UNIVERSITY OF CALIFORNIA

Santa Barbara

Evolution of a Dream: The Emergence of Mayan Ethnomathematics and Expressions of Indigenous Ways of Knowing at a Mayan Autonomous School In Chiapas, Mexico

A Dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Philosophy

in Education

by

Phoebe Hirsch-Dubin

Doctoral Committee:

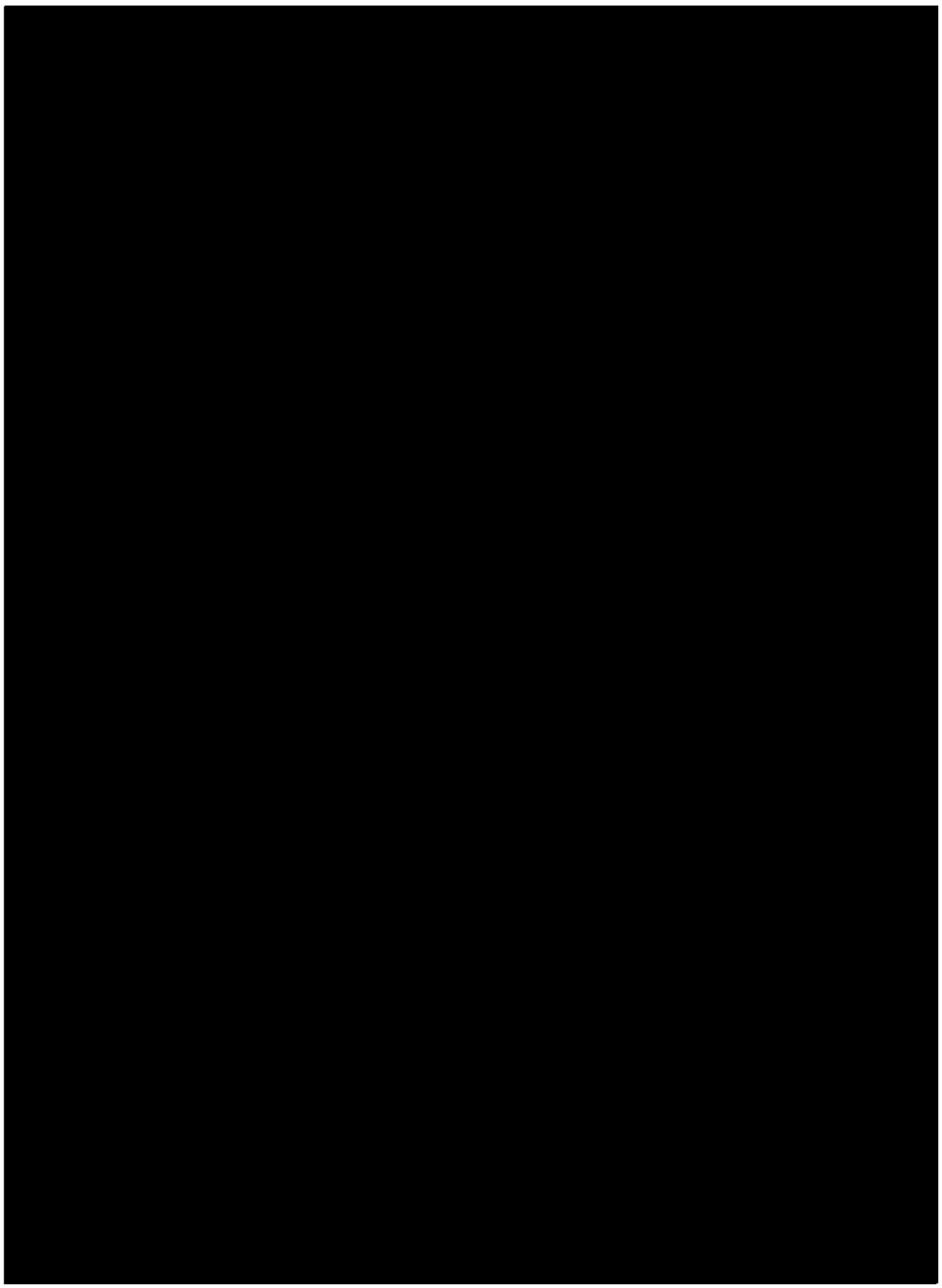
Professor Judith L. Green, Chair

Professor Carol N. Dixon

Professor Mary Betsy Brenner

Dr. Ana Inés Heras

September 2005



The dissertation of Phoebe Elizabeth Hirsch-Dubin is approved.

June 2005

Evolution of a Dream: The Emergence of Mayan Ethnomathematics and Expressions of Indigenous Ways of Knowing at a Mayan Autonomous School in Chiapas, Mexico

DEDICATION

I would like to dedicate my dissertation to the following people: to my father, Dr. Albert Hirsch, who always provided me with inspiration and infinite possibilities; to my husband, Corey Dubin, whose emotional, intellectual and moral support was unwavering; to Dr. Sabrina Tuyay, now in the spirit world, whose honesty, brilliance, and friendship kept me going; and to the Mayan members of the school community in Chiapas who opened their hearts, minds and process to me.

ACKNOWLEDGEMENTS

I want to thank my mentors, members of my dissertation committee: Dr. Judith Green who taught me how to think critically and analyze more deeply, and stretched to meet the challenges and aspirations of the Mayan school in Chiapas; Dr. Carol Dixon whose wise counsel offered strong support for my work and for my personal journey; Dr. Mary (Betsy) Brenner for her guidance in developing my thinking in ethnomathematics, exposure to its international movement and consistent support at crucial points along the dissertation path;

Dr. Ana Inés Heras who was a collaborative partner, intellectual guide, untiring supporter of the work in Chiapas, and dear friend.

I also want to thank other mentors and friends: Juliet Clark-Ruiz, a dedicated, politically conscious teacher who advised me to contact the Mayan school in Chiapas; Maricela Demirjyn, a sister graduate student whose friendship, intellectual support and sharp wit helped me to endure this path; Dr. Beth Yeager, whose friendship as a sister teacher and later as a graduate student, supported my intellectual development and passion for my work in Chiapas; Dr. Frederique Apffel-Marglin, whose friendship and intellectual guidance gave me a clearer sense of direction; Nancy Giuliani, whose support and wisdom helped channel my energies to complete my vision.

Finally I want to thank Juana, Adrian, and many others whose names I cannot mention from the school in Chiapas, for their time, energy, patience, openness to teaching me, love for learning, and courage to create a new path for Mayan peoples.

VITA

EDUCATION

2005 Ph.D. University of California, Santa Barbara.
Graduate School of Education
Emphasis: Teaching and Learning

2002 M.A. University of California, Santa Barbara
Graduate School of Education

1981 Multiple Subjects Teaching Credential
California State, Los Angeles

1967 B.A. University of Wisconsin, Madison

PROFESSIONAL EMPLOYMENT

2004 Teaching Associate, Graduate School of Education,
Culture, Language and Development,
University of California, Santa Barbara

2004 Instructor, Teacher Education Program
Cross-Cultural Education
University of California, Santa Barbara

PUBLICATIONS

In Press Interview with Dr. Arthur Powell. In *NSF Conference Proceedings on Culturally Responsive Mathematics Curricula.*

In Press The Struggle for Ethnomathematics at a Mayan Autonomous School in Chiapas, Mexico: Uncovering Suppressed Knowledge. In B. Barton (Ed.), *Indigenous Education and Ethnomathematics.*

2001 Web Guide for Social Justice. *Center for Teaching Social Justice,* Graduate School of Education, University of California, Santa Barbara http://www.education.ucsb.edu/socialjustice/

PRESENTATIONS

2004 Discussant at National Science Foundation Conference on "Culturally Responsive Mathematics Curricula" in Arlington, VA. November 6-9 2004. Presentation on Themes of Conference.

2003 The Struggle for Ethnomathematics at a Mayan Indigenous School in Chiapas, Mexico, Interdisciplinary Conference on Human Development, University of California, Santa Barbara.

2002 "Eurocentrism, Ethnomathematics and Mayan Indigenous Education" as part of series entitled, "First People' Voices: Diverse Ways of Combating Racism and Ethnocentrism." University of California, Los Angeles.

2002 Discussant at Roundtable on "Indigenous Education and Ethnomathematics" at Second International Conference On Ethnomathematics, Ouro Preto, Brazil.

HONORS AND GRANTS

2004 Grant Award to produce Mayan Ethnomathematics Booklets "Cookie Jar Fund" Grant, Los Angeles, CA

2004 Graduate Division Travel Award for Ethnomathematics Seminar in Chiapas, Mexico, University of California, Santa Barbara

2002 Graduate School of Education Travel Award for International Ethnomathematics Conference in Ouro Preto, Brazil, University of California, Santa Barbara

MEMBERSHIPS

American Educational Research Association
National Council of Teachers of Mathematics

FIELDS OF STUDY

Major Field: Mayan Ethnomathematics, Indigenous Epistemology
Related Fields: Indigenous-based Ethnography, Freirean Pedagogy, Intercultural Education.

ABSTRACT

Evolution of a Dream: The Emergence of Mayan Ethnomathematics and Expressions of Indigenous Ways of Knowing at a Mayan Autonomous School in Chiapas, Mexico

By Phoebe Hirsch-Dubin

The purpose of this four year collaborative teaching and ethnographic study at a Mayan autonomous school in Chiapas, Mexico was to provide teaching and material support for the emergence of Mayan ethnomathematics. In the course of doing so, it became clear that respect for indigenous ways of knowing encouraged teaching partners to work from their own knowledge base. It became important to develop ethnographic methodologies sensitive to indigenous knowledge construction and to demands of this particular site. Gaining access and working collaboratively with Mayan teachers and students was rooted in a mutual conscientization process (Freire, 1973, 1985, 1998) at the heart of our intercultural dialogue. Data analysis principally of teacher workshops helped to identify turning points in the

emergence of a Mayan ethnomathematics perspective over time and the importance of Mayan ways of knowing. Constructs of mutual conscientization and intercultural dialogue were used to analyze contexts, interactions and slices of talk that support a view of Mayan ethnomathematics as a material resource, and expression of indigenous ways of knowing. A study of interactions, both macro and micro, were analyzed within the broader context of autonomous education, including the school's commitment to "reclaim culture, language and resources." Data presented in this dissertation were collected from July 2000 to July 2003 as fieldnotes, journal notes, hand written records of workshops and artifacts of teacher evaluations, interviews and school documents.

TABLE OF CONTENTS

TABLES AND APPENDICES

CHAPTER ONE: INTRODUCTION

"Estamos aqui. Todos somos viento."

"We are here. We are the wind."

-*Tzotzil* saying

Section One: Overview

The dissertation presented here documents a four year collaborative teaching and ethnographic project at a Mayan autonomous secondary school in Chiapas Mexico. It explores a unique context in which collaboration between members of a Mayan educational community and myself took place. It was a collaboration that centered on Mayan mathematics and ethnomathematics but also developed different foci along the way. The importance of Mayan ways of knowing, for example, became visible during the course of our Mayan ethnomathematics workshops as will be demonstrated. I saw aspects of liberation pedagogy (Freire, 1973) in autonomous education, even if the school community did not articulate it in those terms. Mayan members of the school came to see me as a resource generator and provider as well as teacher. They knew that I would bring

articles, books and carefully researched sources of information about ancient Mayan mathematics, astronomy and calendrics to the school as well as literature about current international perspectives on ethnomathematics.

This collaborative teaching and ethnographic study is entitled "Evolution of a Dream: The Emergence of Mayan Ethnomathematics and Expressions of Indigenous Ways of Knowing at a Mayan Autonomous School in Chiapas, Mexico." The title grows out of a powerful belief in Mayan communities in resistance that dreams shape what is possible. The power of dreams derives from ancient Mayan cosmology, today expressed by Zapatista leaders throughout Chiapas as a way to nurture the autonomous movement and its goals. As Subcomandante Marcos (a non-indigenous spokesperson and leader of the Zapatista movement) said in 1999, " *We want a world where all worlds fit and grow…it is a dream that is dreamed awake, that history is born and nurtured from below*" (Marcos, 1999 cited in Marcos, 2001). What Marcos describes here captures the Mayan spirit of autonomy, which is to create and carefully cultivate a history from below, a history that is not exclusive but can include all worlds in a just, equitable interrelationship with each other.

To understand a context for this collaborative teaching ethnographic study at the autonomous Mayan school, it is important to give some background about Chiapas, Mexico. A brief overview is presented to help place the reader in the conditions, resistance movement, beliefs and aspirations of Mayan peoples of the Highlands and other Mayan communities of Southern Mexico.

Chiapas is the southernmost state in Mexico, originally part of what was known before the Spanish conquest as "*Mundo Maya*" or the "Mayan World." The Mayan world consisted not only of Southern Mexico but also Guatemala, parts of Belize, Honduras and El Salvador. Still home to hundreds of thousands of Mayan indigenous peoples who speak fourteen Mayan languages, Chiapas is one of the poorest states in present day Mexico.

While some sources claim that rural residents of Chiapas survive on $2 per day (Cevallos quoted in Stephan, 2002), others say that 90% of the people living in rural areas have little or no monetary income (La Jornada, Jan.24, 1994, cited in Weinberg, 2000). A subsistence agricultural economy defines many regions of Chiapas, including the Highlands. There, indigenous *campesinos* (farmers) are often forced to grow their corn crops on rocky slopes, with the best lands owned by "absentee speculators

or ranchers" (Weinberg, 2000, p.66). At the same time, half the state's population of 3.5 million have no potable water, 2/3 have no sewage systems and only 1/3 of the homes in Chiapas have electricity (Weinberg, 2000, p.81). These figures of severe poverty contrast with a state that produces 55% of Mexico's hydroelectric energy and 20% of the nation's electrical capacity (Weinberg, 2000, p.81).

Such severe socioeconomic disparities between those with access to the natural riches of Chiapas and its impoverished Mayan rural population, account for numerous rebellions in communities since the Spanish conquest. The most recent and defining rebellion however is the one that boiled over on January 1st of 1994. At that time, the Zapatista Army of National Liberation (known as Zapatistas for short) emerged from the Lacondon Jungle to help liberate Highland communities, occupying four towns. This Mayan rebellion was timed in response to Mexico's proposed entry into the North American Free Trade Agreement (NAFTA), which was seen as significantly worsening an already severe set of conditions of both rural and urban poverty in Mexico.

Key to understanding a broader context of the setting of the Mayan autonomous secondary school in which my collaborative

teaching and ethnographic project took place, is realizing that the Zapatista rebellion unleashed a transformative process throughout Chiapas. A movement for autonomy, a self-initiated and self-defined community based democratic process, was at the heart of transformations in education, health care and many aspects of civilian life. No longer would Mayan youth be educated in government schools, where they would be punished for speaking their Mayan languages and be taught a history that denied Mayan civilization ever existed.

The development of a Mayan autonomous secondary school in the Highlands of Chiapas is indeed a remarkable achievement. "Adrian", the head of an elected Education Committee that guides the school, often tells visitors that it took a collective dream to produce the autonomous school. Dreams occupy an important place for Mayan peoples who envision and enact change amidst conditions of such severe poverty. The dreams harkens back to a rich, advanced civilization before the conquest of Mayan lands and beckon the future, birthing what is possible for Mayan peoples to achieve today.

Gustavo Esteva, a Mexican social activist who writes frequently about the Zapatistas, describes two distinct sectors in

Mexican society (Esteva, 2001). Based on the concepts of a Mexican anthropologist, Guillermo Bonfil, the first sector is called "*México imaginario*" (imaginary Mexico) to describe Mexicans who embody the Western model (Esteva, 2001, p.121). The second sector is called "*Mexico profundo*" (deep Mexico); in reference to "*those rooted in indigenous practices, who do not share the Western project or approach it from a different cultural perspective"* (Bonfil, 1987, cited in Esteva, 2001, p.121). As Esteva explains, this distinction cannot be accepted by the elite In Mexico who firmly believe that "*Mexicans belong to the Western world*" (ibid, p.121). These contrasting perspectives in Mexican society, as Esteva argues, resonate within the Mayan movement for autonomy as it fights for a paradigm of national identity rooted in "deep Mexico."

Within this unique set of historical, social and political circumstances, a collaborative teaching project developed at the Mayan autonomous secondary school in the Highlands of Chiapas. An ethnographic research study also grew out of our collective teaching project, though in less visible ways. The ethnographic study needed to be less visible due to strong

feelings at the school about "researchers" and not wanting to be "objects of study." This position was implicitly communicated over four years and the study I adopted reflected sensitivities to these considerations.

I became aware of this autonomous Mayan school in Chiapas in the fall of 1999. A teacher friend of mine put me in contact with a support group in the U.S. working in solidarity with Mayan education. This led to my writing a proposal in Spanish in early 2000 to the school explaining why I was interested in doing a workshop on Paulo Freire and critical mathematics. The proposal included highlights of my own activist, educator, and journalist background (see Appendix A), which seemed might be helpful in the Chiapas context. I received an affirmative response to my proposal in May 2000.

Entering the site for the first time in July 2000 to do a five-day workshop and preceding each reentry in the subsequent four years, a written proposal to the school's leadership was required. Hand carried by others from a group working in solidarity with education projects in Chiapas, my proposals were answered verbally in the affirmative. The next steps were taken once on site

to plan a workshop schedule within a busy and demanding set of conditions for teachers, called "promoters" meaning those who help to promote and stimulate discussion. At times, our plans to meet on a given day changed due to last minute emergencies or altered plans of the entire school. Thus, a flexibility and willingness to adapt to constant change was a prerequisite for building enduring relationships and ongoing work.

To join with an autonomous process means adjusting the angle of vision one brings to the situation to an autonomous lens, working within parameters set by self-empowered Mayan indigenous communities. These Mayan communities have occupied the lowest rung of the ladder since the conquest by the Spanish followed by subsequent colonial governments of Mexico. Mayans refer to those who govern Mexico today as "Castellanos" or "Castilians" (De Vos, 2001), tying today's rulers of Mexico to their Spanish antecedents. In an oppositional response of resistance for more than 500 years, autonomy is described as "what indigenous people already possess" (Esteva, 2001, p.129). Thus, the current phase of autonomy has been developed as a form of parallel governance from below, within which autonomous schools operate.

In a comparative case at another autonomous site in the Lacondon area of Chiapas, two anthropologists have written about their own experiences in working with an autonomous Mayan municipality (Simonelli & Earle, 2003). They describe autonomous structures in the following way: " The autonomos are illegal but they're legitimate...like a shadow government with its own foreign policy" (ibid, p.78). This statement captures the notion of governance from below represented through autonomous structures. Another aspect of Simonelli and Earle's project is developing field studies for their anthropology students in an autonomous community. This indicates a legitimacy being given to research in that particular municipality. Simonelli and Earle's narrative explains what was involved with gaining research approval from an autonomous civilian structure. The experiences of these two anthropologists present a contrastive case with the autonomous school in the Highlands where research was not publicly welcomed. Even with significant differences, however, it is interesting to see how autonomy plays out in different contexts and how researchers respond when confronted by a unique process in which they have to obtain "informed permission" from an autonomous municipality

(Simonelli & Earle, 2003, p.74).

The role of autonomy and how it functions will be presented throughout this dissertation. It will be taken into account through an analysis of interactions that took place over a four-year period from July 2000 to July 2003. Respect for the autonomous process at the Mayan school continues in collaborative work I have engaged in at the school since that time and defines our ongoing interactions.

To sum up the overview, the context of the political, historical situation of Chiapas is critical to understand. Within that, the Zapatista rebellion of 1994 and an ensuing movement for autonomous governance by Mayan communities throughout Chiapas, also informs this study. Gaining access and collaboratively working within an autonomous educational community in the Highlands raised specific demands that became a learning conscientization process (Freire, 1973, 1985, 1998). A mutual process of learning from and changing together with promoters, students and the education committee at the school, what I came to describe later as mutual conscientization, was at the heart of our intercultural dialogue.

The next section of the introduction presents a broad research problem and examines why it was important.

Section Two: Statement of Problem

Statement of Problem: How does Mayan ethnomathematics emerge through intercultural dialogue, mutual conscientization, and respect for indigenous ways of knowing at a Mayan autonomous school?

Why important?

There are multiple ways in which working collaboratively to develop a Mayan ethnomathematics perspective at the autonomous Mayan school raised the following key issues. First, within the goals stated by the school of revitalizing "language, culture and resources" *Mayan ethnomathematics could be seen a vital cultural resource*. Yet it was not understood in this way by everyone in the school community (see Chapter Five) and was not accessible as a resource. It was not accessible as a resource due to the colonial policies of Spain followed by that of the Mexican government, which almost completely destroyed and devalued many of the extraordinary achievements of Mayan civilization. It thus became my task to bring resources to the school site that

could help to materially support a perspective of Mayan ethnomathematics.

Ethnomathematics does not just represent an "interesting angle" on mathematics but a way of knowing the world and acting upon it (see Chapter Two and Chapter Five). As a collaborative teacher and ethnographer at this site, it became clear (as can be seen in the analysis in Chapter Five) that ancient Mayan mathematics and current practices in the community could be extremely valuable, powerful resources that the school could take up if they chose.

A second aspect of importance was *developing a methodology sensitive to indigenous knowledge and process of coming to know*. It represented a re-theorizing of an ethnographic participatory process in this context. As is discussed in Chapter Two (literature review), Chapter Three (methodology) and Chapter Six (analysis), methodologies were needed to be responsive to a context in which traditional forms of research were (and are) rejected. As argued in this dissertation, indigenous scholars are forcefully raising questions about what constitutes principled approaches to research in indigenous contexts. Articulated

principles have consequences for both indigenous and non-indigenous researchers (Apffel-Marglin, 1998, 2004; Battiste, 2002; Grillo, 1998; Kawagly & Barnhardt, 2005; McKay, 1999; Smith, 1999). Thus, developing more fluid responses to ethnography by adapting methodologies to the demands of this particular indigenous site was essential to this work. Without this approach a *confianza* or trust and long-term mutual engagement would not have occurred.

While transformations in the ethnographic process took place over time, particularly in response to being in a highly politicized Mayan autonomous community in which the concept and practice of research had distinct boundaries, it is important to note that basic principles of ethnography were still utilized. This included fieldwork and fieldnotes (Clifford, 1990; Emerson, Fretz & Shaw, 1995; Sanjek, 1990) and participatory observation (Spradley, 1980) as part of gaining implicit and tacit cultural knowledge (Green, Dixon & Zaharlick, 2001; Moschkovich & Brenner, 2000; Spradley, 1980). A "reflexive-recursive" ethnographic approach (Green, Dixon & Zaharlick, 2001), a holistic and contrastive procedure (ibid), and a recognition that consistent paths of data needed to be identified and analyzed

in constructing valid arguments (Erlandson, Harris, Skipper & Allen, 1993; Green & Wallat, 1981; Lincoln & Gubba, 1985) were evident. Thus, fundamentals of ethnography were a part of my collaborative teaching ethnographic study and were deepened through a process of becoming an "ethnographer as learner." Seeing ethnography as a learning process at its heart enabled me to begin to understand the perspectives and worldviews of members of the Mayan community.

A third important aspect of our work was *conscientization* (Freire, 1973, 1985). The Freirean concept of *concientization* refers to "*a process of deepening awareness of both the sociocultural reality that shapes peoples lives and their capacity to transform that reality*" (Freire, 1998, p. 519). It was a pivotal process both for myself as an outsider to this Mayan autonomous community and as mutual conscientization for myself and Mayan members of the education community through our interactions. Mutual or double conscientization comes into focus when angles of vision are shifted to look at what was made visible to Mayan participants through interpretations of their process.

Throughout this dissertation an argument is built to demonstrate how a transformative consciousness linked to action

or concientization shaped our interactions over time. This included learning from "mistakes" or "frame clashes" (Agar, 1994; Green, 1983) in order to get to "rich points" (Agar, 1994) of intercultural dialogue. Based in the dynamic concept of Paulo Freire (1973, 1985), conscientization provided a significant motor of change affecting all participants in this project.

Finally, it must be acknowledged in this introduction, that my lack of knowing the Mayan language *Tzotzil* constrained our collaborative process in ways I don't even know. Since language is both a representation of worldview and an expression of culture and identity, not having access to the first language of *Tzotzil* speakers in this Mayan educational community is profound. Nevertheless there was richness to what we *were* able to achieve together. I attribute this to our communicating through Spanish as a second (or third in my case) language and to my having learned Spanish from Nicaraguan *campesinos* (farmers) during the six years I lived in Nicaragua in the 1980's. I also attribute the richness of our interactions to a determination on all of our parts to understand each other. I came to understand Mayan ways of constructing knowledge and promoters questioned and requestioned me until they understood what I meant.

Section Three: Locate in Broader Range

The problem I investigated and argued throughout this dissertation exists within a broader context. A view of the role of ethnomathematics in marginalized cultures is seen as part of reclaiming knowledges forcibly removed by colonialism, leading to a reaffirmation of cultural approaches to mathematics. Developing locally based approaches that break the hold of European dominated mathematics (Bishop, 1988; D'Ambrosio, 1985; Gerdes, 1985) is part of an international movement that has taken off in the last 25 years. While in no way representing a "majority" opinion within the field of mathematics, the movement for ethnomathematics is growing stronger. Its strength is evidenced by a growing number of international and national conferences, discussions of "culturally relevant mathematics" in US mathematics education circles, and increasing examples of local indigenous and non-indigenous communities reconnecting with traditional ways of doing mathematics.

Ethnomathematics conferences, like the one I attended in Brazil in August of 2002, demonstrate the importance of

ethnomathematics as an emergent field of study and represent an increasingly visible theme within indigenous communities, rural and urban communities in Latin America, Africa and the Americas (Abreu, 1995; Brenner, 1998; Carraher, Carraher & Schliemann, 1987; Gay & Cole, 1967; Lipka, 1998; Hernández, 2002; Knijik, 1998; Morales Aldana, 2003; Pinxton, 1997; Saxe, 1988; Verran, 2001). This burgeoning movement is making a powerful statement about the value and resiliency of traditional ways of doing mathematics, historically and in the present, after having been marginalized for hundreds of years. The emergence of Mayan ethnomathematics at the autonomous school site in Chiapas is also taking place in that context.

The broader context also includes transformative research methodologies or ways of going about research consciously responsive to needs and demands of indigenous communities, including responsiveness to indigenous ways of knowing (Smith, 1999). Forceful, articulate scholars that cannot be ignored, led by indigenous women internationally (Battiste, 2002; Smith, 1999), have raised concerns about how research is enacted in indigenous communities. Scholars like Maori professor Linda Tuhiwai Smith

of New Zealand names the task as one of "decolonizing methodologies." In this effort, Smith and others, like Battiste in Canada (2002) call on researchers to understand the a history of misrepresentation, of agendas that don't serve the communities being "studied" and the need for principles to guide every aspect of the research endeavor in indigenous communities. Apffel Marglin, a non-indigenous scholar and activist, in her work together with PRATEC (Andean Project of Peasant Technologies) in Quechua communities of the Andes of Peru (Apffel Marglin, 1998, 2004), has come to many of the same conclusions. Apffel Marglin argues that fundamental aspects of research need to be re-examined and re-theorized based on priorities set by the communities themselves rather than being driven by paradigms based on Western knowledge (Apffel-Marglin, 1998, 2004). While presenting some serious challenges for researchers, the call for a shift in approaches to work with indigenous communities seems imperative to consider as a basis for potential change.

Finally, the recognition that mutual conscientization is a compelling process that can help to confront and work through issues that arise from asymmetrical power relations in North-South fieldwork, has been taken up by several researchers. Engaging

unequal power relations as North Americans coming into Mayan territories (Nash, 2001; Stephan, 2002; Warren, 1998), as a North American teacher engaging Cuban literacy brigadistas (Blum, 2001) or as a "*gringa*" committed to changing her status in an "intercultural encounter" involving research in a rural community of Ecuador (Weiss, 1993), a number of researchers have brought underlying power issues to the surface. For instance, Weiss explains how calling her a "*gringo*" when she first arrived in a rural community in Ecuador to do fieldwork was based on identifying her with a set of "geo-political realities of wealth and power" (Weiss, 1993, p. 190). Through conscious efforts to confront power differentials by utilizing a dialogic approach to intercultural interactions, "...the signifier switched, as though I passed some kind of test and became *gringita*" (a more endearing term in Spanish) (Weiss, 1993, p.192). Therefore, being willing to open up to a bumpy road of confronting cultural differences (frame clashes) and responding to subtleties of insider/outsider interactions proved to be a fruitful way of bringing about needed changes in the character of relationships.

Section Four: How This Study Addressed These Issues

This study, which grew out of a collaborative teaching endeavor, is both a unique situation historically, culturally and politically yet applicable to other indigenous research sites. The broader contexts articulated above of ethnomathematics as a cultural affirmation in indigenous communities and of mutual conscientization and intercultural dialogue as a way of addressing unequal power relations and resources in North-South work, support my claim that these issues needed to be addressed.

Within these broad parameters, my collaborative teaching ethnographic study required working within boundaries set up by formal and informal "political agreements" that were spoken and unspoken, negotiated with the school's elected leadership. As described earlier in this chapter, each workshop beginning in July 2000 had to be proposed in written form and agreed upon by the school's leadership. An "unspoken aspect" of that agreement was that I would exercise care and caution in revealing the contents of workshops and other things I might learn about the school during workshop periods on site. A necessity arising from this particular site, the constraints also provided a basis for developing greater

insights into Mayan indigenous practices, and creating transformative methodologies in response. My willingness to respond to the school's norms and expectations meant I had to have a fluid approach accompanied by a consistent consciousness of the need to be flexible and aware of the potential impact of my actions.

Further, a commitment to developing a Mayan ethnomathematics approach at the school took four years to take root and flower. This process, which needed time and an internal rhythm to be adopted, was carefully nourished and recorded. I generated, created, and provided resources to support this path. In this way, recognition of the potential role of ethnomathematics as a material resource in marginalized cultures became the center of Our ongoing process through which other understandings, like Mayan ways of knowing, became visible.

Section Five: An Innovative Approach

Within the contexts explained thus far, an innovative approach to research was developed and practiced. This involved carefully keeping the research aspect of my work in the

background, focusing on our collaborative teaching project, with a form and content that reflected these priorities, as will be demonstrated throughout this dissertation. Working within these parameters supported a long-term commitment to our collaborative teaching effort and continued access to the site.

A trust or "*confianza*" was built over time that enabled not only access to the site but a respectful intercultural dialogue and mutual conscientization. These pillars of the study, intercultural dialogue and mutual conscientization, are explored and analyzed throughout this dissertation. Their centrality becomes evident through the emergence of Mayan ethnomathematics, coming to understand Mayan ways of knowing and working through cultural dissonances (or frame clashes) as they arose.

A key piece was my learning to work within the autonomous school framework and priorities. This was demonstrated particularly in year 2 (2001) alluded to earlier, when a possible rupture could have occurred over my desire to carry out a pre-planned three week ethnography workshop. Following the school's priorities in this instance meant backing down on my agenda of having the ethnography workshop as "planned", providing a one day ethnography workshop instead and being

willing to continue in the area in which we had begun our work together, which was mathematics. Letting the school's leadership and promoters define our direction, within which my theoretical and practical arguments for Mayan ethnomathematics were made, was an important shift. It strengthened a *confianza* based upon a recognition of working "at their own rhythm and their own time" (FN Juana, 7-03) and in response to the school's leadership.

Interestingly, even though I did not speak *Tzotzil*, I learned to work in a *Tzotzil* and Spanish environment within and outside of *talleres* (workshops). For example, discussions in groups during *talleres* each year took place in *Tzotzil*, as part of group processing of questions previous to presenting in front of the whole group in Spanish. It was not hard to recognize the processing in *Tzotzil* from the animated promoter discussions, debates, laughter, seriousness, occasional words in Spanish (not naturally occurring in *Tzotzil*) and interactive engagements by group members. Thus, some degree of exposure to *Tzotzil* was inevitable given its centrality to this Mayan community's construction of knowledge.

The complex process of working at the Mayan

autonomous school site deepened my understandings of collaboration, knowledge generation and critical perspectives of Western approaches to knowledge. A dialogue with Dr. Ana Inés Heras working with Quechua indigenous communities (among others) in Northwest Argentina has been part of a longer and deeper series of interactions and collaborations between us from the beginning of this project. In dialogues with Frederique Apffel-Marglin about her work with Quechua peoples in the Andes of Peru, and my work in the Mayan community of Chiapas, my approach and understanding of the Mayan context was deepened. These dialogues, bolstered by readings suggested by both Heras and Apffel-Marglin, supplemented interactions at the school. My own fieldnotes and journal reflections, accompanied by documents of Marcos (Marcos, 2001. 2004) and others about theoretical and practical premises of the Zapatista movement, shaped both the process and outcome of this dissertation.

Section Six: Chapter Organization

Curves of the *Caracol* (Spiral)

Before presenting the chapter organization of the dissertation, I want to explain why this section is called, "Curves of

the *Caracol* or Spiral." As suggested by Dr. Ana Inés Heras, the paths of unfolding this dissertation were not linear but rather more reflective of the ancient Mayan *caracol*. The *caracol*, which is a snail or conch shell, was used traditionally by Mayan peoples to summon the community. It was also used by the ancient Mayans as one of their symbols for zero, representing an extraordinary advance in mathematics. This symbol has also been adopted by the Mayan movement in resistance to reflect ways the communities can look out into the world while the world looks in at them. A spiral lens is a means of deciphering a complex and dynamic process. Similarly, this dissertation has taken on a spiral form in how understandings developed over time in non-linear fashion, in looking inward and outward at the same time, and in recognizing the value of bringing ancient Mayan history and practices into a current picture of mathematics and Mayan ways of knowing.

Chapter Two: A Literature Curve

This chapter presents a curve that examines the conceptual basis of literature for the dissertation. It provides a focused look at key literature that conceptually frames the discussion in the dissertation. This includes an evolving sense of ethnography,

conscientization, intercultural dialogue, developing an ethnomathematics perspective and process, indigenous ways of knowing and transformative methodologies. This chapter also includes operational definitions of key terms used throughout the dissertation.

Chapter Three: A Methodological Curve

This curve examines the methodology used as a basis for analyzing the research questions of the dissertation. With the understanding that methodology grows out of theoretical perspectives and in turn flows back into construction of theory, this curve examines what underlies methodologies chosen. An emergent design, which grew out of the research context of the study, is explored as is the research context, access, demographics, generation of data and approaches to data analysis.

Chapter Four: A Macro-Analytical Curve

The curve of this first analysis chapter is designed to give an overview of a four-year project at an autonomous Mayan school site. A timeline and macro-analysis helps to situate the reader within the dynamics of this particular site amidst the twists and turns of a journey to collaboratively create Mayan

ethnomathematics as a perspective and concrete material resource.

Chapter Five: An Ethnomathematics Analytical Curve

The curve of the second analysis chapter presents the development over a four-year period of a Mayan ethnomathematics perspective and practice. Creating ethnomathematics as a material resource, collaboratively working in response to Mayan ways of knowing, helped to achieve rich points of intercultural dialogue, mutual conscientization and change.

Chapter Six: Liberatory Autonomous Education and Mayan Ways of Knowing Curve

The curve of this third and final analysis chapter explores autonomous education as liberatory pedagogy and Mayan ways of knowing that were made visible through our journey in constructing ethnomathematics. Intercultural dialogue and mutual conscientization once again were identified as having played an important role in this process.

Chapter Seven: Concluding Curve

The last curve of the dissertation provides a view of what the collaborative teaching and ethnographic study addressed.

Core findings, and ways that this study can inform future practice and research were addressed. This final curve looks out into the world to see what has been learned through this process that can be applied to my own work and the work of others.

Chapter Summary

The purpose of the first chapter was to present an introduction to the dissertation and core arguments made throughout. Providing a larger social, cultural and political context for the work at a Mayan autonomous secondary school in Chiapas was introduced. A brief explanation of the key problem of how Mayan ethnomathematics emerged through this study was made, showing how other concepts and practices became visible through the process over time. The problem was located within a broader range of study, followed by a discussion of how my study addressed these issues. Within that framework, my approach was presented. Finally, a brief overview of each chapter was given.

The next chapter presents a conceptual review of literature for the dissertation. Literature is examined that supported concepts and practices central to the collaborative teaching and ethnographic study represented through the dissertation.

Chapter 2: Literature Review

Overview

The purpose of this literature review is to explain the conceptual framework that underlies this four-year collaborative teaching ethnographic study, including literature, which built a framework and guided an analysis of data. It is a conceptual rather than a comprehensive review in that selections were made from vast bodies of literature that support the theoretical and methodological foundations of the dissertation.

Since this collaborative teaching ethnographic study at an autonomous Mayan school in Chiapas, Mexico did not fit neatly into pre-designated theoretical constructs or categories, nor did it fall precisely into a stream of literature that preceded it, my task was to find literature that spoke to the range of experiences at this unique site. At the same time, as in any study, one enters a site guided by initial theoretical ideas that are then tested and altered by practice (Green, Dixon & Zaharlick, 2001).

While my thinking changed significantly over the course of four years of fieldwork and reflection, some of my initial views remained fundamental. These perspectives included developing

and renegotiating access over four years, exercising cultural sensitivity to being on a Mayan educational site as an outsider who did not speak their first language *Tzotzil*, and willingness to follow the school leadership's norms and expectations. Further, being responsive to requests for foci of workshops, keeping my graduate school agenda in the background, not appearing to be a typical "researcher", and sensitivity to asymmetrical North-South power relationships were all important. Therefore, "reading the world" (Freire & Macedo, 1987) of the autonomous educational community to learn what constituted their tacit and explicit practices and assumptions, was essential.

This literature review is organized in five sections to provide a framework for my collaborative teaching ethnographic project at the autonomous school in Chiapas. Throughout, there will be reference to literature that shaped this project, noting a lack of literature that would have been relevant. The first section presents several core theoretical constructs that helped me to create a new vision of ethnographic research. The second section looks at Freirean concepts of conscientization and dialogue, within an intercultural framework, in which issues of language exchanges arise. Section three examines ethnomathematics literature

relevant to work at a Mayan indigenous educational community. The fourth section examines literature that helped to understand indigenous ways of knowing and why methodologies had to be adapted to this Mayan school site. The fifth and final section presents key operational terms used throughout the dissertation.

Section One: Theoretical Constructs and Evolving Sense of Ethnography

One of the key theoretical constructs that was both orienting and explanatory over time was the notion of a "naturalistic research paradigm" (Moschkovich & Brenner, 2000, p.3). This term is described as an "epistemological stance" that does not convey a preconceived notion of what might unfold in the field. Instead, it represents a position in which, "meaning is constructed by both participants and observers so that, in effect, there are multiple realities " (ibid, p.3). Further, prior knowledge is valued and culturally relevant pedagogy can be developed. These components of an ethnographic approach are based on theoretical principles of anthropology and studies of culture rooted in patterns of social actions and interactions over time and were part of my basic approach to the site.

Another key ethnographic theoretical approach that provided both an orienting and explanatory frame was ethnography as a "logic of inquiry" (Green, Dixon & Zaharlick, 2001, p.205). From this perspective, ethnography is seen as "a study of cultural practices, as entailing a contrastive and holistic perspective" (Green, Dixon & Zaharlick, 2001, p.205). A "logic in use", defined as an "interactive-responsive process" (ibid, p.206) demonstrates that theory and methods are interdependent (ibid) and are reflected in practice.

Gaining cultural, local knowledge that is then interpreted through patterns and principles of practice (Spradley, 1980), helped to gain some degree of an "emic" or insider perspective. Further, one needs to learn what are important "consequences for members of the patterns of interaction within and across times, actors, events and practices" (Green, Dixon & Zaharlick, 2001, p.213). An example is learning what constituted Mayan ways of knowing, which came from examining patterns of interaction over time.

In a "reflexive-recursive" ethnographic approach as defined by the authors (Green, Dixon & Zaharlick, 2001), within a "developmental research process," questions and themes are

generated and identified in the local situated context over time. Often the research design itself is subject to change arising from interactions with participants at the local site and learning what counts for them. Similar to Moschkovich and Brenner (2000), this theory-method approach utilizes triangulation of cultural knowledge from multiple sources and perspectives to warrant a credible interpretation.

To summarize, parallel approaches in these two ways of viewing the tasks of ethnography (Green, Dixon & Zaharlick, 2001; Moschkovich & Brenner, 2000) resonated with my own evolving framework as I came to understand particular local meanings over time at the autonomous school in Chiapas.

Several ethnographic principles articulated by Spindler and Spindler (1987, as cited in Green, Dixon & Zaharlick, 2001, p.218), are relevant to how ethnography unfolded in my study. Contextualizing observations, framing "native views," finding creative ways to obtain data, developing a cross-cultural perspective and making visible what is "implicit and tacit" were utilized. Each of these principles supported the innovation and application of a transformative methodology (explained in Section 4), coming to understand indigenous ways of knowing (also in

Section Four), generating data in ways that were adapted to a site wary of "*Investigadoras*" or researchers, and doing collaborative workshops in ways that maximized participation of Mayan promoters and students.

