

**A Case Study of Two Teachers Attempting to Create Active
Mathematics Discourse Communities with Latinos**

BY

CRAIG JOSEPH WILLEY
B.A., Butler University, Indianapolis, 2002
B.S., Butler University, Indianapolis, 2003

THESIS

Submitted as a partial fulfillment of the requirements
for the degree of Doctor of Philosophy in Curriculum and Instruction (Curriculum Studies)
in the Graduate College of the
University of Illinois at Chicago, 2013

Chicago, Illinois

Defense Committee:

Lena Licon Khisty, Chair and Advisor
William Ayers
Danny B. Martin
Aria Razfar
Rochelle Gutierrez, University of Illinois at Urbana-Champaign

This thesis is dedicated to the Dreamers of today, and to all those who have struggled for equity in education in the past.

ACKNOWLEDGEMENTS

I would like to thank my advisor and mentor, Dr. Lena Licon Khisty, for her patience, wisdom, disposition towards teaching, and friendship. To my committee, Dr. Aria Razfar, Dr. Danny Bernard Martin, Dr. Bill Ayers, and Dr. Rochelle Gutierrez, thank you for providing lasting mentorship and investing in my success as a scholar.

I want to thank my CEMELA colleagues at UIC, Eugenia Vomvoridi-Ivanovic, Angela Thompson, Hector Morales, Jr., Higinio Dominguez, Gabriel Viego, Zayoni Torres, Susan Kolian, Dave Segura, Beverly Troiano, and Carlo Lopez Reyna. I extend a special thank you to two unbelievable friends, Carlos LopezLeiva and Alex “Sasha” Radosavlevic. I sincerely appreciate your consultation and willingness to listen. To my extended CEMELA family, thank you for your unceasing support: Jesus Acosta-Iriqui, Maura Varley Gutierrez, Rodrigo Gutierrez, Bill Zahner, Jose Maria Menendez, Marta Civil, and Sylvia Celedon-Pattichis. Also, I extend a special thank you to Rick Kitchen, who initially made this CEMELA experience possible and for serving as an exemplar teacher-scholar. I wish to thank another close collaborator, Kathleen Pitvorec, who I have increasingly come to admire and appreciate over the years.

To my long-time friends, Katie and Ryan Ellis, Whitney and Travis Sealls, Katie and Rob Blair, Lindsey and Justin Voigts, Emily and Adam Ritter, and Matt Schmaling: I thank you for periodically listening to me ramble and refraining from asking me how my dissertation is going. To my family: my Mom and Dad, Marne and Gordon Willey; my sisters, Leah Boulos and Kara Willey; my brother-in-laws, Michael Boulos and Dan Nelson; my sister-in-law, Christie Nelson; my

ACKNOWLEDGEMENTS (continued)

parents-in-law, Cathy and Andy Nelson: I will never be able to name the ways in which you support me and elevate my work.

To my inspiring sons, Graeme and Reid: you help remind me why work like this is important; and, to my wonderful partner, Cara Willey: while I continually test your patience, your unshakable support continues to hold me up.

And, finally, to my two teacher colleagues and friends, Ms. Lenihan and Ms. Hendrix: I thank you for your willingness to share your classrooms and lives with me. Because of your openness, we all have a better understanding of how to support teachers in their quest to be outstanding mathematics teachers with Latinas/os.

CJW

TABLE OF CONTENTS

<u>CHAPTER</u>	<u>PAGE</u>
I. INTRODUCTION	1
A. Background.	1
B. Why Me? Why This Study	2
C. Definition of Terms.....	5
1. Community and Community of Practice	5
2. Monolingual, Bilingual, and Emerging Bilingual.....	7
3. Language.....	9
D. Need for this Research.....	9
1. Perspectives and Initiatives of the	10
2. Latinas/os and Discourse in Mathematics Classrooms.....	12
3. Mathematics Ideologies, Discourse, and Socialization.....	15
E. Latinas/os as a Social Group.....	17
1. Relationship Between Latinas/os and English Language Learners	19
F. Sociopolitical Context Surrounding the Mathematics Education of Latinas/os	20
G. Research Questions	25
II. REVIEW OF RELATED LITERATURE	26
A. Overview.....	26
B. Theoretical Perspectives on Teaching and Learning	27
1. Sociocultural Perspectives	28
a. Mediation	29
b. Spontaneous and Scientific Concepts	29
c. Zone of Proximal Development.....	30
d. Social Practices and Socialization	31
e. Communities of Practice.....	32
C. Mathematics Discourse.....	34
D. Ideologies in Mathematics discourse Communities	36
E. Funds of Knowledge	37
F. Mathematics Socialization Processes	38
G. Language Socialization in the Mathematics Classroom	41
1. Specialized Style of Mathematics Language	42
H. Summary	44
III. METHODOLOGY	47
A. Overview.....	47
B. Research Questions.....	47
C. Why Ethnographic Methods and Comparative Case Study?	47
D. Data Collection and Analysis Processes	49
1. Context of the Study.....	49
2. The School.....	51
3. The Teachers	52
4. The Sociopolitical Context.....	53

TABLE OF CONTENTS (continued)

5.	Data Collection.....	54
a.	Discourse and Dialogue.....	54
b.	Observations.....	56
6.	Data Management.....	57
7.	Data Analysis	57
a.	Grounded Theory	57
b.	Constant Comparative Methodology.....	58
c.	Critical Discourse Analysis.....	59
IV.	FINDINGS.....	61
A.	Overview.....	61
B.	Reiteration of Mathematics discourse Communities	62
C.	Description of Teachers	64
1.	Brief Description of Ms. Lenihan	65
2.	Brief Description of Ms. Hendrix	67
D.	Findings.....	68
1.	Issues and Challenges Surrounding Implementation of MdC's	70
a.	Teachers' (Missing) Appropriation of MdC's.....	70
i.	How do the Teachers Approach the Use and Development of Mathematical discourse?	71
ii.	What is the Relationship Between Mathematics discourse and Learning?	74
iii.	Summary	77
b.	Teachers' Planning Process and Considerations for Latinas/os.....	78
i.	Planning and Ideologies About Latinas/os and Mathematics Learning.....	85
c.	Teachers' Struggle to Model Inclusive Learning Environments.....	91
i.	Troubleshooting Mathematical Exclusion	97
d.	Language Dimensions Influencing the Development of MdC's.....	101
e.	What Constitutes Mathematics Discourse and Its Role in Learning	101
f.	Teachers' Approaches to Facilitating Mathematics Discourse Development	108
i.	Relationship Between Mathematical Discourse and Cognition.....	109
2.	Teachers' Skill Sets and Ideologies Influencing MdC's.....	116
a.	Ideologies Surrounding Teachers' Perceived Role & Struggle to Include	116
b.	Language Ideologies: What Do the Teachers Do With Spanish?	121
i.	Discourse (Big 'D') in the Mathematics Classroom.....	125

TABLE OF CONTENTS (continued)

V.	DISCUSSION & IMPLICATIONS.....	130
A.	Introduction.....	130
B.	What Issues and Challenges Surround the Teachers' Development and Utilization of Mathematics discourse Communities?	131
1.	Planning for Mathematics and Language Development.....	131
2.	Participation, Inclusion, and Access	136
C.	What Linguistic Factors Influence Teachers' Development of Mathematics discourse Communities?	141
1.	What Constitutes Mathematics Discourse and What is Its Role in Learning?	141
D.	What Ideological, Knowledge, and Skill Factors Influence the Teachers' Development of Mathematics discourse Communities?.....	143
1.	Ideologies Mediating Mathematics discourse Communities	144
E.	The Utility of Mathematics Discourse Communities	146
F.	Limitations of This Study	148
G.	Implications and Directions for Future Research	150
H.	Concluding Thoughts.....	151
VI.	CITED LITERATURE	154
VII.	APPENDIX.....	163
VIII.	VITA	166

LIST OF TABLES

<u>TABLE</u>	<u>PAGE</u>
I. FOCI AND CONTENT OF TEACHERS' PLANNING SESSIONS	79

LIST OF ABBREVIATIONS

BLT	Bilingual Lead Teacher
CEMELA	Center for the Mathematics Education of Latinas/os
CHAT	Cultural Historical Activity Theory
ELLs	English Language Learners
MdC's	Mathematics discourse Communities
NAEP	National Assessment of Educational Progress
NCES	National Center for Educational Statistics
NCTM	National Council of Teachers of Mathematics
US	United States
ZPD	Zone of Proximal Development

SUMMARY

This is a qualitative study of two English-dominant mathematics teachers, who I refer to as "monolingual" because they speak only English and do not speak competently or extensively the cultural language of their students. This study explores how these teachers plan, implement, and reflect upon lessons with respect to their bilingual, urban Latina/o students. Ethnographic methods – such as participant observation in classroom activities, formal and informal interviews, regular dialogue, and analysis of artifacts – were used to understand the meaning the teachers attribute to their teaching practices.

Given Latina/o students' unique strengths and needs, this study aims to garner a better sense of how these teachers develop mathematics learning communities – specifically, Mathematics discourse Communities (MdC's) – that emphasize opportunities for students to talk mathematically and work together, in an effort to help shape meaningful mathematical experiences. The need for this study is predicated on the fact that the majority of teachers are White and monolingual, thus precluding them from experiential knowledge of what it means to be Latina/o in school, learn a second language, and develop complex mathematical understandings in a second language. Therefore, a closer examination is warranted of how teachers attempt to create MdC's that underscore mathematics discourse as an integral component to mathematical development.

This study produced three primary findings:

- 1) There are tensions around the teachers' efforts to take up and interrogate the concept of MdC's. Planning sessions rarely take into consideration the unique strengths and needs of emerging bilingual students, yet, at the same time, this planning is driven by particular ideologies about Latinas/os and mathematics learning. Furthermore, a lack of a conceptual framework emphasizing inclusion lead to teacher difficulties including Latina/o students in

mathematical discourses and helping them access the mathematical concepts at hand – especially those students who are developing proficiency in English.

- 2) There is confusion as to what constitutes mathematics discourse and its role in developing mathematical understanding, and how to create discursive structures to support students' development of mathematics discourse. Teachers view mathematics discourse as the repetitive use and overt emphasis of key, technical words commonly associated with mathematics, and incorporated mathematical writing in limited ways.
- 3) The teachers maintain distinct language ideologies and perceptions of Latina/o learners that tacitly influence their design and implementation of MdC's. This leads to uncertainty about what is within or outside of their responsibilities as mathematics teachers of Latina/o students, including supporting students as they take on the additional task of learning English, and specifically, mathematical discourse.

The findings lead to additional questions: How are teachers socialized to think about, build upon the strengths of, and address the needs of Latinas/os? What is it about the two teachers' histories and professional training that leaves them ill-prepared – socially, academically, and otherwise – to directly interact with newcomers, innovate ways to capitalize on students' native language, and intentionally plan for mathematics discourse development? A sociopolitical analysis of this phenomenon is certainly in order.

This kind of examination requires us to look carefully at Latina/o learners' mathematical identity formation over time in relation to the normative ways of doing mathematics they have experienced. In other words, we need to continue to develop the theoretical and analytical construct of Mathematics discourse Communities to allow us to account for micro-interactions between

teacher and students in light of the sociocultural histories of the teachers, as well as the sociopolitical context within which they teach.

I: INTRODUCTION

A. Background

In the U.S., more and more teachers have Latina/o learners in their classrooms. Yet, few are adequately prepared – both academically and socially – to address the unique strengths and needs of this growing population. The unpreparedness of mathematics teachers of Latinas/os is amplified by a cultural and linguistic mismatch; that is, 92.8% of teachers are non-Latina/o and roughly the same percentage are monolingual (NCES, 2008). Therefore, the vast majority of the teacher workforce lacks the experiential knowledge of learning a second language, let alone learning *in* a second language.

At the same time, the one-size-fits-all mathematics curriculum and pedagogies have not been successful in supporting Latinas/os' mathematics learning (Gutierrez, 2002; Pitvorec, Willey, & Khisty, 2011). There is a need to develop a special pedagogy, one that builds on what we already know about supporting student learning, and one that is reflective of Latina/o students' historical experiences with schooling (Valencia, 2002) and mathematics (Varley Gutierrez, Willey, & Khisty, 2011). Before teacher education programs can begin to comprehensively address preparing teachers better to serve this growing and grossly under-served population of U.S. school children, we need to better understand the specific issues monolingual teachers face when creating effective mathematics learning environments for bilingual and emerging bilingual students.

The fact that this void exists led me to develop and conduct a study that investigates how monolingual middle school teachers develop mathematical communities – ones which emphasize the use and development of mathematics discourse – with Latina/o learners, most of whom are learning mathematics in their second language. In this chapter, I discuss the history of personal events leading up to this study, the need for this research in the field of mathematics education, why

Latina/o students inspire this study, the sociopolitical context surrounding the mathematics education of Latinas/os, and a definition of key terms that I use throughout this dissertation. This chapter concludes with an articulation of the specific research questions that guided the collection and analysis of data.

B. Why Me? Why This Study?

This is an interesting place we live in, the United States. As a White American¹, I can virtually pass through life without having significant contact with anyone who looks differently or has notably different life experiences than me. Due to de facto segregation, I can spend my whole life thinking that the way I am and the way I live is *the* way that others should strive for. Since I am happy and successful and my family is what I want it to be, my way of being ought to be – if it is not already – the standard for those less fortunate to achieve. This was my reality growing up and thus the mindset with which I approached teaching Latinas/os in Denver Public Schools.

As White Americans, seldom are we presented opportunities to think critically about how we were able to achieve this lifestyle and status. Rarely are we given or do we look for opportunities to interact with a variety of people who might push us to re-evaluate our values and standards. In a snapshot, this was the frame of mind that emerged as a result of my post-secondary schooling and teaching experiences in Denver Public Schools.

I taught middle school mathematics to Latinas/os – mainly Mexicans, as they self-identify – for four years. Not having traditional or extensive training to be a teacher, I was dangerously left to my own intuition as to what were the best, or most effective, arrangements for Latinas/os to learn. Intuitively, I had suspected that students should be engaged. However, my idea of student engagement was them actively listening to me. I knew that current schooling arrangements had not

¹ I recognize that the term *American* refers to any person residing in the Americas. Here, however, I am referring specifically to those who reside in the United States.

worked well for Latinas/os, but I, like many others, naively assumed that the source of the problem lie in the community and the individuals who make up the community. After all, that is what we are largely fed through the media and dominant public discourse.

I thought I could do better than teachers of the past, because I cared and I had energy – again, I contrasted myself against an image of lethargic, apathetic teachers, not because I had intimate experiences with teachers of this type, but because that is a socially-constructed image of teachers. Through my years of middle school mathematics teaching, I did care a lot, and I did put forth immense amounts of energy. But, underneath, I was still subscribing to the same methods that perpetuated the status quo. I was still transmitting my knowledge, values, language, and ways of being – White, middle class knowledge, values, language, and ways of being – all, I now believe, to the detriment of my Latina/o students. I don't think of myself, my views, or my experiences as exceptional, but rather representative of the White, middle-class social network from which we (middle-class Whites) come.

I don't mean to imply that our ways of being should be conceived as a conscious or deliberate effort to “fix” Latina/o youth or assimilate them to a “better” way of being, though I agree with those who assert that this is the net result of the implementation of dominant educational policies and practices (Gutierrez, 2008; Martin, 2003). Rather, it speaks to the underlying, uncritical notions of what we think are best for Latina/o (or African American) youth (Nieto, 1992). There is a socialization process in schooling that results, one that conveys implicit and explicit messages that devalue Latina/o youth, their communities, and their competencies as learners (Valenzuela, 1999, 2005). The social foundations of education literature is overflowing with examples of the devastating effects of such socialization processes (e.g., Foley, 1990; Olsen, 1997; Valencia, 2002; Valenzuela, 1999; Yosso, 2006).

To think that this process does not happen in mathematics classrooms is a mistake. In the year preceding this study, I worked with two mathematics teachers in a middle school serving mostly Latina/o youth. The experiences I had in their classrooms helped me see more clearly that each teacher has a different way of approaching mathematics instruction to Latina/o children, and these different approaches inevitably invoke different sentiments and affiliations towards mathematics from students. The teachers' respective approaches to mathematics teaching and learning originate in their respective mathematical and life experiences, values, attitudes, and belief systems. In short, they hold particular mathematical ideologies, and their mathematics ideologies manifest in the norms they institute in the mathematics classroom, as well as the mathematical ways of being, ways of thinking, and ways of speaking that they promote daily. These values and norms are conveyed through language, but also nonverbally, and they influence students' relationships with mathematics. This manifestation of a particular way of being and operating in the mathematics classroom is what Gee (2008a) refers to as mathematics Discourse, and it is an integral part of the mathematics socialization process.

It is important to keep in mind, though, that language and discourse are not discrete features of the classroom context. They cannot be separated from belief systems, interactional spaces, identity development, or the teaching and learning process. Language and discourse reflect belief systems (Gee, 2008a), serve as the medium of interactional spaces (Gutiérrez, Baquédano-Lopez & Tejeda, 1999), provide the substance from which identities are formed (Gee, 2004), and mediate the teaching and learning process (Khisty & Chval, 2002). Moreover, to mark the inherent power in language and its political edge, Gee (2008a) has coined the term *Discourse* (with a capital "D") to expand the traditional notion of discourse to reflect the ways in which a particular group thinks, believes, values, and speaks; that is, Discourse signifies the relationships among group members as

evidenced by their shared value system and the way they construct subjectivities, ultimately determining who is included and excluded from core membership of the group.

Discourse, therefore, becomes larger than the language that mediates interactions: it informs community; it *is* community (Gutierrez, personal communication, 2009). A mathematics community, for example, is defined by the Mathematics Discourse used and includes explicit ways of thinking and reasoning mathematically, beliefs about what a competent mathematics “doer” looks like as well as beliefs about the value and utility of mathematics, and the multiple ways we communicate mathematically, either with words, pictorially, graphically, or otherwise. So, Mathematics Discourse, on one hand, foregrounds the discourse that operates in a particular set of social interactions, and on the other hand, highlights the privileged, institutionalized language of a mathematical community and the corresponding actions that contribute to individuals’ co-constructed subjectivities, ultimately serving as a mechanism that positions individuals with greater or lesser access to the privileged center of the community (Gee, 2005).

C. Definition of Terms

1. Community and Community of Practice

I use the word *community* as it has been described by Wenger (1998) in the term *community of practice*, whereas a practice is a socially negotiated activity that “connotes doing, but not just doing in and of itself, and it is doing in a historical and social context that gives structure and meaning to what we do” (p. 47). Furthermore, communities of practice signify mutual engagement, a joint enterprise, and a shared repertoire (Wenger, 1998). In the case of this study, community of practice refers to a shared space where the mathematical goals are established (i.e. joint enterprise), the mathematical activities are derived and completed in order to accomplish the goal, the historical and social ways in which students and teacher interact together and give meaning to the activities

(i.e. mutual engagement) are reinforced and re-created, and the common (and idiosyncratic) resources are established that the participants draw on to engage in the mathematical activities (i.e. shared repertoire).

I use the phrase community of practice with caution, however. In this study, when the community of practice is the mathematics classroom with Latinas/os, it is important not to imply that all participants have equal and central membership in the community (Gee, 2005). Certainly, at this point in their schooling, not all Latina/o students affiliate with mathematical practices in the same way and are equally motivated – for an assortment of reasons, many of which are systemic and beyond their control – to accomplish mathematical goals that are often times determined for them. Similarly, given variation in their learning resources, not all bilingual students access and utilize the same repertoire of artifacts and tools. Uniformity cannot be assumed, and power needs to be acknowledged. In many ways, that is the purpose of this investigation: to determine how monolingual teachers, who have limited experience and knowledge about the students with whom they are working, come to design and implement Mathematics discourse Communities that ideally serve their Latina/o students' unique strengths and needs.

I use the phrase Mathematics discourse Community thoughtfully. It is a phrase meant to capture the uniqueness of each mathematics classroom and the multitude of ways that mathematics discourse (little 'd') is utilized in the classroom. While my attention is primarily concerned with the ways in which teachers use mathematics discourse and how they support and encourage Latina/o students' use and development of mathematics discourse, I am well aware that mathematics discourse is not sterile or static. I acknowledge the fact that mathematics discourse is latent with values and serves to position students in certain ways that has the effect of co-constructing their mathematical subjectivities.

Because of this inevitable reality, I have grappled with using the phrase *Mathematics Discourse Communities*. This phrase, however, is flawed, as Discourse already implies a certain community – one that shares particular beliefs and ways of speaking – making “community” redundant; it is not an adjective to describe a community. So, I moved to frame this work with the phrase *Mathematics Discourse*. This phrase, however, seemed to deviate from the central issues I was concerned with, namely, how teachers structured their mathematical talk for bilingual students, how this talk served to help the students access and engage meaningfully with rich mathematical ideas, and how the teachers aimed to support students’ use and development of their own mathematics discourse. While this mathematics discourse undoubtedly operates within Mathematics Discourse, and arguable cannot be separated from Mathematics Discourse, I wish to be clear that I am talking about the traditional notions of mathematics discourse from the past two decades, ones that primarily underscore the role of mathematics talk (e.g., Herbel-Eisenmann & Cirillo, 2000, Khisty, 1995; Khisty & Chval, 2002; Kieran, Forman, & Sfard, 2002; Lambert & Blunk, 1998; Sfard, 2001). The inclusion of “Community” in this phrase is meant to incorporate the various and dynamic ways that a learning environment is co-constructed by the students and teacher, given their assortment of cultural-historical backgrounds and values pertaining to schooling and mathematics.

2. Monolingual, Bilingual, and Emerging Bilingual

Throughout this paper, I deliberately use the term bilingual to describe the students whose native language is Spanish (or Arabic) and who are in the process of learning English. Indeed, fluency in a language is continually developing, and certainly, the students are on their way to English proficiency. Therefore, I view it as appropriate to capture this reality with the term that honors their native language while respecting their ongoing accomplishments in their development of English. Furthermore, I think this recognition – that the students have a valuable and respectable

skill of knowing two languages – has the potential to make a major contribution in re-defining who are bilingual Latinas/os.

For those youth who come to school with little English proficiency, I will refer to them as *emerging bilingual students*. Again, this recognizes the journey these students are on to develop a second language, hopefully while simultaneously developing their native language skills. I must underscore the importance of giving these students credit for knowing English, as they live in an English-speaking world and are continually making meaning of English; at no point should we assume that emerging bilingual students know no English. Rather, we should situate our interactions in the reality that we are co-constructing meaning of language. Hopefully, this will dispel the myth that English needs to be mastered prior to meaningful engagement with teachers who do not share the same native language. Also, by moving away from the conventional term English Language Learner (ELL), we disrupt the notion that English learning needs to be the central focus of instruction with these learners at the expense of a robust curriculum.

In addition, I use the term monolingual to describe the teachers in the study. I have chosen to use this term to depict the reality that they only use English in the classroom. Undoubtedly, the teachers engage with multiple languages and discourses in their jobs and in their lives, and given my rationale for using the terms bilingual and emerging bilingual, perhaps I should give them credit for these various language encounters. However, I need a way to represent the reality that Spanish is not the teachers' native language, nor do they use Spanish in the classroom, and therefore, they do not share many of the dual-language dynamics that we might find in bilingual classrooms. I need a descriptor that allows me to capture the linguistic incongruencies – when the teacher is English-dominant and the students are speakers of another language – that is representative of the majority of the teacher workforce.

3. Language Ideologies

Language Ideologies is a major theoretical and analytical construct that I use throughout this thesis. I use this term to represent “the cultural system of ideas about social and linguistic relationship, together with their loading of moral and political interests” (Irvine & Gal, 2000, p. 5). In other words, individuals maintain ideas about the role and use of language(s), and these perspectives have significant social and political implications. In the context of this study, I am focused on the teachers’ instructional decisions as they pertain to students’ various language development and proficiency, the relationship between students’ perceived language proficiency and their academic capacity, the relationship between students’ perceived language proficiency and the teacher-student interactions that ensue, and how the teachers’ roles are shaped in terms of creating opportunities for students to develop multiple languages and discourses. These dynamics are inevitably rooted in an ideological system about language(s) and will be reflected not only in what they say, but also through an array of pedagogical practices.

D. Need for this Research

Notwithstanding individual student agency in the socialization process, teachers play an instrumental role in how and to what ends Latina/o students become socialized mathematically. And, mathematics socialization processes are inevitably linked to students’ mathematical identity development and beliefs systems around the utility and benefits of mathematics (Martin, 2000). With this in mind, and given that only a fraction of the teacher workforce reflects the socio-cultural backgrounds of the students they teach, there is an under-stated urgency to examine how monolingual teachers facilitate the creation and development of Mathematics discourse Communities with bilingual, Latina/o students.

Ultimately, it is important to understand how Latinas/os are discursively constructed as subjects within a mathematics classroom context. That is, how are Latinas/os positioned in relation to mathematical competence? I realize that this grossly understudied phenomenon cannot be addressed in a single study or from a single angle. At the same time, knowing the impact teachers have on developing institutional norms, I chose to begin by studying two monolingual teachers as they create discourses within their mathematical communities that serve to socialize students into certain ways of being, thinking, believing, valuing and speaking mathematically. Two teachers will provide a contrasting perspective, thus illuminating the features of Mathematics discourse Communities that influence the mathematics learning of Latinas/os.

1. Perspectives and Initiatives of the Past

Interventions to improve mathematics achievement in the past have focused on the individual: Where are the points in the mathematics teaching and learning process that pose particular difficulties for the learner? Researchers attention has largely been devoted to the cognitive processes of mathematics learning and how teachers ought to capitalize on students thinking (e.g. Carpenter, Fennema, Peterson, Chiang & Loef, 1989; Resnick, 1992; Fennema, Franke, Carpenter & Carey, 1993). Indeed, there have been valuable insights gained from this research, but it failed to emphasize an important reality: mathematics teaching and learning is a social process as opposed to an individual process. Inside and outside the mathematics classroom, students are socialized into the discipline of mathematics in meaningful ways. It is through various mathematical interactions (i.e. teacher-student, student-student, student-parent, student-media, etc.) that students develop meaning around mathematics as a discipline. As a result of the compilation of mathematical interactions, they develop particular ways of thinking, believing, valuing, behaving, and speaking mathematically (Gee, 2008a).

Mathematics research in the past has also failed to recognize that mathematics learning is qualitatively different in different settings. It would be naïve of us to think that mathematics learning in one context can be or should be replicated in another context. Rather, mathematics learning “is highly specific and derivable from the demands of particular [mathematical] practices...for specific and delimited purposes. Individuals’ [mathematics] “skills” – ways of reasoning and behaving – are driven by the particular [mathematics] practices they habitually engage in” (O’Connor, 1998, pp. 23-24). Per my definition of MdC, mathematical practices in which the students engage are part of the Mathematics discourse Community, and thus are included this investigation.

With respect to language in the mathematics classroom, recent literature tends to focus on how mathematics learning can be overlaid upon language development (Coggins, Kravin, Coates & Carroll, 2007; Kersaint, Thompson & Petkova, 2009), treating language development as a linear process. This is consistent with states’ and districts’ adoption of language development “standards” (e.g., World-class Instructional Design and Assessment Consortium [WIDA], Heinle, 2004) to gauge students’ progress through stages. Consequently, I have witnessed teachers’ reliance on a prescribed set of instructional strategies aimed at reaching students at their linguistic level. While the intention is good, the result is a disjointed presentation of discrete language skills as opposed to a functional treatment of language that targets the development of a particular register, say a mathematics register (Halliday, 1978). Instead of teaching sterile, decomposed features (i.e., vocabulary) and representations (i.e., humor) of language in isolation from one another, language ought to be developed in a contextualized manner, within each content area, since each content area demands a specialized way of speaking (Gee, 2004, 2008b; Gutierrez, 2002).

Currently, the dominant approach to developing the requisite mathematical language is through a focus on academic language, which typically is reduced to repetitively defining technical words, such as slope, proportion, intersection, perpendicular, polygon, vertex, and so on. But, educators who approach language development this way rarely consider the meaning that students are making through these word exercises. In Chicago, for example, it is mandated that all elementary school classrooms have “word walls” that display the new vocabulary students are responsible for knowing. In theory, the practice of visually displaying key terms will assist students when they are attempting to recall or label certain concepts. Conceptual meaning, however, is largely elusive. It is not *seeing* the word over and over again that causes the meaning to be retained. Rather, it is the dialogue and meaning-making activities surrounding the word that eventually allow for the concept – and label – to be internalized by the learner (Vygotsky, 1978). While word walls could potentially be a generative and useful learning tool, without a plan to explicitly connect the meaning of the words to classroom discourse, teachers are merely complying with a demand.

