utterances are markers of social position and one's theory of social relations (or one's ideological position).

Examples of teacher's use of mediational means in theories of instruction

I asked Lenny on several occasions why he had one set of standards of classroom interactions for Black students and a different set for White students. Lenny often said that the Black students have to be "three times as good" as white students in school activities. I will present an example from our interviews transcript on this issue. The use of ethnicity as a resource in negotiating sociocultural difference is an interesting place to begin an inquiry into social processes mediating cognition in teaching. One might expect that the answer would be situated within the context of the classroom or his appraisal of individual students. After all, it is a question about classroom practice and one might expect an answer to be similarly situated within that context.

However, Lenny's answer is global, rather than local in his report of the use of social conflicts as the basis for classroom practice. His reports are consistent with observed practice as well as his reports on his actions just after finishing a lesson are basically no different in its basic themes than his reporting during interviews). Lenny does not limit himself to the mediational means within the classroom in describing his actions as a teacher, but takes into account the effects of larger sociocultural systems (racism, as one example) in mediating his actions. Lenny's cultural models of social conflicts between Blacks and Whites integrate local and global contexts when talking about his classroom. He embeds his classroom actions within a folk theory of society.

He attributes agency and the ability to act on one's agency to certain people, based on their position within a racialized social order.

1 Isaac: What are the reasons why Black folks have to be three times as good?

2 Lenny: Because the economic system that we live in the United States is prejudiced. There's no ifs ands or buts about it. If it wasn't then you wouldn't have all these laws, so called laws, to prevent prejudice and racism. Whether it'll be sexism whether it racism or whatever you want.

3 I: So it seems to me then that its basically Whites who are prejudiced against the Blacks so when I ask the question

4 Lenny: Blacks are prejudiced against each other just as much

5 I: Well.

6 Lenny: C'mon. Be honest with yourself. The same game is played. Remember the house slave and the field slave. That game hasn't stopped being played ever since.

7 I: Do you think that Blacks in America have the same power of institutions of this country behind them to exercise their racism?

8 Lenny: No

9 I: I don't necessarily agree with you but if I take your position that that Blacks are just as racist against other Blacks as Whites, do you feel then that absolves Whites of dealing with racism?

10 Lenny: No I didn't even say that. I said prejudice exists even among Blacks towards themselves and any Black who says it doesn't is sticking their head in the sand.

11 I: But why do you bring that up when I started to ask the question that isn't it the White power structure which is part of the problem.

12 Lenny: That IS the problem.

13 I: And you brought up the Black on Black racism

14 Lenny: That is the problem! That is the problem but what I'm saying y'know in order to combat this its made doubly difficult when you have the same prejudice among yourself on a very broad scale.

15 I: What makes you feel it's on a very broad scale? I'm just curious how you...

16 Lenny: Life experience. Let me put it that way, having been cross this country north, south, east, and west. West coast to east coast. From up in Canada down through Mexico.

17 I: Could you give an example of it an experience that contributes to your thinking like this?

18 Lenny: Sure. Looking at so-called who's who in Black America. Take a look through that and look at the color and do it historically. Look back at who were the historical people who so-called were the power brokers.

19 I: I don't get it. What are ...

20 Lenny: Take a look at every one of them. They were light bright and near white. They were less of a threat to the White power structure. They looked White and the education and the opportunities for education was a function of color. The opportunities historically to get a better job were a function of color who got the job in the house where you had a chance to eat better

21 I: It seems that an effect of White racism, not Black racism

22 Lenny: yes, but it's an effect of White racism that is now part of Black racism.

In the course of our exchange, I struggled to make sense of Lenny's references to racism when asked about classroom practice. We were speaking with two different voices. Lenny did not believe I was speaking in my 'true' voice, but instead, that I was re-voicing my experience through a (White liberal) Discourse on race which stops short of analyzing the effects of racism as a pervasive ideology that even Blacks have succumbed to. Lenny appeals to the authority of his personal experience to directing attention away from the immediate consequences of his actions in the classroom to the long term consequences and historical forms of racism as a mediating force in the lives of all people of color.

Utterance 16: Lenny: Life experience. Let me put it that way, having been cross this country north, south, east, and west. West coast to east coast. From up in Canada down through Mexico.

According to Lenny's world view, we still live in an ideological order where skin color is important for it forms the basis for a dominant ideology in our society (White supremacy). In other words, one cannot transcend skin color in modern America (yet one cannot rely on skin color alone for protection). Lenny rejects an analysis of teaching in multicultural settings based on a simple equation of race to oppression. Using Lenny's cultural models, one can interpret the effects of race as mitigated through other social relations in the society (in this case, class and skin color). In the above transcript, Lenny made reference to a color caste system in North America, an outgrowth of White racism. Such a color caste system acts to privilege Blacks whose skin is closer to white than black. He is not alone in theorizing the productive role racism plays in the

development of individual psychologies and the construction of subjectivity between Black people. The internalization of these values by Blacks is a problem addressed in the work of Black intellectuals such as Franz Fanon (Fanon, 1967).

Lenny's theories became most clarified within the parts of our dialogue centered on our contrasting views on race. It took considerable work for us to reach any consensus on the meaning of race. As Paul Gilroy (1987) points out, "race has to be socially and politically constructed and elaborate ideological work is done to secure and maintain different forms of racialization which has characterized capitalist development". Gilroy goes on to argue for a concept of racial formation instead of race: "The concept supports the idea that racial meanings can change, be struggled over. Rather than talking about racism in the singular, analysts should therefore be talking about racisms in the plural. These are not just different over time, but may vary within the same formation or historical conjuncture." (Gilroy, 1987)

This seems to be the case here in the way talk is used to create and maintain the use of racial terms, although we are both African Americans. Our exchanges provide further evidence that the biological determinism of race as a basis for racial identity is suspect. Instead, we find a fragmented, socially situated self, operating within multiple contexts. This has implication for the development of a social psychology of race which has as its focus a decentered subject (Henriques, 1991). My analysis began to question idealized notions of race as a political and ideological category whose meanings do not vary across sociohistorical contexts. We need to recognize that there are huge gaps in our understanding of the way people are constructed as social and cultural beings and how they are constructed as psychological beings. The theoretical groundwork for such an approach is being in laid in other studies besides this one (see Henriques, Holloway, Urwin, Venn & Walkerdine, 1984; Chaiklin & Lave, in press)

Sociocultural issues in the construction of race in everyday classroom practice

My previous theories of ethnicity were being challenged in my dialogue with Lenny. The interview transcript presented above is an example of Lenny's challenges to my theories of ethnicity and race. At the time of these interviews, I was developing an interest in Afrocentric pedagogy; a pedagogic practice emphasizing the cultural and social links between African and African Americans. Lenny was not an advocate of Afrocentric pedagogy. His theories on this subject was based on personal experiences with the Black Liberation movement of the 1960's, ("I've been through that in the sixties, it didn't work then and it won't work now") as well as reports of family

members who have been to Africa. In the following interview excerpt, Lenny describes what happened when his brother went to Africa to make slides for use in American classrooms.

> Lenny: (the slide show) includes all the Benin brass and the kente cloth and the history of the Mali and the Songhay republics and Masai. Its all there [in the slide show]. One thing he did find out: he's American. He was looked upon by Africans as an American not as an Afro-American but as an American. See that's the one thing that kind of shocked him. I think a lot of Americans, Black Americans go over there thinking they are going to be accepted as Afro-Americans or y'know Americans of African heritage. No they not! They're looked upon and treated as Americans. Africans discriminate. You're American.

Lenny 's disinterest in bringing "Afrocentric" pedagogic practices into his classroom, however, did not mean that he did not have specific pedagogic practices for children of the African diaspora within his classroom. Pushing for clarification between his theories and practices, I asked Lenny why he used a different standard for the Black students than the White students in regulating the behavior and assessing classroom performances.

> 1 Isaac: What are the reasons why Black folks have to be three times as good?
> 2 Lenny: Because the economic system that we live in the United States is prejudiced. There's no ifs ands or buts about it. If it wasn't then you wouldn't have all these laws, so called laws, to prevent prejudice and racism. Whether it'll be sexism whether it racism or whatever you want.
> 3 I: So it seems to me then that its basically Whites who are prejudiced against the Blacks so when I ask the question
> 4 Lenny: Blacks are prejudiced against each other just as much

The first two turns involved us interrogating each other. I began with my question, "What are the reasons why Black folks have to be three times as good?". Lenny answers racism, in turn 2. In my next turn (3), I attempt to appropriate Lenny's response into my own frame of reference, a focus on White racism. Lenny's response, "Blacks are just as prejudiced" is clearly not what I expected to hear. Lenny knew this because of our previous discussions throughout the school year. Thus, I interpreted his statement ("Blacks are just as prejudiced") as a challenge to me. This challenge

represents the conflicts between different systems of meanings each of us attached to the term 'racism'. Not only did my attempt to appropriate his answer into my system of meaning fail (in turn 3), but this failure or communicative breakdown changed the direction of the activity. We went from examining what I had thought would be a discussion of the racism of Whites to one on the racism of Blacks. In turn 5, I could only muster a "well" (with descending pitch) as a response, which Lenny correctly interpreted as meaning he failed to convince me of his views.

Lenny continues with a direct appeal to my own personal experiences, which he assumes is closer to his: "Be honest with yourself", he says. The addressivity of his utterance is formulated on our assumed similarity (Bakhtin's "like-minded people"). Lenny's request to me: "Be honest with yourself" is his way of saying, *"from what I know about you and from the task we are doing together - constructing an understanding around issues of ethnicity and race in multicultural settings - your statements are contradictory"*.