Before moving on to other examples of ethnographic and participatory research literature that helped to shape the study in Chiapas, it is important to note that the two articles cited thus far (Green, Dixon & Zaharlick, 2001; Moschkovich & Brenner, 2000), served as analytical anchors. While supplemented by other ethnographically based theory and approaches to methodology, I returned many times throughout this study to the principles articulated in these two articles.

Ethnographic Literature Shaping the Study in Chiapas

Several conceptual approaches contributed to the collaborative teaching and ethnographic research at the site in Chiapas, Mexico. First, a grounded theory approach (Glaser, 2004) is consistent with principles of ethnographic study articulated by Moschkovich & Brenner (2000) and Green, Dixon & Zaharlick (2001). Grounded theory is based on developing theory from the ground up; that is allowing interactions and what is socially constructed on a particular site, to shape how a study evolves over

time. Paired with an "interactive-responsive approach" (ibid, p.213) practice in looking for patterns of cultural knowledge (Spradley & McCurdy, 1972; Spradley, 1980), it became possible to learn about and learn from members of the autonomous Mayan educational community. This was part of developing a "logic in use" (Green, Dixon & Zaharlick, 2001, p.206) or a "logic of what's constructed" (Rockwell, 1987, p.25) in which responsiveness to the local context and my own reflexivity created a path through multiple levels on which this project's meaning was being constructed.

A second key conceptual thread of the Chiapas collaborative teaching ethnographic study reflects some of the principles embodied in participatory action research. In this approach, local knowledge and perspectives are not only acknowledged but actually form the basis of research (Hughes & Seymour-Rolls, 2000; McTaggart, 1994). While "research" as such was consciously *not* a matter of open discussion given the priorities of the Mayan site (described further in section four), some of the principles of participatory research still apply. A definition of participatory action research offered by Kemmis & McTaggart (1988) is "collective, self-reflective enquiry undertaken by participants in social

situations to improve the rationality and justice of their own social practices" (Kemmis & McTaggart, 1988, p.5). While the overall goal stated by the authors is not how members of the school community in Chiapas would define their goals, it does seem accurate to say that we collectively engaged in a form of self-reflective inquiry. I use the term "mutual conscientization" based in Freire (1973, 1998) to explain a joint effort to create changes in consciousness and practice. While the paradigm of participatory action research is only partially relevant, it offers an important perspective in which agency is developed by participants traditionally "being researched." In many ways, however, participation was the reverse at the Chiapas school site in that the leadership of the school let me participate with them in a process of change.

Another theoretical-methodological approach I used in my collaborative teaching ethnographic study derives from the intensive use of fieldnotes. Fieldnotes were at the heart of "data generation" (Heras Monner Sans, 2002) given constraints on other forms of data "collection." A situated "logic-in-use" (Green, Dixon & Zaharlick, 2001) necessitated a "progressive construction" (Rockwell, 1987) of recorded events and interactions using "thick description" (Geertz, 1973) and extensive use of mental notes

(Clifford, 1990). Principles for developing reliable fieldnote records (Clifford, 1990; Emerson, Fretz & Shaw, 1995; Sanjek, 1990) were followed by a regular, systematic recording of observations. Knowledge was gained through daily participation, and later seeking to convey member meanings (in the write-up) through use of excerpts and triangulated data. The result of this inductive process is the creation of an "audit trail" (Erlandson, Harris, Skipper & Allen, 1993; Green & Wallet, 1981; Lincoln & Gubba, 1985), which links interpretations with supporting data over time. In this way a practical methodological approach to "data generation" (Heras Monner Sans, 2002) underlies the basic theoretical constructs of a well-grounded, reliable ethnographic representation. This representation emerges through a "writing of culture" (Clifford & Marcus, 1986), which is an interpretative analysis.

A final theoretical methodological approach is derived from the work of scholars who address issues of cultural sensitivity based in a need to transform our own agendas and relationships with others when working in international indigenous contexts. This includes the work of Apffel-Marglin, who was willing to challenge her perspective in working with Quechua peoples in Peru (Apffel-Marglin, 1998, 2004). While working in a Guarani community in

Brazil, Cavalcanti (1996) was open to challenging ethnocentrism within cross-cultural interactions. Warren's openness in working with Mayan peoples in Guatemala (1992, 1998), welcoming challenges articulated by Mayan scholars to her own social constructivist positions, provided a strong example. Nash (1996) and Stephen (2002) wrote ethnographies in Chiapas that laid a foundation for politicized accounts of what had previously been studied as a Mayan "cultural landscape." A prophetic example from Stephan in naming the "anthropologist as witness" was the following.

> "Researchers must be prepared to cope with circumstances where they will not be permitted to tape record, videotape, or even take notes, because of fear of government or other reprisals should the anthropologist's materials be confiscated. Other ways of documenting and remembering will have to be found" (Stephen, 2002, p.22)

This was indeed a challenge I faced in doing a collaborative teaching ethnographic study in the war zones of Chiapas.

Other well-known ethnographic studies based in the Chiapas Highlands (Collier, 1975; Gossen, 1999; Vogt, 1994) focused their work in the *Tzotzil* communities of Chamula and Zinacantán. These ethnographic studies were different from mine in two respects. One is in the communities studied; Chamula and Zinacantán, sites of

almost all ethnographic work in Chiapas to date. Second, they were more "typical" ethnographies in their stated intention of fieldwork in the communities and in their analysis of cultural practices.

The purpose of the Vogt study was to present the history of the Harvard Chiapas project, a landmark anthropological study of the Chiapan Highlands. Vogt and his colleagues stayed very much inside the margins of anthropological studies of that early era (1950's and 1960's) as they used fieldwork to provide a cultural map of customs, religious traditions, patterns of land use, and agriculture of local people. Collier's study was an early foray into the Highlands looking at "ecological issues" related to land use. Gossen's study was an in-depth ethnography of Chamulan life and ritual practices. While offering background to the Highlands as a region and to patterns of life among *Tzotzil* Mayan people, this research was of limited usefulness in understanding and analyzing a more politicized autonomous school site (see Chapter One and Section Five of this chapter).

In summary, this section of the literature review looked at several ethnographic theoretical constructs of the dissertation, including a naturalistic research paradigm, a logic of inquiry, how a research process develops in a local situation, and fundamental

elements of doing ethnography. The second theme of this first section looked at ethnographic literature that contributed to a framework for the study in Chiapas, examining samples of a large body of literature selected for relevance to the local site.

Section Two: Conscientization, Dialogue and Intercultural Dialogue

This section of the literature review is designed to accomplish three goals. One is to explore some of the relevant literature on conscientization (Freire, 1973) as it relates to the setting in Chiapas. Second, a dialogic approach to pedagogy will be explored in the context of the school site. Third, looking at intercultural dialogue conceptually and in practice (in analysis chapters), affords an opportunity to frame questions of language use, implicit in the notion of dialogue.

Conscientization

Freire's notion of conscientization is an important conceptual foundation for this dissertation. Freire says, " Conscientization is learning to perceive social, political, and economic contradictions, developing a critical awareness so that individuals can take action against the oppressive elements of

reality" (Freire, 1973, p.19). Conscientization was given new meaning in the Chiapas context, in that the community's own conscientization preceded my participation on site and continues as part of their unfolding experiment with autonomous education, as explained in section five of this chapter and more fully in Chapter Six. Nevertheless, the heart of Freire's concept of conscientization remained relevant throughout this study.

Within the Freirean context, then, conscientization embodies both theory and method. It is by no means just an intellectual process but at its core, entails action. Action and reflection combine in a dialectical process that furthers the potential for liberation. This in turn allows for changes in perspectives and practice, as can be seen in this dissertation by a change in promoters (teachers) perspective of Mayan ethnomathematics and by my grasp over time of Mayan ways of knowing. As Freire said in the Politics of Education, " All of us are involved in a permanent process of conscientization, as thinking beings in a dialectical relationship with an objective reality upon which we act" (Freire, 1985, p.172). A concept of mutual conscientization used in the dissertation refers to the joint process

of becoming aware through our interactions and accomplishments. As Freire often said, which was later articulated at the Mayan school (see Chapter Six), "No one conscienticizes any one else" (Freire, 1998, p. 506).

Several authors examined the role of conscientization, in both national and international contexts. Ann Berthoff, a professor who has lectured and written on Paulo Freire's theory and practice in the US since the 1970's, describes conscientization as "an agency of transformation, with change happening as learners found a voice...as they moved away from a culture of silence toward naming and transforming the world" (Berthoff, 1990, p.362). In explaining knowledge as mediating experience, Berthoff speaks of similarities between Freire's and Vygotsky's view of language as a representation of experiences and "in dialectic with thought, entailing action" (ibid, p.364).

Souza Lima, in writing about public school reforms in Belo Horizonte, Brazil, uses a construct similar to conscientization by saying; "meaning will only exist for the individual when there is a transformation in consciousness" (Souza Lima, 1995, p.447). Also extending the Freirean pedagogical tradition to include Vygotsky, Souza Lima refers to an individual and collective "zone of potential

development" (ibid, p.447) within a cultural, historical framework. Souza Lima's "zone of potential development" is characterized as two dimensions of development. "The most immediate form of development" similar to Vygotsky's "zone of proximal development" (ibid, p.447) and "possibilities held in the future that reside in the knowledge fund of the collectivity..." (Ibid, p.447). Souza Lima's concept of a "zone of potential development" is relevant to knowledge construction at the Mayan school site in Chiapas because developing a collective fund of knowledge characterized their cultural and historical approach.

In another study based in Brazil, O'Cadiz & Torres investigate an innovative program of literacy training for young people and adults. They describe conscientization as part of an emancipatory educational program that is also an "epistemological stance that embodies the principles of popular education in Latin America" (O'Cadiz & Torres, 1994, p.209). Popular education in Latin America, the roots of Freirean pedagogy, is anti-elitist, democratic education that challenges the vertical structure of traditional educational institutions. Other studies that looked at intercultural dialogue in collaborative teaching settings

(Blum, 2001; Heras Monner Sans, 2004; Lopez, 1999, cited in Jimenez, 2001) acknowledge that "cultural negotiation is needed to establish a process of conscientization" (Mohatt, 1994, p.172).

To summarize, literature in this section supports a Freirean approach to conscientization, as both a theoretical and practical approach to conscious change and the development of knowledge. Literature on conscientization was examined for its relevance to an intercultural indigenous context. Clearly, the literature within this field is vast but for purposes here was conceptually sampled for its pertinence to my study.

Dialogue and Intercultural Dialogue

While concepts of dialogue and intercultural dialogue are separated from conscientization for purposes of this literature review, it is important to note that conscientization implies both. In the absence of a dialogic approach (Freire, 1970), which designed to maximize the voices and participation of everyone present, there would be no process of conscientization or conscious change. Therefore, each of the concepts examined here exist in an interrelationship with the others.

Dialogue is used in this dissertation in two principal ways. First, in the Freirean notion of two-way interactions that are

inclusive and respect all voices. It can be seen as a way to "unlearn and relearn" (Wink, 2000, p. 48) for all involved. Dialogue encourages problem posing (Freire, 1970; Shor, 1993), a dynamic process of rethinking and recreating knowledge, as can be seen in the problematizing and rethinking of what is mathematics. One of the dialogue forms used from the beginning of this project is culture circles (Freire, 1970; Heras 1999), which were used to facilitate participation. Culture circles replace the belief in individual learning with collective learning, in which ideas and practices are debated and open to change. A dialogic approach was not something new that I brought to the autonomous school. Rather it built upon an already existing collective approach to education, in which promoters work together with students to co-create knowledge relevant to the autonomous development of Mayan communities in the Chiapan Highlands.

A second way dialogue is used in the dissertation is in the Bakhtinean sense of a "dialogic pedagogy based on colliding and testing diverse ideas presented by different voices, by different members of a community" (Matusov on Bakhtin, 2004,p.8). This view of dialogue represents a theoretical and practical approach, whether in fieldwork or in educational settings, in which the process

of interaction within communication is examined. Bakhtin describes that process as "mutual reflections" within speech communication (Bakhtin, 1986) in which the communication of one cannot be understood apart from communication with others.

Intercultural dialogue takes the notion of dialogue one step further. Rockwell uses intercultural dialogue to explain the creation of an interactional space in which "interculturalism is a focus of what occurs between groups in order to understand the dynamic and creative processes in context" (Rockwell, 2002, p.16). This perspective of Rockwell's underlies a number of educational studies in indigenous communities in Latin America (Heras, 2004; Jimenez, 2001; Monsoyi & Gonzalez, 1975, cited in Jimenez, 2001; Romo, 2004) in which the term intercultural is often used to describe recognition of diversity from a place of mutual respect as well as "positive and creative ways for people of different cultures to build relationships" (Albó, 1999, p.55, my translation). It also raises important questions of "asymmetries of power among different groups" (Rockwell, 2002, p.16). While the term intercultural dialogue is not articulated as such, other studies in indigenous and other contexts in Latin America (Blum, 2001; Cavalcanti, 1996; O'Cadiz & Torres, 1994; Souza Lima & Gazzetta, 1994; Weiss,

1993) reflect on asymmetries of power and ways that researchers need to develop cross-cultural strategies that take this into account. Weiss does refer to "Bakhtinean dialogue as a more equalizing approach" (Weiss, 1993, p.193) as relationships change over time.

A concept related to **intercultural dialogue** is **language use.** I am referring here to a perspective on how language transmits cultural ways of knowing (as can be seen in Chapter Six) and shapes how a dialogue between cultures unfolds interactionally over time, as in the course of ethnomathematics workshops (Chapter Five). Language in its social context is looked at in two ways within the dissertation. The first, utilizes aspects of a critical discourse frame (Fairclough, 1989). Texts, in my case mostly oral but also written, (see definition of text in section five), according to Fairclough, "constitute an important form of social action (Fairclough, 1992, p.204). He points to "textual analysis as a good indicator of social change" (ibid, p.204) and uses "intertextual analysis to highlight the role of texts in making history" by "linking texts to contexts" (ibid, p.206). So, for example, in analyzing texts from fieldnotes or collaborative workshops, the social context becomes apparent (see analysis Chapters Five and Six). Further,

intertextual relationships were utilized as a way to develop a concrete material resource of ethnomathematics thinking over time, which also built a relationship between texts and the contexts out of which they emerged.

Kristeva (cited in Fairclough, 1992) offers two concepts of intertextuality, which proved useful to this study. One is "vertical intertextuality" in which texts are tied together historically. This can be from year to year, as within my own project, or drawn from ancient Mayan sources that predate the Conquest. The second is "horizontal intertextuality" (Kristeva, cited in Fairclough, 1992, p.203), which builds a relationship across a group of texts that is responsive to what was in prior or subsequent texts as well as in the moment.

This approach promotes interrelationships across or historically among textual data, whether they are slices of talk, fieldnote excerpts, simultaneously translated speeches, or written documents. Concepts of vertical and horizontal intertextuality (Kristeva, cited in Fairclough, 1992, p.203) helped to build a material resource for ethnomathematics to be taken up (see Chapter Five) and helped to make visible Mayan ways of knowing (see Chapter Six).

Fairclough goes on to question not only how language is socially constituted but also what the hidden connections are between language, power and ideology (Fairclough, 1989). Within a critical discourse frame, Fairclough raises awareness that kinds of discourse vary across cultures (ibid, p.47). It becomes incumbent upon the outsider to the culture to be aware of miscommunications or "frame clashes" (Green, 1983) and differences in power that may characterize the interactions. It stands to reason that a politicized interpretation of discourse and language use would be relevant at a site where Mayan identities are being forged within an autonomous educational community.

A second use of language (or dialogue) in its social context is suggestive of sociolinguistics. If, as Gumperz says, language is "a context-bound system of linguistic choices carrying social meaning" (Gumperz, 1986, p.2), then interpretations that uncover both social contexts and social meaning as conveyed through language are useful. Gumperz goes on to propose what he calls "interactional sociolinguistics", a process of verbal communication that takes place, which among other things relies on "inferential interpretations" (Gumperz, 1977, p.198). This notion of "inferential interpretations" is very important in an indigenous context in which

a great deal of interpretation comes not only from actual moments of talk but from a variety of social and cultural clues/cues constructed on site and understood over time.

"Face-to-face interactions" took place formally in workshops and in less structured settings, and provided a major source of evidence for analysis. But coming to know the Mayan cultural world in this context required a moving back and forth between macro and micro worlds and from words to silences. Gumperz's work does address some aspects of "inter-ethnic communication" (Hornberger, 1992) in which issues of how language represents ethnic or social identities come to be known through interactions (Gumperz, 1982). In a context where data is not generated through video or audio records that can be revisited many times, language exchanges were written in fieldnotes or hand-documented on chart paper in workshops. However many of the same principles that apply to what can be learned from a sociolinguistic examination of language in its myriad contexts, are applicable to hand recorded pieces of discourse and language interaction.

In summary, a conceptual review of literature about dialogue and intercultural dialogue was presented in this section.

Intercultural dialogue was broadened in scope to include how language use is understood in the dissertation, both from a critical discourse and sociolinguistics perspective. These pieces helped to frame building blocks for analysis in subsequent chapters.

Section Three: Ethnomathematics As Perspective and Developmental Process

This section of the literature review will look at two aspects of ethnomathematics that are particularly relevant to the dissertation. The first section highlights a vast and growing body of literature on ethnomathematics. The second part presents several examples of other researchers who went through a developmental process in ethnomathematics as I did at the autonomous school site in Chiapas.

Ethnomathematics as Perspective

Within the ethnomathematics tradition itself, starting in the early 1970s with the work of Ubiritan D'Ambrosio (1985, 1988, 1994) who is credited with being its intellectual guide, there are many strands of thinking. After giving a definition of ethnomathematics that is used in this dissertation, I will go on to

draw upon literature that supports the view of ethnomathematics that shaped this study.

For a more detailed definition of ethnomathematics based on D'Ambrosio (1988) I refer the reader to Chapter Five. To summarize here though: First, cultural groups have their own ways of doing mathematics, which is called "ethnomathematics." Second, what is known as the history of mathematics is "actually the history of European mathematics" (D'Ambrosio, 1988). This dual perspective is important in understanding a protracted process to make visible a Mayan ethnomathemaics perspective at the autonomous school. The process was by no means linear, reflecting a pivotal concept of Gerdes that "an unfreezing of mathematics frozen by colonialism" (Gerdes, 1988, p. 142) needs to take place.

One might think that within a Mayan autonomous educational setting, the use of an extraordinary ancient Mayan mathematics system would be a given. It might be expected particularly at a school whose stated goals include the revitalization of cultural resources. Yet the dominance of European mathematics, as D'Ambrosio made clear, was evident in a setting in which

Spanish and later Mexican colonialism has profoundly restricted access of Mayan people to their own history and knowledge.

Many authors writing about ethnomathematics speak of its cultural dimensions (D'Ambrosio, 1988; Bishop, 1988; Gerdes, 1988; Powell & Frankenstein, 1997) and its expression within practices of daily life (Abreu, 1995; Brenner, 1998; Gerdes, 1985; Knijnik, 1998, 2004). Studies that are the most relevant to my work are those that not only pointed to struggles to achieve a non-Western ethnomathematics perspective but to also to ethnomathematics in international and indigenous settings (D'Ambrosio, 1985; Gay & Cole, 1967; Gerdes, 1985, 1988; Lipka, 1998; Hernandez, 2002; Morales Aldana, 2001; Pinxton, 1997; Verran, 2001). Several of these studies will be looked at more closely in the next part of this section.

The term ethnomathematics implies cultural dimensions (where the name ethno-mathematics comes from) as well as daily practices in the community. D'Ambrosio made it clear that mathematics was not "culture free": That is, the roots of mainstream mathematics are European in origin, known more commonly as "a universal language." At the same time, cultural groups around the world have approaches to mathematics that are

distinctly their own. Bishop (1988) distinguished between "universal activities" that are part of a "cultural knowledge of mathematics" found across cultures, and these include "counting, locating (in space), measuring, designing, playing and explaining" (Bishop, 1988, p.8). It is important however not to confuse "universal activities" with a "universal language." Instead, Bishop's categories provide a framework for seeing similarities in kinds of mathematics activities while not denying the creativity and uniqueness of each culture's approach.

The component of ethnomathematics that constitutes "everyday mathematics" looks at practices that are often taken for granted as simply being a part of everyday life. A closer look, however, shows that such mathematical strategies are developed to farm in Brazil (Abreu, 1995), to sell candy on the streets of urban Brazil (Saxe, 1988), to be market vendors in Brazil (Carraher, Carraher & Schliemann, 1987), or to shop for family groceries in Hawaii (Brenner, 1998). As Brenner points out, most studies of everyday mathematics have taken place in less industrialized countries (Brenner, 1998) perhaps due to the role of the informal economic sector in less "developed" countries.

A useful term coined by D'Ambrosio in describing the mathematical skills developed outside a formal school setting is "spontaneous matheracies" (D'Ambrosio, 1985, p.11). While this explains some of the extraordinary skills developed by children selling candy on a street corner for example (Saxe, 1988), it is often undermined and devalued by the "learned matheracies" (D'Ambrosio, 1985, p. 11) of school (Brenner, 1998; Knijik, 1998, 2004). This view helps to explain a "devaluing" of Mayan mathematics typified by the statement that "2X2=2X2 no matter what" taken from an evaluation meeting at the autonomous school in August 2001 (fieldnote record). In other words, the culturally-based ways of doing mathematics as daily practices in the community or linking back to ancient Mayan mathematics practices were not valued as "real mathematics" to be taught in official government schools nor considered at first at an autonomous Mayan school.

A seminal thinker in ethnomathematics, who has greatly influenced me and my colleagues in Chiapas as well (see Chapter Five), is from Mozambique. Paulus Gerdes calls for an integration of non-formal and formal math (Gerdes, 1988) based upon his work over many years with rural indigenous Mozambicans. Before this

can happen, however, some of the damage wrought by colonialism must be undone. In the case of Mozambique, this means confronting a Portuguese colonial legacy that continued up until the early 1970s. Gerdes talks about the need to "unfreeze mathematics frozen by colonialism" (Gerdes, 1988, p.142) to allow enough cultural confidence to claim indigenous Mozambican ethnomathematics as a resource.

The process that Gerdes describes closely mirrors our experience at the Mayan school in Chiapas. In our case, a mutual conscientization process supported by intertextual evidence built over time, helped to develop Mayan ethnomathematics as a resource for the school (see Chapter Five). The combination of exposure to ancient Mayan mathematics,
seeing examples of how other colonized peoples retrieved their own mathematics traditions and developing a self confidence in asserting a Mayan mathematics identity, were all part of this "unfreezing" course of action.

Several other studies in the ethnomathematics literature have challenged a traditional history of mathematics and "school mathematics." An early landmark study by Gay & Cole (1967) investigates the divide between Kpelle indigenous mathematics

and a Westernized school curriculum, which consistently underestimates the mathematical skills of pre-literate Kpelle adults. Knijik also seeks to make the popular mathematics knowledge of "marginalized and excluded" people of the Landless Movement in Brazil a part of school-based mathematics (Knijik, 1998). Knijik later extended her study with the Brazilian Landless Movement to examine "cultural processes involving oral mathematics and its curricular implications" (Knijik, 2004, p.1). Similarly Abreu (1995), looking at the mathematics practices of sugarcane farmers in rural Brazil, argues that these be included in the school curriculum.

Beyond the research cited thus far, studies that supported the approach of indigenous peoples in mathematics, contributed to my own understanding of ethnomathematics. These included the work of Gerdes on geometry of indigenous Mozambicans that challenges Euclidean concepts (Gerdes, 1997). Gerdes describes this work as "cultural conscientization" in a process of "reconstructing mathematics traditions eliminated by colonialism" (Gerdes, 1997, p.140). Pinxton's work with Navajo conceptions of space as part of a Navajo geometry (Pinxton, 1997) is the basis of his call for culturally meaningful curriculum. Lipka's work over 24 years with Yup'ik ethnomathematics in Alaska (1998) demonstrates

the importance of shaping a mathematics education that values indigenous ways of knowing. More on Lipka's project follows in the next part of this section.

Geographically closer to Chiapas, two projects and research efforts have as their goal uncovering a knowledge base of indigenous ethnomathematics in Mexico and Guatemala. The idea is to make indigenous ethnomathematics available to indigenous peoples and educators. One such project is based in Oaxaca, Mexico and is called "Proyecto Tiacuache" (Hernández, 2002). It promotes indigenous number systems, indigenous languages, the oral history of elders and the reconstruction of mathematics developed by ancestors as part of teacher education programs. While focusing on improving pedagogy in schools, it also calls for a strong community context.

The second project is based in Mayan Guatemala. The ethnomathematician Dr. Leonel Morales Aldana has written several books and articles on Mayan mathematics. Morales Aldana's research, based on extensive work with teachers in Guatemala and other countries in Central and Latin America, developed a more systematic approach to working with the base 20 system (Morales Aldana, 1993, 1998, 2001). Morales Aldana has also investigated

ancient Mayan geometry (Morales Aldana, 1993), which is not well understood even to the present. Morales Aldana's work has mainly drawn on Mayan architecture as a source of ancient Mayan geometric thinking.

In summary then, the perspective on ethnomathematics used in this dissertation is based upon a cultural identification of mathematics, This includes seeing daily practices of ethnomathematics as a valuable part of mathematics knowledge or "cultural capital" (Bourdieu, 1977), while also challenging Eurocentric notions of mathematics and its history. This critical approach to the subject supports the emergence of indigenous ways of knowing and practicing mathematics.

Ethnomathematics as Developmental Perspective

This second part of the section of the literature review on ethnomathematics focuses on two illustrative examples of researchers who went through a process similar to mine in their indigenous-based work. The first is Lipka's project working with Yup'ik ethnomathematics and the second is Verran's work with Yoruba ethnomathematics.

Yup'ik Ethnomathematics

Jerry Lipka has been working with elders on Yup'ik mathematics for more than twenty years (Lipka, 1998). The Yup'ik are indigenous people of Alaska, often referred to as "Eskimos." Having spent many years working collaboratively with Yup'ik culture upon which his research is based, Lipka has found that Yup'ik knowledge forms the foundation for their ways of doing mathematics and science. Developing a more Yup'ik based understanding of knowledge and worldview has been greatly enhanced by having a group of elders, called Ciulistet" or "leaders," (Lipka, 1998, p.3) advise the work of researchers and teachers. This is a dynamic process that progresses over time, as it "co-evolves" (Lipka, 1998) between the school, community and elders. The goal has been to develop a mathematics curricula and pedagogy that "responds to the culturally specific ways each group embeds mathematics within their cultural activities" (Lipka, 1998, p.141).

An important aspect in Lipka's work has been bridging contexts from community to school, drawing on valuable experiential knowledge of Yup'ik culture. One of the goals is to

meet mathematics standards while co-constructing a curriculum vastly enriched by traditional cultural knowledge. Recently, quantitative studies of the project done by professors working with the project have shown that Yup'ik students, who develop mathematics skills from this culturally responsive approach, excel in a variety of assessment modes. These quantitative studies are nicely complemented by in house ethnographic studies that examine the joining of the worlds of school mathematics and Yup'ik ethnnmathematics. Lipka describes, "watching Yup'ik culture go from being invisible to being prized by others" (Lipka, 1998, p.178), and this represents an important achievement of this long-term project.

While there are differences between Lipka's project and my collaborative teaching ethnographic study in Chiapas, there is a similar understanding of what constitutes a viable indigenous ethnomathematics approach. Valuing and incorporating indigenous knowledge previously excluded from schools, whether in Alaska or Chiapas, is a vital part of collaborative work in both contexts. Both studies use a holistic approach in which many aspects of Mayan or Yup'ik ways of knowing are incorporated. Working closely with community members to develop a culturally responsive

mathematics, while much more advanced in the Yup'ik context, is still an important part of the evolution of Mayan ethnomathematics at the school in Chiapas. Finally, Yup'ik identity is tied to "relationships of place and space" (Lipka, 1998, p.168), which provides a basis for geometrical perspectives and Yup'ik ways of knowing. Relationships of space and place are also tied to Mayan *Tzotzil* identity, which has geometric aspects and contributes to Mayan ways of knowing.

Thus, many parallels can be drawn between Lipka's research and collaborative work with Yup'ik ethnomathematics and my own study and collaborative teaching project with Mayan promoters and students in Chiapas. Similarities include valuing indigenous knowledge, using a holistic approach, working closely with community members and space and place as an important feature of Yup'ik and Mayan ways of knowing. Comparing similarities of the two projects highlights the richness of building ethnomathematics in indigenous communities.

Yoruba Ethnomathematics

The developmental journey of Helen Verran's work with Yoruba ethnomathematics in Nigeria (Verran, 2001) presents interesting similarities to my own work on Mayan ethnomathematics

in Chiapas. Verran begins with a criticism of the Eurocentric devaluing of Yoruba ways of doing mathematics, as reflected in a so-called "deficiency model," (ibid, p.18). She argues against a "universalist logic" of number by "...taking on the seemingly ridiculous task of showing 'natural number' as culturally situated (ibid, p.18).

Moving forward from the period of the 1980s when she worked and taught in Nigeria, Verran provides a critique of her own frameworks as she examine the presuppositions that drove her original analysis. Verran's critique made me reflect on my own mutual conscientization process (Freire, 1970) in Chiapas, in which "learning, unlearning, relearning" (Wink 2001, p.48) took place in relationship with others. Verran's reflection on relativism and "generative critique" of what she had come to understand about Yoruba number logic could not have been engaged in isolation. Instead it was through her experiences in various Yoruba classrooms, working with future Nigerian teachers, and getting feedback from Nigerians once back in Australia, that Verran overturned her earlier conclusions. Challenges to her own ways of viewing the premises of Yoruba ethnomathematics, led Verran to question how she set up dual conceptual systems that did not

accord with the experience of students in Yoruba classrooms. Her "relativist study" did manage to "refute established 'proof of primitive' African quantification and opposed the notion of deficiency " (Verran, 2001, p.25). Yet her "oppositional stance," while rooted in an anti-colonialist purpose, caused her to miss the "generative tension" between cultural relativism and universalism (ibid, p.28). In other words, how could "Yoruba logic" and "modern logic" stand side by side?

As Verran continues to explore and explain her practice in an extraordinary tale of great honesty, it becomes clear that the shift she experiences in working with Yoruba numeracy is also about her own conscientization. Verran did not use the term "conscientization" yet her critique and heightened consciousness developed jointly with others is very similar. In this way, as in other aspects of Verran's work, too complex to summarize, confrontations with one's own Western shaped modes of thinking as well as simplistic answers in angry response to colonialist caricatures of indigenous ways of knowing, can both lead to faulty conclusions.

To summarize, Verran offers a powerful mirror in which to reflect on my own work with Mayan ethnomathematics in Chiapas.

My engagement with promoters at the autonomous school led to developing a rationale for Mayan ethnomathematics that could serve as a resource for members of their educational community. This journey included a conscientization process that turned out to be mutual in that a consciousness tied to action was generated jointly. Verran's realization that both sides of the contradiction are valid, that "multiple and singular logics" can co-exist as "hybrid forms" (Verran, 2001, p.236) as she developed a theory of "relative logics " (ibid, p.19) also offers a way to look at change as an opportunity for learning and growth.

Summary

To summarize this section on ethnomathematics as a perspective and a developmental process, literature was selected that highlights my approach to Mayan ethnomathematics in the dissertation. Literature cited and the experiences of two researchers working in indigenous contexts in Alaska and Nigeria, gave a conceptual and a practical sense of challenges faced in developing an ethnoamathematics perspective.

Section Four: Indigenous Ways of Knowing, Autonomous Education, and Transformative Methodologies

The purpose of this section is to highlight literature that is part of a growing field exploring indigenous ways of knowing, which is relevant to my conceptual work in this dissertation as well as being relevant to an analysis of why autonomous education was the response of this community. The second part of this section will present several key examples of literature on transformative methodologies that offered signposts on relatively new terrain.

Indigenous ways of knowing

The first part of this section will examine specific literature that focuses on two issues. The first is how indigenous ways of knowing have been "invisible within contexts of Eurocentric knowledge" (Battiste, 2002, p.4). The second focuses on how that knowledge becomes visible. Woven throughout the two sections' foci is a basis for an argument (developed in Chapter Six) of why a alternative like autonomous education becomes a possible response.

A number of scholars, both indigenous and non-indigenous, present arguments as to why indigenous ways of knowing have been obscured. Tuhiwai Smith, a Maori professor in New Zealand,

who has written a seminal work on what she calls "decolonizing methodologies," says that "traditional knowledge ceased when it came into contact with 'modern' society, that is the West" (Smith 2002, p.55). She goes on to say that a "positional superiority of Western knowledge developed, which came to be known as 'universal knowledge'" (ibid, p.59). This view of Western knowledge as "superior" and "universal" is critiqued at the Mayan autonomous school in Chiapas and in fact, became a basis for their decision to have their own education system.

Battiste, an indigenous scholar who is frequently cited and writes from a Canadian perspective, describes at great length the ways that Eurocentric knowledge displaced, often by force, indigenous ways of knowing (Battiste, 2002). She says that indigenous people are frequently seen as "frozen in time while only Europeans can progress" (Battiste, 2002, p.4). She explains that the impact on indigenous youth is devastating. "The exclusive use of Eurocentric knowledge in education has failed First Nations children" (ibid, p.9). This view is echoed by many other authors in diverse indigenous contexts (Apffel- Marglin, 1998, 2004; Goulet, 1994; Grillo, 1998; Kawagly & Barnhardt, 2005; McKay, 1999;

Nash, 2001; Smith, 1999). As a counterpoint, Battiste says "since the 1970s, international and national fields of enquiry and innovation have validated the usefulness and significance of indigenous knowledge, reconsidering the 'universal value' of Eurocentric knowledge" (Battiste, 2002, p.7). This mirrors the words of Eduardo Grillo working with the Andean Project for Peasant Technologies (PRATEC), who critiques " the official system of education that tries to subject Andean peoples to Western order, claiming it is necessary for self-development since it has 'universal relevance'" (Grillo, 1998, p.124).

Turning to the second part of this section, I look at selected literature that explores how indigenous knowledge becomes evident. Within this theme, alternative approaches to education, like autonomous education, are seen as one way to promote the revitalization of indigenous culture and knowledge. Similar to the domain analysis in Chapter Six, authors and scholars describe aspects of indigenous knowledge. These include *experiential*, *observational learning*, *collective approaches*, *holistic perspectives*, i*mportance of ancestral knowledge*, and the *centrality of indigenous languages*. I will only cite a few illustrative examples in relation to each of these here.

Experiential, observation-based learning is considered one of the roots of indigenous knowledge (Apffel-Marglin, 1998, 2004; Batiste, 2002; Bazylak, 2002; Goulet, 1994; Kawagley & Barnhardt, 2005; Lipka, 1998; Mohatt, 1994; Smith, 2002). Learning happens through "observation not telling" (Bazylak, 2002) as the natural environment is experienced directly (Apffel-Marglin 1998; Grillo, 1998; Kawagly & Barnhardt, 2002). This explains much of how learning takes place in indigenous families and communities as young children observe parents and community members. Battiste explains, "knowledge is embedded in cumulative experiences and teachings of indigenous people rather than a 'library'" (Battiste, 2002, p. 7). For example, knowledge transmitted through oral history, as in most indigenous cultures, provides rich stories, traditions and lessons that are collectively shared.

Additionally, indigenous knowledge is *constructed collectively*, as in " collective voices of sharing circles" (Bazylak, 2002, p. 145). Several authors describe a collective approach growing out of a cooperation and interdependency that comes from observing nature (Apffel-Marglin 1998, 2004; Battiste, 2002; Kawagley & Barnhardt, 2005; Steinhauer, 2000). A view of collectivity is further echoed by Rockwell writing about the process

of consensus building in Zapatista communal assemblies in Chiapas, which she witnessed first-hand during the San Andres Accords (Rockwell, 1999). During this process of negotiation between the Zapatistas and the Mexican government over basic rights of indigenous peoples, government representatives often expressed frustration over delays caused by consensus-based decision making of Mayan communities (Rockwell, 1999).

Holistic perspectives demonstrate the "interconnectedness of all things" (Grillo, 1998; Kawagly & Barnhardt, 2005; McKay, 1999; Steinhauer, 2000) and can be demonstrated through examples like "kinship teaching" in which "all parts are related and taught in context" (Lipka & Mohatt in Mohatt, 1994, p.178). Many authors attest to Native students understanding better when knowledge reflects a "holistic paradigm" (Battiste, 2002; Kawagley & Barnhardt, 2005; McKay, 1999; Smith, 1999; Steinhauer, 2000). When a *milpa* (cornfield) is cultivated, for example, Mayan parents communicate to their children the agency of nature, the practicing of rituals, and acknowledge life in all beings, including corn seed.

Ancestral knowledge is a key component of indigenous ways of knowing. Many scholars address the role that indigenous knowledge plays in carrying forth oral traditions that might otherwise

have been lost (Apffel-Marglin, 1998, 2004; Battiste, 2002; Kawagly & Barnhardt, 2005; Smith, 2001; Steinhauer, 2000). Two comments by Battiste sum up many of the positions taken. First that "knowledge that is oral and symbolic is passed on to the next generation through modeling, practice and animation, rather than the written word" (Battiste, 2002, p.2). Moreover, indigenous peoples "turn to ancient knowledge and teachings to restore control over indigenous development and capacity building" (Battiste, 2002, p.5). Thus, ancestral knowledge is vital to the foundation and process of indigenous ways of knowing. An example from Apffel-Marglin in her work with the Andean Project for Peasant Technologies (PRATEC) describes agricultural capacity building based on ancestral knowledge in the Andes, one of the eight centers in the world where agriculture emerged over 10,000 years ago (Apffel-Marglin, 1998, p.3).

Finally, the importance of *native languages* itself as an expression of culture needed to transmit indigenous ways of knowledge, is acknowledged by indigenous and non-indigenous scholars as central (Apffel-Marglin, 1998, 2004; Battiste, 2002; Kawagley & Barnhardt, 2005; Lipka, 1998; Mohatt, 1998; Nash, 2001;Smith, 2001; Steinhauer, 2000). Battiste says, "Language is

by far the most significant factor in the survival of indigenous knowledge (Battiste, 2002, p.17). Nash, an ethnographer working in the Highlands of Chiapas, powerfully summed up her position.

> The true language, batz'il k'op is full of metaphors, words with parallel meaning, both in Tzotzil and Tzeltal. Only in their own words can we sense the indigenous mode of embracing the generations, capturing the past in the present with the words of the ancestors in the mouths of their children. Neither the Spanish conquest nor 500 years of colonization have destroyed the beliefs and mode of expressing them (Nash, 2001, p.224).

Thus, from Chiapas to Alaska, from the Andes to Canada and New Zealand, indigenous and non-indigenous scholars are recognizing indigenous knowledge and perspectives in a ways that speak strongly for the communities they represent.

In this context, literature that speaks to the need for autonomous education as a response to strengthening indigenous knowledge is limited in English and more readily available in Spanish. This is probably due to the autonomous education concept being an outgrowth of the Mayan resistance movement in Chiapas and thus not used in the same way in North American indigenous communities. An article that directed itself to education and indigenous autonomy in Chiapas echoed many of the points presented in this section. "What we want to study is the real

history, to discover our own thoughts. We want to study how our ancestors organized themselves, including having their own autonomy" (Klein, 2001, p.3). Klein also describes the process of deciding upon autonomous education when it was decided to "teach in the mother tongue and focus upon the importance of the earth within indigenous culture" (ibid, p.7). Ethnographers Nash and Stephen, working in the Highlands of Chiapas, similarly describe the historical, cultural and political imperatives that led to autonomous education (Nash, 2001; Stephen, 2002) and how they were propelled by the Zapatista rebellion in 1994. More will be said on the issue of autonomy is in Chapter Six.

Transformative Methodologies

The purpose of this section is to extend what has been presented in the first section on indigenous ways of knowing to include a call for research methodologies that need to adapt and change in indigenous contexts. It provides a conceptual look at a small portion of the literature that includes the work of important scholars in the field.

A frequently cited seminal work in this area is that of Maori professor Tuhuwai Smith, whose book directly addresses the issue of "decolonizing methodologies" (Smith, 1999). She raises points

that have been echoed over the years by many indigenous educators and scholars when she says, "We are some of the most researched people in the world but still have not seen the benefit of it" (Smith, 1999, p. 23). Smith explains that her view of "decolonizing methodologies" is not a "total rejection of all theory and all research or Western knowledge" (Smith, 1999, p.38) but rather a way to develop indigenous perspectives out of which theory and research can be built that is beneficial to the communities involved (ibid).

Other indigenous scholars hold a similar view. Hermes for example, working in an Ojibwe community in the US says, "no predetermined method could accommodate the paradigm of Ojibwe culture and community (Hermes, 1998, p.157). She also recommends "being in the community first as a member first and a researcher second" (ibid, p.165). When she did her research, Hermes explained that she "went back and forth between stories, practices and writings to help keep research grounded in the concerns of the community" (ibid, p.165). Other authors voice similar views, from Martin who says there is a need to "reframe, reclaim and rename the research endeavor" (Martin, cited in Steinhauer, 2002, p.4) to Battiste who says that "diverse elements

of an indigenous people's heritage can be fully understood only through the pedagogy traditionally employed by the people themselves" (Battiste, 2002, p.8). Many call for a "paradigm shift" that places indigenous knowledge and ways of knowing at the center, calling upon those who are doing research, be they indigenous or non-indigenous, to follow community-based principles of engagement (Apffel-Marglin 1998; Battiste, 2002; Goulet, 1994; Hermes, 1998; Smith, 1999; Steinhauer, 2002).