2. Latinas/os and Discourse in Mathematics Classrooms

In recent years, the effort has intensified to reframe Latina/o students as competent and resourceful learners (Diaz, Moll & Mehan, 1986; Gutiérrez et al., 1999; Khisty & Willey, 2008; Moll, 2001). Gonzalez, Moll, and their colleagues have dedicated themselves to demonstrating that Latina/o households contain innumerable learning resources, or *funds of knowledge* (Moll, Amanti, Neff & González, 1992; González, Moll & Amanti, 2005). In other words, it is not the Latina/o learners who cannot make sense of academic concepts, it is the teachers and schools that are not prepared to maximize the learning capital these learners bring to school. These theoretical principles, increasingly supported by empirical evidence, could have profound implications for

mathematics teaching and learning if teachers accept and subscribe to this line of thinking, one that treats Latinas/os as wells of knowledge as opposed to experientially and intellectually deficient.

Paralleling this effort to reframe Latina/o learners has been an effort to reframe the role of language in mathematics (O'Connor, 1998; Schleppegrell, 2007; Willey, Viego, & Khisty, 2009; Razfar, Khisty & Chval, 2011). The collective position of this group argues for more explicit attention to language in teaching all subjects – including mathematics. The idea is put forth that language does not need to be developed as a prerequisite to meaningful, content area learning. Instead, language can and should be developed *through* meaningful activities.

This position has important implications for Latina/o learners, given the fact that many Latinas/os are not native English-speakers. Despite the mountains of literature on the benefits of bilingual education, only three in 10 English learners were receiving some type of native-language assistance – and not necessarily a full bilingual program (Crawford, 2004). That means seven in 10 English learners are being taught entirely in English. Given that the majority of teachers in the U.S. is monolingual and has English learners in their classrooms (Crawford, 2004), the need for new approaches to language development, or language socialization, in each content area is intensified. As it stands, schools are increasingly dedicating more time to English language development at the expense of rich, meaningful activities in the content areas (Gutierrez, Asato, Pacheco, Moll, Olson, Horng, Ruiz, Garcia, & McCarty, 2002; Menken, 2006). This practice is effectively keeping Latinas/os behind, and perhaps widening the academic outcomes between White youth and Latina/o youth.

It is important to be clear about the role of language in school. Sociolinguists, linguistic anthropologists, and education scholars have become increasingly articulate about the different styles of language that exist in schools and out-of-school contexts. Indeed, schools utilize, privilege,

and promote specialized discourses (Heath, 1983; Gee, 2004, 2008b), ones that are often referred to as “formal language” or “academic language.” Gee (2004, 2008a, 2008b) extends this argument to claim that each discipline (i.e. math, science, technology, etc.) or community setting (i.e. teachers, administrators, counselors, students, etc.) has its own specialized discourse that serves to underscore values and membership in a given community. This implies a need for teachers to be aware of the content of their discourse, including the implicit value messages that are emitted; knowledgeable of how the reproduction of these discourses is encouraged and how students are positioned in relation to these discourses; and deliberate with the ways in which they socialize students *with* and *into* these specialized discourses (Ochs & Scheffelin, 1984).

Gee (2008a) also argues that classroom discourse is not a discrete feature of the classroom experience, but rather is inextricably and intimately connected to the particular ways one ought to act, think, believe, and value, with respect to a particular community. Discourse includes the conventional use of language: to communicate and share ideas in order to make meaning of and develop new understandings of a concept. However, Discourse also elevates the power of language to include the transmission of messages about the subject of the language. How we use the language, and in what ways, helps participants construct importance to certain ideas and attribute differentiated status to ideas. In mathematics, Franke, Kazemi & Battey (2007) contend that “students ways of being and interacting in classrooms impact not only their mathematical thinking but also their own sense of their ability to do and persist with mathematics, the way they are viewed as competent in mathematics, and their ability to perform successfully in school” (p. 226). From this perspective, language is more central to mathematics learning outcomes than previously thought. Accordingly, attention should be focused on how language interacts with other dynamics in the discourses present in a given mathematics community.

3. Mathematics Ideologies, Discourse, and Socialization

Historically, mathematics has been portrayed as a neutral discipline, one that can be taught uniformly without political consequence. Moreover, conventional wisdom would have us believe that it is a subject where language is minimally involved because of the symbolic system of numbers and operations that represent indisputable quantities and ways of manipulating these quantities. In fact, there are some (e.g. Usiskin, 1996) who have been successful in proliferating the idea that mathematics is a language itself, or a universal language. However, these conceptions ignore the fact that meaning needs to be made of each quantity and operation (Resnick, 1992), and this process is language intensive (Khisty & Chval, 2002).

The examples in the previous paragraph are just a few examples of mathematical ideologies. Consider another example of a mathematical ideology: the common claim, “I’m not a math person.” This statement implies a belief that math ability is an inherited trait: one either possesses the math gene or not. Furthermore, it implies that some students are capable of learning mathematics while others simply won’t acquire particular mathematics skills, despite the teacher’s and learner’s best efforts. It is not difficult to see how an ideology of this nature might influence the mathematical experiences of a learner. Persistence in mathematics becomes partly a function of one’s perceived ability to do mathematics as it relates to the perception by others of one’s ability. All identity is socially negotiated (Martin, 2007; Nasir, 2002).

With this description, we can begin to see how mathematics ideologies and mathematics Discourse coincide. Mathematics Discourse surely exists in classrooms (Sztajn, 2003), is the context within which MdC’s are established, and surely needs to be scrutinized. It is the central feature of the mathematics socialization process, because it represents various belief systems, attitudes, and motivations about mathematics that affect how teachers set up mathematics

classrooms, an approach to mathematics curriculum development and instruction, and illuminates to whom teachers aim various mathematical instructional strategies (Sztajn, 2003). Given that Latinas/os are racialized as subordinate (e.g. deficient in experiences and knowledge; lacking “basic skills”), and therefore perceived to have certain educational and mathematical needs (e.g. remediation or compensatory education), there is an emergent need to study how teachers facilitate the mathematical socialization process of Latina/o learners. Latina/o students – like all students – are annually inducted into new forms of mathematics, and therefore, new ways of interacting with the mathematics, albeit in different ways than White students (Martin, 2006). Latina/o students’ sociopolitical realities undoubtedly differ from those of middle class White students and interact with teachers’ life experiences and subsequent mathematics discourses to establish a unique learning environment. Social factors do not stay outside of the classroom walls.

Studying the development of Mathematical discourse Communities with Latinas/os is important not only to “see” how they are socialized and positioned with respect to the discipline of mathematics, but also to see how other realms of schooling intersect with the mathematics teaching and learning process. Despite common belief, mathematics is not an isolated field of study that produces an objective skill base with which students should walk away; rather, it is embedded in a complex, multi-dimensional social web of values, ideologies, and modes of operating. The teacher is the primary – though not exclusive – vehicle through which these (dominant) values, ideologies, and modes of operating (i.e. discourses) are brought into classroom and transmitted to the students. However, students are agentic (not passive in the learning process) and unique (when compared to one another), and they, too, will bring unique perspectives forth in the mathematics learning process. They don't just bring their perspectives, however, they also resist, subvert, and re-signify the meaning of these discourses in subtle and not-so-subtle ways. Studying Mathematical discourse

Communities with Latinas/os will illuminate the points of contention and difference amongst bilingual, Latina/o students and between the students and the teacher, and demonstrate how these contentious spaces lead to (mathematics) learning (Gutiérrez et al., 1999) or alienation (Gee, 2004).

Because the mathematics education of Latinas/os in the U.S. is a complex phenomenon, involving historical, anthropological, social, linguistic, political, psychological, and educational dimensions, I will need to set the context before delving into the specifics of my research questions.

E. Latinas/os as a Social Group

The term Latina/o often refers to a person with ancestry that can be traced to Spanish-speaking, Latin American, and Caribbean nations (Suárez-Orozco & Páez, 2002). This all-encompassing category commonly connotes people with Mexican, Central American, Puerto Rican, or Native American roots, but also can include people from Spain, South America (including Brazil), Cuba, Dominican Republic, or Portugal. The common underlying feature here is that these regions (Spain and Portugal excluded) were profoundly influenced by the Spanish and Portuguese conquests and subsequent colonization. Indeed, the racial and ethnic make-up of Latinas/os is complex and varied (Menchaca, 2001).

When I use the label *Latina/o*, I am primarily referring to Mexican Americans, Central Americans, Puerto Ricans, and Chicanas/os – many of whom have roots in the U.S. far deeper than any European Americans – which make up at least 77% of all Latinas/os in the U.S. (U.S. Census Bureau, 2005). While there is great diversity amongst this group called Latinas/os, they share some commonalities – some shared lived experiences – that make it appropriate to consider them a social group in our sociopolitical reality, especially in the context of the U.S. schooling system.

First, Latinas/os are not White. This is not because they do not possess European blood; indeed, they do. Many Latinas/os also have African and indigenous heritage as well, making them

distinctly racially mixed (Menchaca, 2001). While the majority of Latinas/os have darker skin, I am referring more to the social construct of Whiteness (Ladson-Billings & Tate, 2006). They are continually positioned as “others,” noticeably different – socially, culturally, linguistically, etc. – than the White standard.

Second, Latinas/os have strong, complicated, and diverse relationships with the Spanish language (Fusco, 1995). The majority of U.S. Latinas/os (31 million or over 75%) are Spanish speakers (U.S. Census Bureau, 2005). Those who are not native Spanish speakers likely live in Spanish-speaking communities or have family members who prefer Spanish. For these individuals, there is only a small degree of removal from the Spanish language, and this association with Spanish “generates a powerful gravitational field bringing [Latinas/os] together” (Suárez-Orozco & Páez, 2002, p. 7) and has effects on one’s identity (Darder, Torres, & Gutiérrez, 1997; Mendoza-Denton, 1999). Additionally, given the fact that speaking English in the U.S. is the dominant way of being – and put forth as the only means to success – and is pushed by a strong ideological force, Spanish-speakers are continually engaged in the process of learning English. Though all “Americans” are continually engaged in developing their English language, there is a more intense effort to impose English learning upon Latinas/os (Menken, 2006), which, with respect to Latina/o students in U.S. schools, frequently comes at the expense of Spanish language maintenance and development. Moreover, over half of the 31 million Spanish-speakers in the U.S. report speaking English “very well”; the rest speak English at levels varying from “little” to “well” (U.S. Census Bureau, 2005). For these reasons, it is appropriate to refer to Latinas/os as bilingual, though to varying degrees.

Finally, as a result of the first two realities, Latinas/os are largely bound together by an ongoing sociopolitical struggle for equity and justice in all realms of social life. The U.S. has a long

history of unequal treatment of Latinas/os (e.g., in education, with representation in the political process, with respect to their language). On the one hand, they have resisted oppression and continue to subvert the discourses in education that frame them as inferior or not valuing education (e.g., the Walk Outs of the 1960's). On the other hand, they continue to suffer from severe discrimination and subjugation (e.g., anti-immigrant policy, English-only movement). As a result, Latinas/os have become largely marginalized, only having *peripheral* access to *some* of the rights and services that Whites have enjoyed for centuries. Public education is one of these rights, a system that is compulsory by law, but differential in the services it provides to youth based on class, ethnicity, language, or one of many other demographic factors (Lipman, 2004). While the schooling system is arguably an institution that has the potential to catalyze social change, it has historically done and continues to do little to change that reality; in fact, it is one of the primary vehicles to reproduce existing inequalities (Apple, 2005).

For the reasons outlined above, and the fact that the population of U.S. Latina/os is projected to swell – more than doubling again by 2050 (U.S. Census Bureau, 2004) – it becomes increasingly urgent to focus our attention on these learners, who have distinct sociopolitical, cultural-historical experiences with U.S. schooling systems.

1. Relationship Between Latinas/os and English Language Learners (ELLs)

Discussions of Latinas/os in education inherently involve issues of language given their affiliation with Spanish. While many Latinas/os are native English speakers, the majority is not (U.S. Census Bureau, 2005). Therefore, millions of Latinas/os enter schools with linguistic skills that are largely not valued or seen as resources by schools. Spanish holds a much lower status in the U.S. compared with English and other languages, and pervasive language ideologies are largely responsible for this status differential. For example, there is a perceived need to unify the nation

with an official language (see González & Melis, 2000), and there is also a “common sense” mantra exclaiming that English is the (sole) means to socioeconomic mobility, leading many to believe, consequently, that Spanish ought to be abandoned. In classrooms across the country, Latinas/os’ “English learning” status is seen as an obstacle, a flaw that requires intense, compensatory attention to “fix” (Ruiz, 1984). Often times, the consequence of this position is to design learning environments that emphasize remedial skills, positioning English learners to fall further behind (Lipman, 2004). A preoccupation with learning English becomes the priority above all else (Gutiérrez et al., 2002).

In Chicago Public Schools, the Office of Language and Culture (2008) reports that more than 1-in-4 Latina/o students are classified as ELLs, or conversely, 83% of the almost 53,000 ELLs are Latinas/os. These figures are likely gross underestimations from inadequate definitions of who counts as an ELL. For example, students are instantly reclassified once an arbitrary language ability is reached, which does not recognize the ever-present, ongoing reality of what it means to learn or develop a second language. Because of the large overlap between the Latina/o and ELL student populations, and because the majority of Latinas/os are bilingual, I occasionally will use the three descriptors interchangeably (Latina/o, ELL, bilingual), knowing well that not all Latinas/os are ELLs or bilingual, and not all ELLs and bilinguals are Latina/o.

F. Sociopolitical Context Surrounding the Mathematics Education of Latinas/os

Latinas/os are racialized in ways that relegate them to lower status in society. As such, they deserve more opportunities to access their life aspirations than what is currently afforded to them. Obtaining an empowering education is an elusive – yet critical – first step to expand life possibilities. However, meaningful education – and, in particular, an empowering mathematics

education – is essentially withheld from Latinas/os and bilingual students across the United States (Khisty, 1995; Khisty & Willey, 2008; Secada, 1995).

To illustrate one, albeit limited, measure of the severity of this issue, consider the following data: Fry (2007) reports that results from the National Assessment of Educational Progress (NAEP), an assessment aimed to capture a representative sample of students nation-wide, reveal that ELLs scored far below other major social and ethnic groups in both reading and mathematics. What is more disturbing is that the data suggests the gap on measured achievement widened from elementary grades to 8th grade (Fry, 2008). For example, 46% of 4th grade ELLs scored “below basic” in mathematics in 2005, while 71% of 8th grade ELL scored the same (Fry, 2007). Moreover, “about half of all Latino students fail to graduate from high school, and while all other ethnic groups – including African Americans – have gradually increased their college graduation rates, Latinos have seen almost no such progress in three decades” (Gándara & Contreras, 2008, p. 1-2). It is important to keep in mind, however, that “assessment accommodations for ELLs in large-scale science assessments are either not considered or not consistently implemented, resulting in imprecise knowledge about the strengths, needs, and academic progress of these students (Lee, 2005). This is likely true for mathematics assessments as well.

Public discourses would have one believe that academic failure is the result of personal attributes or dysfunctional families and communities (Santa Ana, 2002). Simple evaluations of our social reality lead some through the following line of logic: we are in the U.S.; equality is legally granted to everyone regardless of race, ethnicity, national origin, language, or a range of other human features that have historically been the cause of discrimination; and, everyone is afforded, by law, the same opportunity to learn and succeed. In essence, the myth of meritocracy prevails. The variable becomes individual motivation and determination, and sometimes, familial support. With

this viewpoint, failure is essentially located within individuals, particularly individuals who come from particular communities (i.e. poor, Latina/o), and responsibility for individual outcomes is effectively lifted from schools the failing Latina/o youth attend. Yet, a closer look puts this simplistic and superficial conclusion to rest and reveals that this is not the reality in which we live. Hegemonic forces and failed social policies intersect with schooling arrangements in every corner of the country (Gándara & Contreras, 2009).

For decades, scholars have rejected the dominant rationale that success or failure is the result of personal attributes or merits exclusively. Instead of accepting Latina/o students as deficient or culturally deprived, new perspectives that consider contextual factors within and surrounding schooling systems (i.e. social, political, etc.) have been offered to explain the underachievement of Latina/o learners (e.g., Scribner & Cole, 1981; Diaz, Moll & Mehan, 1986). They have collectively produced a mountain of evidence that demonstrates how “deficit” views of Latinas/os negatively affect the schooling experience, and thus the educational outcomes, of Latinas/os (U.S. Commission on Civil Rights, 1973; Valencia, 2002; Razfar, 2005).

While people’s perceptions of Latinas/os are developed in complex ways over the course of time, it is likely that the portrayal of Latinas/os in the media and through public discourse is consequential. One the most prominent images positioning Latinas/os as inferior is the widely publicized “achievement gap” (Gutierrez, 2008, 2009; Gutierrez & Dixon-Roman, 2011). With respect to this mathematics achievement gap, Danny Martin (2009a) has pointed out that

the vast majority of mainstream mathematics education research and policy purporting to *explain* the so-called racial achievement gaps between African Americans, Latinos, and Native Americans, on the one hand, and white and Asian students, on the other, continues to rely on inadequate and impoverished approaches to race, racism, and racialized inequality (p. 5-6).

Arguing that mathematics education researchers treat race as little more than a category, he adds: “This inadequate framing is, itself, reflective of a racialization process that continues to legitimize the social devaluing and stigmatization of many students of color (p. 46).

While the mathematics standardized tests scores indeed are lower for Latina/o students compared with their White counterparts, this in no way reflects inferiority, incompetence, or an inability to learn mathematics among Latina/o youth. Instead, this reflects the reality that the educational system as a whole (i.e., early childhood, K-12, higher education) is failing to properly teach mathematics to all learners, and Latinas/os (and also African Americans and Native Americans) are disproportionately receiving insufficient mathematics education (DiME, 2008; Gutierrez, 2008; Khisty & Willey, 2008; Secada, 1995).

While it might be easy to scapegoat teachers for the serious inadequacies in the mathematics education of Latinas/os, it is important to keep in mind this is a far more systemic issue than the moment-to-moment pedagogical decisions that play out in classrooms. As already pointed out, mathematical ideologies inevitably permeate classrooms, sometimes in the form of teacher unknowingly promoting unproductive and traditional mathematical values that are destined to reproduce student mathematical outcomes that stakeholders are trying desperately to reverse. In addition, the climate of schooling is constantly in flux, and many argue that the teachers’ work has intensified (e.g. Apple, 2006), and increasing and accelerated efforts to hold teachers accountable for students’ academic growth, regardless of a multitude of uncontrollable social factors, has dramatically influenced the way in which teachers make priorities and compromise what they know is best for children (Gutstein & Peterson, 2005; Lipman, 2004). These dynamics manifest in the form a barrage of local and state-level – and now national-level – initiatives and mandates that, due to a lack of thoughtful implementation, have the effect of burdening teachers rather than forcing

improvement as proponents often argue (Meier, 2002); these conditions are often amplified in urban contexts (Lipman, 2004, 2011), where this study takes place.

The disheartening educational conditions and outcomes of Latinas/os are exacerbated by the fact that Latinas/os are becoming an increasingly large percentage of the school-age population. In 1990, one-in-eight public school students were Latina/o; in 2006, that ratio had increased to one-in-five, or approximately 11 million learners. By 2050, that total is projected to increase by 166% to 28 million, surpassing the number of White children (Fry & Gonzales, 2008). Given that Latinas/os are the largest and most rapidly growing ethnic minority in the country, the (mis)education of Latina/o youth not only has serious social consequences for their respective communities, but for the nation as a whole (Gándara & Contreras, 2008) in terms of the health of our democracy.

Within the grossly problematic educational system in place to educate Latina/o students, mathematics education is one arena that is especially deserving of attention. At this point, it is widely accepted by scholars that mathematics is indeed a gatekeeper to not only college, but also to an assortment of professional careers (e.g., medicine, nursing, law, architecture, accounting, business management, etc.) (Martin, 2000; Moses, 2001). Beyond the material wealth gained by being part of the professional ranks, Latinas/os are being systematically deprived of the larger tools and ways of being that are pertinent to mathematics and which are gained in a high quality, comprehensive mathematics education. These tools include such things as the ability to think logically, argue effectively, reason, solve problems, analyze, and generalize (Brenner, 1998; Varley Gutierrez, Willey & Khisty, 2011). Without these essential skills, Latinas/os are relegated to be among a subjugated class of citizens. That schools do not adequately develop these powerful mathematical tools with Latinas/os is undoubtedly an issue of social justice (Khisty, 1995; Khisty & Willey, 2008; Tejeda, Espinoza & Gutiérrez, 2003).

G. Research Questions

The fact that Latinas/os are missing an opportunity to engage with empowering mathematics is a serious issue and calls for a re-evaluation of our orientations towards Latina/o learners, our conceptions of the intersection of mathematics and language and racialization, and the alignment of our mathematical teaching methods with these realities. A focus on how mathematics teachers create and develop Mathematics discourse Communities has the potential to address all three of these elements.

The primary question I aim to address is: *How do monolingual middle school teachers develop and utilize Mathematics discourse Communities with Latina/o students?* There are three sub-questions that highlight particular foci:

- 1) *What issues and challenges surround the teachers' development and utilization of Mathematics discourse Communities?*
- 2) *What linguistic factors influence the development and utilization of Mathematics discourse Communities?*
- 3) *What ideological, knowledge, and skill factors influence the development and utilization of Mathematics discourse Communities?*

Implicit in these questions are issues of the teachers' perceptions of discourse and its relation to developing mathematically as well as the teachers' perceptions of the role of the first and second languages in mathematics Discourse and socialization.

II. REVIEW OF RELATED LITERATURE

A. Overview

This study assumed a different theoretical position on mathematics teaching and learning than those that have dominated mathematics education research for decades. In the past, mathematics learning has been conceived as an activity that is commonly located in the mind – an individual, cognitive activity (O'Connor, 1998; Moschkovich, 2002). This parallels how many scholars were treating the act of thinking itself (Engeström, 1994). However, scholars recently have been arguing for a socially-situated act of thinking and learning (e.g., Rogoff, 1991), and mathematics learning in particular (O'Connor, 1998; Khisty & Willey, 2008).

Because I am proposing to utilize the Mathematics discourse Community conceptual framework, I will rely heavily on the theoretical positioning of Gee (2004, 2008a). To my knowledge, no work has been done in mathematics education research using this conceptual framework. There has been, however, work done that looks at mathematics socialization. Because this is the most closely related topic and a central consequence of Mathematics discourse Communities, I will review what we have learned from these studies and theoretical advancements.

There also have been studies investigating mathematical ways of being, or specific social practices, found in mathematics classrooms. In particular, there has been an emergent interest in the discourse practices involved in mathematics teaching and learning (e.g. Gutierrez, 2002; Khisty, 1995; Khisty & Chval, 2002; Moschkovich, 1999; O'Connor, 1998; Sfard, 2001; Sherin, 2002). I will pay particular attention to the construct of *language socialization* in the mathematics classroom (O'Connor, 1998). I will conclude with a statement on what remains to be understood. First, however, I need to situate my proposed investigation in a general theoretical framework, including an elaboration of what constitutes Mathematics discourse Communities.

B. Theoretical Perspectives on Teaching and Learning

Mathematics education is in the process of change (Lerman, 2000; McLeod, 2002). Given the traditional notions and mythologies that have grounded mathematics education in the past, one might call this change a theoretical revolution. If that is too dramatic, however, suffice it to say that a paradigmatic shift is occurring. With respect to the mathematics teaching and learning process, researchers have historically focused on the cognitive and individual activity of understanding mathematical concepts. Psychological perspectives dominated the field, and as a result, much emphasis was placed on the mental processes, such as the cognitive demands of moving from the concrete to more abstract notions of quantities and number manipulation (Resnick, 1992). However, over the past few decades, new perspectives have helped us realize that there are many social factors that need to be considered; in fact, mathematical development cannot be understood in isolation from these social factors (Lerman, 2000). Some of these new perspectives can be attributed to new theories of human development put forth, many originating with the experiments and writings of Soviet psychologist Lev Vygotsky (1978).

The “new” perspective on mathematics teaching and learning that emphasizes the importance of social interactions and language mediation is referred to as sociocultural theory. I approached this study with a sociocultural, or cultural-historical activity theory (CHAT or Activity Theory for short), perspective. While sociocultural theory has a history of illuminating the political dimensions of interactions (e.g., Gutierrez et al, 2002; Moll, 2001; Moll & Diaz, 1987; Razfar, 2005), there has been a more recent push to foreground the sociopolitical nature of teaching and learning interactions, which focuses squarely on the role of power and identity as primary dynamics influencing the academic trajectories of marginalized youth (e.g., Gutierrez 2010; Martin, 2010; Valero, 2004). This being a study of teachers of a historically excluded and miseducated population,

Latinas/os, this literature becomes relevant and is reviewed accordingly. However, since the thrust of the investigation revolves around teacher's mathematical talk and the opportunities they afford their bilingual students to use and develop mathematics discourse, I focus primarily on sociocultural perspectives.

1. Sociocultural Perspectives

A sociocultural perspective is a particular way of viewing the processes through which humans develop socially, culturally, linguistically, and intellectually, all of which are central to Mathematics discourse Communities. Sociocultural theory diverges from other theories of human development, because it places great importance on the social context surrounding an individual and its role in mediating development. In other words, the human mind operates as a result of social stimuli; it is not an organ controlled by the individual. What is going on around an individual (context) matters greatly and directly or indirectly affects internal thought. Cognitive functions are the result of social interactions. A classic description puts forth that speech is not the result of internal thoughts, but thinking is the result of hearing or utilizing speech (Vygotsky, 1962). Given the complexity of sociocultural theory, I will briefly deconstruct some of the critical, fundamental concepts.

a. Mediation

Another element common to sociocultural theory is the process of mediation. There are innumerable cultural artifacts that mediate thought and action. Cultural artifacts can be tangible or intangible objects: language, gestures, physical objects or materials, mannerisms, types of interaction, etc. Mediation, in a sociocultural sense, refers to the two-way relationship between cultural artifacts and thought (Donato & McCormick, 1994). A particular artifact triggers a particular line of thinking. This is not a static or predictable relationship, however. As the dynamics

of the interaction change, the dynamics of the thought process change as well. In social interactions, the actors constantly negotiate the meaning and direction of the interaction (Lantolf, 2000). Given the teachers' emphasis on mathematics discourse and peer interactions, the concept of mediation becomes an important idea through which we can understand students' opportunities to grow in mathematical cognition.

b. Spontaneous and Scientific Concepts

Concepts like *funds of knowledge* are rooted in sociocultural theory, and can be traced to the work of Vygotsky. Vygotsky contributed crucial insights to the ongoing discussion of (academic) concept development. Over 75 years ago, he coined the terms *scientific concept* and *spontaneous concept* (Vygotsky, 1987). According to Vygotsky, each kind of concept has different origins. Scientific concepts are largely the knowledge that is developed through formal instruction. They are systemically organized and historically situated. Vygotsky also describes scientific concepts as “flexible,” which means they can often be generalized or applied to contexts other than the one in which they are acquired (Vygotsky, 1987). In mathematics, scientific concepts can be algorithms, formulas, theorems, or even rote number facts that lack a concrete, conceptual grounding. They are often presented to students as “truths,” despite not having the experiential knowledge to psychologically support the complete acquisition of such concepts.

Spontaneous concepts, on the other hand, are the mental notions that form as the result of participation in everyday activities and experiences. Spontaneous concepts are less flexible, because they are situated in the specific context in which they are experienced. They are those that are most closely tied to concrete events and objects, grounded in the reality of the child. Spontaneous concepts are visible, tangible, and justifiable given the physical world of the child. In

a mathematical context, measurement or combining and dividing using physical quantities are examples of spontaneous concepts.

Children come to school with a wealth of spontaneous concepts, or funds of knowledge (Moll et al., 1992), and one of the under-emphasized responsibilities of the school is to develop, or transform, these spontaneous concepts into specialized knowledge, or scientific concepts. Contrary to spontaneous concepts, scientific concepts tend to be much more abstract, perhaps not at all connected to the lived experiences of the child. Gradually, being guided by a “more experienced other,” the child gets more and more skilled at abstracting properties from the concrete perception of objects and is able to form abstract generalizations about a particular type of object. Vygotsky calls these “*pseudo-concepts*,” or the transitional point or hybrid space in which the spontaneous-scientific dichotomy begins to merge. The notion of scientific and spontaneous concepts plays a significant role in mathematics education given the (often hasty) progression of the development of concrete ideas to abstract ideas. Moreover, as Gonzalez et al. (1995) point out, educators are not necessarily prepared to make sense of and capitalize upon students unique ways of knowing; this is especially noticeable when the teacher and students come to school with distinctly different cultural-historical backgrounds, as is the case in this study.

c. Zone of Proximal Development

Vygotsky (1987) argues that spontaneous and scientific concepts develop as they interact and become associated with one another. For example, spontaneous concepts develop, or move “upward,” when they are connected to scientific concepts. In Vygotskian words, this occurs within the *zone of proximal development*. Consequently, they are integrated into the child’s formal knowledge systems. Conversely, scientific concepts become contextualized as they move “downward” and are applied to spontaneous objects and events. The interaction of these two

concepts results in a psychological transformation, that is, an altered, more meaningful concept that did not exist beforehand. Vygotsky (1987) argued that this development of concepts takes place in the zone of proximal development.