This is a theme that would emerge several times in the course of my interviews with Lenny. Lenny assumed that, as an African American graduate student, I was not examining the socially (and multiply) situated nature of my own experience. Lenny also changed the frame of reference for the conversation, grounding his theories of racism in a concrete sociohistorical setting that is very far in time and space from the science literacy project: the legacy of plantation slavery in the Americas. Lenny has re-voiced my discussion of institutional racism:

6 Lenny: C'mon. Be honest with yourself. The same game is played. Remember the house slave field slave. That game hasn't stopped being played ever since.

Lenny 're-voices' my theme of White racism in general. The theme of 'racism' requires agency. My attribution of agency in utterance 3 ("Whites who are prejudiced") is changed by Lenny's response in utterance 4: "Blacks are prejudiced". "Racism" meant different things to each of us. His response signals a change of position and a corresponding change of theme dialogue's theme of racism.

In turn 7, I counter this move by trying to reframe the question back to my own interpretive framework. This question attempts to clarify what, if any, systems of meaning we share. This discourse move works to some extent, because Lenny agrees with me in the next turn:

7 I: Do you think that Blacks in America have the same power of institutions of this country behind them to exercise their racism?

8 Lenny: No

Although we reached a plateau of agreement, the one word response, (No) is not really what I intended. The second part of my two-part question tries to get the conversation to continue. Having gotten Lenny to agree with my premise that institutional racism gives Whites more power than Blacks, I try to take on his perspective ("but if I take your position"). But this is a complicated move, because I am not *really* taking on his perspective. I am trying, instead, to demonstrate to him, what I believed to be a contradiction in his theories of racism.

Lenny rejects my 're-voicing' ("No I didn't even say that") and he not only reasserts his view, but by implication challenges the depth of my analysis (that 'any Black '- by implication a reference to me - who disagrees with his point is 'sticking his head in the sand'). This is a direct challenge to my cultural models of ethnicity. Lenny does not perceive me as reading the meaning of racism from my actual social group position.

In utterance 11, I ask another assessment question. While on the surface, this question refers to the structure of the conversation, ("why did you bring that up when I started to ask you about the White power structure?"), it is an attempt to extract more information about Lenny's cultural models.

Lenny's response establishes common ground, he finally agrees with me that White racism IS the issue (12: "That IS the problem"). I follow-up in turn 13, with a clarifying, declarative statement which in effect is trying to tie up the loose ends of why *did* Lenny launch into a discussion of Black on Black racism in response to a question on White racism. After listing of personal experiences as a source of validity for his concepts of racism, Lenny summarizes his position in turn 22 ("it's an effect of White racism that is now part of black racism."); The use of the term *c'mon* is indicative of the fact that our conversation is a *social activity* as much as it is an act of communication. *C'mon* denotes a certain type of relationship, he is not giving or requesting information but requesting action. I should recognize and act upon our mutual solidarity. In this case the requested action is for me to re-evaluate the tension between my public face and private life. As Jim Gee observes:

"Sociologists often discuss these two in terms of the technical concept of 'face'. They say a person has a 'positive face' that they face towards others and which represents the need for involvement with others. At the same time each person has a

'negative face' that they face away from others and which represents their need for independence and privacy". (Gee, 1990, p. 97)

In the course of our conversations, Lenny and I kept balancing this aspect of our dialogue. Lenny was aware I had criticisms of his classroom practice. I was aware he had criticisms of the science literacy project (see chapter 4). I was also quite sensitive to the fact that Black middle class Americans are often between (at least) two different cultures - one Black, the other White and middle class. And that a delicate balancing act between conflicting values systems exist for such individuals. What may be a positive face saving move in the core Black culture, say, a premium placed on collectivity, may become a threat to one's private self in middle class culture, where individual achievement is more the norm (Cruse, 1967; hooks & West, 1991).

These conflicts need not be sequential or distributed spatially, (i.e. one acts more "Black" in Black institutions, more "White" in White institutions). In practice, these conflicts often manifest themselves in the same place and time within the same person. The explorations of Lenny's cultural models made this underlying tension most explicit. In the social construction of meaning, issues of face are intimately linked to one's ideology and theories of society. One is always left with making choices between the self and solidarity to the social groups which we belong. There are no easy answers.

The conflicts between self and solidarity are part of the social processes of cognition. For example, a sense of 'solidarity' did develop between us which allowed for the exploration of our different cultural models, and this exploration was reciprocal. I have no doubt that Lenny and I influenced each other through the interplay of personal difference and group allegiance. On my part, I came to see how all models of ethnicity were socially and culturally mediated and that I had not fully contextualized the different social context in which Lenny constructed his cultural models or cultural models.

For Lenny, in the simple but powerful act of listening, I provided a space for the elaboration of his ideas. Even as the writing of this thesis is being completed, almost two years after the science literacy project ended, I still receive occasional calls from Lenny continuing our dialogue. Our dialogue certainly ignited something in Lenny's need for a continued forum or activity setting. In a recent call, he invited me to visit his new group of students at the start of the school year: "Hey, you're still needed as a role model". The connection and mutual goals that we share during the project and beyond it are situated in a much broader set of sociocultural concerns than what goes on within specific classrooms or research projects. Developing and interpreting these mutual cultural models for science teaching in multicultural settings is part of developing a

broader social critique of the cultural models guiding science education and educational research.

Teacher's theories of ideological effects on classroom practices

Conceptualization of ideological effects on teaching practice developed from our on-going dialogue and from ethnographic triangulation with his life experiences outside of the classroom. In the next section of transcribed dialogue, I focus the analysis on the way in which Lenny structures his narrative of teaching strategies. The focus of this exchange begins with the questioning his often-repeated phrase, "the real world". That will be followed with Lenny discussing the events in his 'real world' that help form his pedagogic practice. Lenny's discourse is broken into contrasting parts, emphasizing his use of thematic organization, contexualization and Discourse organization and how they are integrated into the text to give it meaning.

Inside the school: the 'imaginary world' of multiculturalism

1 Isaac: So when you say 'real world', you mean when they leave the Sandy Heights School (SHS)?

2 Lenny: The SHS focuses on positive multicultural social interactions and learning interactions in a positive way.

3 Those are skills that you learn just like math and science or anything else.

4 If you don't teach them, kids don't learn them.

5 How can you expect kids to automatically pick up these skills?

6 You literally have to teach kids to get along.

7 Isaac: So if you've been teaching that at the SHS, and then they go into another environment, what is the difference between the next environment and the SHS that you want to prepare them for?

Outside the school: The 'real world' of racism

Lenny's perspective: school should prepare Blacks to deal with racism

8 Lenny: That they'll be prejudicial attitudes from students and teachers and this will go on the rest of their lives.

9 Once you get away from the environment that nurtures you, now you're out on your own.

10 Let's call it the world that exists outside this small environment.

11 You've got to survive in it.

12 You've got to be able to deal with prejudice for whatever reason it exists.

Appeal to evidence: employment statistics

13 And as I've explained to the kids, if you don't, when you want to look for a job, you're going to work three times harder.

14 You have to be three times smarter or three times lucky.

15 And I use three times because if you look at the ratio of unemployment Black youth to White youth, it's about three to one.

16 And so your odds at getting a job are in proportion to that".

The importance of personal experiences with the 'outside world' for Black children to understand Lenny's message

17 Isaac: How do you think that message is being received by the Black students in particular?

18 Lenny: It's hard to tell because they're not really out there trying to get a job yet, so its just something to kind of collect.

19 I hope they store it in their minds so they will be prepared to say 'oh yeah' when they go apply.

20 When they run across it, they'll be able to recognize the bias and be able to deal with it.

Lenny's narrative has two constrasting parts. His thematic organization works to give cohesive and additional rhetorical power to his arguments. His decision to use this particular structure in his discourse reflects multiple positions in various discourses. There is nothing inherent in the subject at hand that required Lenny to structure his discourse in this way. This provides more evidence that this is a rhetorical move, signifying his perspective or viewpoint that he wishes to defend.

The world of the SHS and the 'real world' outside are seen as opposing pedagogic sites. In the particular institutional setting of the SHS students learn how to get along with other people in the same way they would learn a subject like mathematics. Outside the SHS learning involves how to 'survive' when you don't get along. This lesson learned outside of school is one that Lenny feels is important. He builds on this contrast in order to defend his teaching practices which are as 'outside' of the institutional discourse of the multiculturalism of the school as the 'learning' is (see utterances 8 - 12).

Lenny's implicit critique of the politics of multicultural education is based on 'personal experiences' as an African American male. He sees the politics of multicultural education as being limited to "positive multicultural social interactions and learning interactions in a positive way". Lenny's personal knowledge of racism forces him to include within the politics of multiculturalism preparation for Black children to confront "prejudicial attitudes from students and teachers" that "will go on the rest of their lives." Although he does not name the Black students, they are the subject of this utterance by implication. It is the Black, not the White students who face "prejudicial attitudes from students and teachers". Utterances 2 and 8 are almost completely opposite in that 2 focuses on positive attributes of multiculturalism, while 8 looks at what the racism multiculturalism ignores.

Lenny's discourse can be broken down into the following contrastive elements:

White - Black

Small environment - large environment

School - The real world

positive learning environment - racist society

White children are seen by this teacher as being the beneficiaries of the small, positive learning environment inside of school, because multiculturalism in the school's Discourse is more continuous with their experiences at home. It is taught in relation to the decontextualized school-based Discourse and is thus devoid of any connection to what Lenny calls the 'real world'. On the other side, Black children do not benefit as much from the positive learning environment because they lives are more directly affected by racism. In the "real world" competition for jobs and racism, White employers will be prone to position the Black student as unprepared. To resist this, Lenny argues for over-compensation as a strategy to deal with racism.