As researchers seeking to undo some of the damage that has been done to indigenous communities in the past, it is important to listen carefully to critiques made by indigenous scholars and community members and be open to adapting methodologies in response. As Hermes suggests, "research methods are a situated response" (Hermes, 1998, p.165). That may require that researchers place the cultural protocols of the communities they are in above their own research agendas. As I have alluded to, my own experience accords with Smith's observation that "in many indigenous communities...the word research is believed to mean the continued construction of indigenous people as the problem (Smith, 1999, p. 92) In my case being called, "*Investigadora*" or "Researcher" in a very negative

tone by the head of the Education Committee at the school in Chiapas (described in Chapter Four), makes the conceptual issues addressed here very concrete.

To summarize this section then, I presented a brief look at an important and growing body of literature written by primarily indigenous scholars about transformative methodologies. The argument for adapting methods to a situated context, while the sign of any good researcher, is an essential part of working with indigenous communities both internationally and domestically.

Section Five: Key Terms

In this final section of the literature review, I present operational definitions for some of the key terms that are used throughout the dissertation. While some of these terms are explained in other chapters, it is important to acknowledge their significance to my collaborative teaching ethnographic study at a Mayan autonomous school.

Culture and Identity: A definition that is offered by the Princeton anthropologist Kate Warren in relation to Mayan identity in the Guatemalan Highlands, explains both culture and identity at the

same time. She says culture and identity are "constructed, negotiated and redefined in action" (Warren, 1998, p.205). In addition, Goodenough's view of culture as aspects of daily life expressed in ways of thinking, being, believing and perceiving (Goodenough, 1971) is helpful. Important to the discussion in this dissertation is a view of **Mayan culture and identity**, which is drawn in part from Warren's work.

> Maya culture represents the meaningful selective mix of practices and knowledge, drawn on and resynthesized at this historical juncture by groups who see indigenous identity as highly salient and as a vehicle for political change (Warren, 1998, p.12).

While Warren's definition is very relevant to the *Tzotzil* Mayan educational community in the Highlands of Chiapas, there is an additional aspect: It is *Tzotzil* Mayan identity based on identification with language groups over the last 50 years throughout Chiapas (De Vos, 2001, p.17). As England, a linguist working with Mayan communities of the Highlands of Guatemala explains, "Mayas regard language as the principal symbol of their identity, as well as the principal means through which identity is transmitted" (England, 2002, p.43).

Intercultural: "Interculturalism is a focus of what occurs between groups in order to understand the dynamic and creative cultural

processes in context" (Rockwell, 2002, p. 16). Apffel- Marglin describes interculturalism as "a dialogic two way flow between different collectivities" (Apffel- Marglin, 1998, p.13), which leads to a "flowering of diversity" (ibid, p.13). This term is used more widely in Latin America and Europe than in the United States, often in reference to educational contexts involving the interrelationship of many cultures (Albó, 1999; Heras, 2004; Jimenez, 2001; Romo, 2004; Rockwell, 1999). This term has come to have a different meaning than multicultural in that it speaks to the interrelationship between cultures in addition to acknowledging and respecting the existence of multiple cultures. It is often used to indicate an awareness of "asymmetries of power" (Rockwell, 2002, p.16) among cultures.

Dialogue: This term is used in two ways in the dissertation. The first usage refers to interactions (Freire, 1970, 1985) whose goal is to be inclusive, involving a dynamic process of collectivity creating knowledges. The second use implies a communication in which an interrelationship among members of a collectivity frames both individual and group communication (Bakhtin, 1986; Vygotsky, 1978). See pp. 41-43 of this chapter for more discussion.

Concientization: Freire's term that explains "a joint project that takes place in a person among other people, united by their action and by their reflection upon and acting upon the world (Freire, 1998, p.514). What's important in Freire's concept is that the notions of interaction, action and transformation are part of critical consciousness that contribute to change. Together people have the capacity to uncover why things are the way they are and act to change those realities. The concept of mutual conscientization is also used in the dissertation to describe an interrelational process of change among people.

Text: The meaning of "text" as used in the dissertation is " written, oral, signed, electronic, pictorial, etc.... and as situated" (Bloome & Egan Robertson, 1993). While oral and written texts are most relevant, it's useful to see the scope of potential texts. In addition, Fairclough's view of texts as "constituting an important form of social action" (Fairclough, 1992, p.204) is also utilized in the dissertation.

Intertextual: The key use of this term is twofold. First, according to Fairclough, "Intertextual analysis mediates the connection between language and social context" (Fairclough, 1992, p.206). Second, as vertical and horizontal intertextuality (Kristeva cited in

Fairclough, 1992, p.203). Vertical intertextuality looks at the interrelationship of texts over time, while horizontal intertextuality looks at dialogic relationships across a series of texts (ibid). The other use of intertextuality derives from Bloome and Egan-Robertson who say intertextuality is a socially constructed juxtaposition of texts that is interactionally recognized, acknowledged and socially significant (Bloome & Egan-Robertson, 1993, pp. 1-2). It must be qualified that in the Mayan school context, the "recognition" and "acknowledgment" was often indirect, following norms of Mayan ways of constructing knowledge.

Context: Context is a complex concept, which includes a number of factors such as setting, actions within the setting, and even language itself. It is used in the dissertation in the following ways: First, as "ultra-situational context" (Goodwin & Duranti, 1992, p. 8), which refers to background knowledge derived from other circumstances and times. This is similar to Erickson (1986) who describes three dimensions of time and space that influence contexts and interactions: Local, non-local and remote (Erickson, 1986, p.103). Second, context is used in the sense of Bakhtin's

view of language or speech as providing a dialogic frame of reference for the speech of others (Bakhtin, 1984 cited in Goodwin & Duranti, 1992) and Vygotsky's view of language acquisition within a social situation, including a "zone of proximal development (Vygotsky, 1978, p.86).

Indigenous Ways of Knowing: This term refers to an indigenous epistemology distinct from a Eurocentric view of knowledge. It is rooted in ways of learning and constructing knowledge based in the particular culture, as in the case of Mayan in this dissertation. Aspects of indigenous epistemology include experiential, observational learning, collective constructions, holistic perspectives, importance of ancestral knowledges, and the centrality of indigenous languages. See Section Four of this chapter and Chapter Six for more discussion.

Ethnomathematics: This term refers to cultural ways of conceptualizing and practicing mathematics as well as a history of mathematics tied to ancient practices. In this particular study, mathematics is rooted in Mayan culture. (See definition based in D'Ambrosio, 1988 in Chapter Five). Ethnomathematics is viewed as a counterpoint to Eurocentric approaches that rely exclusively

on European mathematics as a "universal language" (Powell & Frankenstein, 1997; Joseph, 1997). Within a broader view of history, "ethnomathematics is a program on the history, epistemology and pedagogy of mathematics" (D'Ambrosio, 1997, p. xix).

Autonomous Education: An alternative approach to education based on self-defined and self-governed decisions enacted by consensus of Mayan communities. It is distinct from "official" government schools of Mexico in that it is run independently, with no government funding, and offers bilingual education rooted in Mayan history designed to strengthen Mayan identity. See Chapter Six for more discussion.

Chapter Summary

This conceptual literature review examined particular literature that constitutes a framework for the dissertation and guided the analysis of data. It covered core theoretical constructs behind an evolving sense of ethnography. Next it looked at

Freirean concepts of conscientization and dialogue, including intercultural dialogue, within which language use was examined. Then ethnomathematics literature that was relevant to my work at a Mayan autonomous school site was described. The fourth section looked at key literature that helped to construct views of indigenous ways of knowing and transformative methodologies. Finally, key terms used throughout the dissertation were defined.

In the next chapter I will present the methodology that was used in my collaborative teaching ethnographic study at a Mayan autonomous school in Chiapas, Mexico.

Chapter 3: METHODOLOGICAL APPROACH

In preceding chapters, I presented a background for my collaborative teaching and ethnographic study at a Mayan autonomous school in Chiapas, Mexico and a conceptual examination of the literature used to frame it. In this chapter, I will focus on concepts underlying methodological decisions, which guided my approach to aspects of "data generation" (Heras Monner Sans, 2002) on this site as well as how data was analyzed over a four-year period.

Overview

Several keys to the methodological approach taken are important to provide in an overview of this chapter. First, as in all fieldwork, methodological norms are adopted that grow out of the particular context. "What is actually done in the field depends on what is being constructed; the interactions sought with reality; in part what other subjects with whom you're interacting, are doing" (Rockwell, 1987, p.7, my translation).

Following from the premise of Rockwell, the nature of my fieldwork methods, from the beginning of this project in July 2000, grew out of a need to construct a culturally sensitive relationship

based on mutual trust. Knowing that Mayan educational communities are wary of traditional researchers was based on my own readings about the Mayan autonomous educational movement (Zapatista communiqués, 1994-2000; Nash, 2001; Stephen, 2002; Weinberg, 2000; Womack, 1999). I learned more about the view of research at the Mayan school prior to entering the site from conversations with the Director of a Chiapas solidarity group that has contributed to autonomous education projects. Once on site, that wariness of traditional researchers became more concrete. The second year, August 2001, Adrian, the head of the Education Committee, used the term "*Investigadora*!" in referring to me. It was said in such a powerfully derogatory tone of voice that there was no mistaking its negative connotation. While this interaction reflects more complex contextualized meanings then are taken up here (see Chapter Four), it does demonstrate the sensitivity and reactivity of this issue.

My actions in "reading the world" (Freire& Macedo, 1987) of this community to establish trust and negotiate access, meant being careful not to act in ways that could be seen as inappropriate or insensitive. Continuing to be conscious, even as my reading of

their world and my place within it grew, was very important. It led to a series of practices that were affirmed by my experiences and by a politics of renegotiated entry over time. Perhaps In the same way that a recursive analysis is intrinsic to an ethnographic process (Clifford, 1990; Green, Dixon & Zaharlick, 2001; Spradley, 1983), so a recursive analysis of methodological practices became necessary in my case to insure ongoing trust and mutual productivity.

Finally, key to an overview of this methodological chapter is making clear the interdependence of theory and methodology (Green & Allexsaht-Snider, 1991; Rockwell, 1987). Indeed, decisions and actions that comprise my collaborative teaching and ethnographic experience, are shaped by theoretical orientations, as was explicated in Chapter Two. Choices of what is observed and recorded in fieldnotes, what data are constructed, how actions and interactions are interpreted, perceptions of language interchanges, body language, even intuitions and sensations, are all guided by theoretical orientations. As this methodology chapter unfolds, an understanding of the theoretical basis for methodological choices will become clear.

Chapter Organization

Turning now to the organization of this chapter, the sections are as follows: Section One will examine ethnographic methods that developed over time and were used throughout the study. These methods informed both data "generation" (Heras Monner Sans, 2002) and data analysis on and off site. Section Two explores my own social history coming to the Chiapas school site, the process of building trust and access, and how it provided a foundation for developing a "transformative methodology" based on mutual conscientization and intercultural dialogue. This section will specifically examine the structure of the research context, both in terms of gaining access as well as delineating the setting and participants in this collaborative teaching endeavor.

Section Three of this Chapter will look at methodology as analysis or why a "transformative methodology" became crucial in this educational context. Adapting a methodology to this site was needed in order to carry out ethnographic research tailored to an autonomous school where research was not welcome. As a result, traditional research methods were problematized (Freire, 1970, 1985) and reexamined. This discussion will be explored within a research design framework, looking at the purpose of the study,

research questions that developed through it, how data was generated, analyzed and re-constructed, as well as what kinds of approaches were chosen for analysis.

As will be seen throughout the methodological approach explained in this chapter, adapting and transforming ways to collaborate and work together was at the heart of building a "*confianza*" or trust at the school. As the process of trust and mutual work developed, I came to understand and respect the values of Mayan ways of knowing. In many ways, this awareness created a focal point of our project, whose effects rippled out to all corners of our journey together.

Section One: Ethnographic Methods

In this first section of the chapter, I examine ethnographic methods that were utilized in this collaborative teaching study, shaping practices on site at an autonomous Mayan school in Chiapas, Mexico over four years.

Background

The study I did at an autonomous Mayan secondary school over four years, from July of 2000 to July 2003, was an

ethnographic study. It was an ethnographic study in that I sought to identify and understand from an "emic" or insider point of view, as much as that is possible to achieve, the cultural processes and practices of a Mayan social group. Due to the nature of this particular autonomous Mayan educational community, the ethnography was drawn from participant observation built upon collaborative teaching and learning between promoters and myself. Students became formally involved in the same collaborative process only in the fourth year This was not a community open to being researched in traditional ways but instead determined to define and evaluate their own educational process "in their own rhythm and their own time" (Juana, head of consultant group, 7- 03). It should be noted, however, that the community's view of research was never publicly defined but rather had to be tacitly understood.

After a complex negotiation process over three years, I was granted permission to write about the mathematics workshops we did together each summer. Implicit in the granting of this permission was a nonverbalized agreement that I would *not* delve into other aspects of what I had observed and participated in at the school during that time, which involved internal processes of the

school and other sensitive areas. Thus, ethical issues that face all ethnographers were placed at the forefront of my relationship with members of the school community.

The setting of the ethnographic study and collaborative teaching profoundly shaped the parameters of research methods. Typical ethnographic tools like video and audio that permit observation on site and reexamination later using micro-ethnographic analysis were simply not an option in this politically sensitive context. In addition to a concern about research, there were also concerns about taped documentation of processes at the school, given the "low intensity war" (Muñoz-Ramirez, 2003; Nash, 2001; Stephen, 2002; Weinberg, 2000) that marked conditions at the school during the entire project. I had also determined during my first workshop in July 2000, that it was better *not* to engage in other kinds of "typical researcher behaviors", from taking notes during conversations to writing down observations in view of education community members. These issues, so central to how this study unfolded, are further elaborated in Section Three of this chapter and are key threads woven throughout analysis Chapters Four, Five and Six. Thus, methods were adopted that followed

cultural and political protocols, implicit yet mutually constructed on site.

While pointing to restrictions and constraints that were a feature of pursuing an ethnographic study at this site, it is also important to recognize that rich sources of data were available and accessible. In fact, constraints have often been a part of studies done at indigenous sites (Apffel-Marglin, 1998; Cavalcanti, 1996; Hermes, 1998; Weiss, 1993) and are not unique to this context. Culturally sensitive ethnographers have analyzed these kinds of constraints as indicative of indigenous ways of constructing knowledge (Apffel-Marglin, 1998; Nash, 2001; Simonelli & Earle, 2003; Stephen, 2002; Warren, 1998). What perhaps was unique at this site was the requisite political, social background needed to enter the autonomous education community. Once on site, however, further demonstrating cultural and political awareness was needed in order to participate in a Mayan autonomous education process. Although I had a political history and background working with *campesino* agricultural cooperatives in rural Nicaragua for six years from 1984-1990, when I became

fluent in Spanish, a process of mutual concretization (Freire, 1970) was essential to help move forward in our dialogic educational conversation (see Chapter Six).

Methodological Approaches

Specific ethnographic practices were used that enabled me to conduct a longitudinal study within a context of imposed and self-imposed constraints. The negotiation of initial entry, renegotiation of subsequent reentries, participant observation and generation of data using fieldnotes and journals were part of an ongoing approach. Collection of artifacts, production of hand-transcribed documents from workshops, workshop evaluations, and informal conversational interviews all were produced to contribute to the credibility of this study. This enabled "the most textual version possible of what was said and heard" (Rockwell, 1987, p.9, my translation), permitting subsequent textual analysis.

in any ethnographic work, "cultural knowledge is learned through seeing patterns and grasping implicit frames of reference that people have learned" (Spradley & McCurdy, 1972, p.59). This means having a view of culture as socially constructed by members of a group, in this case a Mayan indigenous social group. Cultural knowledge can be grasped over time by following patterns

of perception, actions and interactions as well as construction of "values, beliefs, ideas and symbolic-meaningful systems" (Green, Dixon & Zaharlick, 2001, p. 206). Important terms used in this dissertation, like "culture", "intercultural" and "identities" were defined in Chapter Two, yet are often revisited, as an attempt to convey a more "emic" view of Mayan culture and identity in this particular context. These understandings were not simply "methods" but shaped theory and analysis throughout this process.

Some fieldwork methodologies that were used helped to increase my observational skills as I began to build a picture of Mayan cultural ways in this community. In an effort to create a "thick description" (Geertz, 1973) over time, I wrote fieldnotes and journal notes (Emerson, Fretz & Shaw, 1995) throughout the day, in the privacy of my *casita.* As Clifford notes in defining an "inscription" process in the field, one learns the "act of making mental notes prior to writing things down" (Clifford, 1990, p.51). Further, one "learns to notice what is important to other people and what one has not been trained to see" (Clifford, 1990, p.14). Thus, beginning with the first of recurring phases of ethnography, I found ways to explore the process on site through the eyes of participants in the community. This process is also described as a "grand tour"

(Spradley, 1980), which begins to open up to an outsider how members of a social, political community (in this case) identify aspects of their world. In this Mayan community, their world includes both "human and more than human aspects" (Apffel-Marglin, 2004, p.24). This cosmovision and Mayan worldview is explored in Chapter Six in which indigenous ways of knowing are analyzed but is also relevant to how this Mayan world is "identified."

I would not describe individuals I spoke to on site, to learn from their perceptions and experiences, as "key informants" (Spradley, 1980), as that was never their stated role nor ongoing position. I did however, select or purposefully sample, certain students and promoters to engage in informal conversations. These conversations helped to fill in my emerging grasp of important players and led to insightful interpretations. Each piece helped to construct a puzzle of life at this site.

Engaging in participant observation means that descriptions are written in diaries and fieldnote logs (Emerson, Fretz & Shaw, 1995) to construct multiple layers of "thick description" (Geertz, 1973). It also becomes a way to "create a portrayal of the heart and soul of a group, community or culture" (Clifford, 1990, p.15).

My role as a teacher working collaboratively with promoters or autonomous education teachers gave me even greater access to gaining cultural knowledge at this Mayan site. As a result, I was able to initiate and participate in many learning experiences as well as interact with members of the educational community in a variety of contexts. My data "collection" or "generation" (Heras Monner Sans, 2002) found fertile ground within this Mayan autonomous education community where I lived for month long cycles. Living on site provided strategic access to and participation in the life of the school community, offering both formal and less structured ways to engage in their process.

To summarize, in this section I sought to provide a context to understand why a fluid methodology was necessary at the Mayan autonomous school site in Chiapas. Some guidelines for ethnographic methodological approaches that were used throughout the duration of this study were presented. Establishing a framework for ethnography at this site creates a basis in the next section to explore how trust and access evolved at this site. Within the parameters of building trust and gaining access, my own social history is a theme that underlay a developing basis for mutual conscientization and an intercultural dialogue.

Section Two: Research Context

Gaining Access, Setting, and Participants

Gaining Access

As briefly explained in the previous section, gaining access to the "research context" of the Mayan autonomous school community in Chiapas was a critical part of developing the methodology of this study. Initially negotiated and continually renegotiated, access was a sensitive issue at this site. At any time, demonstrating repeated insensitivity to cultural practices, being unwilling to follow political direction of Mayan autonomous education or placing my "research agenda" above needs of the school as defined by the school leadership, would have been grounds for revoking access. Although not explicitly stated, evidence of these priorities became visible across the years, beginning in July 2000. I was made aware of these tacit boundaries by knowing that a professor who held a workshop before mine in July 2000, had been politely but firmly asked to leave. While not a subject of public discussion on site, I knew before entering the site for the first time that this professor had persisted in breaking the norms and expectations both spoken

and unspoken on site, which led to her workshop being terminated.

Gaining access to any research site must be done with extreme care, as innumerable ethnographers have shown (Emerson, Fretz & Shaw, 1995; Erlandson, Harris, Skipper & Allen, 1993; Spradley, 1980). At this site in Chiapas, however, additional factors were at play. As mentioned earlier, my political and social history as an activist had to be demonstrated before I arrived on site. In a proposal for a first workshop written in March 2000, addressed to the educational leadership of the school, I explained my background. My background included working for six years in rural Nicaragua during the contra war of the 1980's, activism during the Vietnam War, and ongoing work as a radio journalist covering Latin American and indigenous issues throughout the Americas (see Appendix A for copy of original proposal). Thus, my "credentials" as a politically conscious bilingual activist accompanied my proposal to do a workshop entitled, "Paulo Freire and Critical Mathematics."

It is important to note here that a teacher friend in Santa Barbara, California who was aware of my background introduced me to the autonomous Mayan school. She put me in contact with a U.S. based support group working with the autonomous schools in

Chiapas, which I then investigated. Through conversations and e-mail, I found out the areas in which the school wanted help external to Chiapas. I was interested in applying to the school for several reasons. First, I had known about the resistance movement in Chiapas since 1994, out of which autonomous education developed. Second, I felt my teaching skills, knowledge of Freirean methods, critical mathematics, and Spanish learned in the countryside of Nicaragua, might prove of some use and enable me to communicate with the school community. Third, I had previous experience in indigenous contexts and movements in the United States but wanted to extend that to Latin America and Mexico.

Over four years I learned that I continually needed to demonstrate that I could adapt my political and academic consciousness to the needs and demands of this Mayan site. A process of coming to awareness, as Freire's work on conscientization describes (Freire, 1970, 1985,1988) is presented in more detail in Chapters Two and Six. I came to understand this process theoretically and by using cultural sensitivities I entered with to help direct my actions and decisions. As can be seen in

Chapters Two and Six, I developed an awareness through interactions and resultant shifts in perspectives of Mayan promoters that the conscientization process was in fact mutual.

Central to the concept of conscientization, I had to learn to see the inevitable frame clashes or disjunctions in ways of thinking and acting interculturally as rich points (Agar, 1994) in order to understand the cultural demands of the site and to modify my actions and attitudes. This awareness was needed so that I could appropriately support Mayan autonomous education and pariticpate in the community. It also meant shifting what I understood as a research agenda to seeing creative ways to engage in ethnography (see Chapter Four for more discussion of my evolving role at the site).

A key piece of the puzzle was a major shift in my own conscientization in becoming an ethnomathematics teacher, resource provider and ethnographer. I did not enter the school initially as someone with the capacity to teach Mayan ethnomathematics. However, I took up this challenge once it became clear to me that it was important for the school. This journey turned out to be a profound learning experience for myself and for members of the autonomous school, both promoters and

students (see Chapter Five). As a result, across the four years, my role as a collaborative teacher working with groups of young Mayan promoters, and later students, on issues of Mayan ethnomathematics became a key way others saw my public identity or role in the project of autonomous Mayan education.

Thus, the process of gaining and re-gaining access was an important part of the methodology of this collaborative work. It was a dynamic theme that continued throughout the four years on site and was part of developing a consciousness of the need for a "transformative methodology," that is a methodology that continually changes and adapts. Adapting methodologies that reflected underlying Highlands Chiapan Mayan "analytic categories" (Rockwell, 2002) became a goal of mine even though the term "analytic categories" was not articulated. The development of such categories, however, can be traced to how access to the site became possible through interactions with the school's elected leadership over four years.

Setting

The setting for this study is an autonomous Mayan secondary school in the rural, agricultural Highlands of Chiapas.

The principal language spoken is *Tzotzil* Mayan, with students, teachers and others at varying levels of Spanish proficiency. Individuals were selected to teach at the school based on Mayan background, bilingual proficiency in *Tzotzil* and Spanish, and their abilities to represent and contribute to autonomous liberatory education, as internally defined. Internally decided processes also select students.

Due to risks of "low intensity war" in Chiapas (Muñoz-Ramirez, 2003; Nash, 2001; Weinberg, 2000), families of many students living at distances too far to walk on a given day, and harsh conditions imposed by poverty, students and promoters board at the school. Except for once every ten days and longer breaks for the coffee and corn harvests, members of the school community remained on site.

Demographic information about the school population and composition is approximated due to considerations of the school's security. It is possible to say, however, that numbers of students enrolled at the school stayed relatively constant over four years, with the percentage of girls purposefully increasing each year. The fact that the number of girls increased reflects an important priority of the Mayan autonomous movement, which is to educate and

empower young indigenous women. This included the girls learning Spanish at the school to extend their abilities to communicate across Mayan language communities and with people from outside the Highland community. It is acknowledged throughout the autonomous education system in Chiapas that girls represent one of the most marginalized sectors in Chiapas. In a desire to change the marginalized position of Mayan women in Chiapas, the percentage of women teachers was also purposefully increased. This indicated a growing commitment to educating young women and providing female role models for students. The following table shows approximate demographic breakdown, highlighting percentages of girls to boys, men to women, from July July 2000 to July 2003.

Table 3.1: Approximate Demographic Breakdown

Year	# of students	# of teachers	Ethnicity
2000	Total: 125 % girls: 35% % boys: 65%	Total: 14 % women: 25% % men: 75%	Mayan *Tzotzil* 100%
2001	Total: 124 % girls: 30% % boys: 70%	Total: 18 % women: 35% % men: 65%	Mayan *Tzotzil* 100%

2002	Total: 126 % girls: 35% % boys: 65%	Total: 20 % women: 40% % men: 60%	Mayan *Tzotzil* 100%
2003	Total: 125 % girls: 40% % boys: 60%	Total: 22 % women: 45% % men: 55%	Mayan *Tzotzil* 96% Mayan

In summary, many relevant aspects of the setting of the school site will be referenced throughout the dissertation. The purpose of reiterating important factors of this site not only provide a methodological explanation for this context but also help to contextualize theoretical and practical decisions I made on site.

Participants

Participants in this collaborative teaching project out of which an ethnographic study developed, were members of a Mayan autonomous educational community. Mathematics workshops were held each year principally with the grouping of promoters that particular year .The promoter group fluctuated, although some individuals were part of the group over four years. Third year students, who were the most advanced level at the school, participated in a workshop in July 2003 that ran concurrently with the promoter workshop. In year three, July 2002 (see Table 5.2 in Chapter Five). I worked almost daily with two

mathematics promoters as well as with the entire group of promoters during a one-day workshop on Mayan ethnomathematics and agriculture.

As a result, the greatest amount of data was generated from interactions with promoters in structured workshops. The emphasis of my work was on providing resources for the school in Mayan ethnomathematics through an intercultural dialogue of collaborative teaching, *not* on asking individuals to "participate" in a "research study" in the traditional sense. Participants in the sense used here refer to promoters and later students who were part of workshops over four years. Participants also include promoters and students with whom I interacted in less structured situations.

Other members of the educational community, particularly the head of the education committee, were actively involved in the initiation, progress and evaluation of workshops each year. "Adrian", as I refer to the head of the education committee, was a key actor in my work over time at the school, although he was not a "participant" in the typical sense. There were also various consultants both on and off site who played important roles that I am not at liberty to discuss. The head of the consultant group, however, whose name for purposes of the dissertation is "Juana" is

referred to repeatedly, as she and I developed a closer relationship off site which was extremely useful in analyzing the school's process.

It was decided in discussions with Adrian of the school leadership in March 2002, that I could write up what took place in our mathematics workshops for purposes of my graduate work at the University. In July 2002, when I returned to work with the promoters, there a few references made to "my work" at the University, although it remained purposefully oblique. There was essentially no change in the focus of our work together or the meaning described here of "participants." It did make my additional agenda of producing a "thesis" at the University based on our workshops a bit more visible. For the most part however, it did not change the circumstances of our work together. Perhaps individual promoters saw themselves as "participants" beginning in July of 2002 but it was never spoken of in that way. It should be added that cultural practices of this Mayan site influenced what was verbalized and not-verbalized, as the "talkiness" that might accompany some research sites was absent here. Had I been able to speak *Tzotzil*, I might have had access to some insider perspectives of how members of the educational community

viewed my work and their role, as less formal conversations among members were always in *Tzotzil*.

To summarize, this section presented important factors to consider in understanding the setting and participants of this collaborative teaching ethnographic study. Terms of access and entry shaped the parameters of this study and how it unfolded over four years. The setting of the school also influenced how data was "generated" (Heras Monner Sans, 2002) and methodologies developed to meet the particular criteria of the site.

The next section will examine important aspects of research design and transformative methodologies adapted at this site. This discussion includes the purpose of the study, research questions, data collection, and data analysis procedures.

Section Three: Research Design and Transformative Methodologies

Purpose of Study

This study, which explored how Mayan ethnomathematics and indigenous ways of knowing were actualized by intercultural dialogue and mutual conscientization, utilized a research design that combined elements of an ethnographic case study, similar to

a "naturalistic research paradigm" (Moschkovich & Brenner, 2000, p. 458), with a form of participatory research. Typically, a case study involves immersion in a particular setting and relies on the worldview of both the researcher and the participants (Marshall & Rossman, 1999, p. 61). This is true in my case except for the qualification that "participants" in our Mayan mathematics workshops did not see themselves as part of a research project. Nevertheless, their worldviews greatly impacted what was learned over the duration of this study and shaped my own understandings of Mayan members of the educational community. In many ways, the research design process at the Mayan school site is best described as a "logic in use" growing out of a "logic of inquiry" (Green, Dixon & Zaharlick, 2001). In this framework, questions and themes are generated and identified in the local situated context over time. What is crucial to note here is that the research design *itself* is subject to change arising from interactions with participants at the local site and learning what counts for them (ibid).

The design of the study reflects some aspects of participatory research (Kemmis & McTaggart, 1988). My collaborative teaching ethnographic project did involve collective engagement as a form of self-reflective enquiry, similar to

participatory action research. It could be described as "undertaken by participants to improve the rationality and justice of their own social practices" (Kemmis & McTaggart, 1988, p.5). Yet Mayan promoters and students did not see themselves as "participants" in a research study and were not directly seeking to improve the "rationality and justice" of their practices in that context. As a result, participatory research offered only a partial frame of reference for the research design.

The purpose of the study, then, shaped by research design considerations just discussed, was to explore what was needed for Mayan promoters at the autonomous school to take up a perspective on Mayan ethnomathematics and to discover how the worldviews of Mayan participants affected their ways of knowing. This study grew out of our collaborative teaching work over four years, which shaped what our "logic of inquiry" and "logic in use" (Green, Dixon & Zaharlick, 2001) would look like.

Workshops, evaluations, conversational records, and collaboratively produced written texts over four years provided evidence for the focus of this study. The paths we tread were by no means linear, affording opportunities to learn in "transformational

spaces" (Franquiz, 1999), within and outside of structured workshops.

The following research questions, which guide Analysis Chapters Four, Five, and Six, developed over the course of a four-year ethnography and collaborative teaching experience.

Research Questions

1. How does an overview of this four-year project at an autonomous school reveal access, entry and a framework for an intercultural collaborative process?
2. How did Mayan ethnomathematics emerge through intercultural dialogue and Mayan indigenous ways of knowing?
3. How did intercultural dialogue, actualized by double conscientization, uncover Mayan indigenous ways of knowing?

In the analysis chapters that follow this discussion of methodology, it will become clear why these research questions became the focal points of the study. They emerged from theoretical orientations and practices that took place over four

years shaped by my access as a participant in the process of autonomous education.

Data Collection

As mentioned previously, data were "generated" (Heras Monner Sans, 2002) under circumstances unique to this autonomous Mayan school project, which constrained some aspects of more public data collection procedures. As explained in previous sections of this chapter, it was not possible to do audio or video recordings on site due to security considerations. Furthermore, as a result of being a full participant or collaborative teacher, my fieldnotes and journal notes were reconstructed in private after specific events. Nevertheless, rich sources of data were collected/generated. This included over 500 pages of fieldnotes, journal notes, conversational interviews, collaborative printed documents produced from hand-written group records during workshops, workshop evaluations filled out by promoters at the end of each series of workshops, and other artifacts. As can be seen in excerpts of fieldnotes, journal notes, workshop records and other documents (see Chapters Four, Five and Six) generated data comprised an abundant body of evidence.

The following table presents sources of data that were

generated and made available. It permits the reader to see in a more precise way the extent and richness of data sources.

TABLE 3.2: SOURCES OF INFORMATION

Sources	How Extensive
Formal workshop proposals to school leadership	4 written and verbal preceding each workshop
E-mails	To UCSB Advisor: approx. 5-10 per yr. on site To Ana Inés Heras: approx. 5-10 per yr. on site To other UCSB professors: 2-4 for 2 yrs on site To Director of Chiapas solidarity grp: 4-5 per yr. on site
Fieldnotes and Journalnotes	Year 1 (July 2000): 50 pages Year 2 (August 2001): 126 pages Year 3 (July 2002): 132 pages Year 4 (July 2003): 124 pages
Workshop records	Year 1 (July 2000): 10 printed pages Year 2 August 2001): 5 printed pages Year 3: (July 2002): 15 printed pages Year 4: (July 2003): 25 printed pages
Documents	Produced on site: 55 pages total (wkshp. records) Brought to site: 20 articles total 20 books total 2 films total
Promoter evaluations	Following each ethnomathematics workshop: 32 total
Conversational interviews	40 interviews reconstructed in written form afterwards ranging from 15 minutes to 2 hours.
Translations of talks	4 sets of notes taken publicly of Adrian talks to visitors and to entire school 10 publicly recorded notes of shorter presentations by promoters and students

Thus, the preceding table indicates a considerable body of data from which an analysis was developed in this dissertation. Indeed, these data supported an analysis of an emergent Mayan

ethnomathematics perspective and an interpretation of indigenous ways of knowing in subsequent chapters of the dissertation.

My role as participant observer (Spradley, 1980) and intercultural collaborative teacher enabled me to initiate and participate in many learning experiences. The majority of my role was as a participant observer, which falls at the end of Spradley's continuum (Spradley, 1980), with the exception of my translations of public talks by Adrian for my own use, in which I was an observer participant. Data collection grew out of a situated context of living within an autonomous education community for month-long cycles. This situation allowed strategic access to the life of the school community and the community's access to me, in both structured and less structured ways.

Each summer between July 2000 and July 2003, I taught and engaged in collaborative teaching-learning workshops with Mayan promoters (teachers) on site, pre-negotiated with Mayan leadership of the school. In July 2003, I also taught-collaborated with a group of third year students during their mathematics class although I had interacted with students numerous times in less structured settings from the beginning of the project in July 2000.

To get an overview of time I spent on site at the Mayan autonomous school community in Chiapas, a mini-table has been constructed. Its purpose is to indicate the number of days I was on site from July 2000 to July 2003. The number of days included days of formal workshops as well as time surrounding the actual workshops, as indicated in each analysis chapter.

Table 3.3: Days on Site

Month & Year	Number of Days
July 7-15, 2000	8 days
August 6-25, 2001	19 days
March 25-29, 2002	4 days
July 1-24, 2002	23 days
July 1-19, 2003	18 days

In addition to data collected on site, I have copious records of e-mail communications, meetings, written plans and subsequent evaluations before, during, and after each year at the school. Graphic representations of data collection over time can be seen in analysis Chapters Four, Five and Six.

To give a more detailed picture of the kind of fieldnotes I

took, they were written either as observations or as descriptions based on my participation in intercultural teaching learning and other meetings and events. I used as much verbatim language as possible to represent what I witnessed of member perspectives (Rockwell, 1987; Spradley, 1980). I also wrote methodological and theoretical notes in addition to personal notes (Corsaro, 1981; Emerson, Fretz & Shaw, 1995), which added to multiple perspectives over time. As different kinds of patterns became visible, either in my own cultural/multiple identities or in the contexts within which I interacted with Mayan members of the school community, I noted these and indicated possible shifts in activities or understandings. I also wrote down as much relevant contextual information as possible that might serve to triangulate evidence later.

Due to constraints on site, as explained earlier, I sought out informal conversational interviews with students, teachers or other members of the educational community. Having determined during the first few days on site in July 2000 that it was culturally and politically inappropriate to take notes during the actual conversations, I wrote as many details as possible immediately

afterwards. Even with these limitations, however, a rich picture of individual and collective interactions was recorded.

Section Four: Data Analysis Procedures

This ethnographic and collaborative teaching study used methodologies of data analysis that flow from theoretical orientations. Using a "logic of inquiry" to inform a "logic in use" (Green, Dixon & Zaharlick, 2001) generates a theory-method approach to data analysis in which representations and interpretations can be constructed.

Data were analyzed in three initial phases to identify recurring themes or patterns, as is central to an ethnographic methodology (Clifford & Marcus, 1986; Spradley, 1980) In phase one, a macro-level representation of data was constructed for each year. Beginning with year one (July 2000) and working forward chronologically, structured workshops and less formal interactions on site were examined to analyze iterative patterns in multiple contexts to cross reference different sources of data and different perspectives (triangulation) as well as to construct key events or episodes. Fieldnotes, journal notes, collaboratively produced documents, conversational records reconstructed from memory,

workshop evaluations, and other relevant data were coded to indicate patterns and significant interactional events. The coding was designed to show patterns of evidence related to the key themes of the research questions presented above.

The coding categories that I used throughout the different phases of analysis were the following. First, an examination was made of all data for evidence of Mayan mathematics and ethnomathematics. This process included finding patterns in the data that made visible changes in perspective on the part of Mayan promoters and students about the importance and relevance of Mayan ethnomathematics. Thus, it became possible to present evidence of agency by Mayan promoters and students once an ethnomathematics perspective was taken up, as seen through language use in workshops, particularly year four (see Chapter Five). Second, in the course of examining all data centered on our mathematics workshops, I also coded for Mayan ways of knowing. This coding category produced sufficient evidence to ground an analysis of the role played by the social construction of indigenous knowledge as well as dynamic and changing approaches to that knowledge.

Third, coding categories also included frame clashes and

rich points over four years. This analytic category provided evidence of an ongoing process of my own conscientization (as defined in Chapter Two) and mutual conscientization by Mayan promoters, students, and myself through our reciprocal relationship and engagement with issues involved in Mayan ethnomathematics. Fourth, I coded any additional evidence of conscientization and intercultural dialogue. Patterns of this evidence were present throughout our multiple interactions over four years. Fifth, I coded for evidence of ethnographic methods and what came to be called "transformative methods." Evidence pointed to alternative ways I generated and collected data in response to a site in which traditional researchers were not welcome. This arose due to the view of traditional research at this Mayan site, even though it was not explicitly defined. The transformative research I engaged in was implicitly accepted, as evidenced by my continued access over time.

Sixth, I coded evidence of autonomous education and forms of liberatory education in fieldnotes, journal notes, school documents and other collaboratively produced documents.

Evidence for this analysis was amplified by other data sources, including an interview with the head of the Education Committee, Adrian and an introduction to a report on a "Stories Workshop" from a workshop led by other internationalists (see Chapter Six). Seventh, I coded data for evidence of Alex's actions and interactions and a category called "girls" to determine if each constituted grounds for being called, "tracer units" (see Chapter Five). Eighth and finally, I coded for evidence of the different roles that I played on site over four years. This included the sub-categories of teacher, ethnographer (which came to be called in my own work as "ethnographer as learner"), resource provider and resource producer. Therefore, coding within these eight categories surfaced patterns that were a foundation for an emergent analysis.

In the first and subsequent analytic phases, domain and taxonomic analyses (Spradley, 1980) provided a useful strategy for identifying and classifying aspects of the Mayan cultural educational community in Chiapas and categories that arose through our interactions. In other words, since this study was not just seeking a descriptive analysis of the site in question but was geared toward the dynamic components of our collaborative work

together, the domain and taxonomic analyses reflected those priorities.

In phase two, events and interactions that became visible in phase one were looked at more closely, relating macro to micro, in contexts of time and space. In order to show how practices evolved and contrasted with other practices over time, using textual and intertextual analysis (Fairclough, 1990) as well as "vertical and horizontal intertextuality" (Kristeva cited in Fairclough, 1992), a macro timeline and table showing the evolution of the process of take up of a Mayan ethnomathematics perspectives. Tables were also generated that facilitated analysis of patterns in discourse and interactions that made visible, for example, principles of autonomous education and what comprised Mayan ways of knowing.

Practices and interactions of participants in this social context, as had been categorized (to some degree) by domain analyses in phase one, were captured in this phase through slices of talk, anecdotes of illustrative events and significant exchanges within a narrative approach (Evertson & Green, 1986). Additionally, further coding of data sources or altering codes to better reflect

emerging patterns, as explained in detail earlier, was developed, reflective of a dynamic analytic approach. A coding system as a way to interrogate data, continued throughout the analytic process to see what patterns emerged and re-emerged (Emerson, Fretz & Shaw, 1995).

The third phase of analysis provided samples of events (growing out of data analysis in phases one and two) that best told theoretical-practical stories. "Tracer units" (Cole, Griffin & Newman, 1981, cited in Green, 1983) were used to highlight meaningful "loci of observation" over time. Additionally, findings from "telling events" (Green, 1983) were foregrounded to illustrate why this study offered a specific case that might have ramifications for similar studies in indigenous education contexts. In this phase, a degree of micro-level sociolinguistic analysis was possible as well as aspects of critical discourse analysis (Fairclough, 1990). These pieces were key to grounding evidence (Green & Wallat, 1981) based in fieldnote records of slices of talk or of written translations simultaneously recorded of school presentations.