The zone of proximal development refers to a social setting in which there is at least two actors: a person with a more advanced understanding of a concept and one with a more rudimentary understanding of the concept. Concept development occurs when the “more experienced other” interacts with the less experienced actor in a way that provokes new ways of making meaning around the concept. It is important to realize that the “more experienced other” need not be the teacher. Indeed, peers facilitate concept development in the zone of proximal development. Certainly, this perspective is relevant for mathematics teachers creating MdC’s in which this type of transformation of mathematical understanding can take place, especially in middle school mathematics curricula that includes algebra, where concepts become more abstract.

d. Social Practices and Socialization

In short, socioculturalists believe that development follows, or is mediated by, social interactions. One does not learn to talk, think, or act without interacting with another person. Development, from this perspective, can also be described in terms of apprenticeship or socialization. Rogoff (1991, 2008) has argued that development occurs through being apprenticed, or socialized, into particular social practices. Scribner and Cole (1981) describe a practice as

a recurrent, goal-oriented sequence of activities using a particular technology and particular systems of knowledge. We use the terms “skills” to refer to the coordinated sets of action involved in applying this knowledge in particular settings. A practice, then, consists of three components: technology, knowledge and skills. We can apply this concept to spheres of activity that are predominantly conceptual (for example, the practice of law) as well as to those that are predominantly sensory-motor (for example, the practice of weaving)...Practice always refers to socially developed and patterned ways of using technology and knowledge to accomplish tasks. Conversely, tasks that individuals engage in constitute a social practice when

they are directed to socially recognized goals and make use of a shared technology and knowledge system (p. 236).

With this definition of social practice, it becomes easier to see how schools are composed of particular social practices, including the discourses that mediate mathematics learning. Furthermore, social practices are established through Discourse (Gee, 2008a). Indeed, social practices vary from school to school depending on how they are “socially developed,” what value is placed on certain technologies or forms of knowledge, and what goals (curricula) are to be accomplished. Certainly, mathematics classrooms consist of distinct social practices, and likewise, they vary from classroom to classroom. While social practices can form organically, it is more common to be socialized into a particular practice (Rogoff, 1991).

e. Communities of Practice

In mathematics classrooms, teachers play a significant role in the development of classroom social practices. Wenger (1998) proposes that the collective of people who do these practices and the way these practices are enacted constitute a *community of practice*, and that there are essential dimensions of practice that characterize the community: mutual engagement, joint enterprise, and shared repertoire. Mutual engagement refers to the idea that “practice does not exist in the abstract. It exists because people are engaged in actions whose meaning they negotiate with one another” (p. 73). With respect to joint enterprise, Wenger (1998) outlines three characteristics:

- 1) It is the result of a collective process of negotiation that reflects the full complexity of mutual engagement;
- 2) It is defined by the participants in the very process of pursuing in. It is their negotiated response to their situation and thus belongs to them in a profound sense, in spite of all the forces and influences beyond their control;
- 3) It is not just a stated goal, but creates among participants relations of mutual accountability that become an integral part of the practice. (pp. 77-78)

Finally, shared repertoire refers to resources for negotiating meaning that are created in the community as a result of the joint pursuit of an enterprise. The repertoire of a community of practice

“includes routines, words, tools, ways of doing things, stories, gestures, symbols, genres, actions, or concepts that the community has produced or adopted in the course of its existence, and which have become part of its practice” (p. 83). While these components of communities of practice have been laid out in generic terms, it is not difficult to disaggregate the intricacies of a mathematics teaching and learning environment in accordance with these descriptions.

Typically, communities of practice are “so informal and so pervasive that they rarely come into explicit focus, but for the the same reasons are also quite familiar” (Wenger, 1998, p.7). Furthermore, most communities of practice don’t have a name or membership roster. This, however, is not the case when we consider the formal nature and structures of schools. Students certainly know when they are in mathematics class, and their attendance is mandatory. For these reasons, the community of practice of mathematics class is often looser, or more contrived and less voluntary, than other community of practices, say, claims processors, clergy, Parent Teacher Organization, or football players. The “top-down” establishment of certain practices (i.e. teacher selected and reinforced) could have the effect of pushing students to the periphery of the community – where they could potentially still participate – impacting the way they affiliate with the community of practice. Thus, recognizing the differentiated identities that could emerge from the differentiated ways of engaging in the practices is important, especially given that community members are not strategically grouped together and they do not all come to the community with a uniform set resources and skills (Gee, 2005).

Important, however, is the idea that the ways in which students engage with mathematics is constantly evolving and can be strategically re-defined. Similarly, shared repertoires of discourse, resources, and artifacts can be purposely elevated and developed. And, finally, the goal, or joint enterprise, of mathematical activity can be negotiated in different ways, effectively re-distributing

autonomy and re-positioning students in relation to mathematics in different ways. Given this conceptualization of community of practice, therefore, it becomes crucial to examine the teachers' moves towards explicitly and tacitly defining the mathematics discourse Community, and in particular, their perceived role in helping bilingual, Latina/o learners develop the practice of speaking mathematically.

C. Mathematics Discourse

I now turn to the literature on mathematics education to link mathematics learning with a sociocultural perspective and to help justify Mathematics discourse Communities as a conceptual framework for this study.

For roughly the past 25 years, there has been much discussion around and research conducted on the role of language in mathematics education (Schleppegrell, 2007). The interest in mathematical communication was accelerated with the inclusion of "Communication" as a standard by the National Council of Teachers of Mathematics (NCTM) in 1989 and again in 2000 (NCTM, 1989, 2000). Communication, however, has often been narrowly conceived as "talk about mathematics" (O'Connor, 1998). Recent texts addressing the mathematics teaching and learning of English Language Learners (ELLs) present the role of language in mathematics learning in simple ways that do not reflect the complex social dynamics that impact language use and development (Coggins et al., 2007; Kersaint et al., 2009). Given that these texts largely do not account for the ways that English language learners are positioned in relationship to mathematics and mathematics learning via mathematics discourse, it has become clear that new perspectives are needed on the way that language and literacy intersect with mathematics teaching and learning. Language, or mathematics discourse, can no longer be thought of merely as a mechanism to express mathematical thinking.

Understanding that language is unique to a particular social group and that discourse inevitably shapes the practices and identities amongst the social group, Gee (2008) introduced the notion of Discourses (with a capital 'D'). Discourses are

ways of behaving, interacting, valuing, thinking, believing, speaking, and often reading and writing that are accepted as instantiations of particular roles (or 'types of people') by specific *groups of people*, whether families of a certain sort, bikers of a certain sort, business people of a certain sort, church members of a certain sort, African-Americans of a certain sort, women or men of a certain sort, and so on through a very long list. Discourses are ways of being 'people like us'. They are 'ways of being in the world'; they are 'forms of life'. They are, thus, always and everywhere *social* and products of social histories (p. viii).

Discourses, Gee argues, include much more than language and should be appreciated in its social context. Consequently, when investigating the role of language in any context, we cannot focus on language alone.

From this perspective, mathematics classrooms inherently maintain a unique Discourse, which constitutes the power and political dynamics inherent in mathematics communities. When combined with the work done on cultural social practices (e.g., Rogoff, 1991, 2008; Gee, 2004), the power of Discourse to socialize youth becomes apparent. Given that Latinas/os largely are not finding success in mathematics, examining the Discourse through which they are expected to learn becomes all the more necessary and urgent. Martin (2000) writes: "...it is my firm belief that detailed analyses of mathematics socialization and identity – and the multiple contexts that affect them – offer the best hope for understanding long-standing achievement and persistence problems" (p. 186).

The focus of this investigation is on the teacher's role in privileging or mitigating Discourse through her development of a particular Mathematics discourse Communities (MdC's). MdC's involve ways of being, thinking, and speaking that are unique to a mathematics environment. While MdC's refer to the participants, the setting, and the interactions within the setting and between the

participants, the process of being apprenticed into the specialized community can be thought of as socialization. The teacher, being the person of authority, is instrumental in the mathematics socialization process (Sztajn, 2003). However, students are agentive and unique (when compared to one another), and they, too, will bring unique perspectives forth in the mathematics learning process – resisting and subverting the discourses that are developed about them, positioning them with respect to learning, intelligence, and mathematics. Studying MdC's with Latinas/os will illuminate the points of contention and difference amongst students and between the students and teacher and how these contentious spaces lead to mathematics participation, affirmation, or alienation (Gee, 2004).

D. Ideologies in Mathematics discourse Communities

Given that Discourse communities have distinct social practices and ways of speaking and thinking, it logically follows that there are particular value and belief systems inherent in the specific modes of being. Gee (2008a) argues that “each Discourse incorporates a usually taken for granted and tacit ‘theory’ of what counts as a ‘normal’ person and the ‘right’ ways to think feel, and behave...Such theories, which are part and parcel of each and every Discourse, and which underlie the use of language in all cases, are...ideologies” (p. ix). This is why discourses normalize behaviors and practices, and create a sense of surveillance as described by Foucault (Gutierrez, 2009; Anthony & Walshaw, 2007).

Mathematics classrooms, as well as the general public, are rampant with mathematical ideologies. Some mathematics ideologies pertain to people's general competence in mathematics. For example, statements like, “I'm not a math person” is ideological, because it expresses a theory that the ability to learn mathematics is genetically inherited. Other mathematics ideologies pertain to the actual process through which one ought to learn mathematics. For example, a statement like,

“These kids don’t even know the basics” is ideological, because it suggests a theory that fluency in arithmetic facts is a prerequisite to more advance problem solving activities.

Sztajn (2003) illustrates how teachers’ mathematics ideologies related to reform-based mathematics curricula influence the way they adapt mathematics reform rhetoric in their classrooms. These ideologies, she found, differ with the social context and have a significant impact on instructional decisions. Sztajn notes that children from upper socioeconomic backgrounds are more likely to experience problem solving than their peers from lower socioeconomic backgrounds, who are more likely to undergo rote learning.

Each of these types of ideologies has profound implications on mathematics teaching and learning, and has the potential to engage or exclude people or groups of people in meaningful activity (Gee, 2008a). Accordingly, how these ideologies manifest in the mathematics classroom deserves particular attention. These are just two examples of a range of mathematics ideologies. Through careful examination of Mathematics discourse Communities – and teachers’ discourse in particular – mathematics ideologies and their manifestations should surface.

E. Funds of Knowledge

Moll and his colleagues (e.g., Moll et al., 1992) spent the past two decades making the case that Latina/o youth come to school with a wealth of knowledge and experiences – or *Funds of Knowledge* – which can serve as a foundation for academic growth if only teachers are prepared to mine these resources and capitalize on the students’ strengths. Within the context of mathematics education, Civil (2007) discusses the implications for a mathematics education of Latino children that utilizes Funds of Knowledge. She argues that building upon Latina/o students’ and their families’ knowledge and experiences helps students create new meaning around what it means to

“do mathematics in school” and helps teachers re-think how parents might be viewed as “intellectual resources” for their children’s mathematical development.

The notion of funds of knowledge is important to consider when investigating teachers’ development of MdC’s, because how the teacher positions the students as a mathematics “doers” or “knowers” has consequences for how the children perceive themselves as a members of the mathematics community. If home-based mathematics practices are exposed and celebrated, there will be an increased probability that the students feel comfortable and competent members of the MdC (Civil, 2007), which, in turn, would likely positively contribute to students’ identities. The realm of mathematical practices is expanded to include far more than what narrow curriculum covers (Nemirovsky, Roseberry, Solomon, & Warren, 2005). Moreover, multiple mathematics social practices become linked, which has significant benefits for the development of mathematical cognition (Vygotsky, 1987; O’Connor, 1998).

F. Mathematics Socialization Processes

Though Martin (2000) called for increased attention to the mathematics socialization process of historically underachieving groups, few researchers have looked at how the mathematics socialization process unfolds in schools. Martin (2000) has provided us with the most comprehensive example, making use of a multi-level framework for analyzing mathematics socialization and identity among African Americans. Consistent with my theoretical perspective, he evaluated the sociohistorical context, community influences, school influences, and agency and success among African Americans.

While I acknowledge that each of these levels influences Latina/o students’ mathematics learning, and while all have a place in teachers’ design and implementation of Mathematics discourse Communities, my focus is primarily on how teachers mediate these factors in the

mathematics classroom. Thus, the school-level factors identified by Martin (2000) are most relevant to my study. He finds that students' mathematics identity – that is, their perception of their ability to do mathematics – is influenced by at least six factors:

- Institutional agency and school-based support systems
- Teachers' curricular goals and content decisions
- Teachers' beliefs about student abilities and motivation to learn
- Teachers' beliefs about African American (or Latina/o) parents and communities
- Student culture and achievement norms
- Classroom negotiations of mathematical and social norms

Martin's (2000) findings are rich and too numerous to report here. However, an important insight he contributes to our understanding of mathematics socialization processes is the reality that mathematics socialization processes are complex and nowhere near uniform. Given the same classroom environment, mathematics socialization is experienced differently by different actors. He finds that almost all African Americans experienced some form of differentiated treatment in mathematics, presumably because they are Black. This leads Martin (2006) to conclude that mathematics learning – like all experiences on the social plane – are racialized forms of experience. Intrapersonal (individual) agency, however, plays a major role in mediating whether or not this racialized experience can be overcome and individuals are able to construct a positive mathematics identity and/or see mathematics as useful and materially beneficial (Martin, 2000).

Though Martin's study is exclusively on the African American experience with mathematics, his findings and methodologies provided a useful base from which launched this study. Furthermore, we have long known that Latinas/os have racialized forms of experience in

schools similar to African Americans (Diaz, Moll & Mehan, 1986; Foley, 1990; Valencia, 2002). Therefore, many of the factors highlighted by Martin will likely come into play in my investigation.

Rochelle Gutiérrez (1999; 2002) has another take on mathematics socialization, this time with Latinas/os. Though she did not investigate Mathematics discourse Communities, per se, she did examine the school-wide factors that led to mass, high mathematical achievement among Latinas/os in one high school. Her study is particularly relevant, because it introduces the notion of *teacher collectivity* (Gutiérrez, 1999). Teacher collectivity refers to a collaborative, intersubjective effort to address the issues that all of them are facing. This reflects the ‘teacher team,’ or collaborative thinking, model illustrated by Engeström (1994) and is particularly relevant given my proposed work with the two teachers that make up the mathematics department in a middle school.

Gutiérrez (1999) finds that teacher collectivity – particularly their positive, professional relationship with each other – provides a platform from which teachers are inspired to develop meaningful and productive relationships with their students. Consistent with other research on teacher-student relationships among Latina/o students (Valenzuela, 1999), she finds that these relationships are key to successfully advancing large numbers of students through high levels of mathematics traditionally not accessed by Latina/o youth. Gutiérrez highlights how the positive relationships with students manifest from, or into, perceptions of students as mathematical learners and sociocultural beings with particular needs. As a result, the teachers break out of the traditional frame of mind that “kids are kids, teaching is teaching, and learning is learning (p. 276)” that infiltrates the classroom and leads to negative conceptions of students and ineffective mathematical interactions.

Gutiérrez (2002) also reports how teachers’ collective beliefs are influenced by the ways in which they recognize the nuances of Latina/o student identity formation as it is developed in a

(harsh) sociopolitical context; that is, when teachers process who students are individually while recognizing how Latina/os are situated within a racist society, their perceptions of teaching and learning mathematics with Latinas/os change. She also puts forth the idea that one teacher alone may not have the kind of intended affect on students' mathematical development as a group of teachers, underscoring the important professional influence teachers have on one another and consequently, the collective impact they have on Latina/o students.

G. Language Socialization in the Mathematics Classroom

With respect to mathematics education in general, we know there are central features that lead to successful mathematical development. For example, researchers in the field are reaching consensus that classroom practices such as teaching through mathematically rich and authentic problem situations (e.g., Gutstein & Peterson, 2005; Lambdin, 2003) and listening to students thinking and asking them to describe their thinking (Fennema et al., 1993; Khisty, 1997; Yackel, 2003), produce better results than the teacher-centered practices of the past (Franke et al., 2007). Franke et al. (2007) contend that "...we need to consider the relationship between particular classroom practice and opportunities for students to engage" (p. 226).

One of these forms of engagement is through classroom discourse (Cazden, 2001). Within mathematics education, focusing on how the language of mathematics instruction and interactions (i.e. mathematics discourse) mediates learning is a relatively new emphasis (NCTM, 1989). Discourse in mathematics education is taking on more sophisticated forms, as opposed to the initiation-response-evaluation (IRE) format (see Cazden, 2001) that has dominated mathematics classrooms for decades – if any student discourse is solicited at all. This re-thinking of discourse patterns shifts emphasis from the words of the teacher to the interactions of and meaning made by the student. That is, teachers' role in the mathematics teaching and learning process is changing. It

is slowly becoming accepted that the teacher's role is to facilitate students' mathematical language and thinking, and the relationship between the two (Sfard, 2001). No longer is their primary task to transmit information or ask questions for the sake of checking for known answers. Rather, teachers are now to probe student thinking, mine students' innovative strategies, and push students to think at deeper levels with various questions and discussion prompts. Furthermore, mathematics teachers should aim to help students make connections between their everyday, informal ways of making sense of things to the more technical, precise ways of describing mathematical ideas that are privileged in school settings (Gee, 2008b).

Surely teachers will have different levels of understanding how mathematics talk mediates mathematics learning, and thus perceive their role as language developer differently. These factors influence the Mathematics discourse Community they aim to design and implement. In the following section, I outline the relevant studies that have led us to this point, making note of the distinct theoretical and methodological perspectives that have driven these works.

1. Specialized Style of Mathematics Language

Gee (2004) develops the importance of discourse in *Situated Language and Learning*. Here, he argues "there are different ways with words because we need different tools to get different sorts of jobs done" (p. 2). With respect to Mathematics discourse Communities, Halliday (1978) has called the mathematical way with words a 'mathematics register.' He defined *register* as

a set of meanings that is appropriate to a particular function of language, together with the words and structures which express these meanings. We can refer to a 'mathematics register', in the sense of the meanings that belong to the language of mathematics (the mathematical use of natural language, that is: not mathematics itself), and that a language must express if it is being used for mathematical purposes (p. 195).

Halliday underscores the reality that mathematics uses words in new ways. Not only are there new, technical words specific to the mathematics context, there are also everyday words used

in new ways, attached to new meanings. As a result, and as has already been pointed out, language and learning cannot be separated (Gee, 2004, 2008a; Schlepppegrell, 2007; Willey, Viego, & Khisty, 2009).

One particular obstacle to mathematics learning is the linguistic demands of the written language in content areas (Gee, 2004; Schlepppegrell, 2007). In mathematics, this is particularly difficult, because there are multiple semiotic (meaning-creating) systems (Lemke, 2003) and distinct grammatical patterns (Veel, 1999). For example, mathematics problems can be written in text, which has a particular style to it, or they can be written symbolically, graphically, or pictorially. It is important to recognize that these are not discrete components – one cannot learn them one-at-a-time – but rather, these features interact with one another to make meaning. Lemke (2003) points out, however, that not enough attention is dedicated to making explicit the connections and relationships between language and visual representations, for example, thus negatively affecting one's ability to analyze natural and social phenomena.

With respect to grammatical patterns in mathematics, most teachers find it obvious that technical vocabulary needs to be intentionally and clearly introduced (Willey, Viego & Khisty, 2009). This necessity is often explicitly called for through such mandates as “word walls.” However, teachers are not likely to consider the often awkward grammatical patterns that come with the technical language (Schlepppegrell, 2007). This has particular consequences for students whose first language is not English, for they may use very different grammatical patterns in their native language that will not translate well once English is sufficiently learned. Moschkovich (1999) points to the differing meanings attached to particular mathematical language by the teacher and the students. The different meanings reflect different points of view, and it becomes necessary to recognize and reconcile these differences so that accurate conceptual understandings can occur.

O'Connor (1998) illustrates how the six modes of mathematics cognition (modeling, optimization, symbolism, inference, logical analysis, and abstraction) (NRC, 1989) are developed through discursive practices. Critical mathematical practices such as formulating chains of verbal challenges and justifications, adducing evidence to answer a challenge, verbally expressing speculation, and explicitly drawing out consequences of potential courses of action are all developed through “recurrent” practice using language – starting with early “protoforms” and transitioning into more advanced forms of mathematical discourse. They are only developed through intentional practice in the social atmosphere, the Mathematics discourse Community. Like Schleppegrell (2007) and Moschkovich (1999), O'Connor concludes that the journey from rudimentary forms of mathematics discourse to the “standardized” discourse established by the mathematics community at large is not well understood.

While providing students – especially Latina/o students – opportunities to talk about mathematics is important, it becomes increasingly clear that sheer quantities of discursive opportunities is not sufficient. Rather, the specialized style of language required in mathematical context needs to be explicitly taught and modeled (Khisty & Chval, 2002). Additionally, how mathematics language relates to symbolic notation (O'Halloran, 2003) and visual representations (graphic, pictorial, etc.) needs to be an integral component of Mathematics discourse Communities (Lemke, 2003).

H. Summary

As I have discussed, mathematics learning is the product of social interactions and is supported or hindered by sociocultural and sociohistorical factors, which necessarily includes the strong political dimensions surrounding the schooling of youth of color (Gutierrez, 2010; Valero, 2004). This reconceptualization of where mathematics learning occurs – amongst individuals

instead of inside individuals – has important implications for mathematics teaching. First, we must move away from a transmission model of pedagogy. That is, mathematics knowledge is not an entity held by the teacher to be “delivered” to the students (the recipients); rather, mathematical knowledge resides in and emerges from social interactions. This is especially difficult for mathematics teachers, because there are many mathematics ideologies that work to portray mathematics as a special knowledge form, one that only a talented few will ever possess at a deep level; “being” mathematical is not an innate quality that everyone possesses. Naturally, this deeply engrained and reinforced disposition towards mathematics positions mathematics “knowers” as exceptional, and therefore, teachers are inclined to, to the best of their ability, reproduce their mathematical “journey” for others, but with a little more finesse.

Second and related, we must shift away from models that point to deficits to explain underachievement. The dominant narratives about Latinas/os play a key role in perpetuating images of Latinas/os and poor children entering school lacking prerequisite skills to master academic concepts, including mathematics concepts. Ginsburg (1982), however, argues that “poor children’s cognitive skills are not deficient but instead are, to some extent, different, and that poor children’s school failure must be explained on grounds other than cognitive deficit” (p. 204). Learning to capitalize on Latinas/os’ mathematical resources that have historically been neglected becomes an important task. Schools must re-evaluate their institutional structures, attitudes towards non-dominant youth, and methods for educating these students. Moll and Diaz (1987) point to the engrained, yet ineffective, way schooling is arranged for Latina/o students:

Although student characteristics certainly matter, when the same children are shown to succeed under modified instructional arrangements it becomes clear that the problem these working class children face in school must be viewed primarily as a consequence of institutional arrangements that constrain children and teachers by not capitalizing fully on their talents, resources, and skills... (p.302).

This study examines these instructional arrangements in the mathematics classroom – as designed and implemented by the two teachers – paying particular attention to the teachers’ discourse around mathematics, Latinas/os, and language, and the teachers’ role in support bilingual students as they develop mathematics discourse. As Martin (2000) puts it, “...it is necessary to examine the natures of [Latinas/os’] mathematical experiences in sociohistorical, community, and school contexts as well as how their mathematics identities are shaped by forces within these contexts” (p. 77). This study, while not necessarily generalizable, will considerably inform our understanding of how mathematics teachers need to be supported in order to understand the complexities of Latina/o learners and work with them in order to co-construct Mathematics discourse Communities that optimize learning opportunities.

III. METHODOLOGY

A. Overview

Thus far, I have articulated the need to study how monolingual mathematics teachers play a role in the mathematics socialization experiences of bilingual, Latina/o youth. In this chapter, I present this study's research questions, context, and the rationale for its research design (i.e., comparative case study, participant observation), which are based on sociocultural and sociopolitical perspectives. I describe the relevance and appropriateness of the approaches included in this study, such as its methodology, the selection of participants, and the sources of evidence. Additionally, I also present the strategies and tools utilized in the process of organizing and analyzing the data.

B. Research Questions

Given this study's concerns regarding how monolingual teachers plan and implement mathematics discourse experiences with Latina/o learners, the overarching question is:

How do monolingual middle school teachers develop and utilize mathematics discourse communities with Latina/o students?

There are three sub-questions to disaggregate aspects of the teachers' efforts to develop and implement Mathematics discourse Communities (MdC's) with Latinas/os:

- *What issues and challenges surround the teachers' development and utilization of Mathematics discourse Communities?*
- *What linguistic factors influence the development and utilization of Mathematics discourse Communities?*
- *What ideological, knowledge, and skill factors influence the development and utilization of Mathematics discourse Communities?*

C. Why Ethnographic Methods and Comparative Case Study?

To address these questions, I conducted a comparative study of two middle school mathematics teachers from the same school. I employed an ethnographic approach to help garner a robust and in-depth understanding of the intricacies of the teachers' development of Mathematics discourse Communities. Specifically, I engaged in the middle school mathematics teaching and learning process with Latinas/os as a participant observer (Atkinson & Hammersley, 1994; Valenzuela, 1999; DeWalt & DeWalt, 2002). This means that I regularly engaged in as many aspects of school life as possible, but in particular, I strategically involved myself in conversations with and observations of the two teachers, primarily, but also with the students and anyone else whose actions potentially impact what happens in the mathematics classrooms (i.e. teacher teammates, Bilingual Lead Teacher, administrators). This is all in an effort to be able to name and understand the sociopolitical dynamics surrounding the teachers' mathematical interactions with the Latina/o learners.

Undoubtedly, the mathematics socialization process with bilingual learners is a complex phenomenon. Capturing the relationship between how the teacher facilitates mathematics learning – what she says and does – and how students interpret, respond, and internalize mathematical ways of being, is not simple. Interviews, alone, revealed some perspective, but were largely insufficient. Student work told part of the story as well, but leaves much to be interpreted. Observations allowed me to see interactional dynamics, but once again, the analysis and conclusions drawn were those of an “outsider,” subject to misinterpretation. Because of these limitations, I needed a methodological approach that allowed me to verify, to the extent possible, what it was that I was seeing and thinking. Participant observation provided crucial opportunities to fill voids in data and conceptualizations, be present, and live as a member of the mathematics learning environment without significantly altering the daily dynamics and operations of the classroom.

Furthermore, this study is grounded in a collaborative process involving the two teachers and myself. For more than one year preceding the study, we worked together to reach the personal objectives of the teachers in order to improve their mathematics instruction with bilingual students. During the study, we continued this collaborative work, but this school year, we attempted to utilize a conceptual framework that would guide and coordinate our work involving language, mathematics, and Latinas/os: Mathematics discourse Communities. Because of the collaborative nature of our work and the complexities inherent with content area teaching and learning in a second language, participant observation is warranted.

From a methodological perspective, I have been inspired by a number of ethnographic studies – conducted through participant observation – that have exposed critical aspects of the lives of marginalized peoples (Schaffner, 1999; Ayers, 1997; Paley, 2001; Foley, 1990; Olsen, 1997; Valenzuela, 1999; Valdés, 2001). All but one of these (Paley, 2001), have produced much-needed insights into the educational realities of so-called at-risk youth. It was hard for me to imagine a different methodological approach that would garner the same intimacy, sentiment, and depth of meaning, in relation to the issue at hand, that these children experience on a day-to-day basis. The bottom line is that in each of these cases, the understanding of the respective phenomenon is clearer and much more thorough than other methodologies might have produced.

D. Data Collection and Analysis Processes

In this section, I describe the context of the study and the two teachers that served as the cases and how they were selected to serve in that role. Then, I describe the processes I employed for data collection and analysis.

1. Context of the Study

I studied two mathematics teachers, Ms. Lenihan and Ms. Hendrix, who taught at the same school, Southwest Elementary School. I already knew the two teachers professionally, because I had been working with them in their classrooms and at the university for more than one and a half years prior to formal data collection. Our work together was initiated in the Spring of 2008, when Ms. Lenihan sought assistance from our research center at the University in an effort to improve her knowledge base, mathematics curriculum, and instructional practices when teaching mathematics with Latinas/os and other students whose first language was not English. I began observing in her classroom, as well as Ms. Hendrix's classroom, in May 2008. In June 2008, Ms. Hendrix participated in a summer institute, designed and presented by the research center, in which district mathematics teachers learned about and collaboratively explored issues of language in the mathematics classroom. In an effort to support the teachers to continue their development around these issues, I joined the Southwest teacher team at their school at the start of the 2008-2009 school year.