Lenny grew up as one of the few Blacks in a mostly White middle class environment in the 1950's. It is not surprising, based on his own personal experiences - over-compensation was a strategy that had once worked for him.

> Lenny: If you go out late at night fooling around with those White kids, you're the one that's going to get blamed, not them. That's racism. I ran into it all the time. I grew up in an all-White town. Who else was I going to go out with? And of course, this meant at times, you're the one that stole and I had to say 'up yours'. But I grew up in a family that questioned. I was one of the smartest kids in my class. I read a lot and reading is the key.

The science literacy practices of the project that were meant to be univocal came in contact and conflicted with Lenny's 'voice' and its meaning was changed as a result. It can be argued that Lenny's experiences with racism has little if nothing to do with science literacy. But in the context of teaching within this specific multicultural setting it has much relevance.

Lenny's experiences are relevant because they caused him to emphasize the intermental relationships in the class (which can classified under the more lay term, *classroom behavior)* when thinking of the intramental. Lenny is concerned with the way in which larger sociocultural issues such as racism mediate and situate actions of minority students to their disadvantage. His concern is based upon his own sociocultural situatedness. A different teacher (say, a non-Black female) might read the 'texts' of the classroom and science literacy differently.

For example, imagine a well-meaning, relatively liberal, White female teacher in the same context. She might possibly ignore some of the 'behavioral problems' involved in teaching this particular curriculum. She might allow the same group of Black children, that Lenny does not, to go outside and collect shadow data. She might be aware that without her direct supervision there is a chance the task might or might not get done. She is willing to accept this possibility because she feels that the risk is worth it, because, the students will eventually become self-disciplined. Being the good liberal she is, this imaginary teacher will never reveal to the children her own anxieties that unless they apprentice to, as well as learn, the interactional patterns of school Discourse, they will not get good grades and will not receive the 'right' credentials to succeed in this society. Yet she refrains from sharing this knowledge because the Discourse of progressive education is motivated by the idea that the children need to construct knowledge for themselves for it to meaningful. If she 'told them' the answers to the key to success in school and in later life, she would not be 'constructionist' or 'progressive' because she would be placing external constraints on what should ultimately come from the student. She has made a choice and thus her cognitive strategies in teaching will also involve a perspective, a viewpoint, or an ideology reflecting her social position within her social group (and her social group's position to others in other social groups).

Additionally, because my imaginary teacher is a middle class White woman, she probably will be less likely to be accused by a police officer on the street of performing a crime she did not commit and will have no powerful adolescent memories of confronting the brute force of the hegemonic structures of America's capitalist patriarchal society (although she will almost certainly experience other forms of oppression, including 'brute force', in forms specific to her gender oppression, such as sexual harassment).

Her membership in the dominant White culture and the inherent non-violent sexism against women will most likely allow her more leeway in behavior patterns that are seen as threatening when performed by Blacks in general and Black men in particular. Thus, her sociocultural context for reading the behavior patterns within a science literacy project would be different.

Her actions might be read as more 'humane'; 'tolerant'; 'progressive' or a variety of other 'politically correct' adjectives, in the Discourse of progressive education within the setting of a progressive school, while Lenny's actions might be read as being opposite to that in the same setting. The point is, not who is more "just", but rather, before any judgments can be made, an evaluation of people's sociocultural perspective should be part of the agenda. What might seem natural to one speaker/reader is not to another. And the difference is not so much in the qualities we 'possess' than in the qualities that possess us. Whether or not one trusts the police has as much to do with individual's levels of experiences than the institutions of law. This is what is meant by sociocultural mediation of thinking.

Regulatory aspects of pedagogic Discourse and sociocultural mediation in the construction of class

As seen above, the question of 'behavior' looms large in Lenny's analysis of teaching practice. In this case, the issue of behavior is related to the teacher's cultural models of class relations. The formation of the race/class intersection within Lenny's theories can be interpreted as coming directly from him, ideas he carries in his head and have dubious connections to sound teaching practices. *An alternative reading interprets his practices as being resistant to univocal, normative assumptions of a cognitive psychology Discourse which naturalized its own cultural models of learning (progressive pedagogy) as the universal unit of analysis for all cognition.* Lenny fell back on cultural models which felt 'natural' to him, to try and sort out the discrepancies between the social interactions theorized within the instructional design and his own. Cultural models are very good at helping us deal with both the expected, canonical events in the world, and the unexpected ones (Bruner, 1990). If the Haitian students became fluent in science literacy in the manner desired in the design, that would be an unexpected event in Lenny's world view. What is important here is the way cultural models mediate the incorporation of social relations (such as racism) and a Black cultural critique of progressive pedagogies into this teacher's thinking.

What is needed to incorporate such an analysis into analyzing classroom practices is an acknowledgement that all pedagogic practices (as forms of institutionalized voices) are embedded in other forms of Discourse. There is no such thing as "pure" pedagogic Discourse. Pedagogic Discourse must always take a position - a point of view. All pedagogic Discourses contain models of types of interactions, not just the words that go with the interactions (Bernstein, 1990). The way in which certain pedagogies classifies subjects and frames modes of interactions carries a larger Discourse or 'world-view'.

The progressive pedagogic Discourse of the institution where Lenny taught was no exception to the tendency of Discourses to frame world-views. The norms for behavior in progressive education were supposed to be more 'child-centered'. This focus on individual control contrasts with non-progressive pedagogic discourse where the focus is more teacher-centered. In progressive, individual-orientated schools, the success of positioning the locus of control with the child hinges partly on the child knowing the more loosely framed boundaries of inner motivation and external constraints suggested by the school's institutional Discourse. The success of progressive education is based on the assumption that the pedagogic Discourse of the school is an extension of the familial pedagogic context of the child.

This has to be an unspoken assumption because in my time observing in this and other classroom sites of progressive pedagogies, mastering the loosely framed boundaries of progressive education is never explicitly modeled.

Without a window onto cultural theory, the social theory backgrounding a cognitive psychology Discourse on social cognition could not envision a historical subject. Sociocultural relations within the classroom showed the theory of science literacy to be incapable of describing or incorporating the wide range of sociocultural data into their analysis. The theory could not properly account for changes in the social context it had initiated. Lenny's theory of the social context of learning in his classroom began with an emphasis on differences in community Discourses and literacy practices.

The cognitive psychology Discourse guiding the project theorized cultural difference as something to be eliminated. This was to happen through interactions with more expert peers, students were expected to be 'boot-strapped' to science literacy. Apprenticeship to science literacy was to occur through interactions with more capable others who were less socially distanced from you within a 'zone of proximal development' (see Vygotsky, 1978; Wertsch, 1985 and Tharp & Gallimore, 1988 for more on the ZPD). Nowhere in this theory is there room or time in actual practice reserved to examine the existence and analysis of beliefs, desires, etc. in the acquisition of science literacy. Yet, ZPD's do not exist in a social vacuum. Their existence is

punctuated by a series of social and cognitive relationships throughout the life of a student within an institution. While the theory of the ZPD may be sound, what we are asking students to 'boot strap' up to (to use a term that has unfortunate cultural resonances of 'self-help', but is used repeatedly in the cognitive psychology literature) may not be helpful. It is not a question of "how" to boot-strap but a question of 'bootstrapping' to "what"? It is question of meaning, not of representation, requiring social theory, not social tools or technique.

We need an awareness of social relations that can speak to the power of Discourses to create and maintain distances between individuals in classrooms. Neo-Vygotskian pedagogy often betrays an influence of Piagetian Theory with its association of ages with stages of development. Why should we assume that a peer from a social group with more privilege and status, will not in communication with less-powerful others, use resources available in the more privileged Discourse that maintain and distribute social roles. This happens because agency is partly in the Discourse, not solely in the person. The children of the White middle class were not deliberately planning on using their community Discourse to gain an upper hand in classroom communication. But in the context of institutions that privilege their Discourse, while positioning other Discourses as being unconnected to science literacy, the outcome of the process is a reproduction of the social order. As Gee writes:

> "The cultural models of the student's own home culture can conflict seriously with those of mainstream culture. And some of the values of mainstream culture are complicit with with the oppression of some students' home cultures. This is true, for instance, in the case of many Black and Hispanic students, as well as many from third world cultures. These conflicts are real and we should not try and wish them away." (Gee, 1990, p, 90)

The conflict between the Discourse of the institution and the primary cultural models of the non-mainstream child was a factor in Lenny's reasoning. He could not be totally progressive because of the children whose primary Discourse at home was discontinuous with the Discourse of the classroom. To Lenny, 'behavior' is the manifestation of the larger issue of conflicting Discourses. Given the conflicting social identities the teacher brings into the classroom, cognitive practices are as much the outcomes of struggle to 'make sense' within and between multiple discourses.

Chapter 6:
The Social Gravity of Cognitive Research:
the production of knowledge as social practice

Theoretical issues in the analysis of the social aspects of cognition

In the preceding chapter, an ethnographic description of the self as multiply situated was advanced. I hope that the reader is by now convinced that when Lenny is standing in front of his classroom teaching, although he is presenting himself as being one person doing a specific task (talking to students, writing on the board, listening to students, etc.) the situation is actually much more complex than that. Lenny is engaging multiple selves, each with their own 'voices' and sense of 'self'. In this chapter, I present a similar portrait of the multiple, and at times, conflicting Discourses at play within cognitive research in classrooms. My mode of analysis is similar to the way in which I have tried to situate Lenny's theories within an ethnographic description of the cultural models guiding his teaching practice. In this chapter, I socially situate some of the practices of the cognitive researchers under study. While the mode of inquiry is similar to my analysis of Lenny, the implications will be different.