In the course of developing analysis further after data collection was completed, particularly during the writing of this dissertation, I returned innumerable times to fieldnotes, journal

notes and other relevant data to recheck my analytic categories. It was important to ground and re-ground the analysis in data to be certain that I was constructing a reliable interpretation of the data.

Even though a methodological approach to data analysis necessitated a separation of phases and aspects under the gaze of a specific moment, it was important to draw interconnections among phases and see how parts interrelated within the whole. Threads of interconnection are subsequently drawn through three analysis chapters and in the concluding chapter, which offers an opportunity to look back and forward at the same time.

Summary and Conclusion

Methodological decisions highlighted in this chapter were grounded in theoretical principles of ethnography based upon collaborative teaching at a Mayan autonomous educational site. Why a "transformative" methodology adapted to the situated context was needed at this research site was explained. These methodological issues frame discussion in subsequent analysis chapters. There is a dialectical relationship between theory, method and practice, which characterizes both methodology and subsequent analysis. This fluidity and inductive character is part of

what separates an ethnographic approach from an empiricist one (Rockwell, 1987).

In the next chapter, a macro-timeline is presented to begin the analytic process. The purpose of this first of three analysis chapters is to situate the reader within the collaborative teaching ethnographic project at a Mayan autonomous secondary school in order to introduce key themes that arose and that are analyzed subsequently in more depth.

CHAPTER FOUR: MACRO-TIMELINE AND OVERVIEW

"The principles of autonomous education are not to educate people but to share experiences, knowledges, to transform the world that all of us have created."

-Head of Education Committee

Introduction

In the previous chapter I addressed methodological issues involved in the present study. This allowed me to present the role of theory, methodology underlying data analysis, and methods of data collection in this situated context. Chapters One and Two laid a foundation for where this study fits in the broader scope of ethnomathematics, liberation pedagogy, indigenous ways of knowing, and the field of international and indigenous ethnographic research. In this chapter and the next two, I offer data analysis contextualized by questions and concepts discussed in preceding chapters.

The purpose of this macro-analytic chapter is to contextualize for the reader multiple levels of my four-year ethnographic study based on collaborative teaching at an autonomous Mayan secondary school in Chiapas, Mexico. It was an

ethnographic study within and of an interactive, collaborative project shaped by participants on site and myself. It was not only a form of participatory research but also a learning, conscientization process (Freire 1970, 1985, 1998) to understand and implement practices within this particular Mayan community's approach to knowledge co-construction. It was collaborative in choosing the focus of our work together, in a joint approach to ethnomathematics over time, in providing oral and written texts as resources for mutual learning, and participants' agency in taking up new ideas and perspectives. It was also collaborative in that Mayan indigenous pedagogies of the school resonated with dialogic approaches utilized within and outside of formal workshops.

Keys to a conceptualization of the collaborative efforts undertaken at the school lie in four areas: First, that conscientization is at the heart of intercultural collaborative dialogue (Blum, 2000, Freire, 1970; Lopez, 1999 cited in Jimenez, 2001). Second, that transforming processes of frame clashes into rich points (Agar, 1994; Green, 1983) could be engaged by myself and members of the Mayan community in efforts to build mutual conscientization. Third, that indigenous ways of knowing could be

supported through transformative methodologies (Battiste, 2002; Cavalcanti, 1996; Tuhiwai Smith, 2002). Fourth, that Mayan ethnomathematics offered a co-constructed dialogue engaging yet challenging some of the autonomous school's internal directions and pedagogies related to mathematics.

Purpose of Chapter

The purpose of providing a macro-level contextual timeline is to demonstrate how the four key issues that frame this collaborative teaching ethnographic project were taken up over time. Toward this goal of analysis, critical themes and key issues of intercultural dialogue will be presented. Phases of the project are analyzed, using year markers of entry and reentry, to allow an examination of part-whole relationships in the development of ethnomathematics. In turn, data over four years supported findings, both in the Mayan ethnomathematics workshops and in other contexts, of Mayan ways of knowing.

The focus of this macro, big picture chapter, is to engage the themes raised previously in relationship with four "macro questions". These macro questions will look at how Mayan ethnomathematics developed, my evolving role, a changing "field

of study", both physically and in terms of understanding, and in coming to know the significance of Mayan participants approach to constructing knowledge.

Since each analysis chapter of the dissertation is designed to explore a distinct layer, in which spaces are recreated through textual and intertextual ties, this macro overview layer will provide a "big picture view" of thematic developments as stated above, explored further in subsequent analysis chapters. This chapter is meant as a guide to how the project unfolded, placing the reader within contexts of an autonomous Mayan secondary school, my entries and re-entries to the site, and what came to be known over time.

Section One: Macro Questions

While themes raised through questions posed at this macro stage are stated in the previous section and will reappear to be analyzed in more depth in subsequent analysis chapters, it helps to identify the scope of the project over four years. Toward that end, the following macro questions generated themes that are taken up throughout this dissertation, reflective of a collaborative teaching ethnographic project at a Mayan autonomous school

over four years.

The macro questions are the following:

1. What is the nature of the "field" in this setting and how did it change over time?
2. What was my initial and evolving role as a collaborative teacher and ethnographer?
3. How did Mayan ethnomathematics come to be our focus?
4. What became visible over time about indigenous ways of knowing and process?

To help examine these four questions and related sub themes presented above, a macro-timeline of the Mayan autonomous school project has been constructed. As will be explained, the timeline pinpoints key moments in time and themes that follow a longer trajectory. It is important to note the use of intertextual (Bloome & Egan-Robertson, 1993; Kristeva cited in Fairclough, 1992) and intercontextual frames (Floriani, 1994) to piece together interrelationships of parts to the whole and to each other. The timeline is based on over four years of "data generation" (Heras Monner Sans, 2002), including fieldnotes, journal notes, e-mail communications, formal and less structured conversational

interviews, collaboratively produced documents, artifacts and other data sources. Thus, each of the research questions will be explored at a macro level, with intermittent use of a micro lens, to see what an overview makes visible.

TABLE 4.1: MACRO TIMELINE OF MAYAN AUTONOMOUS SCHOOL PROJECT

Pre-entry	**Initial Entry: Year 1**	**Eval.year1/pre-year 2**	**Year 2:August 2001**
Process of gaining entry & preparation	**First workshop, gaining access & what accomplished**	**Building trust, begin conscientization & ethnography workshop plan**	**Frame clash to rich point, reframe investigadora, discussion of 2X2=2X2**
Feb.2000 *e-mails with Chiapas solidarity group re: school proposal **Mar.2000** *proposal to school for 6-day workshop (Paulo Freire & critical mathematics) **May 2000** *proposal accepted **June 2000** *conversations with Paul Brand & professor doing Freirean workshop **June 2000** *meetings with Julian Weissglass, Judith Green re: approach to workshop, ideas for content, e-mails with Dr. Ana Inés Heras	***July 2000** *first workshop with promoters -roots of Mayan mathematics -liberatory pedagogy as indigenous pedagogy: follow their approach to time, process, learning style, collectivity *develop trust within and outside workshop: role of conscientization, build ties with girls, present Chumash gift to Mayan elders *begin role as resource provider/generator *interactions as texts for mutual learning based on intercultural dialogue (in moment and over time) *evaluations of promoters *at end, invitation to return by Adrian, head of Education Committee	*begin trust building/acknowledge frame clash-rich point perspective *initial work on ethnography & proposal for 3-wk ethnography workshop, which was accepted (1st indication of levels of acceptance) *create ethnography booklet in Spanish with Dr. Ana Inés Heras	*strong frame clash with Ed. Committee decision to change 3 week. ethnography workshop to 1 day *Adrian use of term "Investigadora" w me *others (JG and Ana I.) push me to see school agenda over my own *clarification of my role *Education Committee integrates me into consultant group *8/11 participate in daylong school evaluation meeting: key disc. of "2X2=2X2 no matter what" and my public response.

Eval.Yr.2 (2001) & Spring 2002	Year 3: July 2002	Eval of Yr.3/Pre-Year 4:July 2003	Year 4: July 2003
Assess plan for workshop focus *5 day visit needed to assess topic of July 2002 workshop *key discussion with Adrian, head of Education Committee re: agreement to pursue mathematics & agriculture, not ethnography *e-mail communications with consultants on site/off site	**Mathematics & Agriculture workshop, daily work with math promoters & Mayan ways of knowing** *key event in development of ethnomath perspective: one-day wkshp. on math and agriculture w. all the promoters *collective document produced *daily support and work with two math promoters-part of bldg trust, co-teach, develop ethnomath, follow school agenda *do ethnography on dif.level, even less visible *more visible indigenous ways of knowing as approach/process/agency *conversational interviews w. Alberto/girls-develop as "tracer units."	**Ethnomathematics Congress in Brazil, Develop Mayan ethnomath themes further** *attend Ethnomathematics Congress in Brazil Aug. 5-7 2002: discussant in indigenous education and ethnomathematics session * report on Congress written for school & sent to them * develop themes from one day workshop on mathematics & agriculture *proposal for workshop with promoters on origins of ancient Mayan mathematics & daily practices in communities *communications with 2 consultants on and off site	**Workshop with promoters and students on origins of ancient Mayan mathematics** *3 week workshop with promoters and third yr students on ancient Mayan system & current practices *collective document produced *first formal workshop with students *my role as resource provider/generator similar to role in consultant group. *less structured conversations & conversational interviews *content in ancient Mayan system led to request for more information from Dr. Gerardo Aldana from UCSB

Post July 2003	March 2004	Sept. 2004-current	
Ongoing work with school beyond dissertation *completed "official" data collection for dissertation *return trip planned in response to promoter requests for more ancient Mayan resources *UCSB travel grant to do 2-week workshop w promoters on Mayan math, calendrics, astronomy and hieroglyphics	**Follow-up workshop on origins of Mayan math, astronomy & hieroglyphics** * 2 wk workshop with a professor from UCSB *provided both supports & constraints for promoters and myself *collective document produced	**Develop resource of booklets on Mayan ethnomathematics** *grant to produce popular education style Mayan ethnomathematics booklets in *Tzotzil* & Spanish *participant in NSF conference on "Culturally Relevant Mathematics" in Arlington, VA Nov.2004 * 3-day visit to school in April 2005 to review Mayan ethnomathematics booklets, translation into *Tzotzil,* work to complete by end of summer 2005	

Part One: What Was the Nature of the "Field"?

The "field" in the context of this study, is both a physical place-the Mayan autonomous secondary school in Chiapas- and a site of understandings that changed over time. What came to be understood about the "field," happened both physically on site and in pre-entry and post-entry analysis physically removed from the site, in interactions with committee members at UCSB and in e-mail communications with a committee member in Argentina and others, as indicated by the macro timeline.

The timeline in Table 4.1 is constructed using year markers, as my initial entry to the site and reentries are predominantly based on yearly time. Each year's workshop, beginning with the initiating workshop of July 2000, required a written proposal in Spanish. Proposals were hand-carried to Chiapas, negotiated with the Education Committee of the school via the Director of a solidarity group working with projects in Chiapas, and communicated back to me. As can be seen in the timeline and will be analyzed, themes raised by the four research questions were interwoven through the process of this multi-layered project. For purposes of analysis, however, each theme will be looked at separately. The "field" is no exception.

A critical aspect of entry and reentry to the "field" is building trust. Trust building goes further than processes of entry and re-entry yet is embedded within it. For collaborative work to be initiated and continued over time, I needed to "read the world" (Freire & Macedo, 1987) of the school and be responsive to it. A mutual conscientization process, which forms a pillar of this study-collaborative project, was needed at every stage of this complex intercultural dialogue.

Examining page 1 of Table 4.1 of the macro timeline, in the column on pre-entry beginning in February of 2000, it becomes evident that negotiation began right away. I could not have entered the site initially without a written proposal for a workshop accepted by the educational leadership of the school (see Appendix A). Conversations with the Director of a solidarity group supporting education projects in Chiapas helped to orient my first entry but would not have been sufficient to gain trust and retain entry. What would be needed to build trust started to become visible in contrast with a Freirean-based workshop leader who was asked to leave the site before I arrived. This workshop leader had been unresponsive to repeated requests for her to abide by the security guidelines of the school as she overstepped bounds in searching

for "generative themes." I am not at liberty to describe the details of her interactions any further due to my agreements with the school, nor would it be appropriate here. It did however provide an important first lesson in the need for cultural and political awareness as a basis for trust.

Critical to my entry and reentries to the site, was my willingness to follow terms and conditions of the school. Consciousness I had gained over many years of political activism, particularly my work for six years in Nicaragua building houses in rural areas, helped to prepare me culturally and politically to some extent. In the environment in Nicaragua, which had included wartime conditions, I worked closely with local Nicaraguans and adjusted to following their lead.

In carrying out the first workshop in Chiapas in July 2000 entitled, "Paulo Freire and Critical Mathematics", my "political credentials" were as helpful as my educational ones. As will be understood through the multiple unfoldings of this dissertation, a political commitment to the goals and aspirations of the school underlay a two-way "pact", as it were, to pursue educational ends that reflected an emergent agenda of the autonomous school. This theme, which came to be understood over time as conscientization

at the heart of intercultural dialogue, constituted a pivotal underpinning of this particular "field" (as can be seen in Chapters Five and Six).

When I was on site at the school in Chiapas, I lived at the school together with members of the school community and others. My "living-in" situation meant that the number of hours physically on site were a lot greater than a traditional school site participant observation project and constituted conditions of traditional anthropological fieldwork. Being in the field for prolonged periods of time allowed me to see many public dimensions of community life and to see how concepts we developed together in workshops were taken up and used in everyday life. Living on site was required due to security concerns, which were paramount at the beginning of this collaborative project-study in July 2000 and remained in effect through my most recent workshop in March 2004. Security concerns were due to an ongoing paramilitary and military war against autonomous Mayan communities in resistance.

The following fieldnote excerpt demonstrates the concerns about security that permeated life at the school and influenced practical decisions in daily life.

> *Today we saw two helicopters flying overhead, close enough to the ground to be worrisome. Several students told me which branch of the military they were from. They said it would be a good idea when helicopters or small planes fly low, to get inside of the nearest structure in order to not be seen.* (Fieldnote entry, 7-14-00).

Security constraints based on the kinds of conditions just described meant that there was a monitoring of entering and leaving the site by those responsible for the school. Security concerns also impacted what was permissible and/or appropriate to use to record data, such as audio and video. These considerations heightened my resolve to position myself in other ways than a "typical researcher." I knew before I entered the site that the autonomous school did not want be a "subject of research" and it was confirmed a number of times once on site. Thus, a trust-building process and awareness of parameters of the "field" meant learning to maneuver through these guidelines while trying to develop a study. This led to my recording interactions and conversations *after* the fact to the best of my memory. I have described the innovative methodologies created in response to this particular school site as "transformative methodologies." More about this process is explained in Chapter Three and Chapter Six.

Successful workshops with promoters, as evidenced through individual and collective comments made in yearly written evaluations, are interspersed in the three analysis chapters. Positive feedback by promoters contributed to renegotiated access to the school and development of our focus together (macro question # 3). An example from the first workshop evaluation in July 2000 is from one promoter who said, " *Mayan mathematics is our ancestry as indigenous peoples of Chiapas*" and further stated that, "*Even though you are from outside the country, you have the heart to help us. Thanks and come back soon.*" (Workshop evaluations, 7-15-00). This comment indicates interest in Mayan mathematics, which represents the ancestry of Mayan peoples. A context was built at this first workshop to begin an investigation of Mayan mathematics, which involved a sharing of knowledges. Saying "you have the heart to help us" conveys some of the character of building relationships with promoters at the school (see Appendix C).

Relationships were carefully built in less structured interactions with students, especially with young women students who were much less fluent in Spanish and who were staking out

new ground for Mayan girls taking part in autonomous education. Building relationships with women promoters and with young women students reflected a commitment or conscientization on my part to overcome cultural or language barriers that arose in particular ways with young women students. These purposeful interactions helped to create a "*confianza*" and establish a clear sense of my intentions to get to know women on site. More on this important theme is addressed in Analysis Chapter Five, particularly in the section on "girls" as a tracer unit.

Two examples from my fieldnotes the first year and the third year give a sense of what it was like to interact with some of the young women students:

> *In year 1 (July 2000), I bridged the language gap between some of the girl students and myself by showing them photos of Macchu Pichu and of young indigenous girls in a market dressed in traditional clothing. That interchange helped to "break the ice" and got us "talking" in spite of language difficulties* (Fieldnotes, 7-8-00).
>
> *In year 4 (July 2003), a group of girls from the third year students taking my workshop on Mayan ethnomathematics came to see me. They blamed themselves for not understanding the concepts I was explaining in the workshop describing themselves as "muy atrasada" or "very backward." I disagreed, told them the material was difficult, and proceeded to explain it more thoroughly, using visuals as well. They left after forty-five minutes, feeling a bit more confident. The next day in the workshop they played a stronger role, including one girl giving an oral presentation*

for her group (Fieldnotes, 7-16, 7-17-03).

Both fieldnote excerpts describe some of the challenges we faced in getting to know each other. Working through the language barrier, given my inability to speak *Tzotzil,* meant coming up with creative ways to communicate. As indicated in the second fieldnote excerpt from the third year in July 2003, it was important to help the girl students develop more confidence by counteracting images of them as "backward." In fact, they proved themselves that this notion was a myth.

Another aspect of how I was viewed at the school that helped to bridge some of the cultural differences was through my relationship with several Chumash activists living in Santa Barbara, California. Bringing modest but symbolic gifts for Mayan elders from Chumash friends who wanted to reach out to the Mayan community in Chiapas, enabled me to embody an emerging bond (see Table 4.1, Year 1) The bond continued over four years through several exchanges in native languages and through sharing photos from an ancient Chumash canoe (tomol) crossing of the Santa Barbara Channel.

To summarize, the "field" in Chiapas, both physically and in terms of understanding, grew and changed over time. Developing

trust, which was also built over a four year collaborative teaching and ethnographic project, was key to access to the field and to co-constructing a mutual process of conscientization (discussed more fully in Chapter Six). My evolving role, to be discussed next, emerged in the contexts described in this section.

Part Two: What Brought About An Evolution In My Role?

In this predominantly macro analysis of my evolving role at the autonomous Mayan school in Chiapas, it became clear over time the multiple functions and identities I was expected to assume. In the summer prior to officially starting graduate school, I entered the Mayan school site as a collaborative teacher, with some incipient ideas about being an ethnographer as well. Even though I had not formally begun graduate school, my advisor suggested that I read a book called " Writing Ethnographic Fieldnotes" (Emerson, Fretz & Shaw, 1995). This book served as a helpful guide for thinking and practicing ethnography in the field. My collaborative teacher role began with a promoter (or "teacher" as defined by the autonomous school) workshop on "Paulo Freire and Critical Mathematics" (see Table 4.1 and Table 5.1 in Chapter Five) and continued during the entire four years.

In this section, I will discuss three major shifts that occurred in my role after the first year on site. The shifts were becoming part of the consultant group, developing my understandings of how ethnography could be used at this site, and developing my capacity as a resource provider in ethnomathematics.

To begin, I became integrated by the educational leadership into a consultant group at the school during year two, August 2001 (see page 1 of Table 4.1). The consultant group had been working on site, beginning approximately one year before the school's opening in March 2000, and before my entry to the site in July 2000. The purpose of the group was to help young promoters develop curriculum and pedagogy, as well as to offer resources and provide intellectual support to the school. The group was mostly composed of professors and teachers from nearby Universities and schools, as well as a few invited internationalists. Given the negotiated contract I have with the school, the role of this group is purposefully vague. It was in recognition of my role and contribution, relatively early in my project with the school, that I was asked to be part of the consultant group. That role has also remained throughout the four plus years on site and continues to

this date, even though the function of the consultant group has recently changed completely (Fieldnotes, Juana meeting 4-10-05).

Although I was integrated into the consultant group the second year on site, my frame clash persisted that had begun as a result of not being able to teach a three- week ethnography workshop as planned. The following fieldnote excerpt, which occurred during my time on site, reflects a turning point in my evolving role. It led to being able to clarify my understandings of what my principal identity on site needed to be and what the nature of my research would be. This excerpt is from a conversation that took place near my house between Adrian, the head of the Education Committee, and Paul, the director of a solidarity group in support of Chiapas (see Table 4.1).

> *Paul (whose name is changed) chided Adrian for not allowing me to do my three-week ethnography workshop, noting that the workshop given by several teachers from Spain seemed like "simply game-playing." Paul's long-term relationship of respect with Adrian allowed him to speak in that way. Adrian responded with one word in reference to me, which stopped Paul in his tracks and was said vehemently, which was "Investigadora!" The utterance of that one word defined the conversation, making it clear that my "investigadora" or research role was not wanted, that it should not be pushed (even in jest), and that was the final word on the subject. The conversation ended there (FN 8-17-01).*

This intense exchange between Adrian and Paul in

reference to me made visible what was *not* wanted at the school. It also made clear to me how the school leadership perceived researchers and the role I might be playing. Even though these concerns were expressed, my inclusion as part of the consultant group suggests an assessment of my ability to be conscious and respectful in regard to my roles on site. Further, the ethnography workshop that I was permitted to give after the school year ended in mid August was an indirect indicator that they saw the potential for ethnography as a resource. This one-day workshop provided an opportunity to explore some basic principles of ethnography and ways to apply those principles as I viewed them. Even though short, as we only had three hours, the workshop suggested that a "researcher" could be one who learns from people and learns from multiple angles of vision.

During the three hours of the ethnography workshop on August 18th, the following things occurred. After I introduced some basic principles about ethnography and its use in learning about cultural practices, we did activities to demonstrate how observation can uncover multiple perspectives. This included observing enlarged photos from Nicaragua, writing individual observations about the photographs and then sharing points of view with the

whole group. We then did an individual and group activity to learn about identity and culture. It was called, "Dimensions of Me" and had been suggested by Dr. Ana Inés Heras from an ethnography workshop she had done in Argentina. It enabled participants to write reflections about some of their own life experiences and then share in groups aspects of the cultural influences that had shaped their lives and perspectives. This activity took a long time, leaving us only enough time for evaluatory comments about the workshop.

As part of the concluding portion of the workshop, participants gave their comments about the workshop as we went around the circle. What became visible was the potential of ethnography to analyze a wide variety of situations at the school and an interest in learning more about it. At this point, I gave out copies of the ethnography booklet in Spanish that I had prepared with the help of Dr. Ana Inés Heras in order for workshops participants to have it as a resource for the future.

As indicated above, I was able to make several adaptations to the needs of the Mayan educational community as part of my evolving role, which may have been a key factor in my being invited to be part of the consultant team and to return in

subsequent years. I was responsive to concerns expressed by Adrian (see fieldnote excerpt above), was willing to reframe ideas I originally had for a three-week ethnography workshop, and adapted what I had prepared to meet their needs. However, although these adaptations led to a positive outcome in terms of my long-term involvement, as the following series of journal entries on site and e-mail communications with my own advisory team off site will show, I had to work through a difficult frame clash to get to rich points of understandings and new perspectives. This meant taking the next steps in a conscientization process with help from others, which contributed to my participation and contribution to the school in subsequent years.

The following journal entries and e-mails represent my growing conscientization of coming to understand and reframing frame clash conflicts to arrive at rich points of understanding. The two journal entries, which were written five days apart, demonstrate the frame clash conflict that persisted after the educational leadership told me on August 8th that I couldn't do a full three-week ethnography workshop. I had been on site since August 1st unclear as to when my workshop would begin. During the first week, I observed what was going on at the school, participating in events

as they arose and tried to arrange a time to meet with the Education Committee. Once that meeting took place, changes were enacted that were hard for me to accept. My ethnography workshop had been initially approved and I believed I had been acting in good faith in carefully preparing three weeks of activities about ethnography.

> *In realizing that the Españoles are giving a workshop on collective trust building I have to ask: How come they are giving a session at the same time that I was supposed to be giving my workshop?…I am feeling real disappointment and sadness inside. I am also angry that I've worked so hard on this workshop and can't do it the way I planned! (Journal Entry 8-10-01).*
>
> *It is such a shame that I am not giving my ethnography workshop. Maybe folks here don't realize they are wasting a good resource that could really help them to evaluate the school (Journal Entry 8-15-01).*

As these two journal entries show, my frame clash continued. My journal notes provided a personal outlet for the frustrations I was feeling in not being able to do the ethnography workshop as planned. Writing the journal notes also enabled me to avoid public statements about my disappointments, which would have been inappropriate.

The following three e-mail excerpts from my advisory team

at UCSB and in Argentina indicated that I was still in the process of working through the same frame clash. The dates of the e-mails were written in the two days following the one-day ethnography workshop and twelve days after my meeting with the Education Committee in which the change of plans happened. There was no e-mail access on site or it might have been possible to reframe my understandings sooner. What does emerge from these three communications is that rich points were possible to achieve, that I was in a process which both advisors understood, and that I needed a more conscious perspective to move through the contradictions I was experiencing.

> *...the same thing happened to me in Brazil. They are interested in the ideas but need to understand them before engaging in them...remember Plato said 2,000 years ago that you cannot teach what the community does not value...your ability and willingness to adapt is part of the test and part of building trust...stepping back from your agenda to theirs is critical (E-mail communication with Dr. Green, my advisor at UCSB 8-19-01).*

> *...your work is about sharing knowledge so others can take up what they want, if anything...use what happened as a resource...when you write, think of each instance of a frame clash, of broken expectations as a rich point in the next steps to returning. Calmly and slowly take baby steps and let them lead you (E-Mail communication with Dr. Green, my advisor at UCSB 8-21-01).*

> *...write and draw as much as possible. Tape yourself as a way to reflect on what you saw, what things you could and could not do, what you could have done but didn't realize. Tengas fe en tu trabajo! Have faith in your work! (E-mail communication with Dr. Heras, committee member and collaborative partner in Argentina 8-20-01).*

Working through this process of frame clashes to create rich points, as indicated by journal notes and e-mail communications, did establish more clarity as to my role, what was needed by the school at the time and how I needed to respond. Reframing my response was critical and had to be done together with others who had the experience to guide me through this process. These experiences and their outcome greatly influenced the next stages of my work with the school.

As a result of changes in my role during year two and being integrated into the consultant group, my understandings of the "field" and of the inner workings of the school, afforded by the perspective of the consultant group, were deepened. I do not have permission from the school leadership to analyze the consultant group but suffice it to say that being a participant in the group helped to ground me further in the contextual realities and demands of the autonomous school.

After year two (as can be seen in Table 4.1), my role expanded as resource provider but was refocused as a teacher, returning to where we had left off at the end of the first workshop in July 2000. Resuming our work together in mathematics was discussed and agreed upon during a five-day visit I made to the school in spring, 2002 (see p. 2 of Table 4.1). Providing resources and consciously contributing to a Mayan ethnomathematics perspective thus became a focal point of my and our work from that point forward.

Developing my own understandings of Mayan ethnomathematics and contributing that focus to the school was a challenge for me. I had not entered the school knowing about ethnomathematics and therefore had to develop my own knowledge and approaches to it concurrent with teaching and arguing for this perspective in workshops. Attending the International Ethnomathematics Conference in Brazil in August 2002 (see Table 4.1) was very important in the development of my own knowledge and perspectives about ethnomathematics, as well as understanding the significance of ethnomathematics, as an international movement. Additionally, I did my own research

and sought out exchanges with several professors at UCSB who were more knowledgeable about the origins of ancient Mayan mathematics, astronomy and calendrics. These efforts helped to build my resource capacity in Mayan ethnomathematics, which could then be shared with members of the school community.

Resources that I brought to the site included the following kinds of things: Twenty research and analytical articles on Mayan mathematics and ethnomathematics; twenty books on Mayan mathematics, ethnomathematics, Freirean pedagogy and indigenous ways of knowing; two films on indigenous corn traditions and on the ancient Mayan ruins at Toniná; and a report I wrote for the school on indigenous cultures and ethnomathematics based on a roundtable at the Ethnomathematics conference in Brazil. For a full list of resources see Appendix B.

Resources needed to be brought to the autonomous school site for three reasons, which are analyzed in more detail in Chapter Five. First, to provide multiple sources of textual evidence of an ancient Mayan mathematics system, that grew out of Mayan ancestor's approach to astronomy and calendrics. Second, to offer textual evidence and arguments for an ethnomathematics

approach as a viable alternative to Eurocentric-based mathematics. Third, to begin to counter the school's lack of resources on Mayan ethnomathematics, as part of a process of "unfreezing impacts of colonialism" (Gerdes, 1985). A telling quote from Adrian, the head of the Education Committee, speaks to this:

> *"Every people has its roots and must defend them. The Mayans observed the stars without great lenses and could tell all the planetary cycles. That education of ours was destroyed."* (Simultaneous translation of Adrian speech, 3-26-02).

Thus, during the course of offering workshops increasingly focused on Mayan ethnomathematics over four years, promoters, students, consultants, and the head of the Education Committee, came to know and expect that I would bring articles, books, and other resources, These resources provided opportunities for promoters and others to learn more about Mayan ethnomathematics. For example, I located the ancient Mayan game of "Bul" and created a game board with it, providing opportunities for promoters and students to experience this ancient game of chance. I gathered other relevant resources available in Spanish or translated them into Spanish myself. After the first year on site, I gained insight into the fact that resources,

providing background material on ancient Mayan civilization and its mathematics and science, were greatly appreciated. At the same time, these resources helped to support an emergent perspective of the importance of Mayan ethnomathematics (see Chapter Five and Appendix B).

As I explained earlier, clarification of my role as ethnographer and participatory researcher took place during the time on site year two, August 2001. While Adrian's use of the term "Investigadora" created a boundary in relation to traditional research, I was able to carefully and creatively use an ethnographic approach at the school. I also believe that ethnography helped to build our mutual conscientization process and collaborative work together. An argument supporting this view of ethnography is rooted in an interpretation of fieldnotes, journal notes, informal conversational interviews and other hand-recorded interactions over a four-year period that demonstrated the value of a systematic approach. By learning about patterns of life on site, interpreting our interactions, and supporting the development of a Mayan ethnomathematics perspective over four years, it became possible to develop our work further. Through data analysis, a

changing picture of the "field", and ways of examining and interpreting complex conditions and relationships over time, helped to bring many important issues into focus. The importance of such changes will be further discussed in subsequent chapters.

To summarize, my evolving contributions at the Mayan autonomous school in Chiapas over four years on and off site included: collaborative teacher, consultant, ethnographer-participatory researcher, and resource provider. At times these roles were distinct but more often were interrelated and overlapping. These themes, concerning how my multiple identities impacted the project over four years, will be examined throughout this dissertation in many interactional contexts.

Part Three: How Did Mayan Ethnomathematics Come to Be Our Focus?

This question is examined here within a context of a macro-analytic overview. The question itself is the basis of an entire analysis in Chapter Five. It is analyzed briefly in broader strokes here to make visible how its development affected other aspects of collaborative teaching and ethnography in the context of this particular "field." A Mayan ethnomathematics dialogue presented

a challenge to the schools officially stated direction. This theme is touched on concisely here and developed further in Chapter Five.

As can be seen throughout the Table 4.1 and Tables 5.1, 5.2 and 5.3 in Chapter Five, developments in workshop themes supporting a Mayan ethnomathematics perspective and agency among Mayan promoters and students grew over time. Deliberate practices on my part as a collaborative teacher-researcher were constructed to counter an officially articulated view of mathematics at the autonomous school as a "universal language." A view of mathematics as a "universal language" separates mathematics from its cultural roots and manifestations (see Chapter Two). As can be seen by reading the timeline, which provides an introduction, a multi-faceted argument was developed over time. This argument for Mayan ethnomathematics was supported by dialogic methods that produced texts and documents for mutual learning as demonstrated by the analysis in Chapter Five.

Beginning in year 3, July 2002, with a one-day Mathematics and Agriculture Workshop, I had the opportunity to develop some arguments for a Mayan ethnomathematics perspective with twenty promoters. Intertextually and intercontextually that view related to some of the practices in the first workshop (July 2000), in which

we did ancient Mayan mathematics daily. By looking at a table of promoter evaluations after the first year workshop (see Appendix C), it is evident that the interest and excitement provoked by doing Mayan mathematics, created roots for subsequent developments in Mayan ethnomathematics. It's unfortunate that a consistent group of promoters was not able to attend the workshops continually over four years. This happened for a variety of reasons related to school matters, including changes in responsibilities of various promoters.

While an evolving ethnomathematics focus will be analyzed fully in the next analysis Chapter Five and in Tables 5.1, 5.2 and 5.3 on workshops, it is worth noting several points here. First, that basic principles and themes of our work together were established at the first workshop that continued over time. This included a Freirean dialogic approach and working at a pace comfortable for the promoters. Second, it was communicated that knowledge of Mayan ancestor's approach to mathematics could be known and revitalized. Third, that mathematics was embedded in daily cultural practices like agriculture, embroidery, and weaving. Fourth, that open-ended mathematics investigations could be undertaken in which resources and ways of thinking mathematically could be

developed. In many ways, our work together on developing Mayan ethnomathematics as a material resource and perspective could be described as a prolonged math investigation. Thus, a foundation was laid in the first workshop of July 2000 upon which Mayan ethnomathematics practices, knowledge co-construction and agency was built. How these and other themes developed over time, will be analyzed more closely in the ethnomathematics analysis Chapter Five.

Part Four: Indigenous Ways Of Knowing And Process

For purposes of this macro overview, evolving understandings of the role of indigenous ways of knowing and processes, is briefly examined. It will be analyzed more deeply in analysis Chapter Six on indigenous ways of knowing and liberatory education at the autonomous school. In this context, several salient aspects of this process are pinpointed.

While for analytic purposes themes are examined separately, it is important to remind the reader of their interrelationships. For instance, what became apparent to me about indigenous ways of knowing or Mayan approaches to co-constructing knowledge, emerged from the workshops we did together on ethnomathematics. Questions that promoters raised

in discussions, written down and later produced in collective documents, provided specific illustrations of Mayan approaches to knowing, as in one promoter's question:

> "*In relation with nature, when there is the sound of the animals, of the birds, we know that the rains or the dry season will begin. Is this a measurement of time, or a calculation, or something else*?" (Document, 7-03, my translation)

This question made apparent another worldview in relationship to nature, to time and how time and the seasons are measured. These three points within one promoter's question are reflective of a Mayan indigenous perspective that emerged during a workshop year four 2003 (see Table 5.3 in Chapter Five). This particular promoter's question arose in a workshop designed to elicit Mayan conceptions of how daily practices inform an ethnomathematics view. Thus, these kinds of expressions shaped our ethnomathematics discussions as well as providing examples of indigenous ways of knowing.

Mayan *Tzotzil* practices, which may be found in other Mayan autonomous communities as well, of consensus, pacing learning and discussion to conform to "their own rhythm and their own time" (FN, Juana, head consultant, 7-6-03) as well as oral history as memory, surfaced through collective discussion and

investigation in this context. Fluency in *Tzotzil*, including group debating of questions in *Tzotzil* before presenting to the whole workshop in Spanish, made promoters Mayan approach to co-constructing knowledge in this context even richer. This approach of talking through concepts collectively in *Tzotzil* first, took place throughout the workshops over four years and in interactions with two math promoters I worked with almost daily during year 3 (July 2002).

Two fieldnotes that indicate the importance of *Tzotzil* for the promoters at the autonomous school and its use in collectively talking through concepts are presented here.

> *It is clear that Tzotzil is a cultural symbol and an important part of the identity of Mayan members of this school community. It is used all the time but also seems to have more meaning than just the spoken words. It is a symbol of Mayan ancestry, is tied to other cultural norms, is the primary form of communication, and is unrecognized and its use punished in government schools* (Fieldnotes 8-3-01)

> *In the workshop with the promoters today, one group said they could not report back because their group was divided about what they thought. It was important for them (and others) to work through their ideas in Tzotzil first before presenting to the whole gathering in Spanish. Tzotzil was the way they could decide what they really thought as a group…it made me wish I could speak Tzotzil to understand what it really represents for people here* (Fieldnotes 7-9-03).

The importance of Tzotzil for members of the Mayan autonomous school both as cultural identity and as a means of processing their thinking, is discussed further in Chapter Six. What is clear from fieldnote evidence offered here is that I came to understand the dual importance of Tzotzil from interactions with Mayan promoters and students, in spite of the fact that I could not speak their language.

In analysis Chapter Five on ethnomathematics, as will be seen, the theme of indigenous ways of constructing knowledge is interwoven with interpretations of events and interactions. It is also examined more in depth in analysis Chapter Six, where the autonomous school's form of "liberatory education" is understood within a framework of indigenous ways of knowing. Consequently, while looked at briefly for macro-analytic purposes in this section, Mayan indigenous ways of knowing play an important role in how the process of agency, ways of learning and internalization of concepts took place at the autonomous school.

Conclusion

What was presented in this chapter was a macro-timeline analysis, with several micro examples to ground the discussion of year-by-year phases of a four year collaborative teaching and

ethnographic project at a Mayan autonomous secondary school in Chiapas, Mexico. The purpose of this overview was to place the reader within the multiple contexts in which this collaborative teaching and participatory ethnographic research took place. A macro inquiry, explored through four initial research questions, was designed to guide the reader through an unfolding of the situated "field", both as a physical place and site of understandings. It began to make visible my changing roles over time in interaction with members of the educational community. position of Mayan ethnomathematics and indigenous ways of knowing was presented as emergent, becoming more evident in the course of four years.

Key themes concerning the role of conscientization, of frame clashes and rich points, of transformative methodologies and indigenous ways of knowing as well as the challenge presented by Mayan ethnomathematics, were raised at the beginning of the chapter. These themes are important to understand within a context of a macro inquiry but also frame much of the subsequent discussion and analysis in the next three chapters.

This macro overview of the four-year project then, offers

a conceptual and practical umbrella under which subsequent in-depth analyses of ethnomathematics, autonomous education and liberatory education, as well as indigenous ways of knowing can be understood. The next chapter presents a more in-depth analysis of Mayan ethnomnathemics and how it became a material resource for Mayan promoters and students, making possible their agency in adopting this perspective.

> "*Mayan numeration and Mayan calendrics are very important to learn because they are expressed through our mother tongue, which is the mother of our Mayan culture.*"
>
> (Promoter evaluation 7-03)

CHAPTER FIVE: DATA ANALYSIS

How Did Ethnomathematics Emerge Through Intercultural Dialogue and Mayan Indigenous Ways of Knowing?

In the previous chapter I presented a macro-timeline and overview of my four year collaborative teaching and ethnographic study at a Mayan indigenous school in Chiapas, Mexico. The purpose of that chapter was to situate the reader within multiple contexts in which this study unfolded over four years. Chapters One, Two, and Three laid a foundation for where this study fits within the broader scope of ethnomathematics, liberation pedagogy, indigenous ways of knowing, and the field of international and indigenous ethnographic research. In this chapter and the next one, I offer data analysis contextualized by questions and concepts discussed in preceding chapters.

Data analysis is taken up in the next two chapters to focus on a shift in perspectives from ethnomathematics through intercultural dialogue and indigenous pedagogy, to a perspective on how intercultural dialogue, actualized by double conscientization transmitted Mayan indigenous ways of knowing. This chapter presents an analysis of contexts, interactions and slices of talk that support a view of ethnomathematics as a

material resource, made visible through intercultural dialogue, defined in this chapter and in Chapter Two. The analysis draws principally on data collection from *talleres* (workshops) in mathematics and ethnomathematics at the autonomous school from July 2000 to July 2003, as well as from less formal interactions and participant observations. Chapter six offers data analysis of similar data sources, focusing on intercultural dialogue as shaped by double conscientization and indigenous ways of knowing specific to the context of the autonomous school.

Chapter Organization

This chapter is organized in three sections. In Section One, I offer an analytical discussion of why ethnomathematics can be viewed as a material resource, grounded in intercultural dialogue. This framework underlies the analysis developed in Sections Two and Three.

In Section Two, I present an analysis of turning points or rich points (as identified by participants and myself as teacher-ethnographer) as perspectives began to shift and change toward adopting a Mayan ethnomathematics stance. Key events in different contexts over four years are analyzed. Key events begin with the first critical mathematics workshop in July 2000, and go

on to a school-wide evaluation meeting in August 2001, an agriculture and ethnomathematics workshop in July 2002, and concurrent promoter and student workshops on the origins of ancient Mayan mathematics and Mayan ethnomathematics in July 2003. Within this analysis, there is a focus on patterns of intercultural dialogue, mutual conscientization, and Mayan indigenous ways of knowing that supported the emergence of a Mayan ethnomathematics perspective.

In Section Three, I offer an analysis of two telling cases, using a trajectory of "tracer units" (Cole, Griffin & Newman, 1981 cited in Green, 1983). This methodological approach gives another vantage point to follow patterns of intercultural dialogue that supported a co-construction and reclamation of Mayan ethnomathematics. A focus through time, key events and interactions with a student whom I call "Alex" and a gender-defined group, whom I call "girls" for purposes of analysis, revealed additional perspectives on how ethnomathematics became a material resource for a Mayan autonomous secondary school.