Our collaboration was initially centered on the complexities of integrating reform-based mathematics instruction with first and second language development. Each teacher articulated a personal instructional objective, towards which we would work together to accomplish. For example, Ms. Hendrix expressed her desire to create lessons that would allow students more opportunities to use and develop mathematical language. Ms. Lenihan wanted to explore various ways to develop students' ability to communicate mathematically through writing. While issues of language and mathematics were originally the centerpieces of our collaboration, group meetings eventually were taken over by teachers' preoccupations about curriculum coverage and standardized tests. It became clear that the teachers lacked a clear curricular vision for the school year.

While curriculum certainly plays an important role in Mathematics discourse Communities, I aimed to avoid this same divergence of attention in this study by working with the teachers to map out a curriculum plan for the year during the summer months or the weeks preceding the start of the school year. The idea was that, with a well-conceived curricular plan already in place, our collective attention can be primarily dedicated to pedagogical issues. Ms. Lenihan and Ms. Hendrix were excited to alleviate themselves of this workload before school started, though, as we will see in the next chapter, it did not help maintain our focus on the strengths and needs of their Latina/o students.

2. The School

Southwest Elementary School is located on the southwest side of a large, Midwestern city. It is a unique school, because it operates two buildings a block apart from one another. Grades K-6 are in the main building, and the grades 7 and 8 are in the middle school “branch,” a small building that lacks many amenities normally found in schools. For example, there is no cafeteria, specialty rooms (i.e. art, computers, music), or library. Both buildings are severely overcrowded, and the principal has been working to get modular classrooms put on the grounds for the upcoming school year. In the main building this past year, two classes shared space in the library to conduct class.

The student body of Southwest Elementary School consists of nearly 1200 students and is 85% Latina/o, 7.8% White (majority of Middle-eastern decent), 6.2% Black, and 1% multi-racial. Approximately 91% of the students are eligible for the free or reduced lunch program. School officials describe the community as “blue-collar workers” and “low income.” Importantly, upwards of 30% of students are enrolled in Bilingual or ESL programs, though I estimate that at least 85% of students come from homes where a language other than English is spoken, and the majority of these

students reside in Spanish-speaking households. The students in Ms. Lenihan's and Ms. Hendrix's mathematics classes are reflective of these school demographics.

3. The Teachers

Ms. Lenihan teaches mathematics to all of the 7th grade students, and Ms. Hendrix teaches mathematics to all of the 8th grade students. This past year, each of them was responsible for teaching an additional class of Language Arts (i.e., vocabulary development) to their homeroom class. At the time of the study, Ms. Lenihan just completed her second year at Stevenson, and her third year overall. Prior to teaching at Southwest, she taught at a high school in an urban-suburban area immediately outside of the city. She is a young, White, energetic, monolingual teacher who completed her teacher preparation at a prestigious local university. She often speaks of trying to create a classroom that is "student-centered." As a result, students' desks are arranged in clusters, and on most days, the students are given an activity in which they are to work with their groups. Though she has access to mathematics textbooks, she chooses not to use them with her classes. Instead, she strives to develop meaningful mathematics lessons that are project-based and grounded, as much as possible, in the lived experiences of her students.

Ms. Hendrix has just completed her second year at Southwest as well, and her third year overall. Prior to teaching at Southwest, she taught for one year at an elementary school in a predominantly Latina/o neighborhood on the city's west side. She is a young, African American, relatively traditional teacher who completed her teacher preparation at a local state university. Ms. Hendrix's instructional style can generally be described as teacher-centered, though she has ambitions to promote a more collaborative, student-centered classroom. For the first half of the school year, students' desks were arranged in rows. Almost exclusively, classroom interactions follow an initiation-response-evaluation (IRE) format, meaning that Ms. Hendrix would ask a

question, a student would be selected to respond, and then she would comment on the student's response and generally move on. Most questions are "known answer" questions; that is, there is a pre-determined solution, so students either know the answer or they don't, minimizing cognitive engagement. Finally, though Ms. Hendrix speaks limited Spanish (e.g. *Tienes tu tarea?* [Do you have your homework?]), I classify her as monolingual. One of the reasons I make this classification is because she is either not capable or not comfortable speaking Spanish at length with Spanish-speakers (i.e., students, parents).

4. The Sociopolitical Context

It is important to recognize that the teachers and school are situated in a high-pressure, high-stakes atmosphere surrounded by innumerable tensions. They are nested in an enormous bureaucracy, one that is under constant and heightened scrutiny to raise students' performance on standardized exams, and one that is directed by a Board of Education that is not democratically-elected, but rather appointed by the mayor. As Lipman (2011) points out, this political dynamic manifests in many different forms and has contributed to dramatic struggles to protect, and in some cases re-claim, neighborhood schools.

Furthermore, the teachers, principals, parents, and students in this local context of schooling also must mitigate the increasingly restrictive demands of the federal government (Meier, 2001; Ravitch, 2010). That is, they are constantly in a situation where they must make pedagogical and curricular decisions that will ultimately result in the better results on the state's standardized exams (Kennedy, 2005).

5. Data Collection

The data collection process focused on two primary data sources: discourse (i.e., dialogue) and observations. In the sections below, I describe my approach to data collection, as well as the nuances inherent in these types of data.

a. Discourse and Dialogue

As I have mentioned, observations and conversations were the two primary instruments for collecting data. I approached conversations, or dialogue, through a Bakhtinian vein (Brandist, 2002). That is, I conceptualized dialogue as revealing important insights into the subjects' social reality. Dialogue "develops in close connection with the 'historical conditions of the social situation'" (Voloshinov, 1973, c.f. Brandist, 2002). In this sense, dialogue is much more than words, and therefore, I was able to infer more than what the literal meaning of words allows (Gee, 2008a). Because of its rich utility, I engaged in dialogue for multiple purposes, and with varying degrees of formality.

First, conversations more formal in nature were utilized to access the meaning teachers make of MdC's. How the teachers conceptualize MdC's and what they perceive as the benefits or challenges of implementing such a mathematics learning environment with Latinas/os were focal points of our conversations. This is a crucial understanding to have, as it served as a reference point to judge whether or not their actions (instructional decisions) are in line with their proclamations. Additionally, I was able to monitor the evolution of their thoughts on MdC's as the year progressed, though this was not the targeted focus of my investigation.

Dialoguing with the teachers also helped me gather supplementary information to fill gaps in incomplete data sets or conceptualizations. For example, in a formal conversation, a teacher said that she wanted to differentiate concept development. At the time this statement was made, I

presumed to know what she meant. However, upon deeper thought or analysis, I realized that the term *differentiated* was ambiguous and could have meant many different things. As a result, I initiated a conversation – more informal in nature, but with no less intention – that provided greater clarity as to what was likely meant by that statement.

The acquisition of additional information, however, was needed in more situations than simply to clarify meanings. For example, I was intrigued by a particular pedagogical move and wanted to determine the inspiration or thinking behind the move. This type of information warranted either an impromptu or delayed conversation. In the case of a delayed conversation, it was more important to produce a detailed account of the incident so that a stimulated recall could occur and an accurate recollection of the event could be determined.

As I have illustrated, dialogue took on both a formal and informal character, depending on the timing, setting, content of information sought, and urgency. To obtain foundational data on the teachers' design and implementation of MdC's, I met together with both teachers weekly for planning sessions, sometimes twice per week, for a total of 31 sessions. We worked collaboratively to render clearer understandings of mathematics pedagogy that is effective with bilingual students, all while trying to deepen our collective understanding of the role of mathematics discourse and the various ways individual students interact with the mathematics discourse. We read literature, reflected on our practices, and discussed the struggles inherent in creating, developing, and sustaining thoughtful MdC's. These dialogic interactions were more formal given the directedness of the task at hand; that is, in these situations, we had an agenda, or an objective, that we were acutely aimed at accomplishing, and the conceptual framework of MdC's was intended to help us form establish a framework within which we our work was conducted.

At other times, I dialogued individually with teachers. This took on many forms, such as a brief question in between classes or a more focused debriefing session during a preparatory period or lunch. It was important for me to take advantage of all available opportunities to strengthen the robustness of the data set, and thus gain a more thorough understanding of the phenomenon. Most conversations were audio-recorded. There were, however, shorter, impromptu conversations, which I captured in my field notebook I carried with me daily.

b. Observations

In order to understand the teacher's role in the mathematical socialization process, it was crucial that I regularly observed in the classroom, paying close attention to the instructional practices enacted and language used by the teacher to convey particular meanings. In addition to the discrete actions and verbal instruction of the teacher, I focused on the physical learning environment established by the teacher: What is the culture of the classroom/school? What ideological dispositions are worked up in this space? How are the students arranged? Are there multiple modes of conveying information? What are the resources from which students are to draw in order to problem solve effectively? What are the classroom norms? What is the temporal structure of the class?

All of these questions imply specific arrangements created by the teacher in order to facilitate mathematics learning. These arrangements reflect particular philosophies of mathematics learning and have distinct influences. Naturally, it was important that I observe and probe the subsequent responses of the students in order to assess the impact of the various instructional practices and learning arrangements. Furthermore, I participated in faculty meetings other opportunities that arose that contributed to a more clear understanding of the meaning these teachers

attributed to the role of mathematics discourse as part of mathematical learning in a second language.

6. Data Management

I took fieldnotes daily to supplement the video and audio-recordings. Fieldnotes were critical in providing the context and atmosphere that was not captured on video or audio-recordings. All fieldnotes were typed promptly and organized chronologically. Likewise, all video and audio-recordings were digitized, uploaded to a data management software, and organized both chronologically and according to what type of session was recorded (i.e., planning session, class session, debriefing session).

I used Nvivo, a data organization software, to manage my data. Nvivo was useful because it organized data thematically in a manner that resembles a “tree”; that is, codes are positioned as nodes, and sub-codes can “branch off” of any given nodes. Nvivo facilitated the processes of coding, data retrieval, and cross-case analysis.

7. Data Analysis

For data analysis, I used two approaches to arrive at appropriate and accurate claims about the phenomenon of my investigation: grounded theory (and constant comparative method) and critical discourse analysis.

a. Grounded Theory

I used grounded theory (Glaser & Strauss, 1967; Corbin & Strauss, 2008) to isolate the most important themes that surfaced in the data. These themes resulted from an ongoing analysis of the empirical data and were developed in concert with the theoretical lens through which the data is evaluated. For example, I sought to discover themes pertaining to mathematical ideologies, the

nature of student interactions, and the nature of mathematical discourse, mathematics language development facilitation, and mathematical practices.

Additionally, this approach allowed for the emergence of unsuspected themes. When this happened, I consulted new literature in order to make sense of these themes that I had not previously considered. The new themes ultimately resulted in an addendum to the pre-conceived, operating theoretical framework of MdC's. As this occurred, the theoretical framework fit my findings and arguments, as opposed to trying to "fit" my findings and conclusions to a particular framework. Valenzuela (1999) refers to this as an effort to "build – rather than simply test – theory" (p. 274).

b. Constant Comparative Methodology

In order to place and maintain boundaries on my categories, I used cross-case analysis (Miles & Huberman, 1994). This technique entailed comparing successive examples of a particular category with those originally found. By making continual comparisons, I was put in a constant state of reflection; that is, I was continually evaluating whether instances fit the category or code. It facilitated the process of making sound claims based on the data, because categories are held to well-defined terms.

Constant comparative methodology, also introduced by Glaser & Straus (1967), is

[a] strategy [that] combines inductive category coding with a simultaneous comparison of all social incidents observed. As social phenomena are recorded and classified, they also are compared across categories. Thus, the discovery of relationships, that is, hypothesis generation, begins with the analysis of initial observations, undergoes continuous refinement throughout the data collection and analysis process, and continuously feeds back into the process of category coding (Goetz & LeCompte, 1981, p. 58).

From this description, we can see that constant comparative methodology is a natural extension of grounded theory. In the case of Ms. Hendrix and Ms. Lenihan, they thought differently

about how mathematics and mathematics discourse should be taught to students and consequently, planned and implemented lessons differently. This is not surprising given that they have had different experiences with teaching and learning mathematics, and in life more generally. As a result, they have created noticeably different classroom environments. For these reasons, they offered a juxtaposition of what happens in the mathematics socialization process in different classroom environments. They conceptualized and approached mathematics teaching and learning with Latinas/os in markedly different ways. With just one teacher, certain elements of Mathematics discourse Communities likely would not have emerged as readily or apparently as when there was a comparative case.

Additionally, I was able to make a relatively controlled comparison since the students were in the same building, operating under the same school policies, structures, and norms; they were demographically similar since they come from the same neighborhood; and, they have had comparable mathematics histories, since they have likely attended the same elementary school, perhaps with the same teachers.

c. Critical Discourse Analysis

“Language is inextricably bound up with ideology and cannot be analyzed or understood apart from it” (Gee, 2008a, p. ix). This is the underlying rationale for discourse analysis. Because of the intimate relationship between language and ideology, created through sociohistorical interactions, discourse needs to be analyzed in a particular way. Critical discourse analysis aims to answer that call. Traditionally, most discourse analyses only consider the literal value of words; that is, what can be seen or heard in this moment. Gutiérrez and Stone (2000), however, argue for a critical discourse analysis that accounts for the vertical text, or the diachronic history of a text, which considers the sociohistorical context that informs and supplements what is being said.

The primary data source from which I drew conclusions was classroom discourse. A secondary data source was the content of the conversations I had with teachers. In both cases, what was said (and not said) and how it was said helped reveal how the person (teacher, student, or myself) was thinking about a particular issue at a particular moment in time.

IV. FINDINGS

A. Overview

In this chapter, I will present and interpret data from my ethnographic study that respond to the primary research question, *How do monolingual middle school teachers develop and utilize mathematics discourse communities with Latina/o students?* There are three sub-questions to disaggregate aspects of the teachers' efforts to develop and implement Mathematics discourse Communities (MdC) with Latinas/os:

- *What issues and challenges surround the teachers' development and utilization of Mathematics discourse Communities?*
- *What linguistic factors influence the development and utilization of Mathematics discourse Communities?*
- *What ideological, knowledge, and skill factors influence the development and utilization of Mathematics discourse Communities?*

This investigation has produced three critical findings. Below, the findings are divided into sections as they relate to the three sub-questions. This delineation is not meant to imply that the a particular finding neatly and exclusively addresses one sub-question, as each finding certainly informs the others:

Issues and Challenges Surrounding Teachers' Development of MdC's

1) There were tensions around the teachers' efforts to take up and interrogate the concept of MdC's. This was reflected in teacher planning that rarely took into consideration the unique strengths and needs of emerging bilingual students, yet, at the same time, this planning was driven by particular ideologies about Latinas/os and mathematics learning. Furthermore, a lack of a conceptual framework emphasizing inclusion lead to teacher difficulties at including Latina/o students in mathematical discourses and helping them access the mathematical concepts at hand – especially those students who are developing proficiency in English.

Linguistic Factors Influencing Teachers' Development of MdC's

2) There is confusion as to what constitutes mathematics discourse and its role in developing mathematical understanding, and how to create discursive structures to support students' development of mathematics discourse.

Ideological and Skill-based Factors Influencing Teachers' Development of MdC's

3) The teachers maintain distinct language ideologies and perceptions of Latina/o learners that tacitly influence their design and implementation of MdC's. This leads to uncertainty about what is within or outside of their responsibilities as mathematics teachers of Latina/o students, including supporting students as they take on the additional task of learning English, and specifically, mathematical discourse.

In order to get a better sense of who are the two teachers and what they are aiming to accomplish, I will briefly describe their teaching philosophies and approaches to mathematics teaching and learning. Next, I present data and findings on the issues and challenges surrounding how the teachers' related to the notion of MdC's and how their planning reflected this relationship. This data presentation and discussion then leads to a more detailed analysis of the linguistic dimensions of the MdC's created, specifically addressing what the teachers thought constituted mathematics discourse and how they struggled to supported students' mathematics discourse development. Finally, I present remaining data and findings around the skill sets and ideologies the teachers possessed that lead to the particular MdC's that were enacted.

B. Reiteration of Mathematics discourse Communities

Prior to proceeding, however, it is important to reiterate what I mean by MdC's. While every mathematics teacher uses a variation of talk to explain mathematical concepts, deliver instructions, or respond to students' questions, I am primarily referring to the community established when the teacher explicitly promotes and aides in the development of students' use of mathematical talk *in meaningful ways*. In MdC's, it is a primary objective to help students develop their mathematical language, as the development of mathematical language parallels the development of mathematical understandings (Chapin et al., 2009; Chval & Khisty, 2002; Moschkovich, 2011; Pimm, 1987; Setati, 2008). To this end, students are consistently encouraged and called upon to use mathematical talk in multiple formats (i.e. partner talk, small group

discussion, whole class discussion, in writing). Students' mathematical thinking and representations often serve as the source of such talk, and being able to comment on and question a peer's rationale or justification is evidence of a desirable MdC. Consistent with this environment, there is recognition by the teacher that the role of students' mathematical talk is not only to give answers or reveal to him or her any misconceptions the student might have. Rather, ideal MdC's regularly utilize cognitively demanding tasks that allow for substantive mathematical talk, and this talk is aimed at facilitating the mathematical meaning-making process, both individually and collectively.

Furthermore, the language used by the teacher as she talks about mathematics or represents ways of doing mathematics is significant, because it is a privileged perspective (i.e. it comes from an authority figure) and, therefore, exposes students to a particular set of assumptions and beliefs about doing mathematics and being mathematically competent that are not neutral. As a result, it becomes exceedingly easy to reproduce patterns of success and failure amongst groups of students who have historically had limited success in terms of traditional mathematics achievement measures (e.g. standardized test scores, enrollment in advanced mathematics courses). On the other hand, teachers who acknowledge the presence of dominant and pervasive mathematical ideologies/narratives are more likely to disrupt such reproduction of mathematical success as delineated by demographic groups (Adler & Davis, 2006; Martin, 2009a; Stazjn, 2003; Varley Gutierrez et al., 2011).

In the context of teaching and learning mathematics with Latinas/os, it is important to consider MdC's for many reasons. Significantly, many Latinas/os – including the majority of students taught by the teachers in this study – are not native English speakers, and among those who are, a variety of English is often spoken that is not the premium variety valued in schools. In order to become proficient in social spaces that operate in the specialized discourse of mathematics (in

English, nonetheless), Latinas/os need abundant opportunities to practice speaking, listening, and writing mathematically – not so much for the purpose of “learning English,” but rather in order to thrive in discursive environments that require stamina and high levels of cognitive demand as participants engage in mathematical meaning making.

Given these interacting phenomena – among other sociopolitical dynamics of schooling articulated in earlier chapters – it becomes important to examine the ecology within which Latinas/os are learning mathematics. The conceptual construct of MdC’s allows us to tend to the mathematical language, norms, values, and activities created and implemented by the teachers with their Latina/o learners.

C. Description of Teachers

As described in Chapter 3, Ms. Lenihan and Ms. Hendrix teach at a school with a student population that is largely bilingual and Latina/o. During the course of this study, the two teachers were enrolled in a Masters degree program that would earn them the Bilingual/English as a Second Language endorsement. Thus, at the time of the events described hereforth, they had taken or were concurrently taking courses such as *Linguistics for Teachers*, *Bilingualism and Literacy in a Second Language*, and *Assessment and Instruction: A Multilingual/Multicultural Perspective*, among others. The curriculum and ensuing discussions in these courses involved topics such as historical and sociopolitical dimensions of schooling of bilingual students; language varieties, biases, and ideologies; and approaches to engaging bilingual students in meaningful ways as they navigate the world in a new language, represented in a multitude of primary and secondary discourses (Gee, 2008). Often times, course readings and discussions about bilingualism were accompanied by assignments requiring students to interact with emerging bilingual students, and to document and analyze those experiences in light of the literature.

In an effort to contextualize the findings, I will provide a summary of Ms. Lenihan and Ms. Hendrix's backgrounds and teaching styles. The summary is designed to provide the reader with pertinent information that will illuminate common issues, as well as contrast different perspectives (in terms of what it means to teach and learn mathematics with Latina/o students) and pedagogical approaches.

1. Brief Description of Ms. Lenihan

Ms. Lenihan teaches mathematics to all of the 7th grade students (five different cohorts) in 40-minute class periods. She is also responsible for teaching either Language Arts (essentially, vocabulary development) or writing to her homeroom class. Ms. Lenihan is in her third year at Southwest, and her fourth year of teaching overall. She is a young, White, energetic teacher who completed her teacher preparation at a well-known, local private university. She is monolingual (English-speaking), who does not feel comfortable speaking any Spanish.

Ms. Lenihan often remarks about the importance of being able to communicate mathematically. Helping students to “use mathematics language” is her personal pedagogical goal to work on for during the school year with respect to teaching mathematics to Latinas/os. One effort she has made towards this goal is to help develop her students' ability to write proficiently about mathematics problem-solving activities. Her motivation for this goal is largely rooted in the state's assessment program, which requires students to respond to multiple “extended response” items; thus, she has developed a six-step extended response protocol – based on the criteria and formula used to score the written responses – that prescribes to students how they should write. Furthermore, she regularly draws on past test questions in order to help her students improve their mathematics writing skills. As a result, writing becomes a mechanical task to prove one's mathematical

knowledge rather than a tool to assist in the mathematical meaning-making and language development processes.

In the case of Ms. Lenihan, we have a teacher who recognizes that what Latina/o students get by way of mathematics education is largely ineffective. She is well-intentioned, ambitious, and quick to point out “traditional” mathematics teaching approaches in her school and elsewhere. She attempts to create a mathematics learning environment that engages Latina/o students through projects and activities that reflect the context of their lives. This effort, however, is frequently compromised by a perceived need to directly prepare students for the standardized assessment with structures like writing via a protocol and regular practice with test item questions. In addition, Ms. Lenihan strives to establish a mathematics classroom in which students have opportunities to talk. For example, students, situated in small clusters, are often asked to discuss collaboratively an impromptu question as a means to develop an understanding of a mathematical idea. But, as we will see in more depth below, these opportunities are not carefully implemented, which, with students that Ms. Lenihan recognizes don’t have a history of using substantial talk in mathematics class, leads to a community of frustrated learners in which only a relatively small number of students regularly and meaningfully participate discursively. In other words, steadfast participation patterns – in which only an outspoken few are consistently engaged – are not disrupted.

With Latina/o students in mind, this MDC represents only a small departure from the mathematics classrooms that serve well only a small fraction of the students. The pedagogical moves meant to be transformative, such as providing students with more opportunities to talk mathematically, do not automatically have the effect I think Ms. Lenihan hoped for. The remainder of this chapter unpacks the struggles and conflicting initiatives that complicate the development and implementation of an optimal MDC for Latina/o learners.

2. Brief Description of Ms. Hendrix

Our second mathematics teacher, Ms. Hendrix, teaches mathematics to all of the 8th graders (5 different cohorts) in 40-minute periods, and like Ms. Lenihan, she is responsible for teaching one section of Language Arts (vocabulary development) to her homeroom class. Ms. Hendrix is in her third year at Southwest as well, and her fifth year teaching overall. Prior to Southwest, she taught for two years at an elementary school in a predominantly Latina/o neighborhood on the city's west side. She is a young, African American, relatively traditional teacher who completed her teacher preparation at a local state university. Ms. Hendrix's disposition is calm and collected, and her teaching style is consistent and traditional. Her personal pedagogical goal with respect to teaching mathematics to Latinas/os is to provide opportunities for students to talk mathematically through group work; in essence, she wanted to "find out a way to talk less and keep them engaged [and] motivated."

Ms. Hendrix speaks limited Spanish. While teaching, the Spanish she uses is limited to simple phrases like, "*Tienes tu tarea?*" ("Do you have your homework?"). She confesses to her class on the first day of school, "I speak a little Spanish – mostly the bad words." Though her level of bilingualism is debatable, I classify her as monolingual. One of the reasons I make this classification is because she is either not capable or not comfortable speaking Spanish at length with Spanish-speakers (i.e., students, parents). To the contrary, there are times when Ms. Hendrix appears uncomfortable when in the vicinity of Spanish conversations. In one incident I witnessed, she stifled a legitimate academic conversation in Spanish when she thought it was off-topic.

Ms. Hendrix's instructional style is largely teacher-centered, though she has ambitions to promote a more collaborative, student-centered classroom. For the first half of the school year, students' desks were arranged in rows, but were later rearranged to accommodate more interactive

learning. Her authoritative role in the classroom is reflected by particular practices – some seemingly insignificant – to which the students are to conform. For example, she devotes considerable time to making sure each student’s binder tabs are arranged in a particular order. When explaining to students why the tabs must be in this order, Ms. Hendrix says, “I don’t know why. I guess I’m picky. Because this is the order we do things [in a typical class period]. You can do it your own way. You’ll probably lose a point when I check it, but it shouldn’t hurt your grade too much.”

Importantly, Ms. Hendrix, is exceedingly warm and compassionate, despite the regimented classroom she maintains. While Ms. Hendrix seems less committed to making significant pedagogical adjustments in her class in order to establish a drastically different mathematics learning environment for Latina/o learners, her case is noteworthy nonetheless. It is evident that she whole-heartedly believes that creating a caring environment is fundamental to Latina/o students’ success in school, a concept covered in depth in the Masters program (e.g. Valenzuela, 1999). This effort gets us to the point where we have earned the trust of the students, a significant accomplishment. Where Ms. Hendrix struggles, however, is re-conceiving how Latina/o students engage with mathematics tasks so that there are plentiful opportunities to construct meaning and understanding of mathematical ideas and the connections amongst them. One implication of this struggle is the denial of two primary dynamics that aid Latina/o in their mathematics learning environments: language and social interaction.

D. Findings

In the sections that follow, I will specifically address the major question of this study: *How do monolingual middle school teachers develop and utilize Mathematics discourse Communities with Latina/o students?* I will unpack my findings according to three sub-questions:

- *What issues and challenges surround the teachers' development and utilization of Mathematics discourse Communities?*
- *What linguistic factors influence the development and utilization of Mathematics discourse Communities?*
- *What ideological, knowledge, and skill factors influence the development and utilization of Mathematics discourse Communities?*

While I recognize that my findings from this ethnographic study do not fall neatly within only one of these sub-questions, I attempt to respond to each systematically. There are times, however, when data and findings pertain to two sub-questions; in these cases, I attempt to make this clear. It should also be pointed out that data presented in later sections will likely contribute to a more complete picture of the teachers' development of MdC's, and thus offer more complete answers to the three sub-questions.

Also, although both teachers expressed interest in wanting to modify their teaching practices to accommodate bilingual students through MdC's, based on my observations, Ms. Hendrix's instruction rarely moved beyond traditional discourse patterns (i.e. teacher initiates a question, student responds, teacher evaluates the response [IRE]), and there was little change by way of differentiated patterns of student participation and engagement. Therefore, I was not able to gather as much meaningful data about her trials with respect to how teachers grapple with the idea of implementing MdC's for Latinas/os. Consequently, most of the data and findings presented here relate to Ms. Lenihan. Nevertheless, Ms. Hendrix provided an important contrast to Ms. Lenihan's MdC, which was the purpose of having two subjects in the first place.

Finally, at times throughout the analysis of the data, I juxtapose the actions and words of the teachers against the literature on language/discourse development or hypothetical practices I envision as being more supportive of bilingual students' mathematics discourse development. Inherent in these decisions and presentations are my own language ideologies. This ought not be

interpreted as a declaration of the “right” way to conduct a classroom, or even the appropriate way to view and interact with bilingual Latina/o children. Rather, it is a contrast I deemed necessary to showcase the complexities of re-creating mathematics classrooms that are focused on re-positioning Latina/o students as engaged, participating, and communicative mathematics learners.

1. Issues and Challenges Surrounding Implementation of Exceptional MdC’s

In response to the first sub-question, I will describe three findings: 1) the tensions teachers experienced as they struggled to understand and take ownership of the concept of MdC’s; 2) the social context and climate of the school within which teachers tended to plan hastily and without consideration for their students’ strengths and various language development needs, yet in accordance with their ideologies about Latinas/os and mathematics learning; and, 3) the teachers’ struggles to model and promote an inclusive learning environment for emerging bilingual students (i.e. students who have begun schooling in the U.S. within the past year, or those whose schooling experiences in the U.S. have not positioned them for successful engagement with academic English) and support their access to the central mathematical ideas of lessons or activities.

a. Teachers’ (Missing) Appropriation of MdC’s

Perhaps most important to unpack prior to presenting the other findings is the issue that the teachers did not take up nor interrogate the idea of MdC’s. That is, the two teachers did not acknowledge MdC’s as a useful framework with which they can think about students’ patterns of mathematical talk, engagement, and participation. While this raises a number of questions about the political nature and aspects of MdC’s that inhibited the teachers’ utilization of the framework, for the scope of this paper, I will focus on the specific pedagogical tenets of MdC’s rooted in socio-cultural perspectives of mathematics education of Latina/o youth that the teachers *did* “buy into” (e.g. learning is mediated through language, and supported through opportunities to practice

mathematics discourse and through interactions with peers), but did not necessarily know how to optimally operationalize this framework to execute their ambitions and complete the teaching-assessment-reflection-planning cycle with fidelity.