Socially situating the practice of cognitive science and its subdiscipline, cognitive psychology is slightly paradoxical. It requires a critique of the units of analysis used by cognitive science. But the theoretical foundations of cognitive science as it is now constituted cannot produce the critique necessary to make sure that our units of analysis are valid. This case study is an example of why one cannot develop a critique of a Discourse within the Discourses' own language. In this chapter, I hope to explain why this is so. I propose a solution to this dilemma: the construction of a cognitive science Discourse that is multivocal and is also conscious of its own values.

For the purposes of this case study, a thorough examination of the sociocultural resources available for teacher cognition must include a consideration of the social context within which the instructional design was brought into being. This examination will not be as extensive of the social context as that of the teacher's, but crucial nonetheless. The limitations of ethnography as method become apparent for it is much more difficult to do ethnography on those who have power over you than those who are your peers or whose power does not directly affect you. There is a long tradition within ethnography of studying those with less power (for a critique of this tradition see Dominguez, 1987; Said, 1989; Clifford, 1987, 1988).

But ethnographies of advanced capitalist societies must begin to unpack the social practices of those who traditionally have been the 'researchers', not only the 'researched'. Achieving this goal requires displacement of the idea that social action is the result of rational action with a consideration of values and beliefs. As cognitive science and psychology increasingly move towards theorizing the social, self-reflection on the social position of the cognitive analyst will become crucial.

The conferences and meetings between 'senior researchers' are not always places where graduate students writing ethnographies are welcome or invited. At this point, given my present social position, I have learned an important caveat to the axiom of researcher as instrument, so critical to ethnographic studies: you can be limited by your social position in studying those more powerful than yourself.

Institutional frameworks for cognitive practices: the everyday world of cognitive psychology

In January of 1991, (the academic year following the classroom research), I interviewed Randy Murray, one of the cognitive psychologists working in Lenny's classroom. I asked Murray to describe the sequence of events that led to the adoption of the Hatano-Itakura Method by the researchers as one of many pedagogic practices presented to the teachers as part of the Design Experiment. How Lenny's appropriation of the Hatano method should be interpreted was a source of disagreement between the researchers on one hand, and Lenny on the other. Lenny and the researchers did not agree as to how much Lenny a) was supposed to use the Hatano method for the entire instructional design and b) whether or not he actually did. For the purposes of this study, I will try and clarify the sociocultural resources that produces these two different interpretations of teacher cognition. In the previous chapter, I outlined the significant sociocultural resources available and used by the teacher. In a more limited way, I will attempt to do the same for the researchers.

The disagreement over appropriation of cognitive psychology-based pedagogies is a good place to begin socially situating the construction of meaning for the cognitive psychologist. To achieve this goals, it is necessary to describe ethnographically the social practices that comprise cognitive psychology Discourse. As Bakhtin points out, meaning is always created around a self/other relationship. In this case the 'other' is the set of social practices, ways of membership, and the construction of a sense of self in relationship to a public identity as cognitive psychologist. Influenced by Bakhtin, I have used aesthetic categories of *narrativity, subjectivity, stanzas* (in reference to text

organization) in my analysis. Using aesthetic categories to discuss epistemology brings attention to the dialogic nature of communication. We are in dialogue with the world as we construct ourselves (Holquist, 1990).

In the following narrative we hear Murray's theories about the migration of the project from the world of cognitive research to the classroom. I divided this narrative into stanzas by its own internal division of space and time. We first have the meeting of the researcher at some unspecified time in Pittsburgh prior to the summer workshop. The next space/time location is the summer workshop which acts as an intermediary point between the research world and the classroom, which is the last place in the narrative.

Conference

Well the Itakura thing. I think mainly came from Helen Clark and Tim Anderson. Helen and I went off to this conference in Pittsburgh, I took her actually, where Hatano had come. I knew Hatano. He talked about the Itakura method and because Tim Anderson was particularly interested in it and he had a Japanese student they started pushing for Hatano.

Workshop

There was a little bit of discussion at the work shop we held in the summer with the teachers about..... I mean we talked a little bit about the Itakura method so we *did* tell them something about it, but it wasn't stressed particularly. We probably did convey that we wanted teachers to encourage the kids to theorize and that conveying that idea probably conveyed a notion of you shouldn't tell them the answers. That's not. Its something I mean I would say the whole workshop was conveying a notion of science as trying to collect data and figure out y'know explain to the teachers in general.

Classroom

Lenny knew a lot more than they (the other teachers) did. He gave them stuff that they could use in their scope and sequence but I think he decided not to to pay any attention to what they had done. I don't think he followed it (their curriculum) at all.

This is essentially a story of friendships between researchers ("Helen and I went off to this conference.....I took her actually"; "I knew Hatano"); of their desires and how it informs their practice ("Tim was particularly interested in Hatano....They started pushing for Hatano".). There was also an interesting intersection between career and ethnicity ("Tim had a Japanese student".) It is everyday practices like these that provide the background for scientific endeavor. Here we see that the choice of research topics and methods is as much a product of the research world (where they will be analyzed) as it is a product directly related to a research problem. Government and state interests can not be discounted:

Isaac: OK how did the Design Experiment project begin?

Murray: Well, partly it started with the Center for Research on New Technology proposal which was basically the government requesting that the new technology center emphasize looking at the way computers are used in classrooms. How they can be most effectively used. So I, in working with the proposal with Jean Monroe at Upper Manhattan College was pushing the notion that we should be trying to create what I call a design science of education which is instead of people having their innovations going in and testing out whether they work a particular way that you want really to look at sort of the whole social milieu into which innovations get put to have neutral observers who don't have a stake in the outcome looking at the different ways that different kids interact with different kinds of technology in different settings with different configurations so I wrote a paper which sort of has a {inaud.} statement about this view. Now subsequent to that then Helen got the Education Institute (pseudonym) money Helen Clark with Adam Clayton's help and Ed Harris' help and there was in that proposal a component to look at technology and its relations to literacy.

In this narrative, we see the flow of ideas following the flow of research funding from the government request for proposals to the funding of a research center and then to the researcher who collaborates with another research center with a different agenda (and funding source).

Tacit recognition of Lenny's resistance are already evidenced in Murray's noting that he did not think Lenny followed any of the design as it was created during the summer workshop. However, Murray expressed surprise at my interpretation of the reasons why Lenny did things differently. Murray believes that Lenny transformed the

curriculum because he was comfortable using the Discourse of science (astronomy). In my interview with Murray, I presented the following alternative theory of Lenny's practices (developed in greater detail in chapter X):

Lenny felt constrained by many things in the classroom that impeded his successful implementation of the design. One of these things was the design's use of the Itakura method which he felt would privilege the middle class children whose primary Discourse came closest to that of the method's idealized pedagogic Discourse. This critique is part of a broader critique of progressive pedagogies in general.

Murray's responses to my presentation of Lenny's theories (in the same interview) takes two forms. Either the Hatano method was not supposed to be stressed, or even if Lenny did stress its importance, the Hatano Method was not far from Lenny's actual classroom practice:

Theory #1:

"I mean we talked a little bit about the Itakura method so we did tell them something about it but it wasn't stressed particularly. We probably did convey that we wanted teachers to encourage the kids to theorize and that conveying that idea probably conveyed a notion of you shouldn't tell them the answers."

Theory # 2:

Isaac: In my conversations with Lenny, he apparently thought he was doing something different than what he was doing before (the design) because he characterized it as a certain approach that he either at times endorsed or critiqued but all I'm saying is that he did think he was doing something different.

Murray: "Yeah certainly the collecting of data or the degree to which he took Olson's data that he brought in from Japan etc. and tried to run discussions around that I'm sure that was all different or using technology."

Isaac: Right

Murray: He wouldn't have normally done a lot of those things so my sense is that, sure, he did things differently. I would have thought that his natural discourse style was not to tell them answers so much but maybe I'm wrong about that I mean he likes to tell stories about the Greeks and things so I think somebody did do an observation in his class before. What came of that I don't know? So there might be some actual field notes or something from prior observations of his teaching? (Emphasis added)

In the section above, Murray entertains two conflicting theories. His story is an attempt to reconcile the outcomes of classroom practice resulting from his research agenda with the background assumptions of the Discourse of cognitive psychology. In a sense Murray, describing Lenny's teaching practices in relationship to his own research practice, said "it was different, but not that different". To Murray this is a viable response, but for us to understand how this account is valid to him requires that we contextualize his role within the cognitive psychology Discourse.

Throughout my analysis, I have asserted that cultural models and social practices are at the center, rather than the periphery of cognitive science, and that the use of ethnography (to determine the boundaries between Discourses, the self and others) is a viable method for such an inquiry. In this regard, I point to the similarity in narrative structures between Lenny's and Murray's responses to questions about their actions. Both responses weave a narrative of history and agency that includes others usually not considered relevant to classroom practices. For Lenny, it was issues of race and identity. For Murray, it was issues of professional contacts and identity. What does 'knowing' Hatano and the fact that Tim Anderson had a Japanese student have to do with the beginnings of a research project? Why is this a detail in Murray's narrative? Details such as these are not usually written up or at least considered important in the analysis of cognition. Cultural models define what is normal, expected, as well as what is abnormal, unexpected, rejected and ignored. As Jim Gee points out:

"Very often despite the fact that such cultural models may have quite drastic impact on people's lives and self-images, they appear to be "trivial", not worth study or serious concern. This, of course, simply protects them from change and privileges those who are not marginalized by the cultural model, or refusing to behave in terms of it, opens one up to being marginalized by it and thus dismissed", - (Gee, 1992 - *The Social Mind* p. 13- 14).