Section One: Analytical Framework

Ethnomathematics as a Material Resource

An ethnomathematics process has the capacity to surface invisible cultural practices, to reveal the effects of domination of one type of knowledge over another, and connect with historical resources that need to be reclaimed. Reiterating a two-part operational definition of ethnomathematics of D'Ambrosio summarized in Chapter Two helps to frame the discussion of data analysis in this chapter.

> " We call Ethnomathematics the art or technique of understanding, explaining, learning about, coping with and managing the natural, social and political environment, relying on processes like counting, measuring, sorting, ordering, inferring, which result from well-identified cultural groups" (D'Ambrosio, 1988, p.10).
>
> "Often the history of mathematics is actually the history of European mathematics...the mere identification of native mathematics practices in academic archives or in local European publications, in colonial times or in the first years of independence until today, doesn't change the Eurocentric character of what is called 'mathematics'" (D'Ambrosio, 1988, p.9).

An initial view of mathematics formally expressed by several promoters at the Mayan autonomous school in Chiapas during a school evaluation meeting in August 2001, was that

mathematics is essentially a "universal language" which was articulated as "2X2=2X2 no matter what." This view of mathematics was triangulated through evidence from observation of several mathematics classes and a written mathematics curriculum for the school. However, these two sources are not available for analysis due to security considerations of the school.

Subsequently, as developed through intercultural dialogue and respect for indigenous ways of knowing, as will be demonstrated, Mayan ethnomathematics was taken up as a worldview and assertion of a cultural identity linked to Mayan ancestors. Mayan ethnomathematics presented an area of knowledge that afforded an opportunity to extend previous cultural priorities and ownership of ways of thinking mathematically. Over time, documentation of various kinds including fieldnotes, journal notes, workshop evaluations and collaboratively produced documents, indicated that Mayan ethnomathematics was adopted as a material resource (see sections two and three).

In this context, I am defining "material resource" as a set of ideas and practices that were made available in interactional spaces. Material resources included textual reconstruction of interactions, like collaborative documents for example, and other

textual resources brought to the site, to be potentially taken up by participants. Intertextuality, as defined by Kristeva cited in Fairclough (1992), was used both vertically, i.e. historically linked texts, and horizontally, i.e. dialogical relationship across texts. Two analytical questions arise here. First, why was it important for ethnomathematics to become a *material resource*? Second, why did this process necessitate *intercultural dialogue*?

Ethnomathematics As a Material Resource

As will become clear through a more concrete examination of significant events and interactions over four years at the autonomous school in subsequent sections of this chapter, Mayan mathematics and ethnomathematics was adopted by participants in the education community as representing a credible theoretical and practical reflection of Mayan *Tzotzil* experiences. Ancient Mayan mathematics and Mayan ethnomathematics became a *material resource* meaning that it was available as an array of ideas and practices in workshops and in reading materials I brought to the school. It helped to make possible a transformation of perspectives.

This transformation of perspectives took place, as data analysis will show, as positions shifted in the course of

collaborative dialogue seeking to construct a Maya-centered rather than a Euro-centered view of mathematics. This shift motivated participants to examine both daily practices in the communities and ancient Mayan mathematics knowledges that had been removed by colonialism. The shift presented a clear example of what Paulus Gerdes described as "defrosting mathematics frozen by colonialism" (Gerdes, 1985, p.141). It could then be conjectured that ethnomathematics became a material resource through this process of shifting perspectives to "reclaim" a Mayan worldview of mathematics.

Ethnomathematics Through Intercultural Dialogue

The second analytical question, interrelated with the first one about ethnomathematics as a material resource, is why did this process entail *intercultural dialogue*? An intercultural frame (defined more fully in Chapter Two) was chosen to explain a dialogic "two way flow between collectivities" (Apffel-Marglin, 1998, p.13). Apffel-Marglin herself works with Quechua peoples in the Andes where intercultural dialogue and communication are critical to a transformational worldview and process for her as a white professor and indigenous members of an Andean project working to revitalize ancient Quechua agricultural knowledges.

The use of the term "intercultural dialogue" is not meant to mask problematic issues that arise in any situation where two or more cultures are seeking to work together. I pursue in greater depth in the next analysis chapter some of the complexities that surface in bridging spaces between cultures in a context of differential power relations as collaborative relationships are built. Yet, it is important to note here that there are no "culture-free" situations or spaces that are not influenced by "unequal relations of power" (Rockwell, 1998, p.10) within an intercultural dialogue.

With the understanding in mind that asymmetrical relations of power exist in intercultural relationships, it was crucial that a dialogic approach, as argued repeatedly in Freire (Freire, 1970, 1985, 1998), be adopted. Respect and mutual conscientization led to trust and openness needed to sustain a dialogue over time. A careful dialogic process was essential in encouraging a Mayan ethnomathematics perspective to take seed and grow. Negotiating continually took place between members of the autonomous school community and myself, as part of a mutual conscientization explored further in the next analysis chapter. Mutual conscientization was thus able to provide further material resources for productive dialogue.

To sum up this section then, we can begin to see that historical conditions of colonialism for Maya *Tzotzil* peoples of Los Altos of Chiapas repressed or "froze" potential knowledges of indigenous mathematics. By engaging in a careful, over time process of intercultural dialogue and a process of mutual conscientization with promoters and myself, a Mayan ethnomathematics perspective started to emerge. Such a perspective gave a mathematical voice to the cultural reclamation and resistance project of the autonomous school. This ethnomathematics perspective had to find roots within an autonomous view of Mayan education and an indigenous approach to knowledge construction. This occurred in part through ethnomathematics becoming a material resource for members of the education community.

Section Two: Turning Points in Adopting a Mayan Ethnomathematics Perspective

In this section, I focus my attention on an analysis of turning points or rich points (Agar, 1994), as identified by myself, as a teacher-ethnographer, and comments of participants, showing how perspectives shifted and changed toward adopting a Mayan ethnomathematics stance. Rich points arise, according to Agar;

once "breach points" or "frame clashes" have exposed cultural norms and divergences, opening up potential spaces for movement and change (ibid). For purposes of analysis here, a process of clashing frames and rich resolutions is applied to a changing worldview of mathematics held by members of the Mayan educational community. Rich points are being defined analytically as interactions that served to open up and reconnect with a Maya-centered worldview of mathematics as a material resource.

Before turning to Table 5.4 indicating rich points in shifting perspectives of Mayan ethnomathematics, Tables 5.1, 5.2 and 5.3 illustrating the content of three years of mathematics workshops is presented. This series of three tables provides an overview as well as specific content and themes of the mathematics workshops to give the reader a context of what was accomplished over four years. Based on that context, the subsequent Table 5.4 on shifting perspectives of Mayan ethnomathematics over time, will reference back to the workshops in order to ground the analysis.

The first workshop Table 5.1 presents the topics and themes covered during five days of collaborative work with promoters (or teachers) at the Mayan autonomous school in July

2000. The workshop was entitled "Paulo Freire and Critical Mathematics." It framed our work in the context of liberatory education, dialogic community building and critical perspectives of what is typically considered "mathematics." This framework also included cultural ways of understanding mathematics.

Table 5.1: Year 1 July 7-15 2000 Paulo Freire and Critical Mathematics

Event	Time	Key Topics-Actions	Themes
Event 1: first day of workshop	15 min. 10 min. 15 min. 25 min. 25 min. 10 min. 20 min.	a. Introductions around circle b. Why Paulo Freire? c. What is critical mathematics? d. Disc. of accomplishments of Mayan mathematics and cultural roots of mathematics e. Mathematics embedded in time, art, and fiestas. f. Intro. mathematics journals g. Start palindromes	a. Begin dialogic community. b. Liberation pedagogy and dialogic Ed. c. New framework for mathematics d. Tied workshop to cultural resurgence of school. e. Uncover mathematics in daily practices f. Reflective mathematics writing g. Think mathematically with games
Event 2: second day of workshop	5 min. 10 min. 50 min. 15 min. 15 min. 35 min.	a. Repeat why Paulo Freire b. Writing in mathematics journals c. Mayan mathematics operations d. Complete palindromes e. Intro. to mathematics investigations f. Mathematics autobiographies	a. Develop liberation pedagogy. b. Experience writing about mathematics c. Collaborative effort to understand and manipulate Mayan numbers. d. Fun way to add e. Long-term collaborative mathematics study f. Share powerful histories through

			mathematics
Event 3: third day of workshop	5 min. 50 min. 45 min. 30 min. 15 min.	a. Frame with Paulo Freire b. Mayan mathematics c. Mathematics investigation questions-groups. d. Probability dice game e. Mathematics journals	a. More liberation pedagogy b. Collaborative work on add and subtract c. Mathematics embedded in questions d. Exposure to mathematics strategies e. Reflective writing about mathematics
Event 4: fourth day of workshop	30 min. 50 min. 45 min.	a. Symmetrical designs in artisan art b. Mayan mathematics c. Mathematics investigations	a. Uncover geometry in daily artisan work b. Collaborative work on multiplying Mayan numbers. c. Group work on questions of mathematics investigations
Event 5: fifth day of workshop	30 min. 20 min. 40 min. 20 min. 20 min.	a. Calculators: intro and examples b. Probability game with dice c. Mayan mathematics d. Mathematics investigations-wrap up e. Written individual evaluations forms	a. Practice operations, exposure to strategies of use b. Play and share strategies c. Collaborative multiplication and some division d. Exposure to process but more time needed to go deeper e. Participant's perspective on workshop

What the table from the first year's promoter workshop at the Mayan autonomous school allows us to see is what was accomplished and the groundwork established for future developments in Mayan mathematics and ethnomathematics. The

workshop offered an introduction to and practice of ancient Mayan numeration, a discussion of some of the accomplishments of Mayan mathematics, and an exploration of the mathematics embedded in daily cultural practices. Utilizing an approach based on the liberation pedagogy of Paulo Freire and critical perspectives of mathematics as a "universal language," provided a basis for applying conscientization to mathematics during subsequent workshops.

Turning to Table 5.2 that presents topics and themes from the workshop in year 3, July 2002, we can see developments in what was accomplished and a stronger basis for Mayan ethnomathematics. The stronger basis for Mayan ethnomathematics derived from my increased capacity to argue for an ethnomathematics perspective, a contrast with a form of "universal" mathematics that had arisen the previous year at the school (as "2X2=2X2 no matter what"), and a promoter team investigation of ethnomathematics as applied to agricultural practices.

Table 5.2: Year 3 July 9 2002 Ethnomathematics and Agriculture

Event	Time	Key Topics-Actions	Themes
Event: One day work-shop	15 min.	a. Introduction: Why "2X2=2X2" does not mean there is no Mayan mathematics	a. Mayan mathematics perspective vs. "universal" approach
	20 min.	b. Ethnomathematics definition & history (D'Ambrosio, 1988); compare Eurocentric and ethnomathematics worlds	b. Meaning of ethnomathematics and impact of Eurocentrism
	30 min.	c. Ethnomathematics of other cultures & comparisons to Mayan: Mozambique, Incas, Islamic algebra & ancient Mayan	c. Exposure to ethnomathematics of other indigenous cultures
	2 hrs.	d. Applications of Mayan mathematics to agriculture: traditional and "modern" plus embedded mathematics	d. Compare traditional and current practices: ethnomathematics involved
	30 min.	e. Conclusion: ways to continue investigating agriculture and ethnomathematics Note: no promoter evaluations available	e. Summary plus intertextual ties to mathematics investigation from year one workshop

What this one-day agriculture and ethnomathematics workshop with promoters showed was an advance in activities and perspectives relating to Mayan ethnomathematics. Placing our work within a framework of an international movement of ethnomathematics allowed particlpants to see the initiatives of other previously marginalized cultural groups in retrieving their

own ways of doing mathematics. Knowledge of the process of empowerment of other cultural groups informed the collective promoter investigations of Mayan mathematics practices involved in traditional versus "modern" forms of agriculture. This workshop continued to provide the groundwork for emergent perspectives by promoters of Mayan ethnomathematics as a viable and relevant way to view mathematics.

The third and final workshop Table 5.3 presented here, entitled "Origins of Mayan Mathematics and Ethnomathematics" illustrates topics and themes accomplished concurrently with promoters and with students year 4, July 2003. These workshops, which took place over a three-week period, demonstrated the most significant changes in the perspectives of promoters and students in grappling with Mayan ethnomathematics. As will be demonstrated further in Table 5.4 on shifting perspectives of Mayan ethnomathematics over time, we can see that probing questions were asked of groups in both workshops that revealed greater understandings of a Mayan ethnomathematics process. Further, language used indicated agency on the part of both promoters and students in adopting a Mayan-based perspective on mathematics.

Table 5.3: Year 4 July 1-19 2003 Origins of Mayan Mathematics and Ethnomathematics

Event	Time	Key Topics-Actions	Themes
Event 1: first day of work-shops **Note: concur-rent session s of student s and promot er**	50 min. 50 min. 20 min.	a. What is Mayan mathematics? Ethnomathematics? b. How are both used in communities and families today? c. Conclusion: Overview of origins of Mayan mathematics and astronomy	a. Groups explore perspectives on Mayan mathematics and ethnomathematics b. Group inquiry into daily mathematics practices c. Framework for overall theme of workshops & relation to astronomy
Event 2: second day of work-shops	45 min. 50 min. 25 min.	a. Whether Mayan mathematics was learned in Mexican schools? b. Why important to study Mayan mathematics in official schools, autonomous schools? c. Ancient Mayan astronomy	a. Groups provide contrastive cases b. Groups show Eurocentric knowledge vs. Mayan-based knowledge c. Solstices, equinoxes, how measure cyclical time
Event 3: third day of work-shops	50 min. 40 min. 30 min.	a. Is it difficult to access resources on Mayan mathematics? Why? b. How have you gotten resources on Mayan mathematics? Explain c. Mayan calendars and cyclical time	a. Groups explain no Mayan mathematics in school b. Groups present oral history of community elders and grandparents c. Calculations of time as basis for Mayan mathematics system
Event 4: fourth day of work-	50 min.	a. How is Mayan ethnomathematics used in: planting fields, deciding when to plant, do embroidery, make and cook tortillas, other examples	a. Group inquiry into daily ethnomathematics practices

shops	50 min. 20 min.	b. Are there *Tzotzil* ways of measuring to do embroidery, to plant corn, in having a separate calendar? Other examples? c. Mayan calendars and cyclical time continued	b. Groups uncover *Tzotzil* ethnomathematics practices c. Role of calendars, Long Count, significance of Dec.23.2012
Event 5: fifth day of work-shops	50 min. 50 min. 20 min.	a. Do people who speak *Tzotzil* today use mathematics concepts even though they did not learn them in school? Explain b. Is one of your goals for the autonomous school to have the knowledge of ancient and current Mayan mathematics and astronomy be understood and practiced by the school community? c. Origins and application of ancient Mayan numeration system	a. Groups inquiry on use of *Tzotzil* mathematics practices b. Group inquiry on Mayan mathematics and ethnomathematics in their autonomous school c. Explain origins of ancient Mayan numeration in astronomy and calendrics.
Event 6: sixth and final day of work-shops	80 min. 20 min. 20 min	a. Identify and calculate using ancient Mayan numeration. Why multiplication involved b. Summarize themes of workshops and what still need to do: ancient Mayan geometry c. Written evaluations (promoters only)	a. Group practice with ancient Mayan numeration and multiplication b. Review themes to tie parts to whole: origins of Mayan mathematics and ethnomathematics c. Feedback on workshops both written and oral (students)

What this series of workshop tables over four years allows

us to see is developments in what I was able to argue and demonstrate regarding an ethnomathematics perspective over time as well as developments in the perspectives of promoters and later students in taking up the ideas of Mayan ethnomathematics. Placing mathematics within a framework of Freirean theory and praxis year one, including dialogic education, was instrumental to developing initial and subsequent understandings of Mayan mathematics and ethnomathematics. For Mayan participants in the workshops to develop their own perspectives and agency engaging the material resources provided, a process of intercultural dialogue and mutual conscientization was essential. As will be demonstrated in Table 5.4, there were identifiable rich points in the development of a Mayan ethnomathematics perspective over time.

Analysis of key events and interactions over four years, from July 2000 to July 2003, provide support for the interpretation that there were indeed turning points or rich points in this evolving ethnomathematics process. Shifts in perspectives articulated by members of the educational community over time provide evidence for adoption of a Mayan ethnomathematics analysis as seen through themes and actions of workshops over four years.

Table 5.4: Key Events and Interactions Underlying Rich Points in Adopting Mayan Ethnomathematics

Key events	Data Source/Date	Rich Points	Intercultural Dialogue
<u>Year One</u>: "Paulo Freire & Critical Math" Workshop			
1. accomplishments of Mayan math & cultural roots of math	FN: Wkshp. 7-10-00	Potential rich pt.	1. dialogue from 1st day of workshop on Mayan calendars, astronomy, number system, with Mayan math poster. How represents Mayan roots in mathematics.
2. math embedded in time, art, fiestas	FN: Wkshp. 7-11-00	Potential rich pt.	2. together we created a chart to show math embedded in fiestas, art and time.
3. ancient Mayan math numeration	FN: Wkshp. 7-10-7-16-00	Potential rich pt.	3. everyone involved in working together to figure out Mayan math (7-11) *Mayan math is pushing us to think about the operations involved (7-14)
4. role of Mayan math	Evals of wkshp. 7-16-00	Rich points	4.a. "Mayan numbers give us a way to know the history of our ancestors." 4b. "We can use Mayan numbers.

			We've never had this type of activity." 4c. "We can share Mayan math with our students. It is our ancestry as indigenous of Chiapas."
Year Two: School-wide evaluation meeting	FN: eval report to whole group 8-11-01	Frame clash to potential rich point	1a. "We have Mayan autonomous ed. in bilingual ed. and Social Studies but in math, 2X2=2X2 no matter what." 1b. "Perhaps math could also be seen as part of autonomous ed. since it is not the same everywhere."
Year Three: Interactions with math promoters and with entire group of promoters			
1.Question posed to promoters re: Mayan math use.	FN: 7- 8 -02	Potential rich pt.	1. Q." Why is Mayan math not used today?" A. "The Conquest took it away."
2. Question to promoters re: Tzotzil math concepts.	FN: 7- 12 -02	Potential rich pt.	2a. Q." Do you know of Tzotzil concepts in math not translated into Spanish?" A. "We know the concepts exist but don't know what they are." A." Elders probably know more in the communities but that's all we know."

			2b. Interaction w. Naya re: Tzotzil measurements.
3. Ancient Mayan game of "BUL"	FN: 7- 4 to 7- 20 -02	Potential rich pt.	3. Daily activity & dialogue w. math promoters.
4. **Agriculture & ethnomath wkshp**. (all promoters)	FN: 7- 9 -02 Collab.document 7-02	Potential rich points from dialogue and contrasts	4a. dialogue on why "2X2=2X2" doesn't mean there is no Mayan ethnomath. 4b. ethnomath defined (D'Ambrosio) 4c. examples from other cultures, like Mozambique. 4d. trad. vs. modern forms of ag. with math embedded: 1. original seeds vs. hybrid seeds 2. measure land w. brazadas vs. still used some today 3. pray before begin work vs. "Mayans don't pray nowadays." 4. counted planting times using traditional months vs. without respect for nature. Intercultural dialogue

<u>Year Four</u>: Origins of ancient Mayan math and ethnomath wkshp. (simultaneous with promoters and students)			
1.What is ethnomathematics?	Collab. document 7-03	Rich points	1. "Created in the environment of each people, each culture, like the example of Mayan math, which is its own knowledge." (promoters)
2.What is Mayan mathematics?	Collab. doc. 7-03	Rich points	2. "Ideas of Mayan world in which numbers were invented by necessity…basic concepts of our culture." (students)
3.How is Mayan mathematics used in the communities?	Collab.doc. 7-03	Rich points	3a. "Numbers and measurements of the ancestors have been lost but months and numbers are counted in Tzotzil." (promoters) 3b. "They use European math but continue with base twenty." (students)

4. Is it important to study Mayan mathematics in official schools? In autonomous schools?	Collab.doc. 7-03	Rich points	4. "It is important to reclaim knowledge of the ancestors, which we are doing little by little in the autonomous schools. More of European culture is seen in mathematics in official schools." (promoters)
5. Is it difficult to have access to resources to learn about Mayan mathematics?	Collab.doc. 7-03	Rich points	5a. "It is difficult because we do not have the idea of knowledge of all of this, like astronomy. European colonization made it disappear." (promoters) 5b. "It is difficult to reclaim Mayan math because the European invasion had other mathematics. Some elders have knowledge but not like before." (students).
6. How is Mayan ethnomathematics used to cultivate the land?	Collab.doc. 7-03	Rich points	6. "The ancient ones used it a lot to harvest each mata of maize, measuring with their arms, how many seeds in each hole, how much time is needed, when to plant roses or cut weeds, harvest and cultivate the milpas. Ethnomathematical knowledge is used little today."

			(promoters).
7. Do you think there are people today who speak Tzotzil who use math in their language but did not learn it in school?	Collab.doc. 7-03	Rich points	7. "The majority of people who use math in Tzotzil are older. They did not learn it in official schools. We, the younger people, use more European math… Some Tzotzil measurements are traditions and cannot be translated. They are known in indigenous zones not in mestizo zones." (students)

Turning our attention to Table 5.4, which identified key events and interactions over four years that made visible rich points in adopting Mayan ethnomathematics, it is possible to see a progressive unfolding of Maya-centered mathematics consciousness. This interpretation is based on fieldnotes, written evaluations and collaboratively produced documents. Beginning year one, in a workshop with promoters entitled "Paulo Freire and Critical Mathematics" from July 10-16, 2000 (see Table 5.4), a variety of activities contributed to constructing a dialogic exploration: Accomplishments of Mayan mathematics and its cultural roots, mathematics embedded in Mayan notions of time, art and fiestas and exposure to and practice of ancient Mayan numeration. These events helped to begin socially constructing material resources for a Maya-centered view of mathematics and provide initial intertextual references for those kinds of activities and practices. After the first year workshop, however I had not yet begun to produce hand-written recordings of collective activities as documents to be reviewed and reread while I was not on site, because I had not yet understood the importance of providing such documents. Collectively produced documents did however follow all subsequent workshops.

As can be seen in evidence from promoter evaluations of the first workshop (see Appendix C), many promoters linked learning about and using Mayan numbers to their "*ancestry as indigenous of Chiapas.*" A promoter's comment that "*Mayan numbers give us a way to know the history of our ancestors"* is telling. It connects Mayan numbers with the history of ancestors but also demonstrates that Mayan numbers provide a way to know that history.

It is important to highlight a comment by one of the promoters in a written evaluation of the first year workshop, who said that, "*We've never had this type of activity.*" That would seem to indicate that they had not had this type of activity in being trained as promoters for the autonomous school. Further, promoters had not had Mayan mathematics when they were in official government schools, as will be demonstrated later, and this first collaborative workshop, which exposed them to this subject, was just the beginning of a process.

It is instructive to analyze the frame clash and potential rich point, in returning to Table 5.4, which emerged during year two in August 2001. The specific context was a school-wide evaluation meeting that I participated in as part of a consultant group, one of

several roles I came to play at the school. One of the head promoters, in a report back to the whole session from his breakout group, said that, "*Mayan autonomous education could be seen in their program of bilingual education* (in *Tzotzil* and Spanish) *and in Social Studies*." "*But*", he went on to say, "*in mathematics, 2X2= 2X2 no matter what.* " This seemed to indicate that there was no significant difference between mathematics in autonomous schools and official government schools. My response was, after I had raised my hand and been called on, that "*perhaps mathematics could be seen as part of autonomous Mayan education since it is not the same everywhere*" (FN 8-11-01). I referred back to the workshop we had the first year (see Table 5.1) providing an intertextual link for him and others who had not attended the workshop. In the first workshop we had begun to explore or "unfreeze" (Gerdes, 1988) Mayan cultural ways of doing mathematics, both in its ancient and current forms. Thus, while not acknowledged in the moment as providing an alternative way of viewing mathematics from a Mayan perspective, this interaction provided another link in an emergent process over time.

The intercultural dialogue we went on to pursue in year

three July 2002, as presented in Table 5.4, continued to uncover concepts of Mayan mathematics and ethnomathematics. In the first few interactions between myself and several of the promoters, as can be seen in the last column under the heading "Intercultural Dialogue", that the Conquest is named as the cause of the lack of Mayan mathematics usage today. The Conquest is also named as the cause of inaccessibility of *Tzotzil* concepts in mathematics to promoters at this autonomous school. It is important to clarify that these exchanges between myself and two mathematics promoters took place in the context of work we did together almost daily during July 2002 apart from the formal workshop with the entire group of promoters that year (see Table 5.2).

Naming historical reasons for the lack of Mayan mathematics practices and recognizing that *mathematics or other subject area promoters did not easily retrieve Tzotzil concepts* was evidenced by promoter comments. The following comments come from interactions with two mathematics promoters I worked with on almost a daily basis in July 2002 as explained above. In Table 5.4, we read two comments. First, "*we know the concepts exist but don't know what they are.*" Second, "*Elders probably know more*

in the communities but that's all we know." Additionally, I sought out and talked to another promoter (see Table 5.4) who taught *Tzotzil,* did extemporaneous performances in *Tzotzil* for parents of the school community, and was acknowledged by others in the school community to have a lot of knowledge about *Tztozil* practices. The discussion with this *Tzotzil* promoter did not yield much more information on the subject apart from learning that hand and arm measurements are used in embroidery (FN 7-02).

Extrapolating from the two promoter comments, it appears that there was acknowledgement that mathematics concepts do exist in *Tzotzil* but that the two promoters present could not say what they were. Second, and related to the first point is that the promoters conjectured that elders in the communities probably knew more about *Tztozil* mathematics concepts but that was all they (the promoters) knew. This comment also indicates that knowledge possibly held by elders in the communities was not easily accessible to the two mathematics promoters or others at the school, indicated by the minimal knowledge offered by the promoter of *Tztozil* mentioned above.

Focusing now on a one-day Agriculture and Ethnomathematics workshop, the same year as the comments above, July 2002, can be seen in Table 5.4. This one-day workshop with all the promoters (approximately 20 people) proved to be an important turning point in the collective emergence of Mayan ethnomathematics. My introduction to the workshop framed the dialogue of "*why 2X2=2X2 doesn't mean there is no Mayan ethnomathematics.*" I gave international examples from Mozambique and other indigenous countries and peoples, formally colonized, who were reconnecting and revitalizing their pre-colonial ethnomathematics knowledge and practices. The idea was to show parallel possibilities for developing consciousness or "unfreezing" of knowledge "frozen by colonialism" (Gerdes, 1988). I presented the D'Ambrosio definition of ethnomathematics and its history (D'Ambrosio, 1988), which we briefly discussed (see definition earlier in this chapter). After a brief overview of the important contributions of Mayan mathematics, we explored contrasts between "modern" agricultural practices today and those used traditionally, working in promoter teams of two. After an initial presentation to the whole group, the same teams investigated the mathematics embedded

in each agricultural practice. The teams presented their findings, which were incorporated on a group chart. After the workshop, the chart was put on the computer and copies were given to all the promoters.

Contrasting ancient and "modern" practices in agriculture, as documented in Table 5.4, surfaced several points worth noting. One is differences between Mayan cultural practices traditionally and today, that exposed important cultural aspects that have changed over time. Two examples from Table 5.4 are "*praying before beginning work vs. Mayans don't pray nowadays*" and "*counting planting times before using traditional months vs. lack of respect for nature.*" These were interpretations by two teams of promoters who portrayed in few words significant losses over time. It is important to note in this context that these kinds examples indicating loss of traditional practices are part of the reason that the autonomous school names as one of its objectives "cultural reclamation."

A second contrast made by a team of promoters was between "*original seeds vs. hybrid seeds used today*," which can

be seen in Table 5.4. This contrast could itself be the subject of a lengthy analysis explaining why the struggle to maintain and grow original seeds, particularly corn, is so pivotal for Mayan communities in resistance. What is important to know for purposes of analysis here is that "original" corn seed represents cosmologic ritual practices tied to Mayan views of creation. Therefore, fighting against original corn seed being replaced with hybrid seeds is an ongoing battle taking place throughout Chiapas.

A third and final contrast made by promoter teams, which can be seen in Table 5.4, was "*counted planting times using traditional months vs. without respect for nature.*" This contrast indicates several things. First, that planting times were traditionally calculated using "traditional months" which refers to the ancient Maya ritual calendar, called "Tzolkin." This calendar was used throughout the Highlands traditionally to follow periods of agricultural labor as well as to keep track of religious ceremonies and family customs (Calderón, 1966; Contreras Garcés, 1995; León-Portilla, 1988). The only calendar used today is the solar calendar or "Haab" whose months are in *Tzotzil* (FN 7-10-02). No longer using the ritual calendar in the Highlands of Chiapas is considered by many to be a loss. It is interesting to note that

the contrast with the loss of calculation using the ritual calendar is "*without respect for nature*." This comment points to a loss of a cosmological Mayan view, as represented by the ritual calendar, which signaled planting times according to a ceremonial respect for nature (Leon-Portilla, 1988).

Turning now to analyze what emerged through key events and interactions in year four, July 2003, represented in Table 5.4, intertextual links (Bloome & Egan-Robertson, 1993; Fairclough, 1990; Kristeva cited in Fairclough, 1992) can be drawn with previous collaborative texts, both oral and written. Intertextuality helped to provide rich points in developing a Maya-centered view of mathematics. Looking at comments made both by promoters and students during three weeks of workshops (approximately 6 hours per week per group as seen in Table 5.3) reveal an agency in expressing concepts raised in various formats and contexts through the previous three years. This represents a shift in perspectives on Mayan ethnomathematics, referred to in the analysis represented in the table as "rich points."

A shift in perspectives on Mayan ethnomathematics or "rich points" can be seen in slices of talk, which became text, that emerged through intercultural dialogue in year four, July 2003.

This can be seen in Table 5.4. Several telling quotes point to this shift. First, in response to a question posed, "*What is ethnomathematics*"? One team of four promoters said, "*It is created in the environment of each people, each culture, like the example of Mayan mathematics which is its own knowledge.*" This response indicated that promoters were articulating their own view of ethnomathematics. Although the comment of the promoter team is reflective of previous discussions and texts, it was worded in their own way. Attributing ethnomathematics to each people's environment and culture, as well as using the example of Mayan mathematics, is significant. Describing Mayan mathematics as "its own knowledge" points to a body of knowledge that comprises the ethnomathematics of Mayan peoples. A rich point of understanding appeared to have been reached, as indicated by this comment, within a perspective on Mayan ethnomathematics.

A shift in perspectives on Mayan ethnomathematics can also be seen in the words of a team of students responding to the question "*What is Mayan mathematics*"? This intercultural dialogue can be seen in Table 5.4. A team of students said, "*Mayan mathematics is the ideas of the Mayan world in which numbers were invented by necessity...basic concepts of our*

culture." This comment addresses two points. First, the origin of Mayan numeration growing out of a need for it produced by the broader contexts of astronomy and calendrics, which we discussed. Second, that Mayan mathematics represents fundamental aspects of Mayan culture. While this was the first formal workshop with third year students, meeting separately but concurrently with the promoter workshop, their understandings may have emerged from exposure to Mayan ethnomathematics by promoters, from articles and books I left available in the school library, and from discussions with peers like Alex (see section on Alex as "tracer unit").

Two of the following quotes are from one of the student *equipos* (teams) and a promoter team in concurrent workshops in year four, July 2003. They were each responding to a small group discussion about whether it is difficult to have access to resources to learn about Mayan mathematics (see Table 5.4). The student team said that, "*It is difficult to reclaim Mayan mathematics because the European invasion had other mathematics. Some elders have knowledge but not like before.*" This comment names historical reasons of European conquest for the loss of Mayan

mathematics and for difficulties in its reclamation. It also proposes that knowledge of elders, which is "not like before" cannot make up for the loss. The perspective of the student team is triangulated by the comment of a promoter team in a concurrent workshop (see Table 5.4) who said, "*It is difficult because we do not have the idea of knowledge of all this, like astronomy. European colonization made it disappear.*" In both comments, then, it is possible to see rich points of understanding about Mayan mathematics. Acknowledging the "disappearance" of Mayan mathematics as a result of European colonization indicated that the knowledge was difficult for Mayan communities to reclaim.

A team of promoters in talking about how Mayan ethnomathematics was used in cultivating the land (see Table 5.4) spoke of what the "ancient ones" did compared to today. "*The ancient ones used it a lot to harvest each mata of maize, measuring with their arms, how many seeds in each hole, how much time is needed, when to plant roses or cut weeds, harvest and cultivate the milpas. Ethnomathematics knowledge is used little today.*" This comment concretely explains several of the ancient practices of land cultivation used by the "ancient ones." It

is interesting to note, as evidence of an emerging Mayan ethnomathematics perspective, the reference to "ethnomathematics knowledge" being used less today. "Ethnomathematics knowledge" is a reference to a body of thought and practices, an expression of culturally based ways of doing mathematics.

There is further evidence of similar perspectives in quotes seen in Table 5.4 from a dialogue on questions raised and problematized in sessions held in July 2003. A comment by a team of promoters in a discussion about how Mayan mathematics is used in the communities said, *"Numbers and measurements of the ancestors have been lost but months and numbers are counted in Tzotzil."* This comment directly acknowledges the loss of ancient Mayan numeration and ways of measuring, which appears to relate to measurement of time, in a possible reference to the loss of the ritual calendar "Tzolkin." On the other hand, the solar calendar or "Haab" still exists in *Tzotzil*, triangulated by fieldnotes showing the existence of a Mayan solar calendar in *Tzotzil*. (FN 7-10-02). Further, the comment indicates that numbers are still counted in *Tzotzil*, which was evidenced by observations a number of times on site.

A comment by a student team, in a discussion similar to the one in the promoter workshop concerning how Mayan mathematics is used in the communities, can be seen in Table 5.4. This comment is that "*they use European mathematics but continue with base twenty.*" In relatively few words this comment indicates that European mathematics is used in the communities, as opposed to Mayan mathematics, although a base twenty system is still in use. A continuation of the use of base twenty, which was discussed by others in the workshop as only occurring during certain kinds of activities like counting seeds, crops, or measuring a corn field (*milpa*) for example (FN 7-12-03) does show a link with the ancient Mayan system based on twenty.

The comment referenced in the preceding paragraph is mirrored by a comment of a team of students in response to a question about whether there are people who speak *Tzotzil* and use *Tzotzil* mathematics but who not learn it in school (see Table 5.4). The student team said, "*The majority of people who use mathematics in Tzotzil are older. They did not learn it in official schools. We, the younger people, use more European mathematics…some Tzotzil measurements are traditions and cannot be translated. They are known in indigenous zones not in*

mestizo zones." Part of the analysis that emerges from these comments is that older people, who use mathematics in *Tzotzil*, did not learn it in official schools. This would seem to indicate that either the older people did not attend official schools when they were younger or that mathematics in *Tzotzil* was not taught there. Younger people are described as using "more European mathematics" which is likely the result of going to official schools. This view of more "European mathematics" being taught in government schools was confirmed by other student comments in fieldnotes and in several studies that demonstrate a complete lack of Mayan history being taught in official schools (Hernandez Grajales, 1991; Perez, 1999; Trujillo, 1999). At the same time, it is interesting to note that the student team said *Tzotzil* measurements are known in "indigenous zones." This would appear to indicate that there has been some ongoing use of measurements in *Tzotzil* only in areas where Mayan people live, distinct from areas where *mestizos* live.

In a discussion during the promoter workshop on 7-03 (see Table 5.4) concerning whether it is important to study Mayan mathematics in official schools and in autonomous schools, a team of promoters observed the following. "*It is important to*

reclaim knowledge of the ancestors, which we are doing little by little in the autonomous schools. More of European culture is seen in mathematics in the official schools." This comment acknowledges that the autonomous school is working to reclaim ancestor knowledges, which seems to include that of mathematics. Government schools are described as having "more European culture" in their mathematics, which appears to indicate some evidence of European culture in the mathematics of the autonomous school as well.

For purposes of triangulation and confirming evidence of what has been presented thus far, it is important to note a comment by the head of the consultant group. This comment was made during a meeting I had with "Juana," the head of the consultant group, off site in July 2003. She said "*the promoters had gone through changes themselves, in their own rhythm and in their own time, over the last year* (i.e. between 2002 and 2003) *in seeing mathematics from a Mayan perspective*" (FN 7-16-03). Juana's comments support the interpretation presented in Table 5.4 and analyzed in previous comments made in promoter and student workshops in July 2003. This triangulated evidence helps

to demonstrate that rich points of conscientization and change, helped to support the emergence of a Mayan ethnomathematics perspective. Juana attributes part of that shift to an internal process, which had to be undergone in order to develop a view of mathematics as Mayan.

To further triangulate evidence of shifting perspectives on Mayan mathematics and ethnomathematics in the workshop of July 2003, selected written evaluations by promoters are included here. Following the same format as previous evaluation forms (see Appendix D), it gave promoters an opportunity to reflect on what was beneficial, what they might use with their students, ways to move forward and other comments they might have about the workshop. As can be read in Appendix D, promoter comments overall indicate an embracing and appreciation of Mayan mathematics and ethnomathematics for many of the reasons cited in the analysis section up to this point.

Promoter #1 (evaluations Appendix D) said, "*For me the most important part of the workshop is Mayan ethnomathematics because it is important to accomplish in our daily life.*" Promoter #9 said, "*The most interesting part of what we saw I the workshop*

is about the life of our Mayan ancestors because it is important to rescue the ideas that they had." Promoter #17 said, "*The most important was the knowledge that our ancestors had. We want to know everything because their knowledge is wealth."*

What can be seen in these evaluative comments by promoters is an incorporation of Mayan ethnomathematics in their thinking. It is seen as part of daily life and represents precious knowledge of the ancestors. Promoters want to rescue these ideas that have been cut off from collective Mayan knowledge for so many years. Additional comments can be read of other promoters that support this perspective (see Appendix D).

Promoter evaluations of 7-03 also point to the importance of sharing knowledge gained about Mayan mathematics and ethnomathematics with their students. Promoter #17, one of the mathematics promoters who attended all our workshops over four years, captures the spirit of many of the comments. He said, "*For me it is necessary that they (the students) know everything because they, like us, are descendants of the ancient Mayans. Therefore, it is our obligation and right to know what our ancestors did and if possible, carry it on.*"

Lastly, referencing possible ways to move forward,

Promoter #3 said the following. "...*We need to share with the students so that they can have the same knowledge, so we can construct Mayan mathematics together."* Promoter #8 said, "*Definitively, it has helped us to learn this system of Mayan numeration. We would like more classes in this area of mathematics to know more about the Mayan numeration system (our ancestors)."* Promoter #15 said, "*What can help us is investigating more and visiting some Mayan cities to gain more knowledge*"

While other evaluative comments of promoters articulate and strengthen arguments made in this dissertation (see Appendix D), I will close with a few remarks on the last three comments in the previous paragraph. It is clear that promoters view working together with students as a way to construct knowledge together, in this case Mayan mathematics. This comment also supports my claim that a dialogic approach to pedagogy was already in place when I arrived at the school in July of 2000. The second promoter quoted was clear about benefits from learning Mayan mathematics in the workshop and wanting to continue learning more. The last promoter's comment speaks of the use of investigations, which was a theme throughout all the mathematics workshops, and the desire to gain more knowledge from actually experiencing Mayan

cities or ruins. Unfortunately, it has been hard to accomplish those visits due to lack of funds, with the exception of one school-wide trip to Palenque in 2002.

To summarize what has been analyzed through this section, data in multiple contexts provided evidence for an interpretation of Mayan ethnomathematics emerging over four years through intercultural dialogue. I argue that this purposeful, carefully negotiated dialogue, which will be fleshed out further in the next analysis chapter, provided a basis to problematize (Freire, 1973) what is known as "mathematics." Our dialogue, while centered on ethnomathematics, allowed us to move through frame clashes and rich points (Agar, 1984; Green, 1983) so that Mayan ethnomathematics could become a material resource for change and shifting perspectives of indigenous promoters and students. Placing this argument within Rockwell's contention that historical consciousness develops in "particular social and political contexts" (Rockwell, 1999, p.43) which in turn promotes cultural practices of critical thinking, expands the field upon which we can see a Mayan ethnomathematics worldview and agency playing out.

The next section of analysis on Mayan ethnomathematics presents two tracer units, one of "Alex" and one of "girls." This

affords another opportunity to move through data utilizing the perspectives of each of these individuals and groups of individuals.

Section Three: Tracer Units "Alex" and "Girls"

Two kinds of tracer units were analyzed to open up another path through the data that has been explored in Sections One and Two. A "tracer unit" is being defined as " a type of behavior, information, or construct that is traced or followed across and within various settings and/or contexts" (Cole, Griffin & Newman, 1981 cited in Green, 1983, p.189). The purpose is twofold: one is to trace someone I am calling "Alex", a strong student who became a promoter during the period of my four-year project. Alex in many ways embodies as an individual, although always defined within the Mayan autonomous collectivity, the development of a Mayan ethnomathematics perspective. Second, is to trace "girls" as a unit because evidence in and outside of workshops suggests both interest in Mayan ethnomathematics and obstacles to taking it up based on issues of gender.