In the following section, I present some episodes of the teachers in action that illustrate their incomplete understanding of MdC's.

i. How do the Teachers Approach the Use and Development of Mathematical discourse?

There is evidence that the teachers believe in the importance of mathematical communication. Besides them prioritizing mathematical communication as their personal pedagogical objectives, both teachers dedicate time for students to discuss mathematical ideas. Though they offer students this opportunity, the mathematical ideas to be discussed vary widely in substance, and the two teachers offer varying amounts of time and structure to support mathematical conversations. In addition, Ms. Lenihan and Ms. Hendrix have varying degrees of understanding as to the purpose of providing spaces for students to talk mathematically.

To illustrate, consider the following episode during a rational numbers lesson in Ms. Lenihan's class:

As usual, the day begins with a warm-up problem. The following appears on the board:

Put the #'s in order from least to greatest: $\frac{8}{3}$, $\frac{63}{7}$, 0.25, $12\frac{1}{2}\%$

As the students work individually, it quickly becomes apparent that the students are struggling with the meaning of $12\frac{1}{2}\%$. When Ms. Lenihan brings the class back together, many students share with her that they think it equals 1,250, apparently moving the decimal point two positions to the right. Ms. Lenihan suggests that this equality does not logically make sense, and she asks the students to consider 12.5% "as a portion of a pizza." Interestingly, the moment Ms. Lenihan is about to say "pizza," one student finished her thought with the word "whole," but his appropriate use of mathematics language is left unacknowledged. Hurriedly, Ms. Lenihan quickly instructs the students to "discuss in your groups why 12.5% is less than 1."

A small number of students tentatively offer their thinking on the discussion prompt Ms. Lenihan has presented. Long periods of silence separate students comments, perhaps marking students' confusion around what they might say. Concurrently, Ms. Lenihan floats from group to group, listening and offering challenging questions mixed with pointed explanations.

After two minutes (marked by the ding of the timer she sets), and after she felt she had sufficiently convinced the students that 12.5% was a fractional part less than 1 when circulating from group to group, Ms. Lenihan (L) offered the following summary:

L: So, 1,250 doesn't make sense; neither does 12.5 pizzas. The decimal has to be less than 1.

Expressing frustration with this hurried process of reaching this "simple" solution – not to mention trying to converse about abstract quantities - one student commented:

St: It's easier to do it on the board than talk about it.

Next, Ms. Lenihan quickly moves on to the lesson of the day: converting fractional parts of a circle into percentage equivalents (e.g. $6/24 = 1/4$; $1/4(360^\circ) = 90^\circ$). She delivers this lesson in 4 or 5 minutes with the solution already written up from the previous class. Ms. Lenihan talks very fast in an effort to complete this lesson and the rest of her objectives in the short 37-minute class period. Importantly, she does not conduct any verbal checks for understanding (though she may be reading the students' facial expressions) nor does she involve students in this explanation.

This is a common scenario in Ms. Lenihan's classroom. Lessons always involve some sort of mini-lesson, or presentation of the mathematical idea. This teacher-led presentation is sometimes embedded in the Warm-up, as in this case, and typically precedes any exploratory activity designed to complement or reinforce the mathematical idea presented. Ms. Lenihan periodically, although not abundantly, solicits students input as they move forward. This solicitation of answers to basic questions is primarily a mechanism to ensure that students are following along and arriving at the point she is trying to make, though Ms. Lenihan is sensitive to collective confusion. If the back-and-forth is not unfolding as fluidly as Ms. Lenihan would like, she will stop and adjust. Frequently, she creates an impromptu discussion question and hands the conversation over to the small groups.

Theoretically, this move creates a platform for the students to access different ways of thinking about the issue and make sense of an idea together.

While this instructional move is in alignment with a sociocultural perspective of meaning-making, it is the group conversations that result that illustrate the limitations of Ms. Lenihan's discourse facilitation. In this example, the discussion prompt is clearly improvised and didn't appear to garner the substantive mathematical ideas she would have liked. It appears as though Ms. Lenihan was driven by the importance of giving students an opportunity to talk in order to make sense of a mathematical idea; yet, she didn't seem to realize that what she was asking students to talk about is precisely what they collectively didn't understand. The students' hesitation to talk is understandable since they didn't originally agree with the idea that 12.5% is less than 1, and haven't been given sufficient rationale or provocation to change their mathematical understanding. An intermediate question to consider – such as, “What is the relationship between 12.5% and 100%?” – might better facilitate students' sense-making process. I recognize, however, that this is a tenuous pedagogical dilemma since inserting these intermediate steps – as well as affording students the opportunity to discuss and grapple with mathematical ideas – requires more time, requires thorough preparation to manage and leverage students' thinking, and skipping to the conclusion is more time-efficient.

Meanwhile, there is no evidence to support the idea the teachers see within their roles the responsibility to help students develop a new, mathematical discourse. To the contrary, the data shows that they perceive mathematical discourse development to come automatically when they provide students with opportunities to talk and encourage them interact with their peers. There appears to be confusion as to how to underscore and develop mathematical discourse, and this confusion is compounded by limited attention paid to how these communicative spaces are

benefiting the students mathematically, as will be shown in the “Language Dimensions Influencing the Development of MdC’s” section below.

ii. **What is the Relationship Between Mathematics discourse and Learning?**

An important element of the manifestation of MdC’s is how the teacher perceives the role of discourse as it relates to the mathematics learning of Latina/o students. Historically and globally, mathematics discourse has not been a top priority. Both teachers report, however, that they believe in the role of mathematics discourse in the learning process. But, what level of meta-awareness exists as to how and when they should facilitate discourse development? What discursive practices need to be employed in order to maximize mathematics learning?

In the following example, which comes near the end of our time together, Ms. Lenihan reflects on her role during small group facilitation. The students she is referring to are fifth-graders, with whom she has been working with periodically as part of her role as Mathematics Coach for the school. They had just completed a project in which they built a small model car of paper; Ms. Lenihan incorporated geometry concepts into this project.

C: What kind of conversations were they having?

L: Some of the conversations were, like, for instance, how your base and your height are different. [I asked,] “Why did you name that shape square?” So, the girls just looked at each other, then they come up with, “Well, its just a rectangle.” And, then they changed the name of it to a rectangle, because a rectangle has different bases and heights...[*Moving on to another example*] This student had the base and the height for the circle. And, I said, “What does the base and the height have to do with finding the area?” And, he kind of looked at me, and he’s like, “Well, a circle has a radius.” So, then I said, “Well, you know, how can you then use that information and figure out what the area is?” And, he said, “Oh, I have to go back and measure the radius instead of the base and the height.” And, I was like, “What were the base and the height anyway?” And, he said, “I, I don’t know. It doesn’t have a base and a height.”

C: So, would you say, your role is more, kind of like, um –

L: (*interrupting*) Individual.

C: Say more about that. Like, what do you mean?

L: I felt, like, each group, like how you have kids that understand things, and some don't, and some are into actually start cutting out, and you had all different learners in the same room, so it was very individual.

C: So, your focus was more, you know, diffusing or undoing misconceptions -

L: Yeah (*simultaneously speaking*)

C: you know, repairing -

L: Yeah (*simultaneously speaking*)

C: um, errors -

L: Yeah (*simultaneously speaking*)

C: or whatnot?

L: So, just going group to group, "What are you doing? Let's get out, you know, look at your design. What shape are you doing?" And, some kids even said to me, "Well, I'm just counting the boxes." So, that was, like, if I could go back to January, that's how we started off our unit about area, was just counting each individual box, and then we got to a shape that was this big (*motioning with her hands a shape the size of a piece of paper*), and I said, "Well, this is going to take a long time to count all of this. We can use a formula. We can use a short-cut."

This exchange reveals a lot about how Ms. Lenihan perceives her role in helping Latina/o students learn mathematics. Notice that the focus of the teacher-led dialogue is to arrive at particular answers or recall known information (e.g. properties of a rectangle, how we use the radius to calculate the area of a circle). And, if these answers don't emerge, discourse is used to diagnose and confront students' misconceptions. What is important here is that there is no mention of a responsibility to support and develop students' mathematical language. If Ms. Lenihan believes that language development is a goal of mathematics discourse, it is noticeably subjugated to the idea that discourse is utilized to expose what is known.

In addition, she repeatedly mentions the different levels of students. It becomes clear that she sees this as an obstacle *and* a justification for her actions. Discourse is used primarily as a means to communicate that the student has made an error or that their current understanding is off target. From her comments, it seems as though dialogue is primarily utilized to correct these instances of misunderstanding, and it is largely used to address individual needs (as opposed to developing collective understandings). Therefore, she doesn't necessarily have to think about how she will approach the facilitation of the activity. Rather, her default actions will be to go "group-to-group" to check in on them, make sure they are following the protocol she has developed, and (discursively) guide them to a correct answer.

In effect, Ms. Lenihan positions herself as the primary mathematical authority in the classroom. She sees herself as the person who needs to repair mathematical errors and misconceptions. Alternatively, she could create a discursive dynamic amongst the group in which students can take on the responsibility to understand how each other is thinking about the same problem, asking each other questions to access their thinking. This would require special attention to help students develop this mathematical habit of mind (Cohen & Lotan, 1995, 2004). Consequently, Ms. Lenihan could turn her attention to shaping the way the students think about, say, the relationship between a formula and the intuitive way one might approach finding the area. Furthermore, she could model discursive practices that help students make meaning around the new ways of speaking mathematically. For example, she could re-voice a student's response to a question, paraphrasing the central idea being communicated with mathematical language and verifying the accuracy of her interpretation. This would result in a different dynamic around how students are expected to interact in small groups and address an accountability issue (in terms of how seriously students take their group tasks) that Ms. Lenihan has long struggled to establish. In

short, a different MDC would be implemented, with different sentiments being attached to what it means to do mathematics.

Still not quite clear on how Ms. Lenihan viewed her role in specifically helping Latinas/os learn mathematics, I asked her to clarify:

C: What do you mean by...Did you say you think your role is the disseminator of information?

L: Yeah.

C: What do you mean by that?

L: Imagine...that you put up three formulas – one for parallelograms, one for triangles, and one for circles – and they’ve had practice with them, but now they have to make sense of it and figure out how do I use each of those formulas. The groups that are great understand it, like your, you know, traditional learners can take it and do the activity and then the kids that are looking at me like I’m crazy, I can sit there individually with them and talk about why that formula and why it makes sense, so you can have individual discussions with the groups.

This exchange is telling of how Ms. Lenihan views the role of “talk”. As she describes here, engaging in mathematics discourse is appropriate when students aren’t understanding a concept; it is thought of as a tool to remediate misconceptions. Notably, Ms. Lenihan distinguishes between “those who get it” and “those who don’t,” as if there are no other places to be on a developmental trajectory. “Those who get it” are “traditional” or normal, and those who don’t require more attention or re-teaching, which, we will see later, creates a source of tension and eventually depletes Ms. Lenihan’s patience and commitment.

iii. Summary

These are specific examples that show Ms. Lenihan’s limited conceptualization of discourse, and in turn, it reveals an incomplete grasp of the complexity and depth of MdC’s. She did not seem to locate her curricular and pedagogical moves – and, consequently, the implications of these moves – in the larger learning ecology within which the students make meaning of mathematics and how

mathematics fits in their lives, and, ultimately, develop mathematical and academic identities. Rather, Ms. Lenihan remained focused on the curriculum planning and facilitation practices to which they had grown accustomed. Despite being participants in conversations around language (broadly defined) in the classroom, there was not a significant departure from the practices I had witnessed in the years prior to this study. While the quantity of opportunities for students to talk may have increased, there was not evidence that the purpose of this talk, as well as the supports offered to improve proficiency in mathematical discourse, coincided with the theoretical construct of MdC's.

Not only did Ms. Lenihan and Ms. Hendrix not appropriate the concept of MdC's to push the boundaries of what they understand about mathematics discourse, but there also is not evidence that suggests they utilize MdC's as a framework to understand the specific sociomathematical ways of being and interacting that are privileged, positioning and conveying certain meanings to students. Indeed, the teachers have engaged with the idea that mathematics teaching and learning comes with a specialized discourse that is different than everyday ways of talking, and I argue that this notion makes sense to them in theory. However, there is little evidence that the teachers understand the practical implications of a discourse community. That is, there is a disconnect between the sense they can make of the theoretical concept – including how they have at one point experienced being a peripheral member of a community operating in a specialized, or secondary, discourse – and how they might enact pedagogical approaches that facilitate bilingual students' navigation through and development of mathematics discourse, a discourse with a history of neglect (Sfard, 2000).

b. Teachers' Planning Process and Considerations for Latinas/os

Another major finding from this ethnography revolves around the critical teaching component of planning: Generally, Ms. Lenihan and Ms. Hendrix planned hastily in the mornings

for the day's lessons. While each accessed different resources (reflecting their personal values surrounding mathematics education), neither planned lessons according to what they knew about Latina/o students' varying strengths and needs.

This is not consistent with what we have learned about optimal teaching – especially with bilingual and other non-dominant students – namely, that it cannot take place without thoughtful and thorough planning that reflects the strengths and needs of the students (Echevarria, Short, & Powers, 2006; Goldenberg, 2008). I will first lay out what took place in planning sessions and share the teachers' thought processes around how they planned for mathematics instruction with bilingual Latinas/os and what guided their planning. These insights will be juxtaposed against what I (and other scholars) identify as important considerations in planning for and implementing effective mathematics discourse communities, specifically MdC's with Latina/o students.

A critical part of establishing an MdC occurs prior to the students entering the classroom; this is the *planning time*. It is during this time that the teachers are afforded the time and resources to create the mathematics learning environment they deem best for the learners – in this case, second language learners. Yet, we know that teachers approach lesson planning differently, especially in what issues and ideas they take under consideration while planning (Echevarria et al., 2006). In order to thoroughly understand the origins of the teachers' actions in the classroom, it is important to examine how the teachers engaged in planning.

As mentioned in the previous chapter and above, I met with Ms. Lenihan and Ms. Hendrix for 31 planning sessions. While the majority of these sessions were treated as regular lesson planning sessions, four sessions were dedicated to collaboratively analyzing the teachers' instructional lessons in an effort to call the teachers' attention to subtleties in mathematical

interactions with Latina/o students and to help the teachers modify their instructional approaches.

Table I depicts the foci represented in each of the planning sessions.

It is important to keep in mind that our collaboration centered on the teachers' self-identified pedagogical objectives around what they would like to focus on with respect to their Latina/o learners. Both teachers, for example, wanted to help their students improve their mathematical communication. In particular, Ms. Lenihan aimed to do this through structured supports in mathematical writing activities. Ms. Hendrix aimed to purposefully create more opportunities for peer-to-peer mathematical discussions. Given the complexities of working with Latina/o learners from a variety of backgrounds, I might expect these conversations to expand into topics such as what constitutes a comprehensible discussion prompt, how we might model explanations of mathematical thinking and questioning, what approaches might be appropriate for engaging disenfranchised learners or learners new to schooling in English, or how we might support parents so that they, in turn, can support their children's mathematical learning.

Despite our efforts to remain focused on addressing the teachers' pedagogical objectives pertaining to Latina/o learners, however, 74% of the sessions were spent discussing the mathematical content to be "covered," generic teaching issues, or school-level issues that did not directly or substantially affect MdC's for Latina/o students. In only about $\frac{1}{4}$ of the planning sessions were the teachers acutely focused on teaching and learning issues specific to their students; these sessions are indicated with a "Yes" in the fourth column on Table 1. For example, in Session 4 Ms. Lenihan solicited feedback on how to utilize mathematics journals, a tool she wanted to incorporate to reach one of her pedagogical goals: supporting students' development of mathematical writing.

Even when the focus began on issues of Latinas/os, the teachers often did not have a way to draw on the classroom mathematical experiences of their students beyond, for example, sweeping

TABLE I
FOCI AND CONTENT OF TEACHERS' PLANNING SESSIONS

Session	Lesson Plans Ready?	Focus of Discussion	Issues of Latinas/os Discussed?
1	No	Rubrics & Journals: Using vocabulary words in sentences, drawing pictures to represent mathematical ideas	None
2	No	Roles in Small Groups & Gestures and Encouraging Spanish	Minimal ²
3	No	Mathematics Content: Data Representations	None
4	No	How to use journals as a tool to help students develop language?	Yes
5	No	Creating a classroom around questioning and argumentation; Direct Teaching	None
6	No	Curriculum Integration; Difficulty Transitioning from Small Groups to Whole Group Discussions	Minimal
7	No	Student Accountability; "Covering" the Curriculum	None
8	No	Facilitating Group Work; Word Problems	None
9	Yes	Rational Number Lesson Planning; Lack of Help from Bilingual Lead Teacher	Minimal
10	Yes	Rational Number Project; Partner/Group Arrangements	None
11	No	Geometry Vocabulary: Radius, Central Angle, Sector, Arc, Chord, Diameter	None
12	No	General Discussion About Discourse Communities and Mathematics Language Development	Yes
13	No	District Benchmark Exams; School's bilingual program; Students' Listening as a means to develop language	Yes
14	No	Writing Workshop	None
15	No	General Curriculum Planning	None
16	No	Writing Rubric for Extended Response Items	None
17	No	School Logistics that Interfere with Mathematics Learning	None
18	No	Brainstorming Session about how to introduce solving algebraic equations	None
19	No	Motivating Students	None
20	No	Algebra tiles; Writing Rubric; Calculator issues	None
21	No	Mathematics Discourse	Yes
22	No	Area of Polygons	None
23	Yes	Dream Home Project	None
24	N/A	Watched Video of Ms. Lenihan's class	Minimal
25	N/A	Watched Video of Ms. Hendrix's class - focus on content	None
26	N/A	Watched Video	None
27	No	Group Discussions; Class Norms	Yes
28	Yes	Converting Exercise to Problem-based Activities	Minimal
29	N/A	Watched Video of Ms. Lenihan's class - focus on content	None
30	Yes	Anti-smoking Unit; Recap of Professional Development: ELLs in the Content Area	Yes
31	No	Spanish in the Classroom; Questions about Students Learning English	Yes

² Issues of Latinas/os surfaced, but no actionable steps were discussed to modify instruction with respect to the issue. In Session 5, for example, displeasure was expressed about one Latina/o student who was incapable of substituting values for variables, but the discussion did not move to supporting this student's conceptual understanding.

statements that their writing needs improvement, which is set against the backdrop of the reality that students' ability to explain mathematical thinking in writing is "assessed" on the state's standardized exams. As a result, conversations tended to move quickly towards the logistics of implementation. Ms. Lenihan remarked, "I've got to figure out what I want out of these journals. I can't have them write essays. I don't have the time."

While the focus is on the general issue of developing mathematics language, an issue critical to supporting Latinas/os' mathematics learning in a second language, it seems as though the tool is destined for a use that is convenient for Ms. Lenihan, rather than how it might best be used to support mathematics language development. This is an important tension to highlight, as a promising tool to support bilingual students' mathematics language development is never given a fair chance and is compromised due to the necessity to maintain a manageable workload, a struggle for many urban school teachers, including Ms. Lenihan. Consequently, this pragmatic approach to planning the implementation of journals is notably different than a systematic approach to planning that is based on insights around how the students' mathematical writing (i.e. language) needs to develop and how the tool can support it.

When teachers struggle to manage their regular workload, it becomes difficult to commit time and intellectual energy to consider and execute a variety of "new" instructional practices, like, for example, planning lessons based on bilingual students' needs rather than logistical conveniences. This is a possible explanation for the reality that in less than 1/5 of the planning sessions were the plans put together prior to our meeting, where, as mentioned above, we had the explicit objective of re-thinking the implementation of the mathematical activities so as to improve students' access to and engagement with mathematical ideas and discourse. While this might be interpreted as the (un)importance the teachers attach to making solid lesson plans in advance, a

more likely scenario is that this inability to have lesson plans ahead of time is indicative of the teachers' continual challenge to "get ahead of a moving train"; that is, they are constantly trying to keep up, and getting ahead is a rare accomplishment.

On the other hand, there was rarely mention during planning sessions (three occurrences) of individual students and their respective knowledge base or needs – a fact that seems to index a particular belief about mathematics teaching and learning, namely, that good curricular activities are sufficient to engage all students and help them develop meaning around the mathematical concept. In both cases, the teachers report to operate on the premise that students' mathematical experiences need to reflect students' lived experiences, that students need to relate to the mathematical context. Yet, their planning typically did not consider possible variations of how students might engage with the activity in order to build mathematical understanding. This lack of planning is important because, alternatively, planning that is grounded in the specific struggles of students – be they mathematically conceptual, language, or social in nature – is likely to yield a pedagogy catered to the multi-dimensional mathematical development of students (Chapin et al., 2009; Fernandez & Yoshida, 2004; Yackel, 2003).

In the three instances where the teachers mentioned specific students, the comments were marred by a deficit-perspective, highlighting the language and mathematical skills that the student lacked. For example, in Session 5 Ms. Hendrix disappointedly proclaimed that one Latina/o student was incapable of algebraically substituting number values for variables, yet the conversation never turned to brainstorming strategies that might support the student's conceptual understanding. In another instance, Ms. Lenihan, puzzled by a quiet Latina's differential language development relative to classmates who have been in the school's bilingual/ESL program for the same amount of time, questioned if language development is correlated to intelligence. In other words, she was

suggesting that the student was in need of special services, services beyond what she could provide the student. Strikingly, this comment dismisses the multitude of factors – many within teachers’ control – that contribute to a student’s disciplinary or academic language development.

In the case of this student, Maria, she is rarely asked to share her ideas verbally – neither individually, nor in whole class or small group formats. In an effort to help Maria improve her language development, Ms. Lenihan might dedicate a few minutes to conference with her about, say, what she has written. This kind of explicit focus on language development will not only help Maria make more sense of mathematical language, it is also an opportunity to confer about the meaning of the mathematical idea. By relegating this issue of differential language development as Maria’s “problem,” Ms. Lenihan is effectively relieving herself and her colleagues of any responsibility for this student’s success or failure, as the onus is placed exclusively on the innate qualities of the student.

Ms. Hendrix, on the other hand, approaches planning very differently. To illustrate the planning process she engages in, consider the following exchange:

C: When you plan for lessons, what, how do you plan?

H: Over the summer, I kind of sit down and just map out each month and what concepts I want to cover, and then I look at what the textbook has to offer to see if it will cover any of that stuff. For the most part, it does, so I don’t go in order, per se, in the text book, but if I’m trying to teach a particular concept, like if we’re working with integers, I’ll know that I need to touch on the section from the book to support me as far as them having homework, them having any class activities to do with those problems. But, then there are other concepts that I wanna get through as well, I still put them on there and what month I want to cover it, but if I can’t use the textbook to do it, then I either go to online resources to try to teach the lesson or the idea, or, you know, I just go by what I’ve done in the past when I was in school and teach it that way. So, I do rely on the Holt mathematics curriculum, pretty much heavily, but I stray from it as well, because it doesn’t, I don’t know, I’m in between with it. Like, I like it, because it does have, you know, a lot of practice problems for them to do. So, as far as assigning homework goes, it’s great. But, as far as preparing them for any type of real-life math situations, they don’t do it. Like, they try to leap from rote instruction to real-life math problems with no connection, so that’s my problem with the series. So, usually we’re done with the book, or using things from the book, a few months before school ends. So, my

struggle has been to try to do projects in the last couple months to cover whatever else I need to cover, or to re-emphasize things, cuz mostly toward the end, I'm trying to prepare them for algebra.

Clearly, Ms. Hendrix conceives planning as the determination of the order of topics to be covered and when, what many refer to as a pacing guide. A pacing guide is included in most standards-based curricula, or one is often put forth at the district level, relieving the teacher of such a task. She admittedly relies heavily on the exercises (as opposed to problem situations) in the textbook for warm-ups, class activities, and homework. The fact that Ms. Hendrix privileges (with little variation) mathematical activities that are procedural in nature indexes a viewpoint that repetitive practice of mathematical skills is an effective means to mathematical understanding for Latina/o learners.

The major weakness in this approach is that Ms. Hendrix does not differentiate any aspect of the mathematical trajectory given the unique language and social needs of her students. She charges forward as if the student make-up has no bearing on implementation of mathematics lessons. To her credit, Ms. Hendrix has a vision of where she wants to lead the class over the course of an academic year. However, just like in our literal vision, Ms. Hendrix's pedagogical vision has a blind spot, a realm of activity she cannot see. In the case of her classroom, it is the mathematical and language development needs of the bilingual Latina/o students.

i. Planning and Ideologies About Latinas/os and Mathematics Learning

Another finding from this study is that the teachers' planning process is driven by their ideologies around Latina/o learners, specifically, and mathematics learning more broadly. This finding begins to answer the third sub-question, "*What ideological, knowledge, and skill factors influence the development and utilization of mathematics discourse communities?*"

When asked what considerations she makes for this bilingual and emerging bilingual population, neither teacher had a substantive answer. Ms. Hendrix simply admitted, “I don’t really do anything special...” Unfortunately, this response demonstrates no growth from something she wrote nearly one year earlier in the first session of a graduate course on approaches to bilingual/ESL instruction. Teaching the course, I posed the following questions: *What do you think makes teaching bilingual learners special or different from simply good teaching? What does a teacher need to know or be able to do to instruct bilingual learners?*

Ms. Hendrix had the following response:

I think that good teaching is the key to instructing bilingual learners, so there isn’t too much that is vastly different or “special” that a teacher must do. I believe that teachers do need to have a sympathetic or “open-mindedness” about their students’ cultural backgrounds and how that will impact their educational experiences – this will enable bilingual learners to have a good connection with their teacher. In addition, teachers should try to gain info about their students’ funds of knowledge and try to incorporate some of the cultural backgrounds of these students into the learning experience.

This response captures the frame of mind that filters Ms. Hendrix’s approach to planning and subsequent instructional decisions. First, her suggestion to be “sympathetic” or “open-minded” towards her bilingual students situates her in a paternalistic or colonial position in relation to her students (Pennycook, 2001; Shannon, 1995). It is clear that Ms. Hendrix aims to understand the social and linguistic backgrounds of her students. But, there is little evidence that she can, or sees the need to, put herself on the same cognitive or linguistic plane as the student. Rather, there appears to be a strong separation between the students’ backgrounds – laden in struggles and deficits – and hers.

Furthermore, there is a language-as-problem orientation (Baker, 1993) here that insinuates the students’ language situation is an obstacle to be overcome, and the first step to mediating this problem is to be sympathetic. This disposition is concerning, as it often inhibits teachers from doing

the difficult work of reducing the cognitive and cultural dissonance between themselves and the student(s). If she doesn't "see" her students as possessors of unique learning resources (i.e. Spanish) and culturally-specific ways of knowing, she is not apt to lead them to capitalize on their strengths. It appears as though constructs from her Masters courses, such as funds of knowledge (González et al., 2005) or primary and secondary discourses (Gee, 2004), are either lost in the transition from theory to classroom practice, or were only internalized at a superficial level that is hard to detect in her daily interactions with students.

Similarly, Ms. Lenihan, when asked how she plans specifically for Latina/o learners, could not immediately respond. After hesitation accompanied by a contemplative facial expression, she replied, "I will have to think about that more." She did, however, have the following comments about her approach to planning. (At this point in time, she had just finished leading an enrichment program with a class of 5th graders and was drawing comparisons to her 7th grade students.)

C: How did you, um, when you planned, what guided your planning?

L: Um, the ISAT [Illinois Standardized Achievement Test]. The content that they needed to know, which was area of rectangles – excuse me, area of parallelograms and triangles, and that's how I came up with the project.

C: OK, so content drove your –

L: (*interrupted*) Standards. I went in the ISAT Coach book, and I looked at... I want to do a car with the kids. What kind of math is involved with the car? Like, what I do with the Dream Home [another project]. You just hit, you have an idea, and you just try to fit in what math concepts go with your idea.

Just as with Ms. Hendrix, her planning is driven by a list of concepts students should know at a given grade level. Clearly, her motivation for planning this way is the test scores students receive annually. This is not to say that Ms. Lenihan doesn't think about the applicable or aesthetic value of mathematics, but these are clearly subjugated in the name of accountability.

There also is an abundance of evidence indicating that Ms. Lenihan has contemplated how students learn mathematics best. For example, she has long abandoned the “traditional” textbooks adopted by the school, because she thinks they represent the traditional way so many of us have learned – and been unsuccessful with – mathematics. As a result, the majority of her planning time is devoted to coming up with new project ideas, identifying the content standards that might be covered within the project, and then trying to create a series of activities that lead to a final product.