Murray's narratives include details from the everyday world of the cognitive psychologist. Workplaces (such as going to conferences) shape the activities of researchers. At conferences, those from the same research community meet and share ideas and trade commodities (theories).

The collaboration between Murray and Olson and the introduction of the Itakura-Hatano pedagogic theory did not happen by accident. People and ideas were joined together within a common institution, The Education Institute (pseudonym). The Education Institute had been exploring, through the work of Helen Clark and James Anderson the use of the Itakura-Hatano method as a way of producing a certain form of talk in the classroom. Clark and Anderson never intended that the H-E-I (hypothesis-

experiment-instruction) method be used as the basis for classroom pedagogic practices, but rather as the basis for generating certain forms of talk in classroom for study by researchers (and in the case of Clark's teacher-researcher project) teachers as well. So Murray is correct in asserting that Lenny's appropriation of the 'Hatano Method' was not in sync with the institutional voices that introduced this particular way of thinking about talking science with elementary school students.

Clark's previous work on the seasonal change theories of children provided the institutional voice in both seasonal change and the Itakura-Hatano method. What began as a method for conducting research was inadvertently appropriated into the design experiment as a method of instruction. Social practices became salient in determining the parameters of thought. A small group of researchers within a research setting, sharing research methods and ideas, influence each other's research in ways that cannot be predicted by examining the individual actions or voices of researchers by themselves.

These facts are not trivial because they form part of the sociocultural basis upon which both the cognitive scientists and later teachers derived their (different) models of what they were supposed to do in the science literacy project. The 'social' and the 'technical' are intimately linked. As Latour and Woolgar point out in their social study of science: "...the distinction between "social" and "technical" factors is a resource drawn upon routinely by working scientists. Our intention is to understand how this distinction features in the activities of scientists, rather than to demonstrate that emphasis on one or the other side of the duality is more appropriate for our understanding of science.....more significantly, we view it as important that our explanation of scientific activity should not depend in any significant way on the uncritical use of the very concepts and terminology which feature as part of the activity" (Latour & Woolgar, 1979, p. 27).

What research scientists leave out of their reports makes it difficult for us to understand how science is a socioculturally mediated activity. Sociologists of science have begun in recent years to not rely exclusively on published reports, but rather to offer social situated studies of 'laboratory life', including in them the institutional re-voicing of personal conflicts and alliances in the course of doing science (Haraway, 1989; Latour, 1987; Longino, 1990). Latour and Woolgar point out the difference in the viewing of scientific life when many of the unwritten aspects of scientific decision making are examined sociologically and anthropologically: "Unlike many of the written records of the laboratory, informal discussions provide material which has neither been corrected or formalized. It is perhaps not surprising that such material provides a wealth

of evidence of the intrusion of social factors into the day-to-day exchanges between scientists" (Latour & Woolgar, 1979, p. 168).

Thus, it is not irrelevant to my analysis that the adoption of certain theories is often as pragmatic as it is 'theoretical'. In this case, the insertion of the curriculum on seasonal change was partially the result of a research scientist in search of both a research site (classroom) and an institution in search of research to support. This social or pragmatic 'marriage' between researchers and institutions is most definitely part of what should be considered as sociocultural mediation of thinking.

Such information is not recorded in published reports because research scientists generally regard these issues as trivial and 'social', having no bearing on the their findings. As we have seen in the course of the unfolding of my ethnography, such issues are hardly trivial. The cultural context for meaning making among researchers is responsible for why within a different context (such as the classroom) meanings change. Lenny did not have the opportunity to appropriate the Hatano method at a research conference among peers. Socially distributed cognitive artifacts like conferences provide grounding frameworks for orientating meanings of texts. More importantly, cognitive research is connected to the larger social demands of "the government requesting that the new technology center emphasize looking at the way computers are used in classrooms". We see that scientific practice is not far from its larger social origins. As Mary Douglas points out:

> "Scientific theory is the result of a struggle between the classification being developed for professional purposes by a group of scientists and the classifications being operated in the wider social environment. *Both are emotionally charged.* Both kinds of classification depend on social interaction. One (that of the scientists) makes a determined effort to specialize and refine its concepts as to make them fit for use in a discourse that differs from though it is contained within the entrenched ideas of the larger, encompassing social group." p. 56 (Douglas, 1986 emphasis mine).

The division of labor between researcher and teacher reflects the larger classification system which supports the maintenance of boundaries between Discourses. Managing affective states surrounding certain social experiences are part of what Discourses do for people. The emotional charge Douglas speaks of was explored in the last chapter in regards to Lenny's experiences with, for example, the police as a teenager. I described this as representative of the social origins of his theories about teaching and ethnicity. But what of the researchers? Are they impassioned observers with an unwavering faith in objectivity, or do they also have emotional connections to their work?

Sociologists and philosophers of science have identified processes through which "the process of original discovery is embedded in all the forms of institutional life, along with prizes and naming of plants, animals, measurements, and even diseases after scientists" (Douglas, p, 75). The world of cognitive research is governed by "institutionalized competition" in which everyone cooperates within the rules. Thus, a researcher will support the naming and classification of an instructional practice by the name of another researcher because he is part of the same Discourse or social role of cognitive psychologist. Someday the Discourse may award him or her the same honor. Hence, we have the naming of a method for science instruction (the Hatano-Itakura Method) after cognitive scientists. The conflation of personalities with research methods is part of the commodification of the research Discourse. One wants to be identified with a theory; otherwise there are no rewards if the theory is widely recognized.

Localized and decentralized theories of cognition: The interface between the social and the individual

The localized, everyday practices of the social groups (in this case, cognitive psychologists) helps to maintain a sense of self among its members. The meaning of texts and the understandings that they infer are linked to social context, histories and the Discourses of the texts themselves. For example, a text written in the Discourse of the group (in this case Neo-Vygotskian theories) will hold a privileged position in the cognitive scientists' reading of the outcome of the project.

Discourses have their sociocultural constraints and conditions for innovation which become resources for cognition. When Olson writes what he does about the Shadow Data Project, his communication was addressed to an audience of peers through journals and professional conferences. In what sense then is the meaning in the text or in his head? There is something in both, but not the part that counts. No fact or data or research paper is important in isolation, but only in relation.

Yet, it is clear that something *is* going on in Murray's head when he constructs his identity. How does an account of social cognition reconcile the obvious fact that the unique biological entity named Olson does indeed think? What is in Murray's 'head' is a large number of connections with different weights and assignments that are associated with certain tools, institutions, contexts etc. No one could possible store all the little pieces of information one needs to act skilfully and make meaning as a cognitive scientist. How does one dress? Act? Talk?

Cognitive psychology as a Discourse is a form of institutional thinking that socially distributes cognitive resources. It enables people to make localized decisions on the spot, (often called 'on-line' in the cognitivist Discourse) that can be recognized as being 'cognitive psychologist-like' while simultaneously perpetuating the existence of the Discourse (if you go too far out of line, then you get disciplined).

People learn how to be cognitive psychologists through apprenticeship; they go to graduate schools where they learn the dominant Discourse of the field. Ideally, cognitive psychologists are supposed to advance knowledge within their field through dialogue with peers. Cognitive psychologists share a common set of values, interests, etc. that facilitates this dialogue (Traweek, 1988). And as with most social groups, cognitive psychologists position their survival around various ways of maintaining a positive public face (see Chapter 5) for further discussion on the relationship of public face to private identity).

It follows then that if a cognitive psychologist took the theories of a teacher more seriously than those within the Discourse, they would no longer be writing within the discipline and no longer considered a practicing cognitive psychologist. The world of meaning in which the Neo-Vygotskian ideas are embedded will over time correct your mistakes. Eventually, you will write an article for a journal, appear at a conference, teach a course or do something which constitutes some aspect of cognitive psychology work. Otherwise all utterances one might produce, despite their possible relevancy to the understanding of science literacy in practice, will be ignored because they are not in the Discourse.

The identity of what it means to be a cognitive psychologist is not in Olson's or Murray's heads as much as it resides in a set of social practices. This identity is a cultural model that exists not in one text but in social practices that needs to be uncovered ethnographically. I can tell a cognitive psychology text when I read one, but there is not 'a' text that can tell me exactly what to look for. There is no text that can tell me how to be a cognitive psychologist, although somehow we think we can tell when someone says they are one.

My working hypothesis suggests that cultural models, emotions, and desires are legitimate concerns for cognitive science. Cognitive researchers need to be able to see if their collective representations are scientific theories, cultural models or a mixture of both. Correcting for errors in the collective representation of cognitive psychology can be achieved through using ethnography as a tool for cultural criticism. Ethnography is an ideal tool for the discovery of what other models of classification are in use and how do they differ. Stories, history, belief systems and myths all seems appropriate places to

begin a social anthropology of the mind. The challenge to standard cognitive science is that continued inability to situate our own practices within a specific Discourse will render us unable to tell whether or not our classification systems are truly 'scientific' or speak more to ideological meanings rooted in the current sociocultural order.