Alex

Beginning with Alex, it is helpful to represent interactions

and quotes from him over time, both within and outside of formal workshops. My relationship with him, carefully built over time, could qualify as a kind of "purposeful sampling" in that I purposefully sought him out over three years on site. He was a student who demonstrated unceasing interest in and a strong identification with Mayan ethnomathematics and all areas of Mayan history that has been denied to Mayan peoples for so many years. The following table is derived from fieldnotes, conversational interviews reproduced later (from memory, as much as possible), and collaborative documents.

Table 5.5: Alex as Tracer Unit

Date	Source	Comments
8-15-01	FN	In reference to the school's trip to Palenque:" We are descendents of the ancient Maya who had extraordinary knowledge and could calculate in an advanced way. We want to follow in their footsteps because we are Maya too."
8-15-01	FN	"There is a need to capture our oral history, the memory of the viejos (elders). Yet at the same time, "Many viejos don't remember enough because it was destroyed from generations before them."
8-16-01	FN	Alex insisted that "Chumash have to get their language back" as part of "rescatando" or rescuing their traditions that have been lost.
7-16-02	FN	In reference to an ancient game of chance called *BUL*, Alex said, "How did the ancestors come up with this game?"

7-1-03	FN	In workshop with 3rd year students, Alex led his group in a discussion of Mayan mathematics & ethnomathematics.
7-7-03	FN	Alex asked for more help wtih Mayan numbers (in library) & borrowed all articles I had on Mayan geometry.
7-8-03	FN	Alex & team had "duda" about whether Maya invented zero. Asked for more evidence.
7-14-03	FN	After class, Alex & team wanted to know more about Mayan calendrics and the meaning of the end of cycle date (Dec.23, 2012).
7-15-03	FN	Alex came to my casa to practice playing *BUL* and will teach others
7-17-03	FN	Alex reviewed *Tzotzil* in collaborative document & borrowed León-Portilla book.

I want to offer two overall comments before analyzing this table more closely. In looking at Alex's comments and engagement with many aspects of Mayan history, culture and ethnomathematics over three years, he demonstrated a strong identification with the resources and perspectives I brought to the school. As a student over three years, who subsequently became a promoter, he was actively thinking himself about contributions and losses from Mayan ancestors, while trying to assess their impact on modern-day Mayas. His initiative and inquiry into Mayan mathematics set him apart, in some ways, from those at

the school who articulated mathematics as a "universal language" based on seeing mathematics as"2X2=2X2 no matter what" (see first two sections of this chapter). Evidence points to Alex recognizing the importance of culturally-based ways of viewing mathematics before some of the promoters who were not yet convinced. Alex was actively considering matters of Mayan mathematics before he had the terminology to explain his thinking, like "European mathematics" and "ethnomathematics."

A few examples from Table 5.5 on Alex are supportive of this claim. Both comments made on 8-15-01 indicate that Alex saw the importance of the extraordinary achievements of Maya ancestors, as demonstrated at the ruins at Palenque, including the precision of calculations. He was/is convinced that as Mayans, he and others in the community must have some similar capabilities. At the same time that Alex noted the importance of preserving oral history of the elders, he acknowledged how much has been lost. This view helps to understand Alex's unquenchable thirst for knowledge not readily accessible to Mayans today.

Alex was very interested in the ancient Mayan game of *Bul* (from 7-16-02 and 7-15-03) both as a game of chance created by

Mayan ancestors but also as a way to grasp the mathematics thinking and strategy embedded within it. Not much has been written on this subject, leaving Alex to ponder this question, in discussions with others and me.

Further evidence of Alex's engagement with Mayan ethnomathematics can be seen in the series of interactions in which he led groups of third year students he worked with in our workshop, from 7-1-03 to 7-17-03 (see Table 5.3). This more formal, structured setting of the workshop presented a series of opportunities to see Alex's leadership with others and his growing knowledge of Mayan mathematics and ethnomathematics. Alex was willing to raise "dudas" (doubts) or problematize questions about important issues, like whether it was indeed the Mayans who discovered zero (see Table 5.5 on 7-8-03). Alex and his team were also very interested in the significance of the ending date of the current Mayan calendric cycle, based on the ancient Mayan correlation of their solar and ritual calendars, whose current 52 year cycle ends on December 23, 2012 (see Table 5.5).

Alex and others in the class pushed me further in my own thinking, encouraging me to get more resources to provide further

evidence of positions I took. This inquiry process also led to my seeking help from others, like e-mailing various professors at UCSB for example. In this context, "dudas" and responses to them were always framed as part of an investigative process rather than "final answers."

To illustrate this inquiry process and exchange with a UCSB professor as part of that process, an e-mail communication with Dr. Aldana on the significance of the date December 12, 2012 and follow-up fieldnote sample are presented here.

> *There are several points that need to be made in reference* to the date of December 23, 2012. First, the Classic Mayan (and Olmec) calendric system, fell out of use at *the end of the Classic, beginning of the Post-Classic period. Second, the Classic Maya used the Long Count to link the two calendars so that a date in the Long Count could be matched with the Calendar Round. A date in the Calendar Round, however, recurs every 52 years so that it cannot be anchored in historical time wihout its Long Count counterpart...The contentious part is the relationship between the Long Count and the Christian calendar, which could be off by a couple of days or hundreds of years. What mattered was the relative dating, not the anchor in Christian time. The correlation has still not been proven. Hopefully, at some point in the future, Mayan peoples themselves can discuss this issue and come to their own conclusions* (E-mail communication with Dr. Aldana 7-11-03).
>
> *The group of students who raised their "duda" or doubt about the ancient Mayan date calculated as December 23, 2012 were interested to hear about Dr. Aldana's response. We discussed what he said both in and outside of class. Even though we didn't understand all aspects of what Dr.*

> *Aldana explained, it was a lively discussion. We realized there was a lot still to be learned and understood. The students very much liked the idea of being part of discussions of Mayan people in the future who could help decide some of these issues about the Long Count and its relationship with the Mayan calendars* (Fieldnotes 7-15-03).

Both the e-mail communication with Dr. Aldana at UCSB, whose work has centered on ancient Mayan astronomy as evidenced in Copán, Honduras, and the fieldnote indicating follow-up to the e-mail communication, give an idea of our inquiry process at the school. This process involved others from outside as necessary and broadened the scope of possible resources we could access. It also helped to demystify the methods that could be used to obtain information and investigate questions.

In conclusion, Alex presents some interesting counterpoints to the analysis presented in sections one and two of this chapter. His case as a tracer unit allows us to see a different configuration of unfolding events over three years. It extends and departs from what unfolded over the same period of time with the promoters. There was a development in Alex's thinking and articulation of his ideas over three years that demonstrated a grasp of the

importance of a Mayan view of mathematics before some of the others at the school. This might have been due to Alex's role as a student at the autonomous school, which opened him up to a broad repertoire of knowledge. Perhaps in Alex we can see what Adrian, the leader of the Education Committee, described to me in a personal conversation (FN 7-9-02) about the potential of new waves of students helping to lead the autonomous education experiment. Such students would come to exemplify the goals of the school in working to "reclaim resources, language and culture" (Adrian speech, 8-10-01).

The "Girls"

Using a gender designated, multiple group called "girls" as a tracer unit (which includes an interaction with one of the women promoters) is designed to follow experiences and interactions of myself with girls at different moments in time. Following "girls" through the data captures some of their educational challenges at the autonomous school, particularly in engagement with Mayan ethnomathematics.

As with Alex, a table has been constructed to present evidence of interactions explained in fieldnotes (FN), slices of

conversation (recorded as fieldnotes FN and journal notes JN) and from a workshop with third year students in July 2003, recorded as fieldnotes (FN) and collaborative documents (CD). The table covers the period from July 2000 through July 2003, often outside of formal contexts in interactions with me.

Table 5.6: "Girls" as Tracer Unit

Date	Source	Comments
7-8-00	FN, JN	I didn't realize that many girls only speak *Tzotzil*. Communication will be a challenge.
7-9-00	FN	Did an icebreaker with girls by showing them photos of Machu Picchu & indigenous girls at a market in the Sacred Valley in the Peruvian Andes.
8-10-01	FN	Vicenta told me how hard it is to study at the school when your family needs you.
7-15-02	JN	Six first year girls came by my casita to ask why I am here. Explained a little about Mayan mathematics.
7-15-02	FN	Josefina came by to talk about two things: how she gets explanations in *Tzotzil* at this school with "palabras elevadas" in Spanish; she is excited about learning Mayan mathematics next year-she has seen some second year students doing it.
7-19-02	FN	In class with Flora and Jose (mathematics promoters), Flora wanted to know the difference between geometry from nature (Mayan) and Euclid's "scientific" geometry.
7-8-03	FN	Two girls doing tijido with looms tied to a tree agreed there is "probably some mathematics involved in weaving."
7-10-03	FN	Three girls from third year student class came by to ask questions about Mayan mathematics and ethnomathematics. Said it was hard to understand because they were "behind and low." They said it is "hard to speak in front of a group."
7-14-03	CD, FN	One of the girls who had come by (7-10) presented for her group in class. She did a good job!

In analyzing this table based on interactions with "girls" over four years, it can be seen that the language issue was the first

challenge to overcome. Before entering the site in July 2000, I had no idea that all the students were not bilingual in *Tzotzil* and Spanish. In the course of various interactions in the dining room, where I ate the first year, and in the community in which the school is based, I discovered that the girls spoke almost exclusively *Tzotzil,* their native Mayan language. There are many reasons for that, including greater isolation of girls than boys as they were growing up. The reasons for the girls being monolingual, while important in the larger picture of Mayan education, are not the focus of this section. What is important to note, however, are the first steps we took in bridging the language gap. Showing photos I had taken of indigenous girls in Peru and of the ancient Inca sacred city of Machu Picchu (7-8-00, 7-9-00) allowed me to "break the ice" with some of the girls. These interactions with me and with the content of the photos happened in spite of shyness and language difference.

Two fieldnote entries are presented here to provide a context for the interactions I had with the Mayan girls the first year on site.

The whole breakfast scene here is amazing. Fortunately, I am having the opportunity to share meals with the students in their "comedor" or dining room, which opens up more possibilities for communication. I'm really glad that I pitched in helping to roll the "masa" or corn dough for the tortillas. It helped to break down some of the barriers, especially between myself and the girls who don't speak much Spanish (Fieldnote 7-8-00)

Right now I did another icebreaker. I showed the girls several pictures I brought with me from Machu Picchu, the ancient ruins of the Incas in Peru. They gathered around me after breakfast in an instant without thinking about it. They were happy to see the young indigenous girls from Peru in their beautiful traditional clothing, similar to their own...They liked saying the name "Machu Picchu" out loud over and over (Fieldnote 7-9-00)

Both fieldnotes presented here offer a context for my interactions with some of the girls at the school the first year on site. They also indicate creative ways in which interactions were sought out and implemented with girls, even when a language barrier became apparent.

In the next series of interactions from the Table 5.6 (8-10-01, 7-15-02, 7-15-02), it can be seen that various girls and groups of girls became more curious about me and exactly what I was doing at their school. I also engaged girls whenever there was an opportunity. For example, Vicenta (a first year student) and I spoke in the computer lab about her struggles with being able to continue studying at the school, given pressing family needs.

Since that time, Vicenta had to leave the school.

The following summer, several first year girls came by my casita to inquire as to my activities at the school. It led to brief conversations about Mayan mathematics and what it is. The interaction with Josefina (7-15-02), also a first year student, lasted about 30 minutes. The following dialogue makes visible how important it was for Josefina that the autonomous school is Bilingual. Hard concepts in Spanish, which she described as "palabras elevadas", were explained to her and others in *Tzotzil* making them understandable. Josefina also expressed enthusiasm about learning Mayan mathematics her second year, based on having seen other students doing it. Mayan mathematics became incorporated as part of the second year mathematics curriculum for the school year of September 2000 to August 2001. This occurred despite the varying levels of capability promoters feel in being able to teach it well.

It is important to note here that Mayan girls attending a secondary school represent a major achievement of the autonomous education system. Even more so than boys, girls do not often get past third grade in government primary schools. This often prohibits them from potential opportunities to make changes

in their own lives or to contribute to transforming Mayan communities in which they live. Part of opening up potential opportunities at the autonomous school is also due to young women learning Spanish, which enables them to communicate with indigenous speakers of other Mayan languages as well as non-Mayan people from Mexico and other parts of the world. As explained by one of the women promoters in an interview published in 2004, " It is precisely in education where *Tzotzil* women are opening spaces" (FN 9-25-04). This determination of the autonomous education system to make changes has led to the formation over the last five years of over 50 new autonomous primary schools in the Highlands of Chiapas.

Turning our attention again to Table 5.6 on "girls" as a unit, on 7-19-02 in a class with just the mathematics promoters Flora and Jose (which was a large part of what I did that summer), Flora raised some questions about the basis of Mayan geometry. Flora was interested in how Mayan conceptions of geometry compared to that of Euclid. We had briefly referenced in previous workshops that there were differences between the Mayan approach to geometry and that of Euclid, based on Mayan

perspectives of geometrical principles deriving from nature. We were unable, due to time constraints, to investigate Mayan geometry at that time. Yet Flora, who often described herself as "*not very good in mathematics*," wanted to pursue the discussion. So, in spite of self-denigrating comments about her capabilities, which she consistently made, Flora was pushing the three of us present to take the next steps of investigation.

The next interaction analyzed was with two girls weaving *(tijido)* with back looms tied to a tree on 7-8-03 (see Table 5.6). After a short discussion about their weaving, they both expressed that "*there probably is mathematics used in our weaving.*" It is significant that mathematics patterns define the ancient and current weaving process, as has been pointed out by Eglash (Eglash, 2002). Unfortunately, we did not have time to look deeply into the ethnomathematics of weaving during our workshops (see Tables 5.1, 5.2 and 5.3). It would have been particularly interesting to investigate because most of the girl students on site did regionally based embroidery designs and brought out looms during school breaks to do tijido. I knew from previous conversations on site (FN talk with Naya, 7-02) that using traditional hand

measurements to create symmetrical patterns is part of the mathematics embedded in this gendered activity.

During July 2003, I had the opportunity to work in formal class sessions with third year students, as stated earlier. That allowed me to interact with the four girls (out of 30 students total) in the class and outside the class. Three of them came to see me at my casita, as can be seen in Table 5.6 dated 7-10-03, to ask questions about the materials we were discussing in the workshop on Mayan mathematics and ethnomathematics. They claimed it was hard for them to understand because they were "behind and low." I worked to dispel that self-denigrating position by using pictures, photos and explanations from various angles on Mayan mathematics. After about 45 minutes, it seemed to help clear things up for them. I urged them to ask questions, even though difficult, because many students were likely to have the same questions but might not ask. The girls added that it was hard to "speak in front of a group." I had heard the same comment beginning the first year at the school, when girl students and women promoters explained how much of their "traditional" upbringing they had to overcome in taking on new roles at the autonomous school.

Thus, in this analysis of some of the issues involved in "girls" as a tracer unit interacting with Mayan ethnomathematics and with challenges of being at an autonomous school, it is possible to see some dilemmas posed by gender. There is a consciousness of the need to address gender more, as explained by Juana (head consultant) to me on 7-6-03 in a discussion on the issue of "*genero*." Juana said gender issues are being tackled in the community at their own pace. I have been pleased that girls were able to approach me relatively easily to raise their concerns, self-doubts and questions. That means that my gender, in the various roles I play at the school, has helped to draw them out.

Conclusion

In summary, this analysis chapter presented ethnomathematics as a material resource and as a perspective that emerged over time defined by key events and interactions represented through frame clashes turning into rich points. A process of developing understandings and utilizing a variety of intertextual resources during four years, enabled Mayan mathematics and ethnomathematics to become a more widely held view by promoters and students. Mutual conscientization and intercultural dialogue helped to build a basis of trust and

strong working relationships as a foundation for this process. The tracer unit cases of "Alex" and of the "girls" provided different lenses for moving through the data, seeing additional perspectives. Through the tracer unit on "girls", challenges based on gender that persist, even within an autonomous Mayan education setting were made visible.

The next analysis chapter will focus on many of the same data sources as this chapter. Lenses will be shifted to look at how ethnomathematics workshops and data outside of workshops uncovered autonomous education as liberatory pedagogy and Mayan indigenous ways of knowing.

CHAPTER SIX: DATA ANALYSIS

How did intercultural dialogue, actualized by mutual conscientization, uncover Mayan indigenous ways of knowing and autonomous education?

> *" Zapatistas say that it is important to continue down the road of walking and asking. It means teaching and learning as one goes. As the Tzotziles say, 'The tongue is not made of bone'"*
>
> -La Jornada 7-29-04

Introduction and Chapter Organization

The purpose of this analysis chapter is to shift angles in looking at many of the same data sources as Chapter 5, to provide evidence of Mayan ways of knowing "often invisible to Eurocentric knowledge" (Battiste, 2002 p.4). The evidence derives from Mayan ethnomathematics workshops over four years (July 2000-July 2003) recorded by hand transcription and fieldnotes that later became collaborative documents, as well as from other observations recorded as fieldnotes and journal notes outside of more formal settings. Evidence also derives from a speech and interview (not my own) with the head of the Education Committee from the school (Adrian).

A common thread through the evidence is the use of

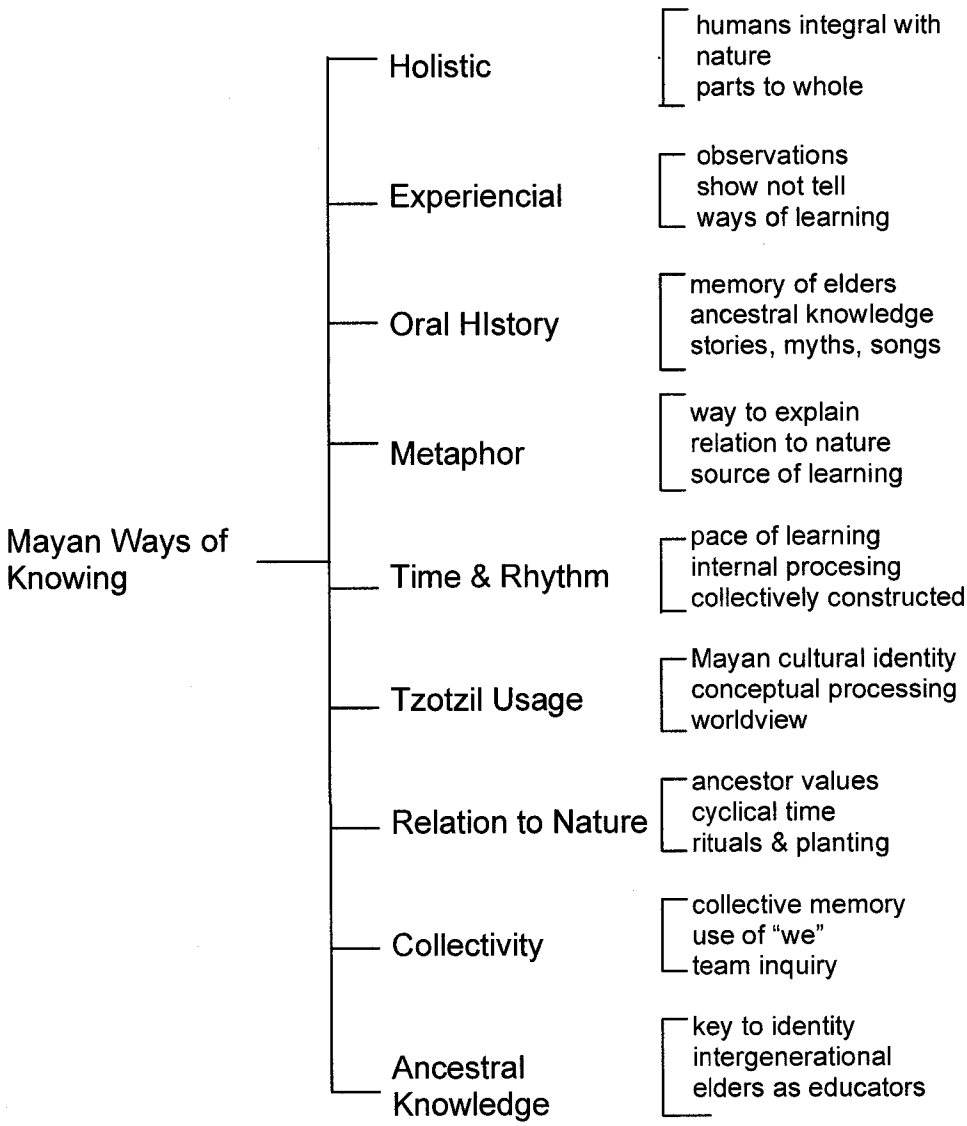
intercultural dialogue and double conscientization. *Intercultural dialogue* is being used in the following sense: a dialogic, interactional space in which "*interculturalism is a focus of what occurs between groups in order to understand the dynamic and creative cultural processes in context*" (Rockwell, 2002 p.16). *Mutual conscientization* is being used in the following sense: "*as a joint project in that it takes place in a person among other people, united by their action and by their reflection upon and action upon the world*" (Freire, 1998 p.514). Thus, mutual conscientization and intercultural dialogue (both defined further in Chapter Two) provided a basis for trust, an ability to move through dissonances to achieve rich moments of mutual understanding, and a determination to find innovative ways to work within the Mayan autonomous school context.

The chapter is organized to examine evidence of a Mayan indigenous perspective in a number of contexts. The first section analyzes several illustrative cases of indigenous ways of knowing that became visible in the course of workshops mostly with promoters (teachers) and in the last year with students. These collaborative efforts, as will be demonstrated, helped to surface and support various aspects of Mayan knowledge. The second

and final section will analyze how the autonomous school's version of "liberatory pedagogy" was rooted in indigenous ways of knowing and process.

Before I begin an analysis of a Mayan indigenous approach to knowledge construction at the autonomous school in the two sections of the chapter that follow, I am providing a taxonomy (Spradley, 1980) of the terms included in "*Mayan ways of knowing.*" The taxonomy is derived from observations in fieldnotes, collaborative documents produced from workshops, school documents and my own readings on Mayan autonomous education. This use of a taxonomy is qualified as being *interpretive* in that practices that comprise indigenous knowledge were not overtly described by Mayan promoters and students at the school but rather were gleaned from observed patterns and practices, consistent with indigenous pedagogy itself. I am using Spradley's definition of a taxonomy as "a set of categories based on a single semantic relationship" (ibid, p.112), which at the same time offers relationships "among the things inside the cultural domain" (ibid). Thus, a taxonomic analysis of Mayan ways of knowing provides a basis for the multiple ways this term is being used throughout this chapter.

TABLE 6.1: TAXONOMY OF MAYAN WAYS OF KNOWING



What the taxonomy in Table 6.1 allows us to see are the various patterns and practices that were observed as constituting Mayan indigenous knowledge. Patterns became visible in workshops, conversations, and observations over four years on site at the autonomous Mayan school in Chiapas. The taxonomic breakdown helps to ground the subsequent analysis sections that explore uses of indigenous knowledge, how an ethnomathematics perspective emerged in this context, and the ways in which a liberatory pedagogy helped to transmit indigenous knowledge and practices.

Section One: Indigenous Ways of Knowing in Ethnomathematics Workshops

In this section, several illustrative cases have been selected for analysis to make visible how indigenous ways of knowing, as defined through included terms (or practices) above, were expressed in ethnomathematics workshops over four years. In reviewing data generated in workshops on site at the autonomous school, there were multiple examples of indigenous knowledge at work. However, for the purposes of analysis here, I have

systematically sampled illustrative cases that are described chronologically beginning with year 1.

Year 1

In the workshop year 1 (July 2000), entitled "*Paulo Freire and Critical Mathematics*", all activities took place in groups. To create a dialogical space in which many aspects of mathematics could be problematized (Freire, 1973), we used a collective approach. It was clear from observations of the Mayan community at the school several days previous to the first workshop, that a collective "we" was common while an "I" was almost never heard (see taxonomy), making a collaborative approach appropriate. The process and content of the workshop sessions reflected and expressed other aspects of an indigenous approach to knowledge construction as well. We did not move from one activity to the next until all groups were done. Group members described this as "*todavía falta*," which meant more time was needed to complete what they were doing. This process reflected a collective approach to inquiry and a pace of learning adapted to the collective needs. Additionally, *Tzotzil* was used by group members to process ideas among themselves before presenting back to the whole group in Spanish. These patterns, reflective of a Mayan collective approach

to time and rhythm and use of the Mayan language *Tzotzil* as a basis to process information and develop concepts, continued throughout the four years of workshops on site (see workshop tables, Chapter Five).

A final illustrative case from the first year workshop was exploring Mayan mathematics on a daily basis. This is part of an indigenous perspective reflecting the importance of retrieval of practices based on ancestral knowledge. As explained by promoters in their written evaluations of the first workshop (see Appendix C), 8 out of 10 promoters who filled out the forms (although there were up to 15-18 promoters present at various sessions) expressed that Mayan mathematics was valuable to them. One promoter said, "*Mayan numbers give us a way to know the history of our ancestors.*" Another promoter echoed the same perspective. "*Mayan numbers are important because it is a form of knowing the history of our ancestors and of knowing that it is an advanced civilization.*"

Both evaluative comments by promoters based on the first workshop demonstrate the importance of learning Mayan mathematics as a way to reconnect with Mayan civilization. This is particularly important in light of discussions in previous Chapters

One, Two, and Five concerning the impact of Spanish and then Mexican colonialism in denying Mayan history, denying the contributions of the ancient Mayans to mathematics and science, and in denying the impact of Mayan civilization on Mexican society as a whole.

Year 3

Several illustrative cases of indigenous ways of knowing emerged in sampling data from an all-day workshop in year 3, July 2002 (see workshop tables in Chapter Five). There was no mathematics workshop year 2 for reasons explained in previous chapters. The workshop year 3 was entitled "Agriculture and Ethnomathematics" and was attended by 20 promoters. First, we set a context for the discussion by using parallel examples of ethnomathematics from marginalized indigenous cultures worldwide from Mozambique to the Brazilian Amazon. Then pairs of promoters collaborated in drawing out comparisons between traditional Mayan methods of agriculture and more modern forms. Three points were articulated that indicate contradictions in Mayan communities today that the autonomous school is working to address regarding Mayan indigenous knowledge and practices.

1. "*pray before beginning work vs. Mayans don't pray nowadays.*"
2. "*counting planting times using traditional months vs. without respect for nature.*"
3. "*used original corn seeds vs. use of hybrid corn seeds.*"

One of the stated goals of the autonomous school is to "*reclaim resources, language and culture.*" That means revitalizing traditions that have been lost for a variety of reasons, like praying before work (planting) and respecting nature. It includes rescuing the ancient Mayan ritual calendar or "Tzolkin" for planting (referred to in the second comment as "traditional months" and religious purposes. The fight for use of original corn seeds and against genetically modified hybrid seeds throughout Chiapas is crucial from a Mayan cosmological perspective (articulated by promoters at a Conference on Corn, Mexico City, 2002). Some of the rituals before planting and decisions when to plant original corn seed according to the ritual "Tzolkin" calendar were presented by several promoters from the autonomous school at a corn conference. While not going into detail here for security reasons, these three examples represent decisions to fortify indigenous

knowledge and practices. They reflect ancestral knowledge, a holistic, integrated perspective in relation to nature and its cycles, and a collaborative identity in taking back/recreating collective memory and history.

In co-constructing a Mayan identity at this autonomous school in Chiapas, ancestral knowledge is seen as crucial to that process and is learned predominantly through oral history. To provide further evidence of the importance of ancestral knowledge, two fieldnote excerpts and an excerpt from a school document are presented here.

> *Our history is based on pre-history. We have to recover our cultural patrimony* (Fieldnote of Adrian speech 8-7-01)

> *One of the students told me in a conversation that the (elders) in the communities have much knowledge. He said they have lots of stories to tell as well as know and use the Tzotzil calendar. We talked about the need to record and preserve this knowledge* (Fieldnote 7-17-03)

> *The stories included in this document can help us to discover our real situation and strengthen our consciousness of struggle. We are also beginning to rescue our culture, that which is ours. In the same way we must conserve this kind of knowledge because if it is not written. Many times it becomes lost to popular memory (my translation of excerpt of school document* 8-01)

These excerpts provide additional windows into the Mayan autonomous school community's view of ancestral knowledge and

its importance. An articulated goal of the school is to reclaim "language, culture and resources" (Adrian speech 8-7-01), which includes the oral history of elders as collective memory and other forms of ancestral knowledge.

Tzotzil is more a spoken than a written language, whose history and traditions are transmitted through stories, songs and myths from elders to those of the younger generation. These stories and myths, components of oral history, are being taken up collectively as the Mayan educational community works to reclaim traditions that are have been lost to the communities.

Year 4

As one of the promoter *equipos* (teams) said, in our collaborative workshop document that I produced in 7-03, "*It is important to reclaim knowledge of the ancestors, which we are doing little by little in the autonomous schools.*" It is worth noting here that creating written texts (documents) of orally based collaborative workshops (7-02 and 7-03), helped to provide material resources and intertextual links (Kristeva cited in Fairclough, 1992). It assisted the reclaiming process of collective memory referred to by the promoter team. These textual resources could then be revisited multiple times to facilitate intertextual links over time.

Several illustrative cases emerge from data of the workshops in year four entitled, "The Origin of Mayan Mathematics and Ethnomathematics" that ran concurrently with students and promoters in July 2003 (see workshop tables in Chapter Five). Cases are presented in Spanish and English to give bilingual access to the reader. In response to a question about why learn Mayan mathematics and ethnomathematics, one of the promoter equipos said, "*Es importante para tener la consciencia a diferentes niveles de estudio de los más antes.*" A translation is, "*It is important to have the consciousness of different levels of study of those who came way before."* This promoter group was expressing a prevalent perspective of the participants in the workshop, which was to acknowledge the importance of ancestor knowledge, requiring multiple levels of study to uncover. Another promoter group described the Mayan ethnomathematics involved in cultivating lands, revealing a similar theme. They said, "*Los ancianos se usan mucho para sembrar cada mata de maíz, mediendo con brazos, cúantas semillas cada hoyo, de tiempo cúando se puede hacer la rosa o tumbar los montes, sembrar y cosechar las milpas.*" Translated as " *The elders use it a lot to cultivate each corn plant, measuring with arm lengths, how many seeds in each hole, the time*

to make roses or cut down the thicket, cultivate and harvest the cornfields." Knowledge passed down from one generation to the next in cultivating *milpas*, the agricultural basis of Mayan rural community life, use cultural practices that rely on their own approach to mathematics. Aspects of indigenous ways of knowing in this example include a collective, experiential approach, based on trial and error to see what works, responding to nature's timetable of what the land can produce and when, intergenerational knowledge and use of finely tuned observational skills.

Another rich case of an indigenous approach to knowledge construction arose when a promoter asked the following question: "*En relación con la naturaleza, cuando hay el ruido de los animales, de los pájaros, si sabe que van a comenzar la lluvia o la sequía ¿ es una medida de la temporada o una calculatión o otra cosa*?" Translated the question is: "*In relation with nature, when there is the sound of the animals, of the birds, it is known that the rain or dry season will begin. Is this a measure of the seasons, a calculation or something else*?" Apart from the inquiry into ethnomathematics focused on in Chapter Five, it is possible to see how much a holistic integral relationship of humans with nature is expressed here. *Having* observed how birds and other animals convey the seasons

is part of an indigenous perspective. The use of metaphor, which arose in many interactional contexts at the school, was expressed here as a way to convey what is learned from the animals and the birds.

In order to triangulate other sources of evidence on the use of metaphors, an excerpt of a school document and a fieldnote are presented here.

> *We are people who are made of corn and earth. We are Tzotzil indigenous. Today they call us Tzotziles because our true name was transformed on the tip of the invader's tongue. We have been indigenous ever since our mother earth gave birth to us, and we shall continue to be so until that same mother earth engulfs us* (excerpt from promoter presentation at Corn Conference 7-10-02).

> *A people without education is a dead people, a weak people, a people who do not know their history* (translation of excerpt Adrian speech 8-7-01).

Both excerpts indicate that metaphor is not just narrative but carries with it meaning and ways to explain a worldview. The first excerpt is from a public statement by a promoter in which metaphors are used to present belief systems and holistic approaches to humans as part of nature and the earth. The *Tzotzil* creation myth, passed on by oral tradition and appearing on murals on the walls of the autonomous school, speaks of people created

from corn. So, part of grasping Mayan indigenous ways of knowing includes an understanding of metaphors as cultural expression.

Conclusion to Section One

Through the illustrative cases analyzed from data generated from four years of workshops at the autonomous Mayan school, it is possible to see patterns and practices indicative of Mayan ways of knowing. The inquiry process into Mayan mathematics and ethnomathematics happened collectively, mirroring Mayan community practices, expressed in *Tztozil* for collective discussion, debate and arriving at a consensus before translating into Spanish for the whole group. Had I been able to speak *Tzotzil* myself, perhaps a Spanish translation would not have been necessary and richer versions of an indigenous approach to knowledge would surely have been communicated. Nevertheless, an indigenous Mayan perspective was transmitted in the course of dialogic workshops in which Mayan participants played an instrumental role.

At the same time, it is important to note in conclusion to this section, that the process of reclaiming the knowledges that comprise indigenous ways of knowing is not a simple or smooth process. Alex's comment, referred to in a tracer unit chart in

Chapter Five (Alex is a student who became a promoter after three years at the school) captures some of the contradictions faced by the autonomous school. Alex said, "*There is a need to capture our oral history, the memory of the elders."* At the same time, "*many elders don't remember enough because it was destroyed from generations before them*" (FN 8-15-01).

Section Two: Liberatory Pedagogy and Indigenous Ways of Knowing

This section will explore how the autonomous school's version of "liberatory pedagogy" was rooted in indigenous ways of knowing and process. Intercultural dialogue, as defined earlier, actualized by an ongoing process of double conscientization, enabled these understandings to emerge. While not articulated as such by school community members, an interpretation of the autonomous school's process as "liberatory pedagogy" will be analyzed in part 1. Part 2 will link that interpretation of "liberatory pedagogy" to indigenous ways of knowing expressed at the school in ways described in section 1 of this chapter.

Part 1: "Liberatory Pedagogy" and Autonomous Education

Parameters of this dissertation agreed upon with the leadership of the school does not permit a full analysis of all examples observed during four years at the autonomous school setting. Nevertheless, illustrative cases, taken in part from published materials, provide evidence for this interpretation.

The following table illustrates comparisons between autonomous education and what is known at the school as "official education." The table is derived from words of students and promoters at a school workshop and triangulated through conversational interviews I had with other students as well. The specific depiction of autonomous education and official education come from my translation of an artifact called, "Taller de Cuentos" or "Stories Workshop," given in April and May of 2002 by international consultants, similar to myself.

Table 6.2: Comparison of Autonomous and Official Education

autonomous education	official education
1. education that responds to necessities of people	1. education is opposite of what we need.
2. is inclusive	2. is exclusive
3. is emancipatory	3. is oppressive
4. freedom of expression	4. few freedoms
5. has own curriculum	5. curriculum of government

6. a pedagogy of mutual learning between students and teachers 7. bilingual 8. rescue cultures who are being left without memory 9. self-sustaining 10. doesn't distinguish gender	6. teachers run the class 7. monolingual Spanish 8. don't learn true history 9. rely on government 10. girls not recognized

What this comparative table allows us to see is what autonomous education is responding to in constructing a different course from official education. Official education was described in several conversations I had with students over four years recorded in fieldnotes, as an "*attack on indigenous people*" (FN 7-02). This is consistent with what students and promoters described in this Cuentos workshop as "*oppressive*" "*exclusive,*" "*not learning true history*," "*Mexican government curriculum*," as well as being "*taught only in Spanish*." Most Mayan students in the Highlands of Chiapas speak their mother tongue *Tzotzil* in primary grades but not Spanish. When I asked a student in August 01 what it felt like to not understand the language of instruction, he said, "*we sat in the back of the room and felt stupid*" (FN 8-10-01). However demeaning the educational experience was for boys, girls were even further marginalized. Girls are not seen as needing to be educated, often not advancing beyond third grade (FN 8-01). As a

result, many parents of students at the autonomous school were so upset about what was happening to their children when they were previously in government schools, that it became an "*act of resistance to remove them from school*" (FN 8-12-01).

Analyzing the autonomous education side of Table 6.2, it is possible to see a number of parallels with principles of liberatory pedagogy (Freire, 1973). A responsive, inclusive education, which is emancipatory, is similar to Freirean principles of a liberation pedagogy, which is participatory, student-centered, experiential and oriented toward emancipatory values. What is described in the chart as "*mutual learning between students and teachers*" is the same as "dialogic learning" (Freire, 1973), in which "all teach and all learn" (ibid). This horizontal approach is constructed to honor the voices of everyone present, including the voices of girls who are gaining greater access to education by attending the autonomous school. The school's choice to call their teachers "promoters" (promoting rather than controlling the educational process) also derives from this commitment. The comparison with official education where "*teachers run the class*" is similar to "banking education" (Freire, 1973). Freire criticizes a banking approach for basing all knowledge and life experience in the

teacher who then deposits it in the "empty bank" of student's minds. The situation is even more serious when you take into account that the content of the education itself in official schools is "*oppressive*" and "*doesn't teach a true history*" of Mayan peoples.

If an "emancipatory literacy" is about "reading the world" (Freire & Macedo, 1987), then it seems possible to say that the students and promoters of the autonomous school, as well as the educational community as a whole, have "read the world" of official schools based on personal experiences and rejected it. Thus, autonomous education could be described as a form of liberatory pedagogy in its rejection of official education and in practicing educational principles of a Mayan community in resistance.

Paulo Freire often said, "*education is not neutral and reflects political perspectives*" (Freire, 1970,1973, 1985). An awareness of the vertical structure of education means being conscious of who benefits and who doesn't within that structure. Mayan peoples, who have occupied the bottom rung of Mexican society for hundreds of years since the conquest, are now becoming "subjects not objects" of their own history. The experience of dignified autonomous education unleashes the process Wink's refers to as "learning, unlearning and relearning"

(Wink, 2000, p.23), Thus, the autonomous Mayan education community in Chiapas is creating an emancipatory pedagogy based in part on "unlearning and relearning" what works and does not work for Mayan people.

Excerpts from a speech given by the head of the Education Committee at the school, Adrian, on March 26, 2002, which I simultaneously translated, is analyzed in Table 6.3 below. It is presented to make evident some principles of liberatory pedagogy reflected in autonomous education. The table also includes excerpts I translated from an interview with Adrian that was published 9-6-04 on a Chiapas informational list serve.

Table 6.3: Adrian's Oral Text as Liberatory Pedagogy

Source	Adrian Text	Liberatory Pedagogy	Meaning of Terms
Speech 3-26-02	Education is fundamental to the new worlds we create.	emancipatory education	education as part of liberation process
	We don't say we can educate you. It is equal.	dialogic method	inclusive interactions and collective framework
	The principals of our Mayan education are not to educate people but to share experiences, knowledge, to transform the world that all of us have created.	dialogic method, conscientization	inclusive interactions and collective framework process of interaction, reflection, action for change
	Our culture taught us to think of those at the bottom. The saints of globalization think otherwise.	problem-posing culture of silence subjects not objects	critical, questioning perspective marginalization as silence, pre-literacy agents of change based on critical reflection
	Every people has its roots and must defend them. The Mayans observed the stars without great lenses. They could tell all the cycles. This education of ours was destroyed.	conscientization problem-posing subjects not objects	process of interaction, reflection, action for change critical, questioning perspective agents of change based on critical reflection
Interview 9-6-04	We provide didactic materials to our own schools.	problem-posing dialogic education	critical, quesitoning perspective inclusive interactions and collective framework

	A child here learns that there are those who rob us, humiliate us, and enslave us. That it is necessary to struggle. I believe that our children (in the autonomous schools) are more reflective, have the possibility to be more analytical. No one conscienticizes anyone. No one is conscientized alone: Conscientization must be created among everyone	conscientization humanizing education dialogic method culture circles problem posing dialogic method conscientization	process of interaction, reflection, action for change transformative reflections and actions inclusive interactions and collective framework collective analysis and actions critical, questioning perspective inclusive interactions and collective framework process of interaction, reflection, action for change accomplished collectively

What this table allows us to see is the relationship between the spoken text of Adrian in two different instances (a speech and an interview) and principles of liberatory pedagogy as interpreted both in the actual text and from observations of the autonomous school process over four years. It is helpful to know that Adrian personally was very interested in the writings of Paulo Freire, a resource I was able to provide to him and the school each year on site. Thus, extrapolating principles of Freirean theory, method and praxis does not seem imposed upon this context, even though it was not articulated in precisely those terms. A reading of this table does give us a feel, I believe, for Adrian's discourse, which lends itself to this interpretation.