Consider, for example, the circle graph rational number project, in which Ms. Lenihan conceptualized an activity in which students identified their daily activities in a 24-hour period of time in order to examine the various representations of rational numbers (i.e., fractions, decimals, percents). The culminating product of this project was to construct circle graphs representing the students’ various daily or weekly activities. She wanted to create a set of mathematics activities around rational numbers that would do two things: be contextualized in the students’ lived experiences and involve an assortment of 7th grade mathematics standards. To her credit, she creatively conjured up an idea for a project and identified a starting point, an introductory lesson. Prior to conceptualizing the entire project, Ms. Lenihan first “feels out” the students’ level of understanding of the topic with the initial lesson, which is often a teacher-led, general discussion of the mathematical concept that includes references and analogies that are relatable to the students and their lives. From this point, however, she does not outline the remainder of the project with a discrete number of pre-determined lessons covering specific mathematical ideas. Instead, the development of the project is choppy; she plans one day’s lesson and then simply picks up where she left off the day before and rather spontaneously identifies and implements the next “logical” step in the mathematical trajectory. Ms. Lenihan frequently relies on internet resources to devise a day’s activity(ies). In fact, the majority of her planning time is spent online scavenging for ideas.

When time is occupied in this manner, it is not difficult to see how attention to critical pedagogy might be lost – particularly, attention to discourse development. First, this is an incredibly time-consuming endeavor. Curriculum developers commit months and years to designing exceptional projects that align with the content standards to be tested (e.g. University of Chicago School Mathematics Project, 2012). Moreover, time spent thinking about curricular activities is time not spent thinking about the needs of students. Second, it is difficult to create a project that coherently introduces a concept, provides multiple ways to understand the concept, then ties them all together in a sensible way. While this sequence is crucial to support any learner, when it is disjointed and incoherent, it has amplified effects on bilingual learners who are diligently trying to piece concepts together in cognitively complex ways (see Abedi et al., 2001; Solano-Flores & Trumbull, 2003).

Often times, it takes many instantiations at presenting curricular activities, working on them together as a class, assessing how well the mathematics concepts were internalized, and reflecting on what facilitated or inhibited successful understanding of the concepts. With each instantiation comes a new level of refinement. In short, mathematics curriculum development is an art form to be mastered iteratively – and that’s without the addition complexities surrounding mathematical language development for students learning in their second language. Yet, rarely does Ms. Lenihan utilize previously developed projects. I estimate that only a handful of curricular activities have been reused. Instead, she continues to “spin her wheels,” continually creating new mathematics activities.

Nonetheless, this is Ms. Lenihan’s rationale to acquiring this approach:

C: So, you think by providing these opportunities to work within a project, within a problem context, that inherently the kids will learn more math or retain more math inherently because of the activity?

L: ‘Cause they’ll either rise to the occasion, and it will be more of an advanced project for them, because they, kind of, aren’t held back by, kind of, like, your slower learners or kids that have language issues, or don’t understand what’s going on because of whatever the conflict is in the room. And, I feel, like, as the teacher, you can help those kids that are not understanding, and the kids that understand the project can just go ahead and be successful and not be held back. And, I feel, like, the kids that need more time can get help from other students in their group and also from the teacher. ‘Cause, like, when you look at a classroom, you have kids of all ranges [with one arm raised, indicating a high level], and then you have these kids [lowering her arm to indicate a lower level], like I was just saying, that are already, they’ve got their [formulas for various] areas, they’re all correct, and they can build their car, and they’re, they’re done, and they’re able to be successful and help each other and have one, maybe, of those lower learners in their group, and do great. And, then you have all the other groups that need more one-on-one attention, and have, come up with issues, like, don’t understand that a shape has a specific formula, and you can get at those when you’re with a smaller group, ‘cause they have to, it’s not given to them, you know? “I’m not giving you a worksheet. You have to tell me, ‘What is that shape?’ You have to tell me, ‘How am I gonna find all that stuff inside of it?’”

C: So, when you (*interrupted*)

L: So, its more, it gives more one-on-one time with me and the students, where I can ask them questions, and we can talk math, and figure out problems together.

This excerpt reveals some of Ms. Lenihan’s motivation to do projects: it allows for more time to be spent with individual students and so not to hold back high achieving students. One interpretation of these comments, considered in the context of other comments and actions, is that it seems as though she measures successful mathematics teaching by her ability to advance a quota of high-performing, self-motivated students. Ms. Lenihan’s praise for students who “can be successful” with her projects simultaneously 1) sets the standard for who is successful and who isn’t, and 2) exposes a non-critical view of how her activities might be difficult to navigate by bilingual students. Moreover, she seems to indicate a threshold, that in order for groups to be successful, they shouldn’t have more than one “of those lower learners.” In direct contrast to literature that argues heterogeneous group members can make meaningful contributions through their various competencies (e.g. Cohen, 1994, 1996), Ms. Lenihan appears to be of the mindset that lower performing students are the sole beneficiaries from working with the high-achieving students.

Furthermore, Ms. Lenihan's reference to kids who "don't understand what's going on because of whatever the conflict is in the room" seems to be a catch-all for an assortment of "issues." This comment is indicative of her inability to disaggregate the mathematical learning struggles that manifest in different ways; rather, she dismisses these struggles as personal, again, alleviating herself from the obligation of analyzing and addressing these struggles. Finally, her discourse suggests that "slower learners or kids that have language issues" – the majority of her students, given they are non-native English speaking Latinas/os – are on her mind when planning, but only in the sense that they are obstacles that need to be creatively detoured. In other words, the origins of her project-based approach are rooted in a deficit perspective of certain learners in her class. While, according to Ms. Lenihan, project-based mathematics learning allows her time to work with struggling learners, we will see in the next section how this is not the norm of her MdC.

As we will see later, particular events that occurred during class periods may have unfolded differently given a more intense focus on thorough pedagogical planning – not just content and activities – in order to build on the strengths and accommodate the needs of a unique student population. Planning for critical pedagogy – in the sense that what we do in terms of classroom facilitation either reproduces current power dynamics and schooling results or disrupts these dismal patterns for marginalized youth (Bartolome, 2003) – is an idea that does not appear to have been impressed upon the teachers; rather, planning was conceived as time spent on making decisions about curriculum, as if curricular activities are the transformative agent that will help students succeed on the standardized assessments, the object on which the school and teachers have their sights firmly set.

c. Teachers' Struggle to Model Inclusive Learning Environments

The last finding pertaining to issues and struggles in the teachers' design and implementation of MdC's is that they had difficulty envisioning and enacting inclusive learning environments for emerging bilingual students. This was especially apparent with Spanish-dominant students (in this case, middle grades students typically with less than two years of schooling in the U.S.), with whom the teachers tended to avoid mathematical interactions. As a result, many students were left without adequate access to the central mathematical ideas presented in the lessons.

Per standard procedure in this district, students' language is formally assessed when, upon enrollment, the "Home Language Survey" indicates that any other language than English is spoken at home. Though the assessment produces a score on various language skills (i.e. speaking, listening, writing, reading), this process typically results in the students being cast into broad categories: limited-to-no English, conversant in English, or English proficient. Ms. Lenihan and Ms. Hendrix tended not to get much more information than one of these concise phrases that sum up a complex language system.

In the cases where students entered the school year of this study with "limited-to-no English", the teachers were apprehensive to interact directly with these students. Based on analysis of videos from their classes, there appears to be an element of discomfort when the teachers are in the presence of students who are functioning primarily in Spanish, perhaps because of the perception of a linguistic barrier; that is, the teachers seem to have difficulty envisioning a means of communicating with the child or building up the courage to enter into a potentially awkward situation where reaching a shared understanding of a message is challenging. While the teachers comfortably work and communicate with students exhibiting a solid command of (conversational) English, interactions with newcomers or other emerging bilingual students is markedly different and

might best be described as “non-interactions” – that is, there is clearly an absence of meaningful interactions that might help the students move from mimicry of academic behaviors (Chval, 2009) to actually accessing the mathematical activities and engaging in the collaborative problem solving sessions. To illustrate this point, consider the following scenario from Ms. Lenihan’s class:

Ms. Lenihan wants her students to learn mathematics through projects based on issues that are important to teenagers. She has developed an anti-smoking unit in which the students will develop proficiency in statistics. The students are to create an interview protocol; collect, aggregate, and analyze data; and analyze historical trends around smoking.

In one lesson from this project, the students are analyzing a coordinate plane graph of cigarette production in the U.S. On the overhead, Ms. Lenihan leads the students through the directions on the worksheet, on which they are given eight data points (year, number of cigarettes) in ten-year intervals (from 1925 to 1995). The students were to plot the points on the graph provided.

In an effort to get the students to determine and communicate how they might find data points that are in between the given intervals on the x- and y-axis of the graph, Ms. Lenihan orally asks them to discuss in their groups the following question:

L: Why is it important to know what points lie between our data points?

One group of three bilingual, Latino boys (Omar, Ramon, and Salvador) slowly begins to mull over the problem. There is a fourth boy in the group, Niko, but he does not speak, nor do the other group members acknowledge his presence. Niko transferred to Southwest Elementary School from Mexico about three weeks prior to this lesson.

Between the time Ms. Lenihan asks the students to discuss this question and when she arrives to interact with this group (about 8 minutes), not much is discussed by the group members; only a few utterances are mumbled by Ramon and Omar trying to ascertain what Ms. Lenihan’s question is asking them to consider. Upon joining the group, she asked the boys what it was that they were supposed to determine. As she discussed this with the students, she makes consistent eye contact with Omar, Ramon, and Salvador, but only briefly glanced at Niko, who was looking downward. In this brief glance at Niko, her body language says, “I know you are there. I recognize that you are not engaging in this activity or this conversation, but there is nothing I can do to communicate with you.”

With Ms. Lenihan using Omar’s desk and paper as the focal point, Salvador and Raul lean in from across the desk. Niko remains seated to the left of Omar, staring straight ahead out the window. For four minutes, Ms. Lenihan rattles off questions without noticeably adjusting her language to increase the probability that Niko garner clues as to what they are discussing, nor inviting him to reposition himself to view the paper. Ramon and Omar respond quickly to the questions:

L: Why didn't you put this point, um, like, here (*pointing to a specific point on the graph*)?

O: Because, um, the number's like rounded, almost rounded to 500. You just go a little down.

L: OK. Does that make sense? (*turning to Ramon and Salvador*) You know, 487 is about here, maybe a little less. What's smack dab in the middle of 450 and 500, like if I wanted to put a point right in the middle?

R: (*responding quickly, stuttering*) Seven, seven, five hundred, seven fifty.

L: (*looking at Ramon*) Seven hundred fifty...?

R: Billion.

L: So, 750 billion is in between 450 and 500?

R: (*standing up to get better access to the paper*) Uh, uh, no, it's six hundred fifty billion.

O: Four hundred fifty-five.

S: Four seventy five (*standing up*).

R: Four seventy five.

L: Four seventy five. How do you guys know that there is twenty-five, twenty-five billion from here to here (*pointing to the adjacent interval markers*)?

(*three second pause*)

O: What?

L: How do you know to add 25 billion?

R: Because, like, uh...

(*four second pause*)

O: Ummm...

L: How'd you know that it was right in between?

O: Because 450, and we're counting by 50, so half of 50 is 25.

L: Very good. (*Stands up*) So, half of that is...(*voice trails off as she walks away*)

R: Yeah! (*raising his hand to “high five” Omar*)

When they respond incorrectly, Ms. Lenihan steers them towards the specific answer she wants them to reach. During this time, Niko sits silently, staring out the window first, then down at his worksheet and holding his forehead with both hands. Ms. Lenihan leaves abruptly, and the three boys congratulate each other with a “high five.” Niko looks up once Ms. Lenihan has left.

While this may be one of the most overt manifestations of Ms. Lenihan neglecting Niko as a learner, it certainly isn’t an isolated incident; rather, it is part of a pattern that has been established for three weeks, and that continues for several more weeks before it is addressed, as I will explain below in this section. Though Niko has been attending Ms. Lenihan’s class for several weeks at this point, she has yet to interact with him personally or mathematically. Therefore, this was not anomalous behavior from Ms. Lenihan. Similarly, this was not simply an “off” day for Niko. To the contrary, his withdrawn behavior appears to be the result of weeks of non-interactions with both Ms. Lenihan and his classmates.

Upon Niko’s arrival to Southwest Elementary School from Mexico in March, Ms. Lenihan asked me if I would determine his mathematical background, which was relatively strong, and I conveyed to her the results of my informal assessment. Her reluctance to speak directly to Niko, both in this example and the preceding weeks, suggests a level of discomfort or intimidation as to how the interaction might unfold. Perhaps, she avoids the situation with hopes that he will be properly supported by his peers. (With the next episode I share below, I discuss how this was an ineffective strategy to support Niko’s mathematics learning.) Now, after avoiding interaction for weeks, the tension between the two has grown. Niko, knowing that Ms. Lenihan hasn’t spoken with him, perhaps is wondering what sense to make of these “non-interactions.” Without support as to how he is to engage in the mathematical activities, his default mechanism is to politely withdraw

himself from the interaction while she is present. While he is slightly more observant when Ms. Lenihan is away, he still does not speak, nor is he spoken to by his group members.

The same type of what I call “non-interactions,” where Ms. Lenihan does not engage with Niko, occurred at least five other times during my observations. It is not as though Ms. Lenihan is an aloof teacher who prefers that Niko not be in her class. To the contrary, Ms. Lenihan is a compassionate and committed teacher. There are at least three elements interacting that may account for her behavior with respect to Niko. First, Ms. Lenihan accepts the fact that Niko is not engaging or participating. As a result, she underestimates the importance of participation in the mathematics learning process. There is no consideration to what Niko is accessing in terms of the mathematical ideas being discussed and learned. Alternatively, she (naively) assumes that Niko is making meaning around these mathematical ideas, despite no verbal indication or gesture that he is cognitively engaging with the activity.

Second, she appears uneasy interacting with a student when there is linguistic incongruence (i.e. monolingual individuals speaking two distinct languages without overlap) and the potential to struggle to communicate. This discomfort is noticeable and has the effect of mounting over time; it also appears to affect the interpersonal relationships between Niko and his classmates. While intercultural communication has the potential to produce anxiety (Gauthier, 2009), it will likely take a willingness to enter in an uncertain and unpredictable space – similar to what Anzaldua (1993) refers to as *Nepantla* – to learn how to maneuver within and what can be gained from this new interactional space. Ms. Lenihan can change the dynamics within this group – and the broader MDC in the classroom – by initiating and modeling more collaborative and inclusive ways of solving problems. As Berry (2006) illustrates, the process of establishing an inclusive learning community

depends on the demonstration of inclusive practices by the teacher and explicit negotiation with students as to what those practices mean for collective learning.

Finally, her actions implicitly – yet strongly – establish the operating norms of the MDC. Ms. Lenihan is signaling to the other group members that it is acceptable to exclude a member of the group if that is the path of least resistance to accomplishing the task. Significantly, there is no accountability for one another's mathematical understanding; thus, her reliance on Niko's peers to support his mathematical access and understanding has proven to be faulty. Whereas Yackel & Cobb (1996) show how “the teacher can serve as a representative of the mathematical community where students develop their own personally meaningful ways of knowing (p. 461),” Ms. Lenihan does not take up this role in order to facilitate marginalized students' mathematical development.

i. Troubleshooting Mathematical Exclusion

Eventually, Ms. Lenihan acknowledges and tries to reconcile Niko's exclusion. The following example illustrates her efforts to incorporate Niko into the mathematics activities.

About one month after the previous episode, the class is still working on the anti-smoking unit. At this point, each student has interviewed a “smoker”, and Ms. Lenihan is leading a discussion about the concept of 100% (in terms of aggregated data and the total number of respondents responding to an item the same way). After a mini-lesson, she asks the students to respond to “record all the ways to represent 1” in their groups on their white boards.

When she visits Niko's group, she realizes that he is not interacting with his group members, Ramon and Juan (J). The following transcript illustrates her approach to addressing the situation:

L: Ok, what do you guys have? (*walking to the group of boys from an adjacent group*)

J: We put 150, as in like the smokers that smoke everyday.

R: Yeah. And, it goes like one whole.

L: Is there anyway Niko could be included by any chance? Could you guys try?

J: Yeah.

L: OK. And, could you put some words, like, you know, “150 out of 150 means all the students...,” like, you know.

R: Smokers.

L: *(walking away to another group, addressing the entire class)* You’re gonna need some words, but you shouldn’t need, like, fifty. You’re gonna need some...to explain.

This entire episode was 44 seconds long. Ms. Lenihan’s acknowledgement and attempt to address Niko’s lack of involvement was six seconds. Importantly – yet, not unusual – Niko does not speak. Throughout this episode, he is carefully arranging papers in his folder and neatly placing the folder in his desk. Niko is the only student doing this, as it is clearly not the time to be transitioning. It appears as though he has appropriated these academic-looking behaviors as a means to cope with his lack of opportunity to participate. As Chval (2009) explains, he is “making himself invisible.”

This is an example of Ms. Lenihan’s recognition that her MdC – the mathematical learning arrangements and what they come to mean for individual students – is resulting in the exclusion of a student; yet, she does not know how to rectify the situation. The fact that she chose to intervene in this situation exposes an awareness of what inequitable learning arrangements might look like – what could be the result of her teacher preparation and development. However, she is either not equipped with the practical knowledge to innovate a way to mediate Niko’s mathematics learning, or she does not deem it imminent enough to see through that Niko is included. Ideally, Ms. Lenihan would have posed a question such as, “Ramon, have you asked Niko how he would represent 100%?” A question of this nature would have signaled to the group members that everyone should be included. Alternatively, Ms. Lenihan might have followed up her request for Niko to be included by modeling how the group members might take turns sharing their thinking and asking each other questions – sophisticated, sociomathematical norms that encourage responsibility and accountability

for each other's mathematics learning, as well as providing equitable opportunities to develop mathematical discourse (McClain & Cobb, 2001). Instead, she apparently was satisfied with Juan's agreement to include Niko and confident that their inclusion strategy would translate to meaningful learning for him. Hence, Ms. Lenihan decided to act on other priorities, as indicated by her quick departure from the group, simultaneously encouraging the other small groups to "use words" in their representations on the white boards. (I will discuss this approach to facilitating students' mathematics discourse development below.)

After she left the group, Ramon and Juan continued to work with each other. After they each recorded a representation of one (1), they passed the white board to Niko and requested that he contribute another possibility. There were minimal words exchanged in making this request. I joined the group to facilitate this process, as it became apparent to me that this, again, was an uncharted interactional space for the boys. In Spanish, I asked Niko to write a representation of one (1), which he did with ease. In fact, he cleverly labeled the representation, indexing a level of familiarity of the context. Interestingly, the conversation continued in Spanish – including Juan and Ramon – demonstrating that, with support, this particular group can make a fluid transition into conducting their work in Spanish and sustain the dialogue in Spanish, marking Spanish as a legitimate learning resource.

For Ms. Lenihan, this undoubtedly is an attempt at inclusion – and, it may or may not satisfy her – but this is not the level of linguistic and cognitively demanding engagement necessary to make significant strides towards mathematical and communicative competence. That is, without my intervention, it did not appear as though this solution would have amounted to cognitively- and linguistically-demanding interactions that would help Niko advance his mathematical understandings. Presumably at a loss for another way forward pedagogically, Ms. Lenihan defaulted

to an approach that passed along the responsibility of mathematical facilitation onto Niko's group members. She strategically placed Niko with two nice, bilingual boys hoping that they would communicate with him in Spanish. However, this did not unfold as planned for at least two reasons. First, the boys did not automatically take up Spanish because they are not accustomed to talking mathematically – or in any academic discipline for that matter – in Spanish; that practice was abandoned in the early primary grades.

Second, Ramon's efforts to "include Niko" consisted of directly translating the written activity prompt displayed on the overhead, a painful process to witness. While Ramon is completely bilingual, he clearly does not have experience translating; the ability to translate well is not an automatic process that comes with being bilingual. His method was to translate each word individually as opposed to synthesizing the main idea and paraphrasing it in Spanish in the way that makes most sense to him. I was able to intervene and translate in a much more efficient and effective way. I attribute my success less to my ability to speak Spanish well and more to past mathematical experiences that have helped me develop the practice of thinking and sharing my thinking bilingually. Unfortunately, Spanish-speaking students seldom have similar bilingual mathematical experiences (LopezLeiva, Vomvoridi-Ivanovic, & Willey, 2012).

The point here is that Ms. Lenihan – like many teachers – makes particular assumptions about her students' abilities to fill-in for her role as teacher-facilitator; how these assumptions play out in micro-interactions is less than desirable. Ms. Lenihan does not provide a model to help established bilingual students (i.e. students proficient in Spanish and English across social and academic contexts) understand how they might include and work cohesively with Spanish-dominant students. The boys are not trained to facilitate a student's mathematics learning nor to manage a

group inclusively. Needless to say, these are complex tasks, and Ms. Lenihan overestimated their ability to do so.

It is not uncommon for monolingual teachers to not know how to best interact with and ensure the learning of emerging bilingual students (Bartolome, 2003). In this example, however, the interaction between Ms. Lenihan and Niko might, again, be called a *non-interaction*. The linguistic incongruence between teacher and student is clearly exposed. While, understandably, Ms. Lenihan might be at a loss for a way to move forward, her critical and improvised instructional decision proved to be problematic. Again, the uncomfortable nature of the situation might have been the reason she did not stay to see how the boys attempted to include Niko, precluding her from recognizing the inherent flaws in this approach and, perhaps, prompting her to try a new approach.

2. Language Dimensions Influencing the Development of MdC's

This section directly addresses the second sub-question: *What linguistic factors influence the development and utilization of mathematics discourse communities?* The data and discussion that follow focus on the teachers' attempts to help students develop mathematics discourse. As mentioned earlier, I use the term *mathematics discourse* to represent the ways and forms of discussing mathematical ideas that are emphasized in the classroom. First, I will present data from Ms. Lenihan's classroom that illustrates what, to her, constitutes mathematics discourse. Next, I will discuss the teachers' approaches to facilitate their students' mathematics discourse development.

a. What Constitutes Mathematics Discourse and Its Role in Learning

From my observations of and conversations with Ms. Lenihan, it is clear that she wholeheartedly believes in the importance of being able to communicate mathematically. However, one theme that emerged in the data was that Ms. Lenihan seemed to have an incomplete understanding of what constitutes mathematics talk. This is evidenced by her treatment of mathematics discourse,

that is, how she encourages students to talk mathematically, and how she establishes parameters – or dialogic norms – in instruction, within which mathematics discourse is to develop and help students construct mathematical meaning.

Consider the following episode from the anti-smoking unit completed near the end of the school year. Ms. Lenihan is preparing the students to engage in small group discussions around the idea that there are multiple ways to represent one (1) whole (e.g. $125/125$; 100%; 1.0) in the context of survey data that the students collected about a smoker they know.

L: Here's the question that I want you guys to think about. (*speaking slowly as she writes on the overhead*) If everyone in our seventh – you don't have to write this – grade smoking survey said that they smoke everyday, what (*pause, then contemplates out loud*) what does that mathematically say? Or,... If everyone, (*pause*) every single person that you gave the survey to... If everyone in this survey when you got them back everyone said they smoked every single day, in your groups, I want you to talk about (*noticeably speeds up speaking speed*) what does that mean when we talk about this in math class? Can you apply any kind of reasoning, any kind of number sense, any kind of...talk about percentages? So, what does that mean in math class, if everyone, everyday smokes? Can we think about this in a math brain? What do we deal with in math? We deal with what?

Sts (multiple): Numbers. Percentages.

L: Percentages.

St 1: Numbers.

L: We deal with fractions.

R: Addition.

J: Subtraction.

L: We talk about numbers.

R: Addition.

J: Subtraction.

R: (*going back and forth playfully with J*) Addition.

L: What else? What am I missing? Percentage. What am I missing? What else am I missing? Percentages.

St 2: Decimals.

L: Decimals. Very good. (*Pause.*) So, what does, if you were going to talk about this data in math class – or in general, but I would like you to kind of think about it more in a math brain – what can you say about the people? Can you talk about it any kinds of percentages? Can you talk about any fractions? Alright, in your groups, I'm going to give you guys a minute. What can you say about, now, these people in a math kind of brain, (*setting timer*) in a math class, kind of...

J: They're smokers.

St 3: (*inaudible*)

J: No, they're smokers.

There are numerous, important subtleties in her talk and presentation to consider here. First, notice the length and content of her initial prompt. It is over two minutes long and asks seven questions. This is occurring in the context of students learning mathematics in their second language. It becomes increasingly important to provide concise, unambiguous directions – and a substantive, clear question – to facilitate comprehension of what is said so that the students can meaningfully engage in dialogue around the mathematical concept (Khisty & Chval, 2002). In this situation, however, we can see the students experiencing a particular type of Mathematics discourse Community, one that is restricted to the most obvious mathematics words from their elementary mathematics lessons. It is doubtful that reproducing this rigid set of words as a form of mathematics talk is helping students advance their mathematical understandings in a meaningful way.

Second, Ms. Lenihan's prompt appears to serve two distinct functions: to provide access to the meaning of the language in the prompt by repeating or using synonyms *and* to provide linguistic clues to facilitate the mathematical sense-making process. This is not a bad strategy; however, it is important to be cognizant of how much we output before we either 1) ask the students to respond to

the prompt, or 2) check that they – preferably less vocal learners – are following, effectively treating the conversation as a dialogue rather than a teacher-directed talk session about an inorganic (i.e. not coming from, or being of limited relevance to, the students) idea. A quick glance around the room reveals looks of confusion on the students' faces. Also, the students do not immediately begin to interact once Ms. Lenihan turns it over to them. This hesitation indicates that while her delivery may have been done in an accommodating way, the overall message was not well understood by the students.

As mentioned before, Ms. Lenihan will periodically notice students' collective confusion or reluctance to talk. At times, she will choose to address this confusion by working with each group individually, and other times, she will reconvene the whole class. She typically rationalizes students' balking as a discomfort talking mathematically due to few past opportunities to develop this practice, which may be somewhat true. However, there is another, more immediate dynamic taking place here: In the course of her initial prompt, Ms. Lenihan moves from giving the students a question for discussion to coaching them on how to talk mathematically in a very specific way. This pivot can be seen when she asks students, "Can you apply any kind of reasoning, any kind of number sense, any kind of...talk about percentages?"

Outlining a mathematical idea to be discussed and establishing a pool of words to serve as the fodder for that discussion are two distinct pedagogical moves that have the effect of convoluting – and even diluting – the central discussion prompt. In fact, this marked transition highlights Ms. Lenihan's underlying confusion as to what mathematics talk is and does. As she leads students to incorporate pre-determined mathematical terminology into the sentences they utter, it becomes clear that mathematics discourse, to her, is the reproduction of technical words that one might find in textbooks or on standardized tests. Importantly, these words do not necessarily carry mathematical

meaning amongst the students, but, hypothetically, they are what ought to be used in the mathematically proficient communication conceptualized by Ms. Lenihan.

This is yet another example of Ms. Lenihan attempting to provide a platform for students to share their thinking. However, students' autonomy to openly discuss the phenomenon with their choice of words is effectively restricted by the short list of “buzz” words they are to utilize when talking mathematically. This could be mitigated by carefully planning the discussion prompts (i.e. identifying language development objectives and envisioning how the dialogue might unfold) that the students will be asked to respond to or by legitimately checking with the students that they understand their task *before* they begin their discussion.

With respect to her effort to support students' access to the meaning of the prompt, there is evidence that Ms. Lenihan is sensitive to the needs of her students, as she often repeats or uses synonymous phrases to support her students as they figure out what she wants them to talk about. For example, she says, “If *everyone, every single person* that you gave the survey to... If *everyone* in this survey when you got them back, *everyone* said they smoked *every single day*...[emphasis added].” Importantly, though, this linguistic support is at the level of the word (i.e. “every”) and does little to support students in engaging in rich mathematical conversations. Yes, it is important to help students make sense of the context, and yes, an understanding of “everyone” is a prerequisite for understanding the mathematical concept of one (1) within data analysis. But, highlighting the meaning of part of the question to be discussed does not, in this case, compensate for the amorphous nature of this particular prompt. Again, it is likely that this discussion prompt would better serve its purpose had it been thought out in advance.

Third, the discussion time is a mere one minute. Ms. Lenihan's struggle to expand the notion of what constitutes mathematical discourse results in an underestimation of the role of “talk” in the

classroom, which, in turn, leads to her hurriedly wanting the students to arrive at a meaningful conclusion. Furthermore, the reduction of mathematical discourse to a set of mathematical vocabulary words lends itself to an inadequate assessment of student understanding of the mathematical idea to be discussed; clarity of the mathematics idea, and thus, “understanding,” is often affirmed by an advanced student or two, and that response is interpreted as generally representing the collective understanding of the class, a frequent pitfall amongst teachers (Chapin et al., 2009).

While one minute may be sufficient time for a group to arrive at an answer to an intermediate question, this is presumably not adequate time to develop meaning around the multiple statistical representations of one (1), the central concept of this day’s lesson. It underestimates the mathematical meaning-making process and grossly limits the number of opportunities for students to talk – especially those students who most need to practice communicating mathematically. It has been my experience that students less confident mathematically or linguistically need more time – and focused attention and encouragement from the teacher (Chval, 2012) – to become comfortable and contribute to the discussion. Ms. Lenihan’s current format has the unintended effect of squelching many of the benefits of operating a student- and discourse-centered mathematics classroom. For bilingual and emerging bilingual learners, space and time to negotiate meaning and gain entrée into a problem-solving context are essential; a pace cannot be set that satisfies the teacher’s needs. Rather, it is crucial to consider the language development needs of the students. If a question is worth thinking about and talking, then adequate time ought to be given to unpack the various elements of students’ responses.