As Foucault (1982) has pointed out, regimes that are participatory cry out for "more participation" when in crisis, while authoritarian ones look towards increased authoritarianism. In this way, bureaucratic institutions perpetuate their power through diffusion through more and more people it 'creates'. The cognitive psychologist must be careful that in our current economic crises of the change from industrial to post-industrial economies, we do not cry 'more science'. Why are we not crying for more art? More film? More philosophy of science? The significance of Foucault's observation is that modern forms of power work through production, rather than repression. "They do not just deny, prohibit, repress and restrict; more importantly they produce Discourses, knowledge, pleasure and goods. Since these powers extend from innumerable sources - education, health disciplines, science, entertainment, the state, the military - there is nowhere in society they can be escaped" (Martin, 1992)

When Olson arrives in the classroom with his graph and his questions about seasonal change, he creates subject positions - the idealized interested classroom full of eager children ready to telecommunicate and a teacher, ready and able to assist. The creation of these idealized subjects is an example of the constructionist nature of scientific interpretation. Missing from Olson's 'story' is his own subjectivity; how his practices are the outcomes of his negotiated position with a Discourse. Olson assumes that the students would not be interested in the everyday world of his educational research workplace (though they are a part of that world even if they don't know it). But, if they are not interested in his 'story', his explanation of his actions, one might ask why they might be interested in his graph.

Olson's reports focus on the role of conversation (in class) as means for dealing with the 'boot-strapping' problem: "The tack we are pursuing is to see the conversation as the construction of sense making in the class. The differentiation of model and data is a function of the form of the conversation driven by the shared goals. The epistemology is found in the conversation. The conversation is thus directly orchestrated by the teacher in interaction with the student and the differentiation thus displayed is available for appropriation by students. We believe that this point of view on the locus of constructive activity, in the interaction rather than in the head, will provide the tools we will need to address the boot-strapping problem with which this study confronts us."

Most of the children were actually not so interested in Olson's 'story', except for the two girls who have been practicing the curriculum. They have more of a sense of Olson's narrative (with its imagined 'shared goals') than the other children did. They adopted the role prescribed in the curriculum for them (that ideally all the children were to adopt): that of apprenticing being 'scientist'. Thus, meaning making in the classroom was not only socially distributed across Discourses in situated activities like graphs and computer databases, but also on-going social practices (outside of the classroom) that provide the context for such 'narratives' and 'texts'.

When we contrast Lenny's ideas on what is 'available' for 'appropriation' from teacher led discussions with Olson's and we see significant differences. Lenny embeds classroom activities in his analysis of on-going activities outside the classroom:

> The Working-class home -which includes most minorities- its an authoritative home. The parent is the authority. You do not question. You do not sass. You do as you are told and there are no ifs ands and buts about it, and in a middle class home children are allowed to question that authority. And they develop this ability y'know, in some its outrageous. In others its done within the allowable bounds. And the idea is to teach, y'know, the ones who do it right, teach their kids how to question authority within the allowable bounds. Whereas you have some where there, you've seen 'em, who tend to try and question outside the allowable bounds and then they are just as horrible in their own right as the ones who have never been able to question and all of a sudden just explode. I think many minority y'know poor families because of the limited resources and the parents working, you just don't want to put up with any questions. You come home tired after working an 8 -10 hour day. 'Mommy why do I have to do this?' You're not going to put up with it you're going to say 'do this'. You're not to put with it. You're going to say do it because I said it and you just are not allowed. Within the home that has adequate resources. The parents come home. They're relaxed. They may even have someone working at home with the child. You can deal with it and it makes all the difference in the world. And now because I think the classic-extended-to-its limit is to take a look at a Haitian family. In Haiti where its absolute authority of the adult, there's no ifs ands or buts about it. You come into a school like an alternative school where you see students discoursing with teachers on a personal basis using personal names. This would never happen (at home).

Lenny was aware that his students brought multiple perspectives to the task of being scientifically literate. His cognitive strategies were situated as a set of social practices he had come to understand as meaningful. The cognitive researcher, although regarded as the 'expert' in areas that teachers are usually not (cognition), was surprisingly univocal in the classroom, only allowing for multivocality to enter into his texts with others in his field. Hence, before the project had ended Olson was delivering papers at conferences without taking into consideration the teacher's critiques. Olson was more open to his text being interrogated by fellow researchers than by a teacher.

Lenny's reflexivity about the multivocality of Discourses present in his classroom (Science, cognitive psychology, institutional Discourse and the sociocultural context of his classroom) was a form of translinguistic metaknowledge that deserved to be taken seriously. That it was not is a reflection of the social distribution of cognition within the Discourse of cognitive psychology. Lenny did not "act" like a cognitive psychologist. Moreover, his ideological perspective was different from that of the instructional design and of the institutional Discourse of the school. Additionally, Lenny's values formed the background to his theories of learning and critique of the design.

Conclusions: Epistemology, ideology and knowledge production in cognitive psychology - a critical appraisal

A critical evaluation of the social distribution of knowledge in cognitive psychology in particular and cognitive science in general begins with epistemology. We must ask what role background assumptions played in the validation of scientific accounts, while at the same time asking how do individuals know whether their accounts are valid. Scientific methods are not produced by individuals but social groups.

To present a contextual reading of scientific knowledge as practice does not necessarily suggest that all science is the result of whims or the beliefs forced on the field by the powerful. Rather, a contextual reading highlights part of social context used by a scientific Discourse to make sense of an observation by an individual or a group (Galison, 1987; Knorr-Cetina, 1981; Traweek, 1988). Community values shape the Discourse and the resources available for individual cognition, thus enabling cognitive psychologists to reproduce the Discourse on a local level in the classroom despite the lack of local support for such behavior.

A critical epistemological approach to thinking about issues of objectivity and validity in cognitive science accounts does not mean to imply that scientific objectivity is not related to the world. If a scientific community has a set of assumption not directly

supported by empirical research it loses validity over time. However, when we declare that we have arrived at a scientific 'truth', we must be aware that the meaning of such truth is embedded in a network of meaning shared by a community, which may not be shared by other communities looking at the same phenomena. Scientists argue all the time between and within disciplines.

We must challenge the assumption that self-interest, desires, self-image, etc do not play a role in knowledge production (Longino, 1990). Career advancement, grants, tenure, etc. are resources in the cognitive processes of the interpretation and analysis of data. As Longino points out in her book *Science As Social Knowledge:*

> Accounts of validation in the sciences must take into account both the role of background assumptions in evidential reasoning and the role of sometimes conflicting goals of inquiry with respect to which hypothesis and theories are assessed. The logic that reflects the structure of this activity will have to abandon some of the simplicity of the positivist account, but what it loses in elegance it will surely regain in application. (p.81)

The study of everyday practices is not insignificant for epistemological studies of scientific practice. The welding of a theoretical idea from the world of cognitive psychological research to the practices of classroom teaching becomes a 'scientific fact' when the welding takes a life of its own, within a Discourse, and ceases to become a point of controversy. The sequence of social events described in this chapter were never seen as problematic by the researchers, yet these events contributed to the construction of 'scientific facts' that were reported at conferences. The ability of the participating cognitive scientists to maintain a link between events in the classroom and their own theories depends on such 'taken for granted' facts. Thus the creation of an objective reality - yes, there was a classroom and we have videotapes to prove it, people really did say these things - is the end product, not the beginning of the scientific enterprise as standard cognitive science would have us to believe.

Standard cognitive science Discourse would like us to believe that the Shadow Data Project was the result of scientists applying 'scientific' principles to solve problems in the acquisition of science literacy. Yet, the fact that the papers written about the project had a life of their own, quite separate from the everyday world of the classroom, is somehow not a 'scientific' fact to be discussed in either professional or lay journals where educational researchers often publish. Without discussion about the way the social practices of certain forms of research divide up the world between various productive modes, we will never get to decide for sure if this is the best way to divide.

Scientists hide or displace the ways in which social practices guide the development of scientific theory in the construction of the relationship of science to everyday practice. This leads us to falsely look for the action where it can never be found: in some 'world' out there, rather than in the interpretative practices we use to construct the world out there. People would continue to use language even if linguistics as a field disappeared over night. Similarly people would still learn without cognitive science. Scientists overcome this existential dilemma through dividing up of the world between 'simple' thinking and the more 'complex thinking about thinking'. This divide is the source of belief and emotional comfort, as well as the impetus to construct 'facts' that supposedly correspond to the world (classroom). But scientists are in truth, as "relativistic" as artists or philosophers, in the sense that they are always asking if the 'facts' really *do* correspond to the 'world'. The facts, of course, change all the time and thus so must the description of the world. But *does* the world change or do *we* change how we see the world? I tend to think it is the latter that is true of the sciences.

However, when facts break down, a sense of deconstruction occurs and for a short time, scientists re-examine their basic premises until newer 'facts' stabilize and then all the work constructing facts is stopped and they return to a 'taken for granted' position in the world of scientific facts. The 'breakdown' in this project began with Lenny's resistance and this study is an attempt to use this moment of deconstruction to advance our collective understanding of thinking about thinking.

There is probably no easy way out of the epistemological dilemmas caused by the perpetual conceptual breakdowns central to the scientific enterprise. And this is not necessary an unwanted situation. The primary danger for educational practice arises when these epistemological issues of science concept formation become lost in the translation from the world of the research scientist through the re-voicing of recontextualizers. What is lost in the translation is sociocultural information crucial to science literacy.

Chapter 7: Conclusions

Implications for research on the social context of teaching and learning

Before beginning my concluding remarks, I will briefly summarize the findings of my research:

1) Theories of mind are grounded in social practices. Social practices have social gravity which bind practioners to certain values and assumptions despite attempts to create alternative theories.