Several points from Table 6.3 stand out. One is that problem-posing and dialogic methods are seen over and over in the autonomous approach to education, as articulated by Adrian. Second, conscientization, defined earlier in this chapter as a "joint project", is part of a collective approach to raising consciousness and creating a basis for change. Third, becoming subjects not objects in a historical and immediate sense is a crucial shift for Mayan participants at the school working to overcome a "culture of silence" (Freire, 1973). Freire described a "culture of silence" as a

characteristic of marginalized peoples in colonized countries who traditionally have not had a voice in their society, have internalized that status, and are often pre-literate due to those conditions (Friere, 1973).

A fourth point arising from Table 6.3 concerns the reason that students in autonomous schools "are more reflective and have the possibility to be more analytical" as Adrian points out. Reflective and analytical qualities stem from the school's commitment to that kind of educational process. Using "cultural circles" (Freire, 1973) for example, in which discussions are based on examining everyday life, contributes to a critical analysis of social and political contexts. Problematizing and dialogic education, purposefully enacted at the autonomous school, are components of a reflective, analytic approach.

For purposes of triangulation of data, two fieldnote excerpts are presented here. Both offer evidence of students at the autonomous school being "reflective and analytical" as Adrian asserts in the interview illustrated in the table.

> *A group of students came up to me after the workshop today. They said they had a "duda" or doubt, which is how they pose questions. They wanted to discuss and clarify which indigenous group discovered zero. We talked about* the contribution of the*Olmecs and the Mayans. They*

wanted to understand the difference in how zero was used between the two peoples. They pursued the discussion for fifteen minutes to ascertain whether it was truly a discovery by the Mayans or something else. After our discussion I promised to bring them more sources of evidence on this question by the next class, which I did. It was clear they were not yet satisfied (Fieldnote 7-9-03)

After an introductory discussion about ancient Mayan astronomy, we were looking at a map of "Mundo Maya" or the Mayan world before the Conquest. One of the students asked me if Columbus knew the world was round when he came to conquer them. He went on to say that, as he remembered it, Columbus thought the world was flat and his boats would fall off the edge. But the ancient Mayans, he said, knew the world was round. You could tell from how they did their calculations of astronomy and their use of cyclical time. They were more advanced than Columbus, he asserted
(Fieldnote 7-3-03)

Both fieldnote excerpts presented here give a sense of the reflective and analytic manner in which students pose questions, consider possible answers and pursue inquiry. As a collaborative teacher in this environment, I found myself pushed to think more deeply and search for more sources of information in response to the leadership of both students and promoters at the autonomous school. It is important to note that the process of collective knowledge building, consistently engaged in at the school, nourishes a reflective, analytic approach. Collective building of knowledge is also an important aspect of Mayan ways of coming

to know.

This last point leads directly to the next section, Part 2, in which an analysis of elements of Mayan autonomous education that support a view of liberatory pedagogy are linked to indigenous ways of knowing. In concluding Part 1 then, it is important for the reader to know that are parallels, which can be drawn from the words of students, promoters and the head of the education committee to provide evidence principles of liberatory pedagogy. At the same time, however, it important to emphasize that a picture of the autonomous Mayan educational approach would be misleading without analyzing Mayan ways of coming to know.

Part Two: Autonomous Education and Indigenous Ways of Knowing

The final part of section 2 of the chapter will explore the relationship between autonomous education and Mayan ways of knowing. The analysis is mediated through the previous discussion of liberatory pedagogy and the processes of intercultural dialogue and mutual conscientization. Intercultural dialogue (as defined earlier) and mutual conscientization cannot be reduced to "methods" applied to the autonomous school process. Rather

each provides a fluid and dynamic "flow between collectivities" (Apffel-Marglin, 1998), promoting awareness of principles of interaction respectful of Mayan leadership and direction.

To begin with an example, a collective approach to conscientization is articulated by Adrian as " *No one conscienticizes anyone, no one is conscienticized alone"* (see Table 6.3), Here, Adrian speaks to the Freirean concept of conscientization within a Mayan indigenous perspective. As analyzed earlier from fieldnotes (FN-00 to FN-03), "we" was heard during four years on site, almost never an "I." This approach goes back to the taxonomic analysis earlier in this chapter, in which a collective mode is reflective of Mayan ways of knowing.

Further evidence of the use of "we" as signaling the collective approach used consistently at the autonomous school is visible in the following two fieldnote excerpts.

> *After several promoters asked why we weren't completing all the questions on the "survey" I had provided, I explained that a couple of the questions were actually repetitious. One of the promoters responded by saying, "We prefer to be complete.* (Fieldnote 7-16-03)

> *During a conversation with a student as we watched a basketball game, I offered him a stick of gum. He asked me how much the pack cost and how many sticks were in a pack. He immediately figured out the cost per stick. When I told him I was impressed with his mental mathematics, he*

looked at me and said, " We need to know mathematics. We are campesinos and we don't want to get robbed (Fieldnote 8-13-01).

What is interesting to note in these two fieldnote excerpts is the use of the collective "we" taking place in formal and less structured interactions. The first interaction took place with promoters in a workshop and the second in an informal conversation with a student as we both watched a basketball game. This would seem to indicate a pervasive collective cultural approach on the part of Mayan members of this school community.

Another aspect of Mayan ways of knowing is the importance given to ancestral knowledge. Adrian asserts, "*Every people has its roots and must defend them. The Mayans observed the stars without great lenses. They could tell the cycles. This education of ours was destroyed*" (see Table 6.3). His words address both the obligation to reclaim lost knowledges due to colonialism, an articulated goal of the school, and the desire to strengthen Mayan identity. This perspective is supported by a quote from Alex (a student analyzed as a "tracer unit" in Chapter Five) in a conversation about the ancient ruins of Palenque in August 2001. "*Somos descendientes de los antiguos Mayas. Ellos tuvieron conocimientos extraordinarios y pudieron calcular muchas cosas*

de una manera muy avanzada. Queremos seguir sus pasos porque también nosotros somos Mayas." Translated it reads, "*We are descendents of the ancient Maya. They had extraordinary knowledge and could calculate many things in an advanced way. We want to follow in their footsteps because we're also Mayas.*"

Additionally, when Adrian says, "*our culture taught us to think of those at the bottom*, " the experiential basis of Mayan ways of knowing comes into play. Living in a marginalized Mayan culture can lead to a broader consciousness of others who have been excluded from mainstream society.

A salient point made by Adrian in the interview on 9-6-04 in Table 6.3 is the following. "*Here, the content of our education is under the orientation of elders who know how we were educated before.*" This statement touches many aspects of Mayan ways of knowing. Respect for elders, for ancestral knowledge and how it is "oriented", speaks to a learning environment reflective of Mayan ways of knowing. Strengthening knowledge and use of the mother tongue *Tzotzil,* as well as working in a holistic manner that reminds humans that we are just one part of a natural order is also

contained within this comment. These components of Mayan ways of knowing are evident in this one remark by Adrian, supported by many observations over four years that surfaced similar patterns.

One of the key areas of contrast Adrian is raising for hearers is the impact of differences between autonomous schools and state government schools, as can be seen in the table on Adrian's oral text. Adrian goes on in the same paragraph to say, "*In the autonomous schools, we are trying to retrieve the historic values of our ancestors. On the contrary, in State schools, we are not allowed to see our own reality, indigenous teachers are made to feel embarrassed to speak their language and to wear traditional clothing*." This situation captured by Adrian of the government educational system contrasts with the process at the autonomous school.

What Adrian's comment makes visible is what the autonomous schools offer, which my ethnographic study at this Mayan school corroborated. What one sees at the autonomous school are women promoters and students in brightly colored hand-woven blouses and traditional skirts, with all members of the educational community communicating in *Tzotzil* in formal and less

formal settings. In addition to capturing knowledges that have been lost, which is where the emergence of Mayan ethnomathematics fits, one priority area to be reclaimed is the "values of ancestors". Ancestor values are viewed as a key building block for, and central to, the areas represented in the taxonomy in Table 6.1, like respect for nature, a holistic perspective rooted in collective experiences, constructing knowledges in a time and rhythm that has its own pace building collective memory inclusive of women, and a strong Mayan identity .

The role of ancestor values for Mayan communities is further confirmed and elaborated in the following excerpt of a document I collected and translated away from the site. The perspective offered here serves to triangulate previous comments made by Adrian as well as the analysis of my ethnographic study at the school.

> *Isabel Marcotegui Angulo is a philosopher and researcher at the UPN or National Pedagogic University in Mexico. She is a specialist in the study of values-based education. She said the following in a recent interview. "Before, morals came from how people lived in nature and the response of individuals to the collective. People both cared for and were part of nature." Angulo further explained that there is a need to get back to this in indigenous communities: preserving myths, rituals, language and traditions. "In current education programs, outside of the autonomous ones, values have been lost because they are not based in myths and rituals.*

> *These are messages that go to the heart, not to the head" she added* (article in *La Jornada* 11-10-03).

Angulo's research from outside the Mayan community, analyzing the link between values from before or ancestor values and morals in education, like Adrian's statements within the community, contrasts what is lacking in government schools with the positive impact of knowledges being retrieved by autonomous schools. Her work shows that knowledge has been lost, when cultural practices involved in carrying on oral collective memory through myths, stories and rituals does provide powerful examples of teachings and values of ancestors are removed. This research supports the need to reclaim what has been lost, which is a central goal of autonomous education.

The triangulation of these excerpts of a published interview of research by Angulo and a speech given by Adrian, the head of the education committee (see Table 6.3) provided convergent evidence of how Mayan knowledge is developed, promoted and practiced. Set against observations over four years and the emergence of indigenous ways of knowing in our collaborative dialogue of developing Mayan ethnomathematics, Mayan ways of knowing did indeed become visible.

Conclusion to Section Two

This section, whose goal was to explore how the autonomous school's version of liberatory pedagogy was rooted in indigenous ways of knowing, utilized intercultural dialogue and mutual conscientization. This approach to our interactions and joint growth created fertile ground for my participation over time and a window into Mayan ways of knowing. In Part 1, the contrast of autonomous education with official education made goals of the school visible and supported an interpretation of Freirean principles in this context. The analysis was further developed through a textual and intertextual examination of excerpts of Adrian's oral texts. In Part 2, the relationship between autonomous education and Mayan ways of knowing was explored, principally through textual analysis of additional excerpts of Adrian's speech and interview. An interpretation of selected pieces of text from a key leader of the autonomous school helped to provide an overview of autonomous education, liberatory pedagogy and Mayan ways of constructing knowledge.

Conclusion

Analysis of data in this chapter looked at some of the same data sources as the previous chapter yet from a different angle.

The purpose here was to look at Mayan ethnomathematics workshops over four years, fieldnote observations, and translations of a speech and interview with the head of the Education Committee of the autonomous school, in order to see autonomous education's version of a liberatory pedagogy and Mayan ways of knowing. Shifting lenses enabled us to see contributions of autonomous education in opening up a liberatory process, engaging a process of conscientization and expressing a Maya-centered knowledge.

The next chapter will present the conclusion of the dissertation. It looks at issues addressed by my collaborative teaching project and ethnographic study, core findings therein, and how it informs theory, practice and future research.

CHAPTER SEVEN: CONCLUSION

> *" So there you have a Mayan conch. A spiral with no beginning or end. Where does a conch shell begin or end? At its inner-most point or its outermost point? Does a conch shell wind in or out?"*
>
> -Subcomandante Marcos, 2001

The purpose of this concluding chapter of the dissertation is to review the ground covered thus far in my four-year collaborative teaching ethnographic at a Mayan autonomous school in Chiapas, Mexico. The conclusion is divided into three sections. The first section looks at what my study addressed. The second section presents core findings from the collaborative teaching study. The third section explores how my project-study informs theory, practice and future research.

Section One: Issues Addressed by Study

A number of issues have arisen during the course of this collaborative teaching ethnographic study that need to be addressed. These include: Developing an ethnomathematics perspective in a marginalized international indigenous community; engaging in transformative research methodologies in this context; creating an emergent perspective of ethnography; seeing

autonomous education as liberatory education; and recognizing Mayan ways of knowing in a Highland community of Chiapas.

Part One: Ethnomathematics Perspective

My four-year collaborative teaching ethnographic study at a Mayan autonomous school in Chiapas is built around the construction of a Mayan ethnomathematics perspective and practice. This process hinged on developing trust, engaging in a process of intercultural dialogue and mutual conscientization, in order to take the steps toward constructing a perspective of Mayan ethnomathematics in a collective fashion. While the autonomous school's stated goals are "reclaiming culture, language, and resources" (Adrian speech, 2001), the field of mathematics was publicly articulated in a school-wide meeting (8-11-01) as being the same everywhere (i.e. universal) or "2X2=2X2 no matter what" (FN 8-11-01). This view of mathematics as universal also was apparent in the school's math curriculum and in math classes that I observed several times in 2002 and 2003, which I am not at liberty to quote for reasons of the school's security. Even though this view did not represent a full panorama of opinion at the school on mathematics

(see Alex in Tracer Unit Table 5.5 in Chapter 5), it presented real challenges to what lay at the heart of a cultural perspective on mathematics.

What came to be understood through the course of this study and its re-presentation in the dissertation is that this Mayan community in Chiapas is indeed a marginalized culture which was ravaged first by Spanish colonialism and then again by Mexican Castilian colonialism. Consequently, the community was cut off from critical ancestral knowledges of ancient Mayan mathematics. This culturally based way of approaching mathematics is rooted in a very advanced system of astronomy and calendrics. Part of constructing an ethnomathematics perspective involved exposure to non-European mathematics practices internationally. Locating Mayan mathematics within a broader international movement, which began formally in our Agriculture and Mayan math workshop in July 2002, encouraged the reclaiming of this ancient system. Ancient Mayan mathematics, acknowledged by many scholars to be one of the most advanced and innovative of its time (Closs, 1997; Contreras, 1995; De Vos, 2001; León-Portilla, 1988; Ruz, 1993; Sharer, 1998) needed to be made available to this Mayan educational community. The result was that Mayan promoters and

students had sufficient time and resources to collectively process the concepts and practices of Mayan ethnomathematics, to decide whether it expressed a worldview they could adopt (see list of resources in Appendix B).

As made abundantly clear in Gerdes' work with indigenous Mozambicans (Gerdes, 1985, 1988), a process of "unfreezing mathematics frozen by colonialism" (ibid) is neither simple nor linear. There are many challenges to confront in the course of reclaiming traditional knowledges that has been devalued for hundreds of years. As a self-designated "superior" colonial power, Spain and later Spanish descendents ruling Mexico relied in part on a dominance based on hegemonic control of knowledge. In contrast, developing a self-confidence about and celebration of traditional knowledges held by marginalized cultures requires a long-term commitment to reclaiming culturally based ways of knowing. Given the pervasive effects of colonialism, it is not surprising that the adoption of Mayan ethnomathematics at the autonomous school in Chiapas took four years.

Part Two: Transformative Research Methodologies

This collaborative teaching and ethnographic study engages important questions currently being raised by indigenous and non-indigenous scholars about research methodologies in indigenous communities internationally and in the US (Apffel-Marglin, 1998, 2004; Battiste, 2002; Goulet, 1994; Grillo, 1998; Hermes, 1998; Kawagly & Barnhardt, 2005; McKay, 1999; Smith, 1999). Charting a course divergent from solely Western-based approaches to research, an articulate group of scholars is arguing that fundamental changes are necessary in conception and practice of work within indigenous communities. This is relevant for all indigenous communities if research is to respond to locally based needs and the cultural norms of those communities.

The transformative methodologies generated and practiced in our collaborative teaching project over four years developed in response to a situated context that corresponds to the positions articulated by indigenous scholars cited above. To generate methods that were respectful of Mayan community norms, including a strong position against traditional research as defined

by the educational leadership of their autonomous education experiment, I had to find ways to contribute to their educational goals while doing ethnographic research in more subtle ways. Over time, once a *confianza* or trust was more firmly rooted, I was able to discuss writing up four years of our experiences with ethnomathematics workshops for purposes of my dissertation. While this agreement was verbally made, there was also an unspoken agreement to *not* write about the full picture of what I had access to at the school during that time.

Finding methodologies that adapted ways of doing ethnographic research to fit locally defined needs had to accompany collaborative teaching with promoters at the school in order to maintain access at this site. It was important that this study be representative of a new wave of research in indigenous communities that is more responsive to local needs and mindful of reciprocity. It is an approach that changes some of the key assumptions behind "researcher-researched" relationships, in a way that reflects the greater power being exercised by the communities themselves.

Part Three: Evolving View of Ethnography

As demonstrated in the dissertation, my view of ethnography evolved over time in the course of this collaborative teaching ethnographic study. To be sure, theoretical and practical principles of ethnography were utilized throughout, even if enacted in less visible ways. These principles and practices included participatory observation, extensive fieldnotes, and methodical construction of cultural knowledge. The adaptations in my ethnographic approach were prompted by unfolding understandings of doing research in ways that were tacitly acceptable to the educational leadership on site. My approach to ethnography was rooted in a commitment to equity and a desire to address asymmetries of power that tend to accompany North-South relationships. (see Chapter Two). Consciousness of and respect for the leadership of the Mayan autonomous community was central to an implementation of equity in this context.

It is important to acknowledge that many ethnographic studies in indigenous communities, both internationally and within US borders, have been carried out in principled, ethical ways that respect the communities in which research was done (see Chapter

Two). In my case there were two critical realizations: One is that researchers ("*investigadoras*") whose exclusive goals are to "study" indigenous people, were viewed at the Mayan school site in negative terms and not allowed access to the site to "study" the school. Second, I came to see that this Mayan educational site is similar to others critiqued by indigenous and non-indigenous, in which adaptations were needed to research based on non-Western approaches to knowledge. In responding to these two important points, this collaborative teaching ethnographic study addressed an indigenous-centered paradigm of research.

In short, what ethnography became in this Mayan autonomous school context reflected the priorities and contexts set by the school community. For me, as teacher and ethnographer, it offered profound and challenging opportunities to change and learn. This could not have happened without an ongoing process of mutual conscientization and intercultural dialogue.

Part Four: Autonomous Education as Liberatory Education

My collaborative teaching and ethnographic study explored issues raised by autonomous education expressed as a form of

liberatory education. The study looked at why autonomous education was a response to the Mexican colonial context by comparing goals of government schools to those of autonomous schools in Chapter Six. The study also demonstrated similarities between principles of autonomous education and that of liberatory education espoused by Paulo Freire (1973, 1985). My own pedagogical approach at the school was consciously based on the theory and praxis of Paulo Freire, and a number of pedagogical frameworks of the autonomous education community were similar even if not articulated in Freirean terms. (see Chapter Six)

My framework, then, sought to place autonomous education within contexts of liberatory pedagogy, as it is rooted in parallel educational experiences of developing countries in Latin America and the Third World (Blum, 2001; Cavalcanti, 1996; O'Cadiz & Torres, 1994; Souza Lima, 1995; Weiss, 1993). My study also sought to explain the rationale for autonomous education within a resistance movement of Mayan communities who have developed autonomous structures as a way to counter Mexican colonial hegemony and reassert their construction of Mayan identities and culture.

Part Five: Mayan Ways of Knowing

Mayan ways of knowing became evident during the course of our collaborative teaching project in developing a Mayan ethnomathematics perspective and practice. Recognizing what constitutes Mayan knowledge construction became an important part of what this study needed to address (see Taxonomy Table 6.1 in Chapter Six).

There were two steps involved in coming to appreciate Mayan ways of knowing. One was coming to understand why indigenous ways of knowing have been "invisible within contexts of Eurocentric knowledge" (Battiste, 2002, p.4). The second step required looking at other indigenous contexts, in which local knowledges have become a priority. In acquiring a broader view of the origins and potential responses to common problems facing indigenous communities, I also gained a heightened appreciation of Mayan ways of knowing.

Finally, it was important to find threads of agreement among various indigenous approaches to revitalizing traditional knowledges. As in many indigenous cultures, Mayan ways of knowing are characterized by experiential, observational learning, holistic perspectives, the centrality of ancestral teachings and the

importance of original languages (see Taxonomy Table 6.1 in Chapter Six). Articulation and affirmation of indigenous ways of knowing provides a constructive counterpoint to the damage caused by over 500 years of colonial destruction of indigenous communities and their epistemological roots.

Section Two: Core Findings

This section on core findings from the study and dissertation process flows directly out of the previous section on what the study addressed. Issues addressed by my collaborative teaching ethnographic study substantiated the findings that arose through that process.

The findings are grouped into four areas. The first area concerns changes in ethnographic research approaches as a consequence of transformative methodologies. The second area is what came to be understood as mutual conscientization and intercultural dialogue. The third group concerns what gaining a Mayan ethnomathematics perspective meant for the school. Fourth and last is the need to place at the center of one's work respect for indigenous ways of knowing; which in my case also included

respect for autonomous Mayan leadership.

Part One: An Evolving Sense of Ethnographic Research

A key finding of my collaborative teaching ethnographic study is that an approach to ethnography is subject to change as methodologies are restructured in response to the specific political, cultural and historical context of work. The participants of the education community of the autonomous Mayan school in Chiapas defined what "research" would look like, mostly in unspoken ways. The research emerged from a process of collaborative teaching, as our priorities were not research oriented. Over time, my role included being a teacher, a consultant as defined by the school, a resource provider and a less visible ethnographer.

As is explained in the previous section, there were fundamental aspects of an ethnographic approach I employed throughout the four-year project, even if this was less apparent to the education community on a day-to-day basis. These approaches included doing participatory observation, careful recording of fieldwork through fieldnotes and journal notes, triangulating data, and generating conversational interviews with key individuals who

were not informants in the traditional sense. Additionally, approaches included making hand written records of group presentations in workshops over four years, finding patterns in the social construction of cultural knowledge, and capturing a reiterative-reflexive path of ethnographic cycles (Green, Dixon & Zaharlick, 2001). Over time, I developed methodologies particular to the site, and even though my approach changed to fit the need, it nevertheless rested on a firm foundation of ethnographic practices.

The norms and expectations of this autonomous Mayan education community called for creativity in developing methodologies that would not be identified as "typical researcher" behaviors. From the very beginning of my access to this site, in doing a workshop entitled, "Paulo Freire and Critical Mathematics" In July of 2000, my approach focused on what we could accomplish together rather than on doing ethnographic research. My use of dialogic, intercultural workshops was designed to broaden and deepen possible cultural approaches to mathematics important to the autonomous school regardless of any research that might accompany it.

In the second year (August, 2001), I urged the school to implement a pre-planned workshop on ethnography, as I was convinced that the school should make use of ethnographic methods to evaluate their own process. In refusing to go ahead with the three-week ethnography workshop and changing it to one day, the school leadership made it clear that the work of "*Investigadoras*" (Adrian comment to Paul, 8-01) needed to have boundaries (see Chapter Four). Even so, I was able to get back on track within the parameters set by the school leadership because of practices established in the workshop of July 2000 and a widespread recognition that my commitment was truly to help the school. Having established a strong foundation the first year on site gave me some room to meet these difficulties and accept the school's decision not to have a three-week ethnography workshop. I describe this in the dissertation as experiencing a frame clash (Green, 1983). Fortunately, these clashes led to my acceptance and greater appreciation of autonomous education. This experience is what Agar would call a "rich point" (Agar, 1994). Reframing the frame clash into rich points of understanding grew out of communications with others off site, including my advisor at UCSB and a committee member and collaborative partner who resides in

Argentina. This help was instrumental in my being able to refocus priorities (see Chapter Four).

This illustrative case of what happened the second year on site, in August of 2001, is presented here to demonstrate three things. First, it shows that the school's leadership was clear in how they saw my ongoing roles and what was *not* acceptable in my researcher role, even if less visible. Second, this experience indicated that I needed to refocus my position as a collaborative teacher working with the promoters on mathematics and Mayan ethnomathematics. Third, this frame clash demonstrated that my research needed to happen within the context of being a collaborative teacher working with promoters at the autonomous school.

The challenge of adapting research methods within the particular restrictions I encountered at the school meant building upon innovative research approaches I had already begun to establish in July 2000. This meant writing fieldnotes away from where interactions took place and relying upon memory to recall important points from conversational interviews that were not appropriate to record. I noted important transitions in our workshops and would write these observations at a later time. In general, I

observed and later recorded as fieldnotes and journal notes a variety of processes at the school in order to provide ample evidence for subsequent analysis. These methods were developed partially in response to a tight security situation at the school due to an ongoing military and paramilitary "low intensity war" (Muñoz Ramirez, 2003; Nash, 2001; Stephen, 2002), Careful methods were also crafted in response to a Mayan indigenous community who did *not* want their educational experiment "studied" in traditional ways until they felt ready for such scrutiny. They would possibly be ready to agree to such research once they could define how they wanted it done and perhaps carried out by members of the school community.

And so I discovered that becoming an ethnographic learner in this context took on very specific meanings. Particularly crucial to this process was respect for a Mayan indigenous path of autonomous education in which research was not defined in a positive light by the educational leadership. Being able to develop a long-term collaborative teaching project together meant being conscious of these boundaries at all times. By managing to stay focused on our collaborative teaching project and building enough

confianza or trust, I eventually gained permission to write up our Mayan ethnomathematics work for academic purposes.

Part Two: Mutual Conscientization and Intercultural Dialogue

In addition to the first core finding of how transformative methodologies changed my ethnographic research, a second central finding of this collaborative teaching ethnographic study is that a process of mutual conscientization and intercultural dialogue was needed for us to grow together over time. Mutual conscientization and intercultural dialogue were both defined in Chapter Two to explain how they were used in this dissertation and to acknowledge their centrality to the process. I go on to explain the evolution of each concept here.

In the early stages of the project, I understood my own need for conscientization, as defined by Paulo Freire (1973; 1985, 1998), as theoretical and practical changes in consciousness tied to action, within a dialogic approach to teaching. I had used these approaches in working with fifth grade Latino/a students during ten years of teaching bilingual fifth grade classes in Santa Barbara, California. As the project developed and my own understandings of

it grew, I became aware that the process of conscientization was mutual: It depended on how the lens was shifted toward myself, Mayan participants or towards our interactions together. There was indeed a process of growth and change taking place as promoters or autonomous "teachers" developed a Mayan ethnomathematics perspective. This perspective in turn involved a heightened awareness of the value in cultural ways of seeing mathematics. The process of conscientization led promoters to re-examine prior views of mathematics and open up to adopting a view of Mayan ethnomathematics (as documented in Chapter Five). A mutual conscientization also characterized our workshop interactions, and this enabled us to gain greater awareness of each other's strengths and ways of knowing.

As the project progressed, I was exposed to Latin American studies which use the term "intercultural" to explain a new standard for cross-cultural communication (Apffel-Marglin, 1998; Blum, 2000; Heras Monner Sans, 2004; Jimenez, 2001; Monsoyi & Gonzalez, 1975 as cited in Jimenez, 2001; Romo, 2004). Rockwell writes about interculturalism both as a concept and practice in the Mexican context, where she is based, as well as internationally (Rockwell, 2002). These theoretical and practical approaches

mirrored my experiences in the collaborative work in Chiapas and for this reason the term "intercultural" became a compelling way to describe our dialogue.

An important understanding of the concept of dialogue as used in the dissertation is dialogue as interactional communication or "mutual reflections" within speech communication (Bakhtin, 1986). Language was frequently looked at in its social contexts, which is in line with aspects of sociolinguistics based on the work of Gumperz (1986). At times in this study, as audio and video recordings were not an option, I was able to get beyond the literal meanings of language by relying on "inferential interpretations" (Gumperz, 1977, p.23). Many interpretations of both spoken and unspoken exchanges on site were inferred due to less direct cultural patterns of communication. It must also be remembered that Spanish was the second language for all members of the Mayan educational community. When it came to group work in the workshops, participants relied on their first language, which is *Tzotzil.* This further complicated the language picture for me while also enriching it. Hearing *Tzotzil* and seeing the ways it was used by promoters and students at the school to process their thinking and collectively decide on what they wanted to communicate in

Spanish enhanced my appreciation of its significance for members of the Mayan educational community.

Oral texts that I captured in written form included slices of talk, fieldnotes and hand-written documentation of workshops were initially analyzed for this dissertation (see Chapter Three). Subsequently, intertextual analysis "highlighted the role of texts in making history" (Fairclough, 1992, p.206) by seeing the role of a variety of texts in relation to each other, what they meant for Mayan promoters and students and for myself over four years. This intertextual analysis was valuable in constructing an interpretation of language exchanges framed within a wider context. This wider context involved looking at what was said (or not said) in an attempt to capture meanings. Dialogue, after all, involves words exchanged through interactions as well as simultaneously trying to read the context of those exchanges. This type of analysis was done with excerpts of language even though audio and video recordings of such events were not feasible.

Repeatedly, this research affirmed the importance of mutual conscientization and intercultural dialogue. These were not "tools" through which our relationships improved but a conceptual and

practical approach to a dynamic situation, which called for innovative ways to approach complex situations in order to advance our work together.

Part Three: Developing a Mayan Ethnomathematics Perspective

In addition to an evolving sense of ethnography and the role of mutual conscientization and intercultural dialogue, a third core finding of this study, which permeated the collaborative teaching efforts at the school, was the development of a Mayan ethnomathematics perspective. This finding led to two questions: First, why an ethnomathematics perspective was not adopted at the autonomous school before this project? And second, what was needed in order for this perspective to be taken up by the education community.

Why Mayan Ethnomathematics Was Not Part Of The Autonomous School

When I initially came to the school in July 2000, I was surprised to discover that the resources I brought for the first workshop, which included basics of a rationale and operations of ancient Mayan mathematics, was not already on the agenda of the school. There are several reasons why a Mayan ethnomathematics

perspective was not part of the autonomous school's curriculum. I began to understand that oral history transmitted over many generations did not go back far enough to capture the ancient Mayan system. Written evidence of ancient Mayan systems had been almost completely destroyed by the Spanish conquest and deemed irrelevant in Mexican government schools. Resources, like books and articles about the ancient Mayan mathematics system were absent from the school library. Elders, who might have contributed their knowledges to help piece together what happened to this system over time, were not available to come to the school for a variety of reasons. Thus, it became my task to provide resources (see Appendix B) and a conceptual perspective on both the ancient practices of Mayan mathematics and daily practices in the communities. In short, I helped to co-construct an ethnomathematics approach in this setting.

Over time, I began to understand that there was an inconsistency within the school itself toward Mayan mathematics. This is discussed in Chapter Five, as the "official line" of an evaluation workshop in August of 2001 is contrasted with the perspective of a student named Alex. Alex was enthusiastic about learning the ancient Mayan system as part of building his own and

a collective Mayan identity. Although students like Alex articulated a perspective more consistent with ethnomathematics, a position articulated by one of the head promoters during a school-wide evaluation session in August 2001 was that "2X2=2X2 wherever you are" (FN 8-11-01). I interpreted the comment about "2X2=2X2" to be another way of saying mathematics is a "universal language." This interpretation was substantiated by observations of several mathematics classes in 2002 and 2003 as well as by the mathematics curriculum of the school. I do not have permission of the school to detail this evidence any further, as I mentioned earlier.

The reasons for not having a Mayan ethnomathematics perspective and practice were multiple and complex. These included historical factors such as Spanish colonialism as well as the impact of modern-day colonialism implicit in government beliefs and practices in Mexican state schools that teach European mathematics as "universal" (D'Ambrosio, 1988; Bishop, 1988; Gerdes, 1988; Powell & Frankenstein, 1997). I heard many reports from students and promoters over four years critical of government schools for "leaving out" the entire history of Mayan civilization. Commonly the beginning of Mexican history is marked with the Conquest. These were some of the challenges facing promoters

and others in the school community in asserting their Mayan identity that I needed to acknowledge as a collaborative teacher and ethnographic researcher at the school.

What Was Needed For This Perspective To Be Adopted

The second part of this section looks at what was needed for a Mayan ethnomathematics perspective to be adopted by the autonomous school. This is discussed in greater depth in Chapter Five where the process is analyzed over time. Adopting Mayan ethnomathematics was made easier by the fact that the stated goals of the school were to reclaim "culture, language and resources" (Adrian speech, 8-10-01). I believe that the goals of the school had not yet been applied to the area of mathematics, but later helped to guide the process of promoters and students taking up a Mayan ethnomathematics perspective once that view was understood.

Several factors supported the process of developing a Mayan ethnomathematics perspective. One was the budding interest of promoters that was demonstrated in written evaluations of the first year workshop in July 2000 (see Chapter Five and Appendix C). Second was my commitment to teaching in a manner

respectful of Mayan culture, utilizing a dialogic approach (Freire, 1970, 1985) and helping to support a mutual conscientization process in our work. Workshops were constructed so that all voices were heard. This meant there was no "expert" on the subject, and collectively based learning consistently took place.

Adoption of an ethnomathematics perspective was also made possible by my growing understandings and appreciation of Mayan ways of knowing. In this sense, the "time and rhythm" (FN Juana, 7-6-03) of workshops reflected promoters and students process and not mine. It became clear that all groups needed to complete work, for example, before any group presentations were made. Not rushing through materials to get to the next part of the agenda meant allowing enough time for promoters and students to experience the concepts and practices, raise questions and at times, simply sit and think.

A fourth factor that aided the adoption of ethnomathematics was that I provided written documentation of our workshops at the end of the session each summer. This meant that promoters could reread documents and make intertextual links for themselves during the year. In addition, I left articles and books for the school to read, while I was not on site (see Appendix B).

The adoption of Mayan ethnomathematics was also made possible by relating it to daily practices in the communities (Abreu, 1995; Brenner, 1998; Gerdes, 1985; Knijik, 1998, 2004). These included practices in agriculture, which is the basis of the Mayan subsistence economy. It also included weaving, which has the distinction of being one of the oldest Mayan traditions carried out principally by women. In this way, ethnomathematics was grounded in everyday experience.

My ability to provide a political and historical perspective on ethnomathematics also struck a chord. The contrast between European mathematics and ways of doing mathematics in marginalized cultures, whose knowledges had been "frozen by colonialism" (Gerdes, 1985, p. 18), was a revelation to promoters. It opened up identification with international counterparts who were inspirational to this Mayan autonomous school.

In summary, understanding both why the autonomous School did not have a Mayan ethnomathematics perspective in July 2000 and what it took for this perspective to be embraced were important findings of this study.

Part Four: Respect for Indigenous Ways of Knowing and Mayan Leadership

A final core finding of this study is that respect for indigenous ways of knowing encouraged teaching partners at this Mayan site to work from their knowledge base. It was crucial that all voices of indigenous members of a group be heard. By communicating through indigenous ways of knowing, an alternative to Eurocentric knowledge could be expressed and acknowledged. My recognition of holistic perspectives, observational collective learning, importance of ancestral knowledge, and the centrality of indigenous languages, all worked to deepen my own understanding of what constituted Mayan ways of knowing (see Taxonomy Table 6.1 in Chapter Six). A Eurocentric view has dominated what counts as knowledge for hundreds of years. And for this reason, it was challenging to me and to Mayan educators to overcome this bias.

Working from an indigenous knowledge base stands in contrast with studies that have been done in anthropology and other fields in which studying the "Other" is a way of objectifying indigenous people. Objectification has led to the skepticism I encountered at this site about "Investigadoras" or researchers. To be sure, progress has been made in this area over the last ten

years. And yet, it is important to remain aware of the indigenous and non-indigenous scholars who critique the history of research in indigenous settings. Too often, a researchers agenda get placed above the interests of those being studied. Too often, indigenous people were "studied" and left without deriving any benefit from the research product (Smith, 1999, p.15) Frequently, research is not rooted in respect for indigenous partners. Being humble and flexible about one's own agenda is often not easy to do when demands for a well-packaged academic product are so high.

Based on my experiences and lessons I learned through the course of this study, however, I am convinced that deep, lasting relationships can be built. But such relationships rest upon a foundation of openness and willingness to change as needed. In this respect, a process of mutual conscientization and intercultural dialogue is essential. With this approach, indigenous ways of knowing, which is similar in many sites throughout the world (Apffel-Marglin 1998, 2004; Battiste, 2002; Goulet, 1994; Grillo, 1998; Hermes, 1998; Kawagly & Barnhardt, 2005; McKay, 1999; Nash, 2001; Simonelli & Earle, 2003; Smith, 1999; Warren, 1998; Weiss, 1993), can be expressed. A commitment to addressing

asymmetrical power relations and challenging a Eurocentric knowledge base is a theme throughout these studies as well (ibid).

The process of helping to make indigenous ways of knowing visible also entailed a respect for Mayan leadership. This was salient at this autonomous education site, given their participation in a wider resistance movement of Mayan peoples throughout Chiapas. While autonomy is uniquely defined at each site in response to community process and goals, it reflects a broader meaning as well. Esteva, writing about autonomy in Chiapas, says, "This notion of autonomy implies recognition of respect for *what the indigenous peoples already possess*" (Esteva, 2001, p. 129, italics in original). As Esteva asserts, autonomy is not something external to be obtained or imposed but rather to be found within traditional patterns of community life. Esteva's words are echoed in a recent communication from one of the autonomous communities. "...Our autonomy comes from our history, our customs, our authorities and systems of justice, from our culture" (Consejo Autónimo, 2004, my translation).

Within an autonomous context, respect for Mayan leadership is key to building relationships over time. By implication, this includes placing one's own agenda within the parameters set by

the leadership. Simonelli and Earle, two anthropologists working in another autonomous community in the *selva* (jungle) of Chiapas, describe their experiences as "becoming part of a social and political experiment" and giving the community their "informed consent" (Simonelli & Earle, 2003, p.88). This insight articulates that alternative power relationships can develop, so that researchers and collaborative teachers accept an inversion of roles within an autonomous structure. Joining an autonomous process means working within an elected leadership structure whose decisions grow out of community based consensus. This is the implication of giving one's "informed consent" (Simonelli & Earle, 2003, p.88).

Summary of Section Two

In this section of the conclusion, core findings from my collaborative teaching ethnographic study were presented. These findings included the importance of an evolving sense of research, a process of mutual conscientization and intercultural dialogue, the need to develop a Mayan ethnomathematics perspective, respect for indigenous ways of knowing and Mayan leadership. As explained in the introduction to Section Two, the findings grew directly out of issues addressed by the study.

Section Three: Informing Theory, Practice and Future Research

In this final section of the conclusion, I present how my ethnographic study based on collaborative teaching informs theory, practice and future research. It is divided into two parts: theory and practice, and future research.

Part One: Theory and Practice

The theoretical aspect of my study will be presented with reference to Zapatista theory as presented by Sergio Lascano (Lascano, 2003), who in turn quotes Subcomandante Marcos of the Zapatistas. For Lascano, the heart of *Zapatismo* rests "not in reflections and theoretical analysis but in our practice" (Lascano, 2003, p.1). He goes on to explain that actions do not grow out of a theoretical perspective alone but in accordance with a sense of responsibility. He distinguishes a guiding sense of practice, however, from pragmatism, which is " a way of saying a practice without theory and without principles" (Lascano, 2003, p.1). This perspective is expanded further by a quote from Subcomandante Marcos of the Zapatistas who says, "Theoretical reflection about

theory is called 'Metatheory'. The Metatheory of the Zapatistas is our practice" (Marcos cited in Lascano, 2003, p.1).

Considering the interrelationship of theory and practice in this light, I discuss theory praxis emerging from my study. *First*, guidelines for practice and recognizing a need for ongoing negotiation in Mayan indigenous communities is rooted in a process of *mutual conscientization and intercultural dialogue*. Both of these concepts have been discussed throughout this dissertation, as they occupied a central place in our collaborative teaching. Mutual conscientization and intercultural dialogue also supported our ability to work through frame clashes (Green, 1983) to get to rich points (Agar, 1994) of intercultural communication. This conceptual and practical framework does not provide a "model" or "formula" for productive ethnographic approaches in working with indigenous communities but rather points to responsive practices generated in engagement with this community.

A *second* conceptual and practical approach was "*developing research that grew out of collaborative teaching* and *consciously supportive practices in the community*. This included providing relevant literature on ancient Mayan mathematics and articles in Spanish on ethnomathematics perspectives from

different parts of the world. It was important to tailor my agenda to the needs of the autonomous educational community. When I tried to implement a three-week ethnography workshop for the school's use in year two, I quickly experienced the need to realign my agenda with that of the autonomous school. I did have the opportunity to give a three-hour workshop on ethnography after the school term ended in August 2001 (see Chapter Four).

A *third* aspect of a conceptual and practical approach was in the form of *innovative approaches to methodologies*. Transformed methodologies were generated in response to a political, cultural, social situation at the Mayan autonomous school, in which I learned to respect norms on multiple levels of interaction. I found this challenging, particularly because so many norms were unspoken yet essential to grasp. After my first workshop in July 2000, my decision was to err on the side of caution, which meant looking for creative solutions to constructing an ethnographic study in this context.

A *fourth* conceptual and practical approach was the understanding over time that *an ethnomathematics perspective can be encouraged but ultimately is up to the specific community to adopt*. Mayan ethnomathematics was adopted successfully as a

material resource because this autonomous Mayan community decided "at their own time and their own rhythm" (FN Juana, 7-6-03) that it fit their needs. Aside from the interactive processes we engaged in our workshops together, the community needed opportunities for its own internal processing before adopting this perspective in year 4 (see Chapter Five).