Fourth, in promoting this form of mathematical communication, Ms. Lenihan treats mathematics discourse as an end product, a skill that students are to take with them outside of

mathematics class in order to be successful. Alternatively, we can look at mathematics discourse as a *means* to developing and solidifying mathematical understanding (Sfard & Kieran, 2001). There are often times when we think we have a handle on a particular mathematical idea, but after an attempt to articulate an explanation, we begin to question the clarity we initially thought we had. Talk becomes an important tool with which we can attempt to refine or deepen our understanding of those ideas, to prove to ourselves and others that the idea makes sense and fits within an overall schema of the mathematics concept (Chapin et al., 2009). In this vein, mathematics talk can be utilized as a *means* to evaluating students' level of understanding. In addition, mathematics discourse should be used as a tool to create a learning community in which students help one another arrive at the greatest level of clarity possible. These are different functions than what are evidenced in Ms. Lenihan's actions and indeed result in a different MdC.

Finally, Juan's succinct and immediate response to Ms. Lenihan's lengthy prompt is telling. He is right: if a group of people smoke everyday, they are smokers by conventional standards. The fact that he captures the conversation so simplistically, in two words, indicates that either the task was not properly outlined or he is not practiced in discussing this matter in an alternative way (i.e. using mathematics talk). When trying to create a functional discourse community, one that implements carefully crafted opportunities to develop language and utilizes language as a means to develop mathematical understanding, it is important to anticipate (as well as possible) the responses students might provide. In this case, if this prompt would have been written in advance, Ms. Lenihan would have been able to evaluate whether her prompt was intelligible, whether it would have encouraged students to discuss dynamic ideas, and she might have been able to recognize that her line of questioning would lead to insubstantial student responses. Of course, all of this is

predicated on the idea that there is a clearly identified mathematical objective, with a corresponding objective for students' mathematical language development, which was not the case.

b. Teachers' Approaches to Facilitate Mathematics Discourse Development

Building on the previous finding that there is confusion surrounding Ms. Lenihan's conceptualization of mathematics discourse and how it ought to be utilized to facilitate mathematical understanding, this study illuminated that there is confusion as to how to create discursive structures to support students' development of mathematics discourse. Ms. Lenihan's rational numbers project episode, for example, reveals the complexity of facilitating mathematical discussions and students' difficulty talking about mathematical ideas – especially when the mathematical concepts are unexpectedly difficult and the students historically may not have developed this practice:

This project asked the students to identify their daily activities in a 24-hour period of time in order to examine the various representations of rational numbers (i.e., fractions, decimals, percents). The culminating product of this project was to construct circle graphs representing the students' various daily or weekly activities.

Near the end of this unit, Ms. Lenihan identified this problem as an essential piece of mathematical knowledge because of its frequent appearance on state standardized exams: Put the #'s in order from least to greatest: $\frac{8}{3}$, $\frac{63}{7}$, 0.25, $12\frac{1}{2}\%$. As the students work individually, it quickly becomes apparent that the students are struggling with the meaning of $12\frac{1}{2}\%$. Many students argue that it equals 1,250, apparently moving the decimal point two positions to the right. Ms. Lenihan suggests that this equality does not logically make sense, and she unwittingly asks the students to discuss this question:

L: How do we know that $12\frac{1}{2}\%$ is not greater than 1?

There is hesitation, as the students struggle – given that they have already expressed that it makes sense to them that $12\frac{1}{2}\%$ is larger than 1 – to understand the question and put forth an initial, coherent thought. The one minute Ms. Lenihan allotted for discussion passes quickly, without much substantial talk, and she quickly re-groups the class to deliver her explanation as to why $12\frac{1}{2}\%$ is clearly less than one (1) given its relative size:

L: So, 1,250 doesn't make sense. Neither does 12.5 pizzas. The decimal has to be less than 1.

Anxious to implement her practice of allowing students to discuss contentious “problems” in an effort to build understanding, Ms. Lenihan overestimated the level of preparation the students have had to tackle an abstract problem like this and, at the same time, underestimated the amount of scaffolds the students would need to make the transition between the heavily contextualized problems (e.g. students developing an understanding of fractions by proportionately assigning values to the various activities that make up a typical day) and more abstract, test-like problems like this one. She does not necessarily predict, nor pay attention to, what kind of mathematics talk the discussion question will elicit. Moreover, it is not clear whether she recognizes that the students are not discursively and cognitively positioned to arrive at the same meaning of her concise conclusion.

The apparent disconnect between Ms. Lenihan’s thinking (and discourse) and the students’ thinking renders this opportunity for student talk unproductive. Certainly, Ms. Lenihan intends talk to be used here to help students negotiate and sort through their ideas around the value of $12\frac{1}{2}\%$. However, to facilitate this, a second question is needed such as, “What do we know about the value of $12\frac{1}{2}\%$?” Alternatively, Ms. Lenihan might have utilized mathematical discourse to talk through the difference between the students’ and Ms. Lenihan’s conception of $12\frac{1}{2}\%$, to help mediate a new understanding of percentages. This effort would require more time than Ms. Lenihan apparently was willing to allocate, as well as soliciting and listening to students points of misunderstanding and allowing herself to deviate from the linear trajectory aimed at a speedy arrival to the mathematical fact that $12\frac{1}{2}\%$ is less than one (1).

i. Relationship Between mathematical discourse and cognition

As we see in this case, providing students with opportunities to talk mathematically does not automatically convert to mathematical understanding or mathematics discourse development. As evidenced in the examples presented thus far and by her explicit goal to support students’

mathematical communication, Ms. Lenihan believes in the power of student discourse to help develop mathematical understanding. Yet, there is confusion around what that mathematical discourse sounds like and how to create discursive structures so that students' mathematical discourse can be used to make meaning of mathematical ideas. Specifically, there is confusion as to how mathematical discourse interacts with mathematical cognition is not clear. To illustrate this point, consider the following exchange where Ms. Lenihan discusses how she designs interactions in an effort to support mathematics learning:

C: And, why do you tend, attend to that kind of arrangement [of heterogeneous groups]?

L: Because I want a variety of learners to engage in the learning process. So, if you have, say, a lower learner, they can learn from a student that is advanced, or that uses the language the student can hear, because it's peer. It's peer learning. They're learning from each other. And, I've seen that, and it works great. I think when you have all lower learners together, you're not going really far with anything 'cause they're both looking at each other like they're confused; they're very confused.

C: I just, kind of, wanna build on that, you know? You think the students will engage with one another. I'm trying to assess where you think the math learning happens. And, it sounds like you think it happens, you know, in peer interactions.

L: Yeah.

C: Can you say more about what that, you know, like how, how learning occurs in this group?

J: Like, having this project [constructing 3-dimensional paper cars] has them make sense of [the mathematical topic of] area. They have to use formulas. They have to not just count boxes, but, you know, use the shortcuts, the formulas. So, I give them to them, I practice with them, but then they have to talk to each other and figure out how that works with their individual projects. So, I feel that I'm, like my role in the classroom is just kind of like a disseminator of information. And, then you have to have a structurized project that gets at the information, that makes them use it, that makes them talk about it, that makes them successful in using that information. So, it's kind of a, um, (*pause*) negotiation. So, what I would have hoped with this is that when they looked at, "OK, this is a triangle. Which formula am I going to use?" 'Cause we had all the formulas up in the classroom. Base times height, you know? And, as you can see, some groups were successful, and were able to do that, and I could hear them talking, "Ok, this is the formula we wanna use" – and some were not.

From these comments, it is clear that Ms. Lenihan believes that talking, in general, helps students arrive at an answer to a given problem. She also implies that, because they use “the language students can hear,” the language of peers is more accessible for students, as it is qualitatively different than the language of the teacher. What Ms. Lenihan does not appear to recognize, however, is how the mathematical talk between peers, which can vary widely, helps students make sense of mathematical ideas. In other words, the “nuts and bolts” of student-student discourse and how it influences understanding is not something she mentions or attempts to facilitate when she works with groups, which suggests she has an incomplete understanding of how language mediates learning.

Interestingly, she uses the word “negotiation” to describe what occurs in small groups. While “negotiation” could be referring to the cognitive process through which humans develop meaning around a particular scientific concept (Vygotsky, 1987) or usage of language as a result of various situated inputs, from this context (and consistent with other instances) it seems as though Ms. Lenihan is more referencing the public debate between students to arrive at a conclusion or solution. For example, in one planning session, Ms. Lenihan posed the following question: “Should they do this with a partner? It would give them opportunities to negotiate and use language. For example, if one kid says, ‘Church is one hour’ and another, ‘Five,’ they’ll have to come to some agreement.”

Certainly, both interpretations of negotiation are critical to the meaning-making process. The social, or interactional, level of negotiation is the primary step that leads to the internal or individual level of negotiation (Donato, 1994; Emerson, 1983). However, when a teacher’s understanding of mathematics discourse development ends at the notion that language develops automatically when students simply talk and interact, it has implications for the discursive supports the teacher

deliberately puts in place for students, and thus, how well or with what proficiency a specialized discourse, such as mathematics discourse, will be achieved.

It is important that we do not let ourselves conclude that this is about Ms. Lenihan's inadequacies as an instructor. By promoting talk and creating opportunities for students to talk about mathematical situations, she is instituting pedagogical practices in line with, say, the *Communication* process standard put forth in the NCTM Standards (2000). The critical take-away from this analysis is that understanding the role of and facilitating the development of mathematics discourse is far more complex than merely providing opportunities to talk. Rather, it becomes necessary to explicitly assess the meaning students are attaching to a given mathematical concept as a result of talking, as well as explicitly discussing the language we are using to talk about that concept (Gee, 2008). This would produce a MdC in which student-to-student talk serves a role in which not only are multiple perspectives considered, as in the spirit of compromise that Ms. Lenihan describes, but additionally, the talk leads to linguistic and mathematical sense-making.

Still, Ms. Lenihan does not appear to have a comprehensive understanding of the cognitive and linguistic benefits of students' micro-interactions. Additional evidence to support this claim can be found in the fact that, when planning for students' mathematical learning, she places the most importance on the selection of a good activity, and thus, placing the onus for stimulating mathematical discussion and developing mathematics discourse on this piece of curriculum. Noticeably, Ms. Lenihan does not describe within her role as mathematics teacher the responsibility to help students talk mathematically; rather, this comes automatically with a project.

This is not a surprising finding given the pressures absorbed by urban teachers in the age of heightened accountability and the corresponding messages they receive as to how their attention should be allocated (Meier, 2002). Still, however, Ms. Lenihan does not plan or implement lessons

differently for Latina/o students than she would for any other student population; that is, she plans lessons generically. This is important to note because it is a reflection of her level of understanding of the process of language development and its role in developing mathematical understanding.

Here, in a debriefing session near the end of the school year, I asked Ms. Lenihan directly about her tendency to improvise the mathematics discourse that transpires in her class:

C: Have you ever sat down and really outlined in your head what it is that you want them to talk about and how it is that you want them to talk about it, so that its more of a streamlined, efficient way to the sense-making, the sense-making process is more streamlined and focused so that they will come out with that kernel of knowledge or whatever through the conversations, instead of more like, we go here, we go here, we go here,

J: Right (*speaking simultaneously*)

C: and sometimes there's no, like, closure...

J: Right (*speaking simultaneously*)

C: ...or whatnot?

J: Hmmm. Probably not, no. I mean, because what I want them to know is, "Here's a circle. This is the formula to find it. This is the radius." The traditional how to get there. This, this is what you use that your learners can latch onto right away. Getting there is sometimes difficult when you don't know where everyone is coming from.

Noticeably absent from Ms. Lenihan's comments is any mention of the complex meaning-making process in which students engage; rather, mathematics discourse is a straight-forward matter, as evidenced in her last statement. One interpretation of what she is saying is, "These are the things they need to know, so these are the things I say, and mathematical understanding should happen as a result of processing these words." While this may appear to be oversimplifying her comments, when considered along side the examples presented above that illustrate a focus on a limited set of technical mathematics words, it becomes clear that a nuanced understanding of the role of language in learning is missing.

Furthermore, Ms. Lenihan does not take up the idea of strategically using opportunities to talk and developing talk in purposeful ways. This reinforces the interpretation that mathematics discourse, in Ms. Lenihan's purview, is a means to collectively arrive at a correct understanding of mathematical facts, or simply language to be processed in order to develop mathematical understanding. From this perspective, the acquisition of mathematical knowledge is straightforward: there are clearly defined mathematical facts (i.e. what is a circle, how do we measure the dimensions of a circle), and these pieces of information are tangible and able to be understood by proceeding through a certain set of directives. Ms. Lenihan does not demonstrate that she makes important considerations such as, for example, that a formula is abstract, or how the symbolic form of a formula relates to the measurement process. Her comments suggest an unawareness that such mathematical ideas need to be explicitly discussed, which makes sense since these mathematical ideas underpin more prominent mathematical concepts and often fall outside of the state standards that guide her lesson planning. Ironically, without listening to students' conceptions of what it means to measure a circle and generalize a formula that allows us to measure any circle, knowing "where everyone is coming from" is nearly impossible.

In passed years, Ms. Lenihan implemented a practice in which small groups were held accountable for sharing out on their discussions in a whole group setting, providing every student a final opportunity to internalize new meanings and the teacher an opportunity to assess these meanings. Yet, this practice was abandoned after the first year of my observations. According to Ms. Lenihan, this consumed far too much valuable class time, and she made this sacrifice in order to "cover more topics." While this is an understandable pressure facing today's teachers, the fact that this routine was abandoned suggests that she is unable to see the value in a promising practice and space for her and her bilingual Latina/o students to meaningfully *negotiate* mathematics

discourse. Again, to Ms. Lenihan, the role of mathematics discourse in mathematics learning is nebulous. Furthermore, this highlights the importance of a previous theme, that planning was done hastily and without consideration for the necessity to support bilingual students' mathematics discourse development. With a broader range of considerations for the language development needs of bilingual Latina/o learners, planning could be used to increase efficiency in lesson implementation (e.g. planning manageable lessons that can be started and concluded in a given period).

To imply that Ms. Lenihan does nothing by way of supporting students' language development would be inaccurate, however. As has been pointed out in her biography and description of her approach to mathematics teaching, she certainly has developed sensitivity to emerging bilingual learners' difficulties. For example, she recognizes that some students may not understand her messages in their entirety and that some students have weaker written skills. While she has struggled to find a way forward, she has attempted to incorporate various resources to help facilitate the language learning process. One solution she developed was to occasionally focus on the World-class Instructional Design and Assessment (WIDA) language proficiency standards (WIDA Consortium, 2007), which essentially outline a continuum of proficiency levels in the four communicative competencies (listening, reading, speaking, writing) and articulate the numerous social scenarios in which language must be understood (e.g. "express or respond to humor or sarcasm in conversation," Grades 6-8 Speaking domain, Social and Instructional standard, Level 5). While the WIDA standards were likely useful in broadening her purview of the multitude of social situations in which different aspects of language are developed, the data presented thus far suggest that this general orientation to language development did little to assist her in helping students develop mathematics discourse specifically. Similarly, she places students in groups where a

common first language can be utilized, and again, provides students with opportunities to talk. But, this has not resulted in an environment in which time and attention are consistently dedicated to explicitly making connections between mathematical ideas and the corresponding discourse – one last, but critical step to facilitating the meaning-making process.

3. Teachers' Skill Sets and Ideologies Influencing MdC's

In this final major section, I present data and discussion to address the third sub-question: *What ideological, knowledge, and skill factors influence the development and utilization of mathematics discourse communities?* One finding is that the teachers express uncertainty around what is within or outside of what they perceive to be their roles as mathematics teachers of Latina/o students. Included in this discussion is an articulation of contextual factors that make it difficult for them to accommodate all learners – especially those students who are just beginning their English development trajectory and those who have become disenfranchised from the mathematics learning community. The final finding is that the teachers maintain distinct language ideologies and perceptions of Latina/o learners that tacitly influence their design and implementation of MdC's. To close, I profile an episode from Ms. Hendrix's class to illustrate what it looks like to privilege mathematics Discourse (big "D"). I briefly discuss how the promotion of institutionalized mathematics language indexes particular ideologies of mathematics learning that further reflect a lack of specific considerations for Latina/o learners.

a. Ideologies Surrounding Teachers' Perceived Role & Struggle to Include

One of the findings of this study is that the teachers experienced uncertainty about what is within or outside of their responsibilities as mathematics teachers of Latina/o students, including supporting students as they take on the additional task of learning English, and specifically, mathematical discourse. In particular, the teachers hold viewpoints, or ideologies, that influence the

roles they assume, their planning of mathematical activities, and their instructional decisions. In this section, I will highlight some thoughts Ms. Lenihan shares regarding her struggles to work with Spanish-dominant students. Many of these conversations occurred outside of recorded sessions, and thus were not captured *verbatim*.

The fact that Ms. Lenihan chose not to directly engage with Niko in the two episodes presented above – and in the weeks preceding, in between, and following these episodes – is telling. It is a manifestation of an assortment of beliefs about her capacity to teach emerging bilingual learners, as well her beliefs about the learners themselves and the lack of support she is receiving from various resources she feels ought to be allocated to her classroom. Her comments in a debriefing period following the class period highlighted in the second episode with Niko provide some insights regarding her actions.

Before I present the details of conversations around teaching mathematics to emerging bilingual students and the issue of resource allocation, it is important to make clear the context within which the teachers teach. This is a large urban school district that has been experimenting with a wide range of management structures and is situated underneath the national spotlight as it amplifies its efforts to close down neighborhood schools and re-open charter schools and various academies ran by Educational Management Organizations (EMOs) based on data produced by high stakes tests such as state standardized examinations (Lipman, 2004, 2011). At the time of the study, more resources and energy were being funneled into efforts to analyze assessment data and micromanage curricular matters and building-level logistics (Lipman, 2004), and little or no time is invested in the difficult task of supporting teachers as they learn about their bilingual students who bring very different learning capital to the classroom than to what they might be accustomed (Valenzuela, 1999).

It is within this context that Ms. Lenihan struggles to define her multiple roles as a mathematics teacher of bilingual Latina/o learners. She has pointed to several dimensions of institutional and classroom-level practices she wishes were adjusted. First, Ms. Lenihan has mentioned on more than one occasion that she desires more assistance from the Bilingual Lead Teacher (BLT). She reports that the school's BLT spends nearly all of his time in the K-6 classrooms and doing administrative work. Ms. Lenihan, as well as Ms. Hendrix, wishes the BLT would be more outgoing in communicating with teachers the students' backgrounds and needs, as well as particular strategies for interacting with them. Importantly, the fact that Ms. Lenihan defers to the BLT for specific ways to interact with Niko and waits for him to help mediate these interactions is indicative of ambiguity with which she perceives her role as mathematics teacher of Latinas/os. By doing so, she effectively renders useless her outgoing personality and frequently-utilized creativity.

When considered in light of the other episodes presented, this dynamic contributes to the establishment of a distinct MdC. Through observations, it becomes apparent that Ms. Lenihan has energy and time to circulate amongst the small groups, asking questions of the students, and making suggestions. However, once within these groups, her attention is differentially allocated. There are some students, like Niko, for example, that are not invited to participate in mathematical activity, and evidently, this is acceptable classroom practice. This is not meant to challenge Ms. Lenihan's compassion, but illustrate the materialization of events within the given context. It is understandable there is little consideration for how we might improve meaningful interactions with emerging bilingual students since there is no time and (intellectual) space committed to sorting through these complex pedagogical matters.

Second, Ms. Lenihan is critical of job responsibilities assigned to the lone bilingual paraprofessional, who, aside from the office secretary, is the only Spanish-English bilingual staff member in the middle school. She wishes the paraprofessional would take a more active role in working with the handful of newcomers. These critiques of other school personnel index a feeling of inadequacy within Ms. Lenihan. Her desire to be directly supported by Spanish-speaking personnel suggests a sentiment that she is incapable of working Spanish-speaking students. On many occasions, Ms. Lenihan has endorsed the utility of Spanish as a tool to mediate mathematics learning, a theme reiterated across courses in her Masters program. It appears as though she is conflicted, or caught between believing that there is truth in this notion, that Spanish is the primary vehicle to support Niko's mathematical learning, and developing a sense of urgency that would help her innovate a way to facilitate mathematical activity that is conducted in Spanish. Given her inability to support Niko in Spanish, Ms. Lenihan is positioned in such a way where she does not know how to move forward (in engaging with Niko).

Third, this teaching dilemma of knowing a student needs assistance accessing the mathematics but not knowing how to support the student is compounded by the struggle to manage time. But, there are clearly more dynamics interacting to produce this form of non-interaction. Ms. Lenihan is cognizant that some students require more attention, but feels restricted by time and incapable of dedicating the time they need. Niko aside, she voices frustration with certain students' lack of English development and questions whether their development of English proficiency is linked to intelligence. She notices that some students have not developed their written English as well as others who have been in the bilingual program for more or less the same amount of time. In questioning English learners' innate intelligence, she locates students' capacity to learn and achieve within the child, as a particular trait within a particular type of person. By directly comparing

students' language skills, she assumes that their developmental circumstances have been identical and views development as an individual phenomenon. This relieves her – and the MdC she creates – of any responsibility for their mathematics language learning and helps us make sense of the episodes above.

Finally, Ms. Lenihan expresses an interest in developing a voluntary peer-tutoring program that would function to support emerging bilingual students. In voicing this idea, she shows us that she recognizes certain students are not attended to in ways that are going to help them access and cognitively engage with advanced mathematical ideas. Furthermore, she reveals an awareness that she needs to explore alternative learning arrangements for the variety of Latina/o students she has in her class, ones that would leverage peer interactions for everyone's developmental benefit. On the one hand, this is a proactive and commendable idea. On the other hand, Ms. Lenihan is once again passing off responsibility for facilitating mathematics learning onto the bilingual students.

This hypothetical situation begs the question: what will that training look like? Perhaps thinking in terms of how to develop peer-facilitators would have a positive effect on Ms. Lenihan's specialized pedagogical approach. This idealism is dimmed, however, once she expresses concern for the students that would "have to work with" newcomers, implying that in working with Spanish-dominant students, their mathematical development might be obstructed.

Again, through Ms. Lenihan's words and actions, we are able to glean where her commitment lies. It appears as though she is more concerned about advancing the advanced students than devoting critically important resources (i.e. her time) to those students who most need it. As a result, a clearer picture of MdC emerges, one that very well might look and feel different, from a student's perspective, depending on the student's language and mathematical proficiency and Ms. Lenihan's relative comfort in engaging with the student.

When considered with an educational environment that emphasizes test performance above all other ends of education, we can better understand Ms. Lenihan's frustrations, which lead to the development of particular outlooks with respect to certain students. With the standardization of pedagogy and curriculum (Joseph, 2011), it becomes understandable how it becomes more difficult to synchronize oneself with the learners' needs and innovate approaches to address the less-than-perfect ways in which particular students are engaging with the teacher's mathematics. Generally speaking, emerging bilingual students and their language development needs don't fit neatly into the way we are socialized to envision mathematics teaching and learning unfolding. A much different MdC needs to be imagined – and supported by institutional practices – in order to disrupt the dismal mathematical trajectories of bilingual Latina/o youth.

b. Language Ideologies: What do the teachers do with Spanish?

The final finding from this study is that the teachers maintain distinct language ideologies, specific belief systems pertaining to the status and role of language, and perceptions of Latina/o learners that tacitly influence their design and implementation of MdC's. In the following section, I highlight the teachers' views of the importance of Spanish, as well as their efforts to incorporate it into learning scenarios. To close, I profile Ms. Hendrix's use of mathematics Discourse (big "D"), which illuminates the privileged status of technical mathematics language. I briefly point to how this potentially has an alienating effect on bilingual Latina/o students, many of whom already have fragile mathematical identities, presumably, given their historically underwhelming collection of mathematical experiences.

This is a study that aims to better understand how two teachers – of distinctly different backgrounds from their students – understand their roles as facilitators of mathematical learning with bilingual Latina/o students, students that have multi-dimensional histories that culminate in

particular learning strengths and needs. As mentioned in Chapters 1 & 2, Spanish has been identified as an under-utilized resource for mathematics learning among Latinas/os (Khisty & Willey, 2012; Varley Gutierrez, Willey, & Khisty, 2011), and the incorporation of Spanish presents a unique teaching dilemma for monolingual teachers.

Relevant to the teachers' design and implementation of MdC's are their thoughts and actions around the role of the students' native language, Spanish. It is clear that both Ms. Lenihan and Ms. Hendrix believe that Spanish is a learning resource for the students. Ms. Hendrix, for example, opens the school year by letting her students know that "it's OK to speak Spanish in here," an important invitation given that Ms. Lenihan and Ms. Hendrix regularly comment on the dynamic that the use of Spanish is overtly discouraged in various spaces of the school. Yet, this message is not reiterated throughout the semester, which puts into question the seriousness with which this message is delivered, especially when considered in the context of an overwhelmingly English-dominant schooling environment. In fact, Ms. Hendrix subtly delivers a counter message: at times, she appears nervous when Spanish is being spoken in her class, as she struggles to determine whether the conversations are on topic or not. As an example, consider the following incident:

The class was working on multiplying variables with exponents. Salvador, who is a newcomer and operates almost exclusively in Spanish when working with his classmates, are debating a mathematical approach with his close friend, Mateo. Ms. Hendrix, who often regulates Salvador's playfulness, arrives to check-in on the pair to make sure they are on task. With a half smile that indicates she suspected they were engaging in personal (non-mathematical) conversation, she asks the generic question, "How are you guys doing [with the mathematical exercises you are working on]?" The boys' conversation halts, they suddenly become serious, and Mateo reports to Ms. Hendrix exactly what they were discussing, that one can only add the exponents and combine alike coefficients when they are exactly the same (e.g. $ab^2 + ab^4 + b^3 = ab^6 + b^3$).

Upon Ms. Hendrix's departure, the boys resumed their mathematical talk in Spanish, though the enthusiasm with which the pair was originally dialoguing was not recovered.

Not knowing how to monitor and involve herself in mathematical conversations in Spanish, Ms. Hendrix is stuck at the level of simply validating her students' language choice. What once

began as encouragement to use Spanish freely, however, has faded over time with infrequent references. To others, like Salvador and Mateo, this validation might appear inauthentic because of mixed signals. Ms. Hendrix is noticeably ill-equipped – practically, philosophically, and ideologically – to promote the productive use of Spanish for learning purposes. From the literature and discussions from her Masters courses, she knows that Spanish is a legitimate and valuable means of facilitating students' learning, but it seems she does not understand the intimate affiliation and importance of Spanish to Spanish-speakers, nor does she know how to maximize its potential other than permitting its use in the classroom. Given public discourse around English Language learners, which inevitably suggests that learning English is the most pressing matter to resolve in their schooling, and the immediate school culture that makes advocacy for Spanish a constant battle, it is little wonder why Ms. Hendrix might shy away from interactions in Spanish in favor of English interactions rather than trusting students and persisting in finding ways to mediate Spanish-English interactions.

Ms. Lenihan, on the other hand, takes a different approach. She has observed that when she approaches a group engaging in a discussion in Spanish, they abruptly shut down upon her arrival. Her solution is to leave the Spanish-speaking groups alone, so that she does not inhibit or prematurely end a meaningful discussion. While this decision is rooted in the belief that Spanish is a valuable resource to facilitate mathematical meaning-making, Ms. Lenihan is effectively neglecting these students – leaving them *without* an expert facilitator and *with* the responsibility of independently making sense of the mathematical concept at hand. By removing herself completely from the interaction, she cannot monitor or contribute to their conversation. Assessing this group's understanding is not an option. It quickly becomes apparent that this decision leads to a disservice and an inequitable distribution of her attention.

Alternatively, Ms. Lenihan might ask the students to capture what it is that they were discussing, strategically ask questions of the students to assess whether a shared meaning is being developed, and help the students make sense of the mathematical topic in relation to what they already know (i.e. make mathematical connections). Each of these three pedagogical moves directly engages students in the mathematical meaning-making process in a more sophisticated way than if they were left by themselves. This conversation with Ms. Lenihan might move back and forth between English and Spanish, each time capturing and representing in English what was previously exchanged in Spanish for Ms. Lenihan. On the other hand, it may be that the conversation shifts entirely to English to accommodate Ms. Lenihan. This does not, however, need to be a permanent shift. If the students were operating in Spanish, they can once again operate in Spanish; it might take a purposeful encouragement from the teacher, but if done in a way that affirms the shared value of utilizing Spanish in mathematical contexts, increased Spanish use will likely follow.