2) Theories of the mind are generated outside of the established modes and sites of production (universities, research centers, academic journals and conferences). Classrooms provide particularly interesting sites for epistemologists to explore the influence of social and cultural models on thinking. We can begin to socially situate theories of mind through contrasting the Discourse of cognitive psychology with other Discourses. These contrasts are important validity checks for the sociocultural bias of researchers.

3) Differences in the everyday worlds of researchers and classroom practice create barriers to understanding and interpreting cognitive practices across contexts. Marginalized researchers can play a vital role in bridging gaps in our understanding of marginalized producers of knowledge in the classroom. In order to fully appreciate the work that they can do, marginalized researchers (such as myself) must become reflexive about their paradoxical role of being neither completely inside or outside the academy. Currently, there are very few settings where one can play with the outside/inside distinction without being labeled one or the other.

4) Mainstream theories of the social in current cognitive studies of science literacy do not account for differences in power between adults and children. Without such a consideration of power dynamics, cognitive theories run the risk of doing unwanted ideological work: maintaining and reproducing the status quo. Theories of power and ideology must be included in the work of cognitive researchers, if for no other reason that these issues play a role in constraining cognitive practices of marginalized teachers who are engaged in struggle with dominant forces in society. Cognition must be historicized to a greater degree than it is in North America.

These conclusions have a common theme: assuring that all students have access to science literacy requires an examination of social processes that occur both outside and inside the classroom. One must be willing to examine a variety of 'conversations' in a variety of voices and be open to hearing the multiplicity of voices within any exchange between two speaking subjects. In activity settings such as classrooms, teachers have considerable influence in the general direction of the construction of science literacy texts with students. Teachers' cognitive strategies are based on what happens outside the classroom as well as inside the classroom. In the case of African American teachers, race, class and ethnicity appears to loom large in their proscriptive assessment of children's abilities (Foster,1990). For these teachers, the world, based on their personal experiences is one filled with racism and double-standards. The question of what does 'constructionism' mean in a culture that is 'destructive' to Black children looms large in the cognitive strategies of African American teachers. Although there are many answers to this question, we cannot begin to answer it without recognizing the importance of this question. These problems, rarely addressed within standard science literacy curriculum, are part of the 'hidden curriculum' Black teachers feel they must address in teaching Black children. By white middle class standards, these teachers are often viewed as at best, wrong-headed, at worst 'racist' (Delpit, 1988). These Black teachers appear to place unwarranted attention on the destructive nature of a white supremacist social structure than on the constructive, creative nature of the Black child. Yet, in the case of white middle class pedagogies such as progressive education, there is plenty of evidence suggesting that non-middle class people have difficulties reading the cultural codes they convey (see background chapter for review of this literature). Granted, even if 'progressive' pedagogies are in some sense 'better' for children than 'traditional' ones, the wide-spread perception in the African American community that they are white and middle class is a challenge to overcome, not dismiss. My study suggests that whether true or not in principal, in perception at least, progressive pedagogies have acquired in the current arrangement of social relations a definite cultural symbolism that progressive pedagogues and researchers must in good conscience address.

Multicultural settings present real challenges to teachers of science and researchers of cognitive practices. Science literacy compounds problems already inherent in most institutional settings for marginalized students. Autonomous theories of science literacy incorporates ideologies or world views that may not be shared by marginalized students and teachers. How teachers deal with this social reality has as much to do with ideology as it does with any specific content area. Cognitive researchers doing work in this area must recognize that they are entering new terrain when trying to understand the social processes involved in teaching science literacy in multicultural settings. My study demonstrates the

need for cognitive researchers to abandon a model of science literacy based solely on what scientists currently do if they are genuine in wanting to reach the non-traditional science student. Part of this process is broadening the unit of analysis from classroom interactions to larger social relations that position children and teachers differently (often at odds) in relation to each other and science literacy texts.

In this case study, the teacher brought these wider concerns into his production and interpretation of science literacy texts. Common sense reasoning is at the intersection of personal meaning and cultural cohesion. Deny the importance of the interpretation of cultural models and one faces the possibility of creating a sequence of events similar to the ones described in this dissertation. Instead of cultural cohesion, we create cultural incongruence. Through the efforts of the teacher, a fragmented patchwork of conflicting Discourses were stuck together in a bricolage of elements from the various Discourses. Lenny was simply doing what all people do when asked to make sense of our actions in relationship to others (whether distant or close). He used his cultural models to reference what he thought was the right thing to do when asked to make sense of the disparate Discourses of astronomy, standard cognitive psychology, progressive education and the various community-based Discourses in his classroom. Olson and Murray, the cognitive psychologists did the same, using their own cultural models about science and community to add cohesion to the same disparate mix.

Through qualitative methods, I have analyzed where cultural models begin and end in a case study of teacher cognition. The theory of the instructional design rested on the assumption that changing the local, immediate instructional context can provide an effective teaching environment in multicultural settings. The results of my study puts this assumption in question by suggesting that this theory is closer to a cultural model, than a scientific theory. Local social context drastically changes instructional design. The differing cultural models and subject positions that are possible within different readings of science literacy cannot be predicted in advance. The scientific Discourse of cognitive research in this project could have been, in my view, skewed towards a language interpretation rather than to one of experimental causation (design *experiment*).

Ideally, teachers can be significant partners in assessing the role of local, contextual processes for cognition, but only if institution-wide changes, not merely local ones are implemented. Teachers have primary theories of learning processes based on experience, and they know more about their classrooms than researchers. Thus, for example, teachers could be co-authors with researchers or researchers should team-teach with teachers. But even these institutional changes will not suffice if educational theory continues to be dominated by a small elite of researchers. We might run the risk of creating a subaltern

class of teachers, right below researchers, but above the common teacher: a class of teachers that 'we can work with'.

Cognitive growth and change in teaching practice can only occur within interactions of interlocutors who are not blinded by sociocultural bias. Adopting the Discourse of the experiment is not the only way to go. As anthropologists have already discovered, cognitive psychologists are going to have to leave the academy and get out in the world. The first step in this process is listening to how others frame the situation. The next step (and this is also a relatively new interpretative turn for anthropology as well) is to then use the differences between how others frame their world and how the researcher does to reflect on interpretative frameworks in use in social science. Only then can cognitive researchers be certain that their influence on the activity setting of the classroom will be a positive addition. I am advocating not a retreat from the Discourse of science, but a re-positioning within its true communicative context, not a fictionalized disinterested, dehistoricized myth of autonomous literacy. This myth of literacy has strong roots in western civilization and will require not only conscious efforts by individuals to resist this myth, but institutional changes. These changes have yet to be realized in any significant scale in North American education.

I recognize that incorporating within cognitive studies the cultural models of marginalized groups in order to advance the design of learning environments can be threatening because it entails changing not only the activity setting, but also our subject positions in relation to the production of knowledge. In addition, such an epistemological change demands a shift in power relations. This is a challenge we must accept if we want to break the cycle of 'failing' students and teachers who do not live up to our models of producers of knowledge. Isn't it time we begin failing our models of culture and communication instead? While they may work for some of us, it is too presumptuous to think what is good for the few is good for the many. And if you don't think science literacy (as it currently is viewed) is for the few, you have not visited the campuses of major scientific research institutions in the past or in the present.

Calling a teacher a collaborator and researcher is not enough. In the final analysis, we must question common sense notions of science literacy and how it should be taught and who the teacher is, as well as what does s/he teach when teaching science. These questions are at the core of an ideological analysis of communication and cognition. The everyday psychology of cognition, communication and culture is embedded in deep and naturalized sociocultural structures that maintain the unequal distribution of science literacy in North America today.

Developing a theory of the social context of learning requires understanding that meaning construction happens not just in our heads, but interpersonally. Systems of meaning are rooted in culture and history, and these are given shape by institutions in a dynamic process that involves engagement with the present and our possible futures. In this analysis of teacher cognition, I have come to see this teacher as not just a passive recipient of sociocultural forces, but an active voice in trying to change the sociocultural order. Thus, we need to move towards an understanding of sociocultural settings as lived cultural experiences. This means moving beyond the analysis of teacher practices inside schools to include an investigation of narratives of self that teachers construct in thinking about teaching. This will help us in fleshing out the complexities of teaching practice in the diverse and challenging settings we currently call multicultural.

Where should we go with these conclusions? How do we proceed to address these issues in future collaborations between teachers, students and researchers? As a first move, educational researchers must heed the words of Black feminist theorist and activist bell hooks when, in dialogue with Cornell West, another Black intellectual, states: "White people are accustomed to taking the labor of Black people for granted. We have to see that the same thing can happen with intellectual labor, so that sometimes confronting that situation in a positive way can make for a meaningful critical intervention." (hooks & West, 1991, p. 37) As a Black scholar who has reached the highest level of educational achievement in the American educational system, I never had a Black teacher or professor. This fact speaks to how far we still have to go before we can say that we do not take the intellectual labor of Black people for granted. In this study, I have presented the theories of two African American males together, in struggle against racist hegemonic Discourse as an example of the 'critical intervention' of which hooks speaks.