A *fifth* and final conceptual and practical approach that grew out of my study was *recognizing the importance of Mayan ways of knowing*. These practices became evident through our collaborative work on ethnomathematics, and yet the practices themselves became important to recognize and analyze independently of ethnomathematics. In doing so, links were made to similar practices of knowledge construction in other indigenous communities around the world as I discussed in Chapter Two and Chapter Six. Coming to understand these practices of Mayan knowledge construction was an important part of "reading the world" (Freire & Macedo, 1987) of the Mayan autonomous school. It was very important as well that I understand how supportive spaces were consciously provided by the autonomous education community, making it possible for Mayan ways of knowing to be expressed.

Part Two: Future Research

Looking toward future research possibilities, there is great promise in the process we developed together to support Mayan ethnomathematics as a material resource beneficial to the education community at the autonomous school. While this process was never referred to openly as "research" it did involve ethnographic approaches tailored to the particular context. I believe that future research projects that are geared toward expanding a collective knowledge of Mayan ethnomathematics would follow similar parameters that guided this project. Any changes toward a viable approach as an "*investigadora*" or researcher would only emerge from changes in currently held views about research in the community.

There are certainly opportunities for future collaborative teaching projects in Mayan ethnomathematics at other Mayan autonomous schools in Chiapas. and this would include the possibility of additional ethnographic study. One or two other autonomous communities have already proposed such work to me. Such work would offer an extremely interesting expansion of my original study, making visible contrastive cases of developing

Mayan ethnomathematics at different autonomous sites. The creation of other collaborative teaching ethnographic research sites of Mayan ethnomathematics would enrich my own understandings by providing cross-case comparisons that would in turn inform each community's approach to ethnomathematics. This additional research could also illustrate differences between communities in terms of cultural priorities and resources, as well as variations in autonomous educational practices. In short, such research would demonstrate multiple expressions in Mayan ways of knowing.

This multi-site project would be possible with the development of a series of Mayan ethnomathematics booklets that grew out of this collaborative teaching ethnographic project, with assistance from Dr. Ana Inés Heras and her team in Argentina. These Mayan bilingual (in Spanish and *Tzotzil*) ethnomathematics booklets, developed through a grant I received in the U.S., provide a well-researched and accessible resource for the autonomous school in the Highlands and potentially for other autonomous schools as well.

Finally, there are research and practical applications I learned in this study for school sites in places like California. What

is described in the US context, educators have called "culturally relevant" or "culturally responsive mathematics" (Gutstein, Lipman, Hernandez & Reyes, 1997; Tate, 1995), terms that are used interchangeably with ethnomathematics. This stems from a desire by mathematics educators to encourage ownership of mathematics. Students who have been marginalized by the school system, like many Latino and African American students, could take pride in learning about and identifying with their rich mathematics heritage (Khisty, 1995). As a former fifth grade teacher of Latino/a students for ten years, I saw some of the benefits of bringing culturally relevant mathematics into the classroom. More recently, in teaching a one-day research seminar on ethnomathematics at the University of California Los Angeles (UCLA) in 2002 for undergraduate and graduate Native American students, it became clear that there is an avid interest in investigating cultural roots found and expressed in ethnomathematics. The UCLA students were intrigued with my work in Chiapas, as they found it relevant to their own experiences.

Chapter summary

This final concluding chapter of the dissertation presented three key areas growing out of my four-year collaborative teaching

ethnographic study at a Mayan autonomous school in Chiapas, Mexico. It examined what was addressed in the study, core findings that emerged from the process and ways that my project informs theory, practice and future research.

My hope is that this collaborative teaching and ethnographic study can assist others working in international indigenous settings. Although the analysis and conclusions of this dissertation are specific to this Mayan autonomous educational site, there are important links to other indigenous centered approaches to collective work and principled research. In this way, this study perhaps is part of a growing body of literature that supports indigenous ways of knowing and dreams for the future.

> *"We want a world where all worlds fit and grow…it is a dream that is dreamed awake-that history is born and nurtured from below."*
>
> -Subcomandante Marcos, 2001

References

Abreu, G. (1995). Understanding how children experience the relationship between home and school mathematics. *Mind, Culture and Activity*, 2, 119-142.

Agar, M. (1994). *Language shock: Understanding the culture of conversation*. NY: William Morrow.

Albó, X. (1999). *Hacía unas politicas interculturales y linguisticas para Bolivia* 1, La Paz: MEC/CIPCA

Apffel-Marglin, F. (Ed.). (1998). *The spirit of regeneration: Andean culture confronting Western notions of development.* London: Zed Books.

Apffel-Marglin, F. (2004). Criar juntos mundos vivos y vivicantes: Conversaciones entre lo andino y lo moderno. Balconcillo: Gráfica Bellido.

Bakhtin, M.M. (1986). The problem of speech genres. In C. Emerson & M. Holquist (Eds.), *Speech genres and other late essays* (pp. 60-102). Austin, TX: University of Texas Press.

Battiste, M. (2002). *Indigenous knowledge and pedagogy in First Nations education: A literature review with recommendations.* National Working Group on Education & Minister of Indian Affairs (INAC). Ottawa, ON. Retrieved from http://www.ainc.gc.ca./pr/pub/krw/ikp_e.pdf

Bazylak, D. (2002). Journeys to success: Female aboriginal high school graduates. *Canadian Journal of Native Education,* 26 (2), 134-151.

Berthoff, A.E. (1990). Paulo Freire's liberation pedagogy. *Language Arts,* 67 (4), 362-369.

Bishop, A. (1988). Mathematics education in its cultural context. *Educational Studies in Mathematics,* 19, 179-191.

Bloome, D. & Egan-Robertson, A. (1993). The social construction of intertextuality in classroom reading and writing lessons. *Reading Research Quarterly*, 28 (4), 304-334.

Blum, D. (2001). Teaching about Cuba: The conscientization of a US teacher-researcher. *Qualitative Studies in Education,* 14 (2), 255-273.

Bourdieu, P. (1972). *Outline for a theory of practice*. NY: Cambridge University Press.

Brenner, M.E. (1998). Meaning and money. *Educational Studies in Mathematics*, 36, 123-155.

Calderón, H. (1966). El simbolismo de los números Mayas. In *La Ciencia matemáticas de los Mayas* (pp. 93-116). México DF: Editorial Orion.

Carraher, F., Carraher, D. & Schliemann, A. (1987). Written and oral mathematics. *Journal for Research in Mathematics Education,* 18 (2), 83-97.

Cavalcanti, M. (1996). Collusion, resistance and reflexivity: Indigenous teacher education in Brazil. *Linguistics & Education,* 8, 175-188.

Clifford, J. (1990). Notes on (Field)notes. In R. Sanjek (Ed.), *Fieldnotes: The makings of anthropology* (pp. 47-70). Ithaca: Cornell University Press.

Clifford, J. & Marcus, G.E. (1986). *Writing culture: The poetics and politics of ethnography*. Berkeley, CA: University of California Press.

Collier, G.A. (1975). *Fields of the Tzotzil: The ecological bases of tradition in Highland Chiapas*. Austin, TX: University of Texas Press.

Contreras Garcés, G. (1995). *Pensamiento matemático y astronómico en el México precolombino*. México, DF: Instituto Politecnico Nacional.

Corsaro, W.A. (1981). Entering the child's world: Research strategies for field entry and data collection in a pre-school setting. In J.L. Green & C. Wallat (Eds.), *Ethnography and language in educational settings* (pp. 117-146). Norwood, NJ: Ablex.

D'Ambrosio, U. (1985). Ethnomathematics and its place in the history and pedagogy of mathematics. *For the Learning of Mathematics*, 5 (1), 44-48.

D'Ambrosio, U. (1988). A research program in the history of ideas and cognition. *ISGm Newsletter*, 4 (1), 9-14.

D'Ambrosio, U. (1994). Mathematics, history, ethnomathematics and education: A comprehensive program. *The Math Educator,* 9 (2). Retrieved from http://jwilson.coe.uga.edu/DEPT/TME Issues/v9n2/3dambrosio.html

D'Ambrosio, U. (1997). Where does ethnomathematics stand nowadays? *For the Learning of Mathematics*, 17 (2), 13-17.

De Vos, J. (2001). *Nuestra raíz*. México: Centro de Investigaciones y Estudios Superiores en Antropología Social (CIESAS).

Eglash, R. (2002). A two-way bridge across the digital divide. *Chronicle of Higher Education,* 48. Retrieved from http:// chronicle.com/chronicle/v.48/4841.htm

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

England, N.C. (2002). *Maya linguists, linguistics and the politics of Identity*, (pp.33-45). Austin, TX: Texas Linguistics Forum 45.

Erickson, F. (1986). Qualitative methods in research on teaching. In M. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed.) (pp. 119-161). NY: McMiillan.

Erlandson, D.A., Harris, E.L., Skipper, B.L. & Allen, S.D. (1993). Quality criteria for naturalistic study. In *Doing naturalistic inquiry: A guide to methods.* (pp. 131-162). Newbury Pk., CA: Sage.

Esteva, G. (2001). The meaning and scope of the struggle for autonomy. *Latin American Perspectives*, 117 (28), 120-148.

Evertson, C. & Green, J. (1986). Observation as inquiry and method. In M. Wittrock (Ed.), *The handbook of research on teaching* (3rd ed.), (pp. 162-213). NY: MacMillan.

Fairclough, N. (1989). *Language and power.* UK: Longman.

Fairclough, N. (1990). Discourse and text: Linguistic and intertextual analysis within discourse analysis. *Discourse & Society* 3 (2), 193-21.

Fairclough, N. (1992). Intertextuality. In *Discourse and social change*, (pp. 101-136). UK: Polity Press.

Floriani, A. (1993). Negotiating what counts: Roles and relationships, texts and contexts, content and meaning. *Linguistics & Education*, 5, 241-274.

Franquiz, M. E. (1999). Learning in the transformational space: Struggling with powerful ideas. *Journal of Classroom Interaction,* 34 (2), 30-44.

Freire, P. (1970). *Pedagogy of the oppressed.* NY: Continuum.

Freire, P. (1985). *The politics of education.* MA: Bergin & Garvey.

Freire, P. (1998). Cultural action and conscientization. *Harvard Educational Review,* 68 (4), 499-520.

Freire, P. & Macedo, D. (1987). *Literacy: Reading the word and the world.* MA: Bergin & Garvey.

Gay, J. & Cole, M. (1967). *The new math and an old culture: A study of learning among the Kpelle of Liberia*. NY: Rinehart & Winston.

Geertz, C. (1973). *The interpretation of cultures.* NY: Basic Books.

Gerdes, P. (1985). Conditions and strategies for emancipatory mathematics education in underdeveloped countries. *For The Learning of Mathematics,* 5 (1), 15-34.

Gerdes, P. (1988). On culture, geometrical thinking and mathematics education. *Educational Studies in Mathematics,* 19, 137-162.

Gerdes, P. (1997). Survey of current work in ethnomathematics. In A. B. Powell & M. Frankenstein, *Ethnomathematics: Challenging Eurocentrism in Mathematics Education* (pp. 331-371). Albany, NY: SUNY Press.

Glaser, B. (2004). Naturalist inquiry and grounded theory. Forum: Qualitative Sozialforshung/ Forum: Qualitative Social Research, 5 (1). Retrieved from http://www.qualitative researchnet/fqs-texte/1-04/1-04glaser-e.htm

Goodenough, W. (1971). *Culture, language and society* (1st ed.). MA: Addison & Wesley.

Goodwin, C. & Duranti, A. (Eds. (1992). *Rethinking context: Language as an interactive phenomenon*. UK: Cambridge University Press.

Gossen, G. (1999). *Telling Maya tales: Tzotzil identities in modern Mexico.* NY: Routledge.

Goulet, J.A. (1994). Ways of knowing: Towards a narrative ethnography of experiences among the Dene Tha. *Journal Of Anthropological Research*, 50, 113-139.

Green, J.L. (1983). Research on teaching as a linguistic process: A state of the art. In E. Gordon (Ed.), *Review of Research in Education,* 10, (pp. 151-252). Wash, DC: American Educational Reseach Association.

Green, J.L. & Allexsaht-Snider, M. (1991). Constructing data: Exploring the relationship between theory and practice. In M. J. McGee-Brown (Ed.), *Diversity and design: Studying culture and the individual (*pp. 76-86).

Green, J.L., Dixon, C.N. & Zaharlick, A. (2001). Ethnography as a logic of inquiry. In J. Flood, S.B. Heath & D. Lapp, *Handbook of research and teaching of the language arts*, (pp. 201-224). NJ: LEA.

Green, J.L. & Wallat, C. (1981). Mapping instructional conversations: A sociolinguistic ethnography. In J. Green & C. Wallat (Eds.), *Ethnography and language in educational settings* (pp. 161-195). Norwood, NJ: Ablex.

Grillo, E. (1998). Development or cultural affirmation in the Andes? In F. Apffel-Marglin with PRATEC (Eds.), *The spirit of regeneration: Andean culture confronting Western notions of development* (pp. 124-145). London: Zed Books.

Gumperz, J. (1977). Sociocultural knowledge in conversational inference. In M. Saville-Troike (Ed.), *Linguistics & Anthropology, Georgetown University Round Table on Languages and Linguistics* (pp. 191-211). Wash, DC: Georgetown University Press.

Gumperz, J. (1982). *Discourse strategies.* Cambridge: Cambridge University Press.

Gumperz, J. (1986). Interactive sociolinguistics in the study of schooling. In J. Cook-Gumperz (Ed.), *The social construction of literacy* (pp. 45-68). NY: Cambridge University Press.

Gutstein, E., Lipman, P., Hernandez, P. & Reyes, Rebeca (1997). Culturally relevant mathematics teaching in a Mexican-American context. *Journal for Research in Mathematics Education*, 28 (6), 709-737.

Heras, A.I. (1999). Taking action with family and community members: Critical pedagogy as a framework for educational change. In Z. Cline & J. Necochea (Eds.), *Advances in Confluent Education*, 2, (pp. 73-107). Stanford, CT: JAI Press.

Heras Monneer Sans, A.I. (2002). Acerca de la relaciones Interculturales: Un presente-ausente tenso. *Scripta Ethnológica*, (XXIV), (pp. 149-173).

Heras Monner Sans, A.I. (2003). El rol de faciladores interculturales en la comprensión de la identidad y diversidad. *Revista Andes*, 14, Universidad Nacional de Salta.

Hermes, M. (1998). Research methods as a situated response: Towards a First Nations methodology. *Qualitative Studies In Education*, 11 (1), 155-168.

Hernández, I. (2002). *Proyecto Tlacuache: Desarrollo de una educación matemática regional Mesoamericana.* Oaxaca: Universidad Pedagógica Nacional.

Hornberger, N. (1992). Biliteracy contexts, continua and contrasts: Policy and curriculum for Cambodian and Puerto Rican students in Philadelphia. *Education & Urban Society*, 24 (2), 196-211.

Hughes, I. & Seymour-Rolls, K. (2000). Participatory action research: Getting the job done. *Action Research E-Reports,* 4. Retrieved from http://www.fhs.usyd/arer/004.htm

Jimenez, M.A. (2001). *Wata Muyuy Ciclos de vida en culturas agrocéntricas y tiempos de la escuela: Una aproximación sobre gestión educativa y interculturalidad en un distrito quechua de Bolivia.* Buenos Aires, Argentina: UNESCO.

Joseph, G. (1991). *The crest of the peacock: Non-European roots of mathematics*. Princeton, NJ: Princeton University Press.

Kawagly, A.O. & Barnhardt, R. (2005). Education indigenous to place: Western science meets native reality. *Alaska Native Knowledge Network.* Retrieved from http://www.ankn.uaf.edu/EIP.html

Kemmis, S. & McTaggart, B. (1988). *The action research planner* (3rd ed.). Geelong: Deakin University Press.

Khisty, L.L. (1995). Making inequality: Issues of language and meanings in mathematics learning with Hispanic students. In W.G. Secada, E. Fennema & L. B. Adajian (Eds.), *New directions for equity in mathematics education*, (pp.279-297). Cambridge: Cambridge University Press.

Klein, H. (2001). Education and indigenous autonomy *Boletín Chiapas Al Día*, 262, 1-9.

Knijik, G. (1998). *Ethnomathematics and the Brazilian Landless Peoples education.* Presentation to First International Conference on Ethnomathematics, University of Grenada, Spain. Retrieved from http://www.fiz-karlsruhe.de/fiz/public

Knijik, G. (2004). "Profaning the holiness" of school mathematics: Adult education and oral mathematics in the Brazilian Landless Movement. In *Topic Study group 6 Adult Learning and Lifelong Education*. 10th International Congress on Mathematical Education. Retrieved from http://www.icme-10dk-Programme-TSG-6.

Lara-Alecio, R., Irby, B. & Morales Aldana, L. (1998). A math lesson from Mayan civilization. *Teaching Children Mathematics*, 5 (3), 5-10.

Lascano, S.R. (2003). ¿ Puede ser verde la teoría? Si, siempre y cuando la vida no sea gris. *Revista Rebeldía,* 8, 1-9.

Léon-Portilla, M. (1998). *Time and reality in the thought of the Maya* (2nd ed.). Norman, OK: University of Oklahoma Press.

Lincoln, Y. & Gubba, E. (1985). *Naturalistic inquiry.* Beverly Hills, CA: Sage.

Lipka, J. (1998). Transforming the culture of schools: Yup'ik Eskimo examples. Mahwah, NJ: Erlbaum.

Marcos, S. (2001). *Our word is our weapon.* NY: Seven Stories Press.

Marcos, S. (2004). *Reading a video: Three Shoulders.* Chiapas 95 Listserve.

Marshall, C. & Rossman, G. (1999). *Designing qualitative research* (3rd ed.). Thousand Oaks, CA: Sage.

Matusov, E. (in press). *Bakhtin's debut in educational research: Dialogic pedagogy.* (pp. 1-15)

McKay, M. (1999). *Relating indigenous pedagogy to the writing process.* Retrieved from http://www.sigc.edu/indian%20 studiesindigenousthought/fall99/pedagogy-mckay.htm

McTaggart, R. (1994). Participatory action research: Issues in theory and practice. *Education Action Research* 2 (3), 313-337.

Mohatt, G. (1994). Cultural negotiation and schooling: New idea or clothing for an old idea. *Peabody Journal of Education,* 69 (2), 172-185.

Morales Aldana, L. (1993). Mayan geometry. *ISGEm Newsletter*, 9 (1), 1-5.

Morales Aldana, 2001). Matemática Maya. *Consultoría de Etnomatemáticas.* Guatemala: Ministerio de Educación.

Moschkovich, J. & Brenner, M.E. (2000). Integrating a naturalistic paradigm into research on mathematics and science cognition and learning. In A. Kelly & R. Lesh (Eds.), *Research design in mathematics and science education* (pp. 457-486). Mahwah, NJ: Erlbaum.

Muñoz-Ramirez, G. (2003). *EZLN: 20 y 10, el fuego y la palabra.* México, DF: La Jornada Ediciones.

Nash, J. (2001). *Mayan visions: The quest for autonomy in an age of globalization.* NY: Routledge.

O'Cadiz, M.P. & Torres, C.A. (1994). Literacy, social movements, and class consciousness: Paths from Freire and the Sao Paulo experience. *Anthropology & Education Quarterly,* 25 (3), 208-225.

Pinxton, R. (1997). Applications on the teachings of mathematics and the sciences. In A.B. Powell & M. Frankenstein (Eds.), *Ethnomathematics: Challenging eurocentrism in mathematics education* (pp. 373-401). Albany, NY: SUNY.

Powell, A.B. & Frankenstein, M. (Eds.). (1997). *Ethnomathematics: Challenging eurocentrism in mathematics education.* Albany, NY: SUNY.

Rockwell, E. (1987). *Reflexiones sobre el proceso etnográfico: 1982-1985.* México, DF: DIE.

Rockwell, E. (1999). Occidente, los otros y la construcción de un nuevo espácio público. *Revista Cidob D'Afers Internacionals,* 43-45.

Rockwell, E. (2002). Constructing diversity and civility in the United States and Latin America: Implications for ethnographic educational research. In A.U. Bradley, N. Levinson, S.L. Cade, A. Padamer & A.P. Elvir (Eds.), *Ethnography and education policy across the Americas* (pp. 3-19). CT: Praeger.

Romo, A.D. (2004). Consideraciones prácticas a la educación intercultural urbana desde la experiencia de la escuela Tobalaba. *Revista Digital UMBRAL 2000* (14), 1-12. Retrieved from http://www.reduc.cl

Sanjek, R. (1990). The secret life of fieldnotes. In R. Sanjek (Ed.), *Fieldnotes: The makings of anthropology* (pp. 187-272). NY: Cornell University Press.

Saxe, G. (1988). Candy selling and mathematics learning. *Educational Researcher*, 17 (6), 14-21.

Sharer, R. (1994). Arithmetic, calendrics, astronomy, language and writing. In *The ancient Maya* (pp. 557-624). Stanford, CA: Stanford University Press.

Shor, I. (1990). Liberation education: An interview with Ira Shor. *Language Arts*, 67 (4), 342-352.

Simonelli, J. & Earle, D. (2003). Meeting resistance: Autonomy, development, and "informed permission" in Chiapas, Mexico. *Qualitative Inquiry*, 9 (1), 74-89.

Smith, L.T. (2002). *Decolonizing methodologies: Research and indigenous peoples*. London, UK: Zed Books.

Souza Lima, E. (1995). Culture revisited: Vygotsky's ideas in Brazil. *Anthropology & Education Quarterly*, 26 (4), 443-458.

Souza Lima, E. & Gazzetta, M. (1994). From lay teachers to university students: The path for empowerment through culturally based pedagogical action. *Anthropology & Education Quarterly,* 25 (3), 236-249.

Spradley, J. (1980). *Participant observation*. Orlando, FL: Harcourt.

Spradley, J. & McCurdy, D.W. (1972). *The cultural experience: Ethnography in complex society*. Chicago, IL: Science Research Associates.

Steinhauer, E. (2002). Thoughts on indigenous research *methodology.Canadian Journal of Native Education*, 26 (2), 69-81.

Stephen, L. (2002). *Zapata lives: Histories and cultural politics in Sourthern Mexico.* Berkeley, CA: University of California Press.

Tate, W.F. (1995). Returning to the root: A culturally relelvant approach to mathematics pedagogy. *Theory into Practice*, 34, 166-173.

Verran, H. (2001). *Science and an African logic*. Chicago, IL: University of Chicago Press.

Vogt, E.Z. (1994). *Fieldwork among the Maya: Reflections on the Harvard Chiapas Project*. Albuquerque, NM: University of New Mexico Press.

Vygotsky, L.S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Warren, K. (1992). Transforming memories and histories: The meanings of ethnic resurgence for Mayan Indians. In Alfred Stepan (Ed.), *Americas: New interpretive essays*. NY: Oxford University Press.

Warren, K. (1998). *Indigenous movements and their critics: Pan-Maya activism in Guatemala*. Princeton, NJ: Princeton University Press.

Weinberg, B. (2000). *Homage to Chiapas: The new indigenous struggles in Mexico*. NY: Verso.

Weiss, W. (1993). Gringo....gringita. *Anthropology & Education Quarterly*, 66 (4), 187-196.

Wink, J. (2000). *Critical pedagogy: Notes from the real world.* NY: Addison-Wesley Longmann.

Womack, J. (1999). *Rebellion in Chiapas: An historical reader.* NY: The New Press

Appendix A

Proposal for a Workshop at the Autonomous School in Chiapas, Mexico

2-12-00

My name is Phoebe Hirsch-Dubin and I am a fifth grade bilingual teacher in Santa Barbara, California. I was recently informed of the program at your school and am interested in participating. I have experience from having lived for six years in Nicaragua during the 1980s with construction brigades and working with *campesinos* in the rural areas of the country. I have also been a reporter for a radio station in Los Angeles, which has given me the opportunity to interview many people and cover the conditions of war in Nicaragua.

More recently, I have worked in a collective to produce a weekly radio program here in Santa Barbara called, "Latin American Journal." It addresses the people, cultures and politics of Latin America and the Caribbean. Each week we also cover news of indigenous struggles on the continent.

I have experience as a bilingual teacher of Latino students for over eight years. I have fought, along with others, to keep the bilingual program in California. We lost the battle but continue to work for change in the education system.

The following are some ideas I have for a workshop on mathematics. I believe that mathematics is a key area of critical pedagogy. There is a large reform movement in mathematics that includes work that has been done here at the University in Santa Barbara (UCSB). The goals of this movement include challenging the way mathematics is used to exclude women and people of color from more advanced courses. Teachers and students can see what is possible to understand and achieve in mathematics once one's self-concept is improved. Issues of racism, gender and class are examined by this movement to find how they are conveyed through mathematics. I had the opportunity to participate in two Mathematics Institutes at UCSB based on these concepts. I learned some helpful approaches, changed my own self-definition in relation to mathematics and have worked with my own students using this perspective. It was exciting to see the results.

It would be an honor to contribute to the development of your autonomous Mayan school. I am certain I would learn a lot about the process and about you. I could prepare materials here to present some of these ideas in a workshop and perhaps later we could think more specifically of things it would be helpful to bring. A possible time for me to come is during July or August. I would love to learn about

your school and understand its goals in order to be able to support your project. I hope we will know each other soon.

Sincerely,

Phoebe Hirsch-Dubin

(This letter was originally written in Spanish)

Appendix B

List of Resources Utilized in Chiapas

Articles

Bidwell, J.K. (1967). Mayan arithmetic. *Mathematics Teacher*, 74, 762-778.

Burin, D., Corral, S. & Heras, A.I. (2001). *El dasafio del cambio: Hacia una dirigencia mejor.* Buenos Aires, Agentina: FACEPT.

Calderón, H. (1966). El simbolismo de los números mayas. In *La ciencia matemática de los mayas* (pp.93-124). México, DF: Editorial Orion.

D'Ambrosio, U. (2000). Mathematics, hisotry, ethnomathematics and education: A comprehensive program. *The Mathematics Educator,* 9 (2), 1-4.

Delgado, G.E. & Hernández, E.O. (2001). El orígen del cero. 1-6, Universidad Michoacana de San Nicolas de Hidalgo. URL: http://148.216.84/matemáticas/cero/htm

Diaz, R.P. (2003). The mathematics of nature: The four vertices of the 'Canamayté' *ISGM Newletter* 1(1) 3-12.

Gerdes, P. (1981). Changing mathematics education in Mozambique. *Educational Studies in Mathematics*, 12, 455-477.

Gerdes, P. (1985). Conditions and strategies for emancipatory mathematics in undeveloped countries. *For the Learning of Mathematics* 5(1), 15-20.

Gerdes, P. (1988). A widespread decorative motif and the Pythagorean theorem. *For the Learning of Mathematics*, 8 (1), 35-39.

Gutierrez, L. (1990). Paradigmas cuantitativo y cualitativo en investigación socio-educativa: Proyección y reflexiones, 1-16. URL: http://cidipmar.fundacite.arg.gov.ve/parxiv.htm.

Herbert, L. & Brown, R. (1997). Patterns as tools for algebraic reasoning. *Teaching Children Mathematics*, Focus Issue, 340-348.

Hernández, I.A. (1999). *La numeración mixteca de Nochixtlán*, pp.1-7. Oaxaca: Academia de Matemáticas de la Unidad Oaxaca.

Hernández, I.A. (2001). *Proyecto Tlacuache: Desarrollo de una educación matemática regional mesoamericana*, 1-12, Oaxaca: Universidad de Pedagogica Nacional.

Lara-Alecio, R., Irby, B.J.& Morales Aldana, L. (1998). Mathematics lesson from the Mayan civilization, *Teaching Children Mathematics*, 5, 154-158.

Morales Aldana, L. (1990). *El calendario religioso maya y la aritmética*, 1-4. Guatemala: SIMAC & DIGEBI

Morales Aldana, L. (1990). *El estudio de la matemática maya en Guatemala*,1-5, Guatemala: SIMAC & DIGEBI

NASGEm Newsletter 1 (1), 2003. Entire Newsletter.

O'Connor, J.J. & Robertson, E.F. (2000). *Mayan mathematics.* URL: http://www.history.mcs.st-andrews.ac.uk/history/HistTopics/Mayan_mathematics.html.

Santana, L.D. & Borobia, L.G. (1991). *La investigación etnográfica: Experiencias de su aplicación en el ámbito educativo*, 1-17. URL: http://cidipmar.fundacite.arg.gov.ve/parxiv-x/art-2.htm

Books

Apffel-Marglin, F. (2004). *Criar juntos mundos vivos y vivificantes: Conversaciones entre lo Andino y lo moderno*. Balconcillo, Peru: Gráfica Bellido.

Arguelles, J. (1993). *El factor maya.* México, DF:Circulo Cuadrado.

Ascher, M. & Ascher, R. (1997). *Mathematics of the Incas: Code of the Quipu*. New York: Dover Publicaitons.

Aveni, A.F. (1997). *Skywatchers of ancient Mexico*. Austin, TX: University of Texas Press.

Brennan, M. (1998). *The hidden Maya*. Santa Fe, NM: Bear & Company.

Closs, M. (Ed.). (1986). *Native American mathematics*. Austin, TX: University of Texas Press.

Coe, M.D. (1999*). The Maya*. New York: Thames and Hudson.

Diaz-Bolio, J. (1987). *The geometry of the Maya and their rattlesnake art.* Yucatán, México: Area Maya.

Freidel, D., Schele, L. & Parker, J. (2001). *Maya cosmos: Three thousand years of the shaman's path.* New York: Perennial.

Freire, P. (1986). *Pedagogía del oprimido*. México, DF: Siglo Veintiuno Editores.

Freire, P. (1997). *La educación como práctica de la libertad*. Méxcio, DF: Siglo Veintiuno Editores.

Freire, P. (1999). *Política y educación.* México, DF: Siglo Veintiuno Editores.

Freire, P. (1999). *Pedagogía de la autonomía*. México, DF: Siglo Veintiuno Editores.

Freire, P. (2001). *La importancia de leer y el proceso de liberación*. México, DF: Siglo Veintiuno Editores.

Garcés Contreras, G. (1995). *Pensamiento matemático y astronómico en el México precolombino*. México, DF: Instituto Politecnico Nacional.

Gomez, M.S. (1998). *Creencias de nuestros antepasados*. México, DF: Imprenta Madera.

Huff, S. (1984). *The bio-mathematical basis of the Mayan calendar*. Yucatán, México: Area Maya.

León-Portilla, M. (1988). *Tiempo y realidad en el pensamiento Maya*. México, DF: Universidad Nacional Autónoma de México.

Morales Aldana, L. (1994). *Matemática Maya*. Guatemala: Editorial Gran Aventura.

Powell, A.B. & Frankenstein, M. (Eds.), (1997). *Ethnomathematics: Challenging eurocentrism in mathematics education*. New York: SUNY Press.

Price, T. & Hall, L. (1983). *Agricultural development in the Mexican tropics: Alternatives for the Selva Lacondona of Chiapas*. Ithaca, NY: Cornell University Press.

Appendix C: Promoter Workshop Evaluations July 2000

Interesting & important	Useful with students	How improve	Other comments
1. For my part, the workshop that you shared with us was very important. Because we, as indigenous, barely have a good education. I liked your class a lot. It was very interesting.	1. I can use the things you taught us with my students. What I can use most are the investigations so that we can investigate what the students like.	1. For my part, I have no idea about the question but yes, your presentation was good and I understood the class.	1. Only to thank you for the knowledge you shared with us. You have love for the people. Thanks.
2. For me, the two days I was at the workshop, I saw things that were important. I could not attend all of the classes because of some illnesses that I have.	2. The colors and the dice can be used depending on the theme that we have with the students.	2. For my part, the presentation was good. At this time, I have no criticism for you.	2. No. I only want to thank you for putting in the effort to share your knowledge with us.
3. For me, everything that I saw was important because it helps us a lot in our formation. A few things were difficult but trying hard and questioning about the doubts, makes it possible to learn.	3. I believe the investigation is very important because through it you can obtain a lot of information and enrich our knowledge. Also, the Mayan numbers are important because it is a form of knowing the history of our ancestors and knowing it is an advanced civilization.	3. It seemed very good and I have no further opinion about it.	3. (No comment)
4. For my part, the workshop was good in which you imparted Mayan math. It helped us a lot in our new	4. We can use addition, multiplication and subtraction of the Mayas. We never	4. I believe that to improve the presentation we could have had more practice to improve. I would	4. Everything went well. It was understandable for us and will serve use too.

education to know more about Mayan numbers. I hope it is not the first or the last.	had these types of activities.	like to know about square roots.	
5. I liked everything I saw in the workshop. I hope you return to help us in this school, which is for everyone.	5. The knowledge of Mayan numbers who are our ancestors as indigenous of Chiapas. It is important to share with the students.	5. To have more workshops and more discussion like we had.	5. Thanks for helping us. Even though you are from outside the country, you have the heart to help us. Thanks and come back soon.
6. What we saw in this workshop was important, especially the Mayan numbers and how to do the operations with them.	6. We can use the calculators and the dice.	6. For me, the presentation was good. Also the way you explained was well understood.	6. Only to say that it is hard to understand well the explanations in Spanish.
7. I really liked the Mayan math. I was surprised how much it could advance mathematical thinking. I liked your manner of presentation.	7. Mayan math, investigations, probability activities, autobiography.	7. More time on the investigation. It would be better to have more time and do a simpler question.	7. I enjoyed the workshop.
8. Mayan math, investigations, participation of everyone, math autobiographies.	8. Everything. I'm going to practice Mayan math with my daughter. When I have my class, I'm going to start whatever subject with an autobiography.	8. For more time- a year or more.	8. (No comment)
9. The most interesting part was using calculators and Mayan math. Thanks for helping us and sharing your experience.	9. Proportional calculating and Mayan numeration.	9. I can only give criticisms that are constructive.	9. (No comment)

10. Everything was interesting because you explained well and I like it. We never had Mayan numeration in secondary.	10. Mayan math operations, graphs, calculators and games before starting a theme.	10. Bringing more materials, if it were possible, to have one for each person.	10. No. **NOTE:** Teachers #7 and #8 attended the workshop but are from the US.

Appendix D: Promoter Workshop Evaluations July 2003

Interesting & Important	Use with Students	How Move Forward	Comments
1. For me the most important part of the workshop is Mayan ethnomathematics because it is important to accomplish in our daily life. We saw the solar calendar, the ritual calendar, the codices of the Mayas and how writing began. Moreover Mayan numeration represented by a point, a bar and a shell.	1. We can teach them Mayan math. For example traditional measurements, Tzotzil numeration and Mayan numeration.	1. For me, everything we saw during the ethnomath workshop needs to be carried out by the promoters, students and also Faviana.	1. We need more workshops on ethnomathema-tics and Mayan math so that we can continue learning more of what we don't know. I say thanks for what you've shared and hope you return very soon.
2. The most interesting is learning the truth, we did not know the things we saw in this taller. I hope it's not the last so that we can know more.	2. As promoters it is necessary to teach it to the students so they can understand better what Mayan math is.	2. We promoters can continue investigating in books. Also you can come back to help us with what we don't know to share with the students.	2. For me, I would like another consecutive workshop.
3. What we learned is interesting because we don't know Mayan math. We need to know more because it forms a part of our history and for this reason is important.	3. What we can use is Mayan knowledge to know it better and the questions to see what they know about ethnomathematics.	3. To move ahead with math, the knowledge that we had during the taller helped us a lot. We need to share with the students so that they can have the same knowledge so that we can	3. I want to say that this is to the last time because we need another workshop soon. It should have more ideas about ethnomathema-tics.

4. During the taller with Faviana everything is interesting and important. Some things we've never seen that we need to do and explain.	4. We can use everything with the students because they need to learn it too.	construct Mayan math together. 4. The things that can help us move forward are, for example, Mayan numeration and traditional measurements.	4. My only comment is that we'd like you to help us again. I was pleased with the teaching you shared with us (Faviana).
5. For me it is very important what was shared and learned from you.	5. The Mayan numbers because the students need to learn them and other things.	5. Mayan numbers and other things. Study more about the life of the Mayas.	5. (no comment)
6. This taller is very important because I learned some things about Mayan math. Thanks for teaching us.	6. What I can use is the knowledge of what each student has in their mind and also what they want to study.	6. The ideas that can help me are all the ideas of our ancestors and moreover continue with the ideas of Mayan math.	6. I'm not sure what to say because it's the first day I could attend the workshop.
7. All the themes were important because it helped us understand and know mathematics of the Mayas. Moreover we need to learn Mayan math.	7. What I can use with the students is Mayan math like: the Mayan calendar, and Mayan numbers. Also other themes that we studied about Mayan math I can also share.	7. The classes, the struggle, education, numeration, the explanations, Mayan numbers and the Mayan calendar.	7. I have no comment. Thanks.
8. It is valuable to more about the system of Mayan numeration and ethnomath. With the classes and themes you taught, we learned more and don't have doubts we had before.	8. The promoters must share all the themes of Mayan numeration. What you taught and we shared about Mayan math.	8. Definitively, it has helped us a lot to learn this system of Mayan numeration. We would like more classes in this area of mathematics to know more about the Mayan numeration	8. (no comment)

		system (our ancestors).	
9. For me the most interesting that we saw in this workshop is about the life of our Mayan ancestors because it is important to rescue the ideas and knowledge that they had. It is important for us because it is our ancestry. What we saw in this taller is important to be able to recuperate some of the Mayan ideas.	9. What we can use is everything we saw because it is all-important so that they know some things about our Mayan ancestors. That's why I tell you that we can use everything. Like the Mayan calendar because we need to take it back so that they can know how our ancestors counted the days.	9. Mayan numeration is very related with the mathematics of today. Not because it's equal when it is not seen as important but because it has the same value. It's just done in another way. Clearly we did not get to the bottom of Mayan numeration but it is something for us.	9. I have no other comment than to say that we need to continue investigating Mayan math.
10. This math taller is very important and necessary to know because it is a study we have never seen, like Mayan math among others. I consider that this workshop helps us to reflect and carry out mathematics.	10. The main parts we can share with our students is Mayan numeration or Mayan math.	10. One of the things we can use is Mayan math. All the operations we did helped us to know more about the life of Mayan math.	10. Until this moment, I have no questions. Thanks for the effort of the workshop.
11. Speaking of the Mayan math workshop, it is very interesting and necessary to learn. As education promoters it has much value to be able to use it and teach it to students.	11. We can use with our students Mayan math with the themes of: astronomy, Mayan numeration, the calendars and different types of measurements.	11. We as promoters are very thankful for the workshop and hope it will not be the first nor the last.	11. I would only like to comment that we need more workshops about Mayan mathematics.
12. Mayan numbers are very	12. All the ethnomath, Mayan	12. Numerations, measurements	12. (no comment)

interesting to me because we learned how the ancient Mayans thought. It is very important.	numbers and also how it is used now in the community. In this way, we can we can retake traditional measure-ments like *jchix* for example.	and counting.	
13. Everything we saw in this workshop is important. It is important to learn Mayan numeration and Mayan calendars because our mother tongue is the mother of the Mayan culture.	13. What can be used with the students is mathematics of today and also Mayan math. The students need to have the ideas and knowledge of Mayan numeration, Mayan calendars & traditional measurements.	13. What we saw during the days of the workshop will help us with everything. It was all important.	13. (no comment)
14. Everything in this workshop was important. Ethnomathematics and Mayan numeration are important so we can know a little about how our ancestors wrote.	14. For my part, we can use everything we saw. The students need to know ethnomathematics and Mayan numeration because it makes us equal for them to know it.	14. To move forward with the idea of mathematics, investigate more in the communities, like what we saw of traditional measure- ments. There are others that we don't know because we're young.	14. Only many thanks for teaching and sharing with us what you know!
15. In the taller we had it was important because we almost don't know about Mayan math. Also some of the traditional measurements we don't know.	15. The math that we learned we can share with the students. Traditional measurements are a form of rescuing the culture.	15. What can help us is investigating more and visiting some Mayan cities to gain more knowledge.	15. (no comment)
		16. The	

16. It is impressive what we learned in the taller about the calculations of the Mayan calendars, which is more complete than that of Europe. 17. The most important was the knowledge that our ancestors had. We want to know everything because the knowledge is a wealth. We hope to learn more so that we can share with the students of our school and other places.	16. What we can use a lot are the traditional months because they are being lost now in the communities. 17. For me it is necessary that they know everything because they, like us, are descendants of the ancient Mayans. Therefore it is our obligation and right to know what our ancestors did and if possible, carry it on.	positional value of the numbers and the importance and significance of zero. 17. The most important is the solar and ritual calendar, the Long Count and sources of information. Also operations that possibly we can see more of when you come back to our school.	16. In the next workshop, I want to learn to read the signs of life based in the hieroglyphs of the Mayan calendar. 17. I want to say thanks for having come here again to the corners of our lands. Thanks for your efforts to come and share your knowledge. We hope you return again to continue this work because we really need people in solidarity to help us construct autonomous education.