Personally, this is the biggest challenge of my conclusions. When I, as an African American male decided to make another African American male the center of my dissertation research, I realized that I was going against some of the core values of today's intellectual community of educational researchers: that Black people are not important sources of knowledge, particularly around the education of Black children. The other conclusions, of course, are also very important. The interactions of conflicting Discourses must be examined at the level of values. But for me, the theoretical issues raised here are very concrete, as everyday racism proscribes and constraints my mobility not just through ideas, but through the very streets of North America where I live and 'theorize'. If I learned anything from Lenny, it is that my struggles in the academy are not that different from his struggles in the classroom. I have found a new meaning for the term 'solidarity'

and a new set of practices for the identity of 'intellectual'. Gramsci's notion of the 'organic intellectual' is an important image for marginalized researchers. We should value our roles as 'inside outsiders' within educational research. We should learn what we can from the academy without losing sight of the communities our struggles are rooted in

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Appendix A

Young children have a form of biology: Some experimental findings

GIYOO HATANO

Carey (1985) claims that young children (below 10) do not have biology---they make predictions and explanations for "biological phenomena" based on their intuitive psychology, i.e., on intentional causality, because (a) their biological inferences are human-centered, that is, based on the target animate object's similarity to human, (b) ~pplying mechanical causality to the workings of the bodily machine is impossible, and (c) they are totally ignorant of the physiological mechanisms involved.

Based on a large number of experiments with K. Inagaki, I would like to claim that children as young as 6 years of age possess a form of biology, which is differentiated from psychology, though I fully agree to (a) to (c) above and thus that they do not possess the modern science of biology. More concretely, I would claim:

1. Young children have well acquired the mind-body distinction and thus seldom apply intentional causality to bodily phenomena. They have understood that something inside the body is not fully subject to the intention of our mind. Therefore, their humancentered inferences are not necessarily psychological.

2. At least 6-year olds have non-intentional, though nonmechanical, causality which might be called "vitalistic causality". Their vitalistic explanation, that is, "X influences Y through giving vital force" seems similar to that used in the Japanese endogeous biology. The workings of a human body, as well as of other personified objects, are governed, not by individual intentions, but by more or less autonomous laws of vital force.

3. Even adults rely on the person analogy and vitalistic explanation when they do not have well-articulated, useful pieces of knowledge. In other words, (a) to (c) above are true, though to a lesser extent, of adults who have not majored in biological science.

Appendix B

Agenda
Design Group Meeting (first of the year)
September 18, 1989

I Business Items

1. The Equinox is coming -- a prologue for design experiments.

2. Interviewing 6 kids in each classroom

3. Classroom observations before we start

Getting clearer about the curriculum before we start:

-- assistance with the software and other **technologies**
-- finalizing drama plans
-- codifying the curriculum --
- how much similarity?
- documenting our intentions more explicitly;
- a meeting just on the curriculum7

5. videatoping the lessons

Your journals: your goals; what you saw happen; your insights and reflections;

7. Kids journals:

- make time for in-clsss entries;
- have kids talk toqether first, then move to writing;

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- What questions do you have about what you just heard/ saw/ did?
- What did you come away with from havinq participated in this experience?
-What surprised/ pleased/ puzzled/excited/ frustrated you?
-What else do you want to know?

- Work out the teachinq schedule: need to coordinate with drama specialist and ethnographers.

11. Planning for the Equinox Activity (Sept. 21)

1. About Hatano Experiments 2. collecting Shadow Data .
-- Why
-How
-- Materials You' ll Need

Appendix C

Toward a Design Science of Education
by Randy Murray

We have had many technologies introduced in classrooms all over the world, but these innovations have provided remarkably little systematic knowledge or accumulated wisdom to guide the development of future innovations.

The Technology Institute is part of the new Center for Technology. A major goal of the Center is to synthesize research on technological innovation, to develop a methodology for carrying out design experiments, to study different ways of using technology in classrooms and schools, and to begin to construct a systematic science of how to design educational environments so that new technologies can be introduced successfully.

Historically, some of the best minds in the world have addressed themselves to education; for example, Plato, Rousseau, Dewey, Bruner and Illich. But they have addressed education essentially as theorists, even where they have tried to design schools or curricula to implement their ideas. What is different today is that some of the best minds in the world are addressing themselves to education as experimentalists: their goal is to compare different designs to see what affects what. Technology provides us powerful tools to try out different designs, so that instead of theories of education, we may begin to develop a science of education. But it cannot be an analytic science like physics or psychology; rather jL must be a design

science more like aeronautics or artificial intelligence. For example, in aeronautics the goal is to elucidate how different designs contribute to lift, drag, maneuverability, etc. Similarly, a design science of education must determine how different designs of learning environments contribute to learning, cooperation, motivation, etc.

There are, however, major problems with the kind of design experiments currently carried out that prevent our gaining much information from them. Typically the experiments are carried out by the people who designed some technological innovation, and so they have a vested interest in seeing that it works. They typically look only for significant effects (which can be very small effects) and test only one design, rather than trying to compare the size of effects for different designs or innovations. Furthermore, such experiments are so variable in their design and implementation that it is difficult to draw conclusions about the design process by comparing different experiments. Finally they are carried out without any underlying theory, and so the results are, for the most part, uninterpretable with respect to constnucting a design theory of technology innovation in education. While we plan to look at past experiments in detail, we think only very limited conclusions can be drawn from them.

Our goal then will be to construct a more systematic methodology for conducting design experiments, and ultimately to develop a design theory to guide implementation of future innovations. The kind of methodology we anticipate will involve working with teachers as coinvestigators to compare multiple innovations (different media and software) at one site with no vested interest in the outcome. The design theory we envision will identify all the different variables that affect the success or failure of any innovation, and will specify critical values and combinations of values with respect to the different variables. This paper will elaborate on these two goals of our work.

1. Methodology for Design Experiments.

We will describe our initial ideas about a methodology for carrying out design experiments, but we expect to refine the methodology during the first years of the project. One difficulty is that there is a huge space of possible designs one might try out in schools. Therefore, a major goal of such a methodology must be to systematically explore the space of designs in relatively few experiments, so that one can extrapolate into the regions of the space that cannot be tested directly. At the same time there are a large number of constraints deriving from the school setting and the capabilities of administrators, teachers, and students to deal with new technologies, that limits our ability to try out different designs. So the goal must be to maximize the information gained within the limitations of any particular experiment.

There are several desiderata we think are critical in developing such a methodology:

1) Teachers as coinvestigators. Any experiments must work within the constraints that the teachers involved think are necessary to be successful, and at the same time must address questions that the teachers would like answered. Hence it is absolutely critical that teachers take on the role of coinvestigators helping to formulate the questions to be addressed and the designs to be tested, making refinements in the designs as the experiment progresses, evaluating the effects of the different aspects of the experiment, and reporting the results of the experiment to other teachers and researchers.

2) Comparison of multiple innovations. In order to assess the relative effects of different innovations it is important to try out multiple innovations at each **site and across sites.** Within a site it is possible to hold constant the teachers, students, school culture, etc. in order to make comparisons. Across sites it is possible to vary these same factors systematically.

3) Objective evaluation. In order to develop a design theory, **we want to break** the pattern of developers testing their innovations to **see if they** work. We need to address questions of how well different innovations work and under what circumstances. To do that we need to view different innovations objectively. While we will be testing some of our own technologies, they will be embedded in situations where other technologies are tried out for comparison and we will not include the developer in the design team for that site.

4) Testing technologies most likely to succeed first. In school settings, videotape, electronic-network, and tool-based technologies, such as word processors or graphing packages, are most likely to have wide application and be used most successfully, because they require least restructuring of the school milieu. Therefore addressing questions about their effective **uses** is most likely to have a high payoff.

5) Multiple expertise in design. In any design of a classroom (or larger unit) there are a vast number of different variables that may affect the outcome. The goal should be to optimize all those variables as far as possible within the constraints of the setting. To accomplish this requires multiple expertise: teachers, designers, technologists, anthropologists, psychologists, etc. Sometimes several kinds of expertise may reside in the same person, but these multiple perspectives are necessary.

6) Systematic variation within sites. In order to test specific hypotheses about particular design questions, it is best to make specific comparisons within a site. In this way most variables can be held constant, while addressing a
question about, for example, the structure of the classroom or the role of the teacher or the activities using a particular technology. The designs compared in this way should be as good as we can make them. The teacher(s) must be interested but neutral about questions addressed, and confident that they can execute the two variations successfully.

7) Flexible design revision. It may often be the case that the teacher or researchers feel a particular design is not working early in the school year. It is important to analyze why it is not working, and take steps to fix whatever appears to be the reasons for failure. In this way we collect information about failures, which are of equal value to successes, plus information gathered from the attempted repairs to the design, and whether they succeed or fail. It is critical to document the nature of those failures, and the attempted revisions, as well as the overall results of the experiment.

8) Multiple evaluation of success or failure. Success or failure of an innovation cannot simply be evaluated in terms of how much students learn on some criterion measure. There are a number of different kinds of evaluation that are necessary for addressing questions such as: how sustainable the design is after the researchers leave, how easy is it to realize the design in practice, how much the design emphasizes reasoning as opposed to rote learning, how the design affects the attitude and motivation of teachers and students, how much the design encourages students to help other students learn, etc. To evaluate these different variables, it is necessary to use a variety of evaluation techniques, including standardized pre- and post-tests and ongoing evaluations of the classroom milieu. For these latter evaluations we anticipate using both observation and interview techniques, and perhaps primary trait scoring based on videotapes of the classrooms. Issues such as sustainability require follow-up studies to see what haappens to the design in later years.

A major goal of the center then will be to develop a specific methodology incorporating these desiderata (and others we discover in the course of our research). Below, we describe a design experiment to give a specific idea

as to the kinds of designs we anticipate might be viable in sites we have worked with in the past. It is not a final design, because teachers and other researchers must arrive at a final design given particular settings. But it at least concretizes the abstract principles described here.