What appears difficult for both Ms. Hendrix and Ms. Lenihan to gauge is how power and socio-historical context play important roles in these language interactions. Ms. Hendrix, for example, does not seem to notice that simply permitting students to speak their native language is going to do little to help them use it effectively in developing mathematical understanding. Spanish, as a learning resource, has systematically and increasingly been squelched since kindergarten. In order to reclaim it as an effective medium to help students develop mathematical understanding, significant steps need to be taken. For example, as uncomfortable as it might initially be, Ms. Hendrix might consider increasing her presence in those interactions and creating a space where Spanish can be the primary language of communication amongst group members, while English is used strategically and in moderation to keep her abreast of the group's progress.

In Ms. Lenihan's class, due to the MdC that has been established, she is positioned as the supreme authority. As such, her language, English, becomes the language of power and the de facto language of mathematics, as it has been for many years with these students. Historically, students have become accustomed to teachers listening and evaluating what they are saying. So, it should be no surprise that the students feel as though they should not operate in an incomprehensible language when Ms. Lenihan is around. Furthermore, I gather that the students have few experiences bouncing between languages in the formal mathematical classroom setting. Therefore, we should not assume that switching to English is an easy transition to make "on the fly." These tricky linguistic situations need careful encouragement and modeling from the leader of the class, Ms. Lenihan. If the teachers had an acute awareness of the dynamics of language choice, we might see them innovate ways to engage with the group while still sustaining Spanish dialogue.

c. Discourse (Big "D") in the Mathematics Classroom

Another instantiation of language ideologies infiltrating the classroom and its implications for Latina/o mathematics learners is captured in the Ms. Hendrix's overt emphasis of mathematics Discourse (big "D"). Up to this point, I have been describing and illustrating discourse as 1) the conventional use of language as it mediates the learning process, and 2) the conventional use of language to establish the values and norms around what it means to do mathematics and, consequently, positions Latina/o learners in relation to mathematical competence. There is also the big "D" mathematical Discourse – the institutionalized, technical, and oft-privileged variety of mathematical language – that appeared throughout my time with the teachers. While it is not a central focus of my analysis, it deserves attention and consideration for future examination.

Despite her knowledge that a mathematics discourse is significantly different from everyday English, Ms. Hendrix seems unaware of the power distributed through mathematical discourse

(Herbel-Eisenmann & Wagner, 2010; Hodge, 2006). While monitoring students doing warm-up exercises from the textbook on combining like terms, she addressed the class as follows:

H: How are you on like terms? (*no pause*) I see some of you are trudging ahead. Great. Great. I hope Distributive Property is coming out of you somehow. It's nothing we haven't talked about at all this year, but it's a very, very important property. For those of you who feel comfortable going ahead, the answers are in the back.

Needless to say, Ms. Hendrix is clearly emphasizing the importance of the Distributive Property – not the applications of the Distributive Property, but the generalized formula and function of the Distributive Property. This is an important distinction to make given that abstracting and generalizing are elusive skills to develop independent of more concrete activities (Civil, 2007) and because they often are not properly supported in tandem in mathematics classrooms (Moses, 2000). Without explicit attention to building these mathematical skills, they effectively serve as sorting mechanisms, separating those who are successful with mathematics and those who are not.

In her promotion of the Distributive Property, Ms. Hendrix does at least four things, all within a succinct delivery. First, she asks a rhetorical question, “How are you on like terms?” While the rhetorical nature of her question limits the insightfulness of feedback she might get from students, she also does not allow any time for student feedback. This gives the impression that she is doing nothing more than going through the motions of what she thinks teachers should be doing and saying to their students. It invokes a traditional mathematics teaching methodology consistent with the way she has described how she envisions mathematics teaching and learning with any student population.

Second, she praises those who have affiliated with the task. By doing so, she tacitly reprimands those who resist – to whatever degree – engaging with the task. She is making a value statement and divisively positions students in categories: those doing exceptionally well, those struggling to do the exercises quickly enough, and those not able or willing to do the exercises. This

short statement offers us insights into how she views teaching mathematics: it suggests that mathematical knowledge or capacity to understand a concept lies within the learner, and through a given activity or as a result of some trigger, it will “come out” or emerge or make sense.

Third, Ms. Hendrix grants permission for students to go ahead and verify answers with those in the back of the book. This further illuminates her view of mathematics learning as an individual, cognitive activity. She essentially offloads primary responsibility for supporting students’ mathematical meaning-making and defers mathematical authority to the textbook, identifying it as the tool most likely to help students learn. Furthermore, her comments insinuate that mathematics learning occurs after an internal struggle with the problem in the book. Success becomes defined in a particular way and can be validated “in the back of the book.” As a result, Ms. Hendrix’s role is minimized. It also reflects a view that students should be intrinsically motivated to work with new mathematical ideas, which becomes the normative way of engaging with mathematics in her classroom. Unfortunately, there is no evidence that reflects an awareness of how struggling students – especially those whose mathematical engagement are influenced disproportionately by language development processes – might interact with mathematics and how she might see herself mediating these mathematical learning experiences.

Finally, her emphasis on the formal properties of mathematics as discrete pieces of mathematical knowledge to be learned invokes the institutionalized or formal body of mathematical knowledge (see “classical knowledge” in Gutstein, 2006) already defined by someone else as important and worthy of learning. Alternatively, Distributive Property can be framed as a tool with which we can solve particular types of mathematics problem situations. This is an important example of Discourse that holds the power to sort mathematics learners into various categories (i.e. those who are willing to learn sterile knowledge for knowledge’s sake [blind faith]; those who resist

going through the motions of schooling without seeing the value in the content, reluctant to be treated as an item being processed, to use the manufacturing metaphor that has been historically used by critical educators to describe the schooling process in the U.S. [Spring, 1989]).

About six minutes later, Ms. Hendrix addresses the class once again:

H: Most of you seem to be OK. Once you get past 12, that's something that I haven't taught you yet this year. Of course, you are going to know Distributive Property – very important as I mentioned.

Again, Ms. Hendrix privileges the institutionalized or formal language of mathematics. This is representative of her practice and reminiscent of the example above in which she introduces the lesson on rational numbers by providing a technical definition. It is a critically important element of her teaching practice that helps shape what it means to do and engage with mathematics. At the same time, it reflects an inability to recognize that she likely is reproducing the mathematics education arrangements that have not served Latinas/os well in the past; that is, when the institutionalized language of mathematics is privileged and historically entrenched meanings of mathematics are reinforced, it is difficult to imagine how Latina/o students might re-define a way of engaging with mathematics that serves them differently than their (collective) past experiences. Ms. Hendrix's history likely contributes to this dynamic: having been a learner with strong affiliation to mathematics and willingness to conform to the historical norms of mathematics, it appears to be a challenge for Ms. Hendrix to see the potentially alienating effects of privileging mathematics Discourse.

When introducing and helping students develop a specialized discourse, it is important to be cognizant of the institutionalized nature of specialized discourses. That is, there is an inherent power in a given discourse community, and a group member's peripheral or central participation is often determined by how they are introduced and welcomed into the discourse community (Gee,

2005). When historically marginalized Latina/o youth are the new members of the discourse community, this reality becomes increasingly important.

V. DISCUSSION & IMPLICATIONS

A. Introduction

This study aimed to answer the question, *How do monolingual middle school teachers develop and utilize Mathematics discourse Communities with Latina/o students?* Essentially, I want to understand the issues monolingual teachers encounter as they attempt to develop and implement an effective mathematics learning environment – one that emphasizes speaking mathematically, engaging with peers, and thoughtful teacher discourse – for bilingual, Latina/o students, most of whom are learning mathematics in their second language. This question is best addressed by answering these sub-questions:

- 1) *What issues and challenges surround the teachers' development and utilization of mathematics discourse communities?*
- 2) *What linguistic factors influence the development and utilization of mathematics discourse communities?*
- 3) *What ideological, knowledge, and skill factors influence the development and utilization of mathematics discourse communities?*

In the previous chapter, I presented the findings of this qualitative study as they pertained to the primary research question and each of these three sub-questions. In this chapter, I will summarize these findings and discuss what can be concluded from the collection of themes that emerged from data analysis. This discussion is organized around the questions that guided this research. In a subsequent section, I discuss the limitations of this study. Finally, I highlight the implications of these findings and directions for future research, paying particular attention to what this means for preparing future teachers and developing teachers currently serving Latina/o youth.

Before I begin, however, I would like to re-state what I mean by *Mathematics discourse Community* (MDC). In this study, I specifically define MdC to be the mathematical community the teachers are trying to create for Latina/o learners – one where mathematics learning is designed

around the teacher's purposeful discourse, and where students are afforded opportunities work collaboratively and use and develop mathematics discourse. This is occurring in a context where the teachers do not have the luxury of sharing the students' native language, and the majority of the students are learning mathematics in a second language.

B. What Issues and Challenges Surround the Teachers' Development and Utilization of Mathematics discourse Communities?

The data analyses suggest that there were tensions around the teachers' efforts to take up and interrogate the concept of MdC's. This was reflected in teacher planning that rarely took into consideration the unique strengths and needs of emerging bilingual students, yet, at the same time, this planning was driven by particular ideologies about Latinas/os and mathematics learning. Furthermore, a lack of a conceptual framework emphasizing inclusion lead to teacher difficulties in modeling and promoting an inclusive learning environment for emerging bilingual students, one that supported their access to the central mathematical ideas of lessons or activities.

1. Planning for Mathematics and Language Development

It is known that lesson planning is an under-developed skill amongst teachers of diverse learners (Irvine & Armento, 2001), and this finding was confirmed with this study also: I found that planning for MdC's for bilingual, Latina/o students was an issue for teachers. Ms. Lenihan and Ms. Hendrix already did little pedagogical lesson planning, relying primarily on their prior experiences and historical conceptions of teaching mathematics and, in the case of Ms. Hendrix, on the textbook. While teachers in general have been found to do little lesson planning that departs from the conventional model (i.e., specify objectives, select activities and formats for engagement, evaluate lesson) (John, 2006), the lack of planning with considerations for Latina/o students, in this case, is particularly problematic. Planning for the kind of learning environment that requires

simultaneous attention to both mathematical understanding and language development is not what teachers are used to.

The teachers didn't budget sufficient time for planning lessons that take into account the particular cultural-historical and language needs of their bilingual students that will help make the mathematical activities more comprehensible and connected to students' experiences. And, by not planning conscientiously, the teachers are not able to significantly re-shape the mathematical and language experiences the students receive. Instead, they continue to employ the same, or similar, practices that have historically excluded Latina/o students from meaningful mathematics learning (Khisty & Willey, 2008). Blame, however, ought not be assigned to the teachers, given that institutional structures – at each of the building, district, state, and federal levels – are not aligned with instructional goals and practices that aim to take into consideration and address Latina/o students' historical mathematics schooling experiences, the different learning capital they bring to the classroom, and their unique and often-overlooked learning needs (Valenzuela, 2005).

Mathematics classrooms that successfully support bilingual students require special attention (Khisty, 1997; Razfar, Khisty, & Chval, 2011). Teachers need to plan for classroom interactions that afford students plentiful opportunities to practice meaningful and increasingly sophisticated mathematics discourse. In addition, the teacher needs to utilize instruction that models speaking mathematically and concomitant values and behaviors, and explicitly emphasizes mathematics discourse development. This requires careful planning that assures clarity of mathematical communication. These two elements – classroom arrangements that encourage substantial talk among students, and consistent attention to language development and clarity of communication – point to the need to spend extra time planning. For teachers who only speak a language different from their students (as in the case of Ms. Lenihan and her student, Niko), such planning becomes

even more crucial, and as my findings highlight, with haphazard teaching actions, instruction can be confusing.

As I reported in the previous chapter, the idea of a Mathematics discourse Community was sorely missing in the teachers' planning of the lessons. Consequently, the teachers did not have a conceptual model of mathematics pedagogy for bilingual learners that would help coordinate their efforts to create opportunities for students to talk mathematically, support students as they engaged in more sophisticated mathematics talk, and facilitate students' development of second language skills in general. While both Ms. Lenihan and Ms. Hendrix attempted to incorporate opportunities for students to talk mathematically in their lessons, these opportunities were most often improvised instead of strategically planned. In the case of Ms. Lenihan, this led to class discussion questions that were not clearly communicated, peer interactions that were limited to debating "right" answers, and mathematics talk that emphasized the production of technical mathematics vocabulary that did not necessarily help students construct meaning of these new ways of using words. Furthermore, that the teachers did not take up MdC's suggests an incomplete understanding of how students are socialized *into* and *through* language (Ochs & Schieffelin, 1984) and how important talking is for learning mathematics, as well as second language learning more generally.

While these elements would have significant consequences to the mathematical learning community in any classroom, it is especially important to consider this finding as it pertains to bilingual, Latina/o learners. These are learners whose success in mathematics – and other academic disciplines, respectively – depends on their ability to make mathematical meanings (Khisty, 1995, 1997) and be able to operate in spaces where mathematics discourse is used; importantly, mathematics discourse should not preclude students' use of vernacular as they communicate mathematical ideas (Adler, 1999; Gee, 2008). Often times, however, and as was the case with Ms.

Lenihan and Ms. Hendrix, teachers seem to over-emphasize the canonical mathematics language they have (somehow) come to know and understand. When mathematics discourse is viewed in this way, the purpose for affording students the opportunities to talk becomes obscure. Students may get the opportunity to talk, but these opportunities are not structured in a way where students can construct refined meanings of new language, meanings that depend on students' current language repertoire. Without fore-planning to support mathematics discourse, bilingual students risk exclusion from meaningful and more advanced mathematical experiences in the future. Bilingual students need explicit support to help make connections between the language they currently have in order to make sense of mathematical ideas and the more precise and privileged language used (at large) to communicate these same mathematical ideas (Khisty & Chval, 2002).

Given this perspective that language development is an important part of mathematics lesson planning and teaching, and that a student's home language plays an important positive role in learning, the students' existing language repertoire, which likely includes Spanish, deserves special consideration. In fact, in many cases Spanish is a primary asset and learning resource. How Spanish can be maximized in MdC's also warrants attention. While there is no simple process through which monolingual teachers are to promote and monitor the use of Spanish for the purposes of facilitating mathematical learning, its absence from the general MdC is significant in that it was not deemed a learning resource worth innovating ways to incorporate.

To the contrary, as was illustrated in the episodes with Niko, Spanish was perceived as a major obstacle, preventing Ms. Lenihan from any direct interaction with Niko. In the case with Ms. Lenihan and Niko, there appears to be ambiguity and apprehension as to whether she should support his mathematics learning in Spanish or "push" him into interactions in English. The result of this ambiguity and apprehension for Niko is no support in Spanish and non-interactions with Ms.

Lenihan in English. I am suggesting that a focus on MdC's as a framework for making pedagogical decisions for bilingual students with a variety of language proficiencies would help draw attention to the ways in which bilingual learners are interacting with mathematics discourse; consequently, the teachers would be better positioned to intentionally plan approaches to support students' access to and engagement with the mathematical idea and corresponding language, thus eliminating gross neglect of emerging bilingual students in the classroom.

If there is little planning for language development and little attention given to critical mathematical learning conditions – such as the kinds of questions being asked of the class, the wording of questions by the teacher, and modeling the way students should discuss the mathematics – then the mathematics teaching process is less-than-productive for bilingual students as I described in my findings. Planning then becomes a much more important matter than previously assumed. Yet, the teachers I observed did not plan appropriately or extensively, underscoring an insufficient understanding of how language mediates mathematics learning.

Ms. Lenihan and Ms. Hendrix both spend the majority of their planning time developing or evaluating mathematical tasks. Ms. Hendrix, for example, relies on the textbook for a variety of tasks. Ms. Lenihan, on the other hand, has a similar preoccupation with mathematical tasks during planning time although her primary resource is the internet. She, however, has the added task of trying to expertly piece together mathematical activities that coincide with the ways students generally develop mathematical understandings, a very difficult task, indeed. In both cases, curriculum, or mathematical “problems,” are the central object of planning and instruction, and not how to ensure clarity of instruction, student engagement and meaning-making, or access to ideas and peers.

While Ms. Lenihan focused on selecting or creating mathematical activities that (ideally) relate to students' lives, she often did not budget time well so that the lessons began and closed with clear mathematical objectives. The lack of clear objectives and closure to lessons are likely to obscure for students how mathematical ideas fit together cohesively, amplifying the cognitively-intensive tasks students – who are learning mathematics in their second language – are left to do on their own. With bilingual and emerging bilingual students, it becomes increasingly important to make explicit the daily mathematical objectives (Echevarria, Vogt, & Short, 2009), weave the corresponding mathematical discourse throughout the activities, and support students as they generalize or synthesize the mathematical message and make connections amongst developing mathematical ideas (Hansen-Thomas, 2009; Khisty & Chval, 2002). This, of course, can only happen with thoughtful planning. With no mathematical “road map” to support the simultaneous development of mathematical concept formation and mathematical discourse development, students are left to haphazardly make mathematical meaning.

2. Participation, Inclusion, and Access

With this depiction of the teachers' planning in mind, it becomes clear that the teachers' pedagogy is limited in the ways it fosters or supports mathematical dialogue or behaviors, and thus, does not significantly depart from what might be thought of as the “traditional” teaching practices of the past. That is, the teachers continue to disproportionately ask students mathematical questions that are limited to a right answer; they disproportionately focus on computational processes over conceptual understanding; and, when they do ask questions of “How” and “Why,” these questions are frequently unfocused and prompt insubstantial thought and dialogue among peers. These practices compound to create a troublesome MdC amongst Latina/o learners who are struggling to gain access to complex – and often abstract – mathematical ideas in their second language.

As I described in my findings, these conditions accumulate to create mathematics learning environments that do little to move marginalized students towards the center of thoughtful mathematical experiences. Recall that Ms. Lenihan thought of herself as an accommodating teacher, generally having a positive effect on the mathematics learning of her bilingual students. The data reveal, however, that she actually tends to avoid interactions with Spanish-dominant students (e.g., Niko). She seemed to be unable to think of how to genuinely engage with, for example, Niko, especially since she did not speak Spanish and Niko did not speak English. Ms. Lenihan relinquished instructional interactions to a group of students and to the Bilingual Lead Teacher, who was seldom present in class. The only communication with Niko was via whole class instructions, and these were often not communicated well. The combination of not really understanding the nature of dialogue and group work in mathematics, along with the lack of instructional planning for these two elements, results in a dynamic process that actually excludes bilingual students. In addition, different standards of participation and engagement are used with different students, largely based on the student's language proficiency, as was evidenced through the case of Niko. Ms. Lenihan's attempt to improve Niko's class participation was to put him with a friendly group of Spanish-speaking boys; however, this simply resulted in degrading Niko and making him feel more excluded and embarrassed since the boys did not know what to do either. Niko's group members – nor anyone in the class for that matter – had not been taught how to work together and be accountable for one another's mathematical understandings.

While the teachers would surely say that they expected all students to participate, they regularly allowed some students to sit in class non-disruptively and unengaged. These students tended to be the most Spanish-dominant students. In an effort to explain this, Ms. Lenihan confessed that she was constrained by time and “didn't have the time that Enrique required,”

referring to one student who sat quietly each day, but rarely engaged in a meaningful way with the mathematical tasks. Class periods are indeed short, class sizes are large, and she evidently feels pressured to make decisions as to who is deserving of her time and attention. The resulting reality is a sizeable proportion of the class left to fend for themselves or access other resources (i.e. peers, family members). As such, the “community of practice” within the mathematics classroom has differentiated meaning for different participants, even though they share the same space (Gee, 2005); that is, students who present more significant challenges to the teacher (i.e. emerging bilingual students, students with mathematical knowledge and skills below grade level) are allowed to operate on the margins of the “community,” effectively shut out from “doing” mathematics (Stein et al., 2000) and acquiring a more meaningful affiliation with the mathematics community.

Related to this phenomenon is how teachers recognize non-participating students and subsequently, how they promote inclusion. It has been argued here that Ms. Lenihan, in particular, noticeably lacks the tools to establish inclusive learning environments. Not only do they rely on students to convey meaning to and engage newcomers in small groups as in the case of Niko, but she also fails to engage those same students (and many others) in whole class formats, missing out on a prime opportunity to establish a precedent on how classmates might reach out to and include marginalized students; that is, if other students observe Ms. Lenihan creatively engaging Niko in whole group conversations, this becomes the standard by which they are to collectively operate in problem-solving activities. Not only will this convey to Niko that he is expected to participate as best he can, but other students very well could appropriate this inclusive practice while in small groups. As I pointed out earlier, it is difficult to know how to engage a shy, non-verbal newcomer without a model, especially as a young student.

It is also important to keep in mind that while Ms. Lenihan's and Ms. Hendrix's students are proficient in conversational English, they still need support in maneuvering through the complexities of academic English, like, for example, the discourse of mathematics. For the most part, they may be the same words they use in out-of-school interactions; however, the words hold different meanings and are used differently in the mathematics classroom (Khisty, 1995). In short, the context is different, including tacit assumptions about what constitutes mathematics and why we study it. This reality needs to be considered when planning and enacting lessons because it affects emerging bilingual students' access to how they are to engage with a mathematical task, the important mathematical ideas embedded in the task, and how these mathematical ideas relate to one another, as well as real-life phenomena. Strategic arrangements can be made to facilitate access. Examples of such supports include how the teacher promotes the use of diagrams and representations and helps students talk about them, how students are encouraged to interact and be accountable for productive interactions, and how students are supported in their discourse development by being provided safe opportunities to attempt articulation of mathematical ideas, as well as through talk moves like repeating, re-voicing, and adding on (Chapin et al., 2009; Khisty, 1997).

The point is that Ms. Lenihan perceived herself as having limited solutions. Strategically incorporating peer interactions and orchestrating language-rich activities could work to facilitate emerging bilingual students' mathematical learning, as was demonstrated in the work of Elizabeth Cohen and her colleagues' with Spanish-dominant migrant students and the curricular activities of *Finding Out/Descubrimiento* (Cohen, Bianchini, Cossey, Holthus, Morpew, & Whitcomb, 1997; De Avila, Duncan, & Navarrette, 1987; Neves, 1997). The success of this work was attributed to strongly contextualized activities that had an intrinsic capacity to promote meaningful "talk" in

either language (Spanish or English) among students working collaboratively (Neves, 1997). The development of this kind of curriculum and pedagogy is predicated on a substantial time and intellectual investment in planning for the mathematics learning of second language learners *and* a solid theoretical understanding of how language and cultural resources interact to support bilingual students' sense-making and learning. As has been pointed out in the findings of the previous chapter, these were precisely two of the teachers' shortcomings.

C. What Linguistic Factors Influence Teachers' Development of Mathematics discourse Communities?

In response to this question, the data and analysis produced the following findings: there is confusion as to what constitutes mathematics discourse and its role in developing mathematical understanding, as well as how to create discursive structures to support students' development of mathematics discourse.

1. What Constitutes Mathematics Discourse, and What is its Role in Learning?

The cases of the two teachers presented in the preceding chapters illustrate the atmosphere created when teachers have an incomplete understanding of what constitutes mathematics talk and the role it plays in bilingual students' learning. Furthermore, the data suggest that the teachers do not know how to maximize communicative spaces, nor do they have a solid understanding of how students develop specialized discourses, the importance of developing these discourses, and their role as a discourse facilitator. The teachers have, however, displayed that they are thinking about providing opportunities for their students to speak and write as part of their mathematical development. Additionally, I witnessed the teachers' embrace particular themes that they explored in their Masters program courses (e.g. notion of secondary discourses, making connections to students' lives).

While this is not an evaluation of the teachers' Masters program, it should give us pause as to what kind of experiences we design to help teachers change their outlook and practices with respect to bilingual and emerging bilingual learners. It is naïve of us to assume that any of what we do in a Masters program will automatically transfer into pedagogy. As is the case with children's development, what is needed is sustained attention on a given topic, accompanied by a more experienced person (Vygotsky, 1974), as well as opportunities to practice and make connections between the theoretical underpinnings and concrete realities of mathematics discourse development (Vygotsky, 1987). This is especially crucial for those teachers who do not have the life experiences of learning a second language, including specialized academic discourses within that second language.

To start, it is important to address with teachers what constitutes math talk and what role it plays in their mathematical development. In the case of Ms. Lenihan, her stated pedagogical objectives and teaching practices indicate that she is aware that speaking mathematically is a part of "doing" mathematics. Yet, her idea of what constitutes mathematics discourse is extremely narrow, which has the effect of perpetuating the idea that mathematics is limited to numbers and operations. Consider the example presented in the previous chapter, where Ms. Lenihan is encouraging students to "use their math brain" and they are collectively brainstorming a list of "math words" that represent "how we speak mathematically." When students are asked to speak mathematically with a restricted set of pre-determined vocabulary words that have little personal meaning (e.g. decimals), the resulting MdC is one where the students are trying to fit into the pre-existing world of mathematics, rather than being positioned as co-constructors of mathematical knowledge. It is important to understand that mathematics discourse is more than incorporating technical words – words that often represent broad ideas but may have very concise (and important) mathematical

definitions (e.g. opposite, proportion). Mathematics talk is also the use of everyday vernacular as a means to make sense of mathematical ideas. In fact, we should expect students to utilize meaningful words with which they have the most familiarity; eventually, if mathematics discourse is properly modeled and explicitly taught, new, technical language will be appropriated by the students.

In this example, it is important to note that the class and Ms. Lenihan agree on what talking about mathematics entails. From this exchange, both Ms. Lenihan and her students express that mathematics is nothing more than numbers and operations. This represents a conception of mathematics socially and historically constructed over the course of seven years of mathematics education for the students; it likely reflects an overt emphasis on these components of mathematics over this time span. At the level of the teacher, it indexes Ms. Lenihan's mathematics education priorities and goals: she wants her students, first and foremost, to be able to talk about numbers and operations and their various representations. In essence, she would like them to verbally communicate what is represented in the symbolic form on the paper.

Given what we know about bilingual students' growth in classrooms where rich mathematical language is diverse and plentiful (e.g., Gutierrez, 2002; Khisty & Chval, 2002; Moschkovich, 1999, 2002), it is disheartening to see the deployment of mathematical language be reduced to such a minimal standard. Yet, it is understandable when considered in the context of a district that, for example, mandates the use of "Word Walls" in every elementary school classroom, reinforcing the unfounded – yet pervasive – idea that language development occurs word-by-word. When the student population is one that has an increased dependency on the teacher's ability to support their specialized discourse development, the implications of these practices are amplified. To begin to remedy this situation, it is important for the teachers to make at least two

considerations: 1) the socio-historical context of the students' learning over the past seven years, and 2) how students develop a secondary discourse.

In addition, it is important that teachers develop an authentic understanding of what it means to learn a language or develop a secondary discourse. The teachers certainly sympathize with the challenges inherent in learning a second language. At times, however, their sympathy can be debilitating, as the students who need the most opportunities to practice language are often asked to speak the least. Perhaps the teachers are stuck operating within outdated models of second language acquisition (e.g. Krashen, 1981) and are honoring the "silent period." At some point, they must realize that the silent period has morphed into an inactive learner, and letting the student continue to be silent is a gross disservice to the student.

Furthermore, I have no doubt that the teachers understand what a secondary discourse is and that mathematics discourse is such an example. But, this understanding falls short of being able to comprehend the intrinsic complexities in developing proficiency and making meaning of the secondary discourse. That is, just because the discourse is used in the presence of students does not necessarily mean that the students are using the discourse in meaningful ways and affiliating with the community of practice as a result. Teachers need to be intentional about asking students to communicate mathematical ideas – with their own vernacular – and are then responsible for making explicit connections between their words and the privileged mathematical discourse.

D. What Ideological, Knowledge, and Skill Factors Influence the Teachers' Design and Utilization of Mathematics discourse Communities?

In response to this questions, the data and analysis produced the following findings: The teachers maintain distinct language ideologies and perceptions of Latina/o learners that tacitly influence their design and implementation of MdC's. This leads to uncertainty about what is within

or outside of their responsibilities as mathematics teachers of Latina/o students, including supporting students as they take on the additional task of learning English, and specifically, mathematical discourse.

1. Ideologies Mediating Mathematics discourse Communities

The episodes presented in the previous chapter illustrate how the teachers' ideologies and values surrounding mathematics teaching and learning – and teaching emerging bilingual students in particular – play a significant role in the foci of lesson planning. Ms. Lenihan and Ms. Hendrix's lesson planning efforts, for example, revolved around previewing the textbook's next topic and lesson or developing curricular activities "from scratch." I have discussed how the teachers planned generic curricular activities that did not take into account complex considerations for individual Latina/o learners. These behaviors suggest that the teachers don't have complete understandings of the ways to support Latinas/os' mathematics learning, but, also, that they don't think Latinas/os need "special" arrangements to facilitate their learning. I have shown how the teachers struggle with the latter, both in their words and actions. Given that both teachers are acutely aware of Latinas/os' dismal, historical pattern of mis-education, it raises the question as to whether there is some ideological barrier keeping them from innovating and enacting pedagogical approaches that look different than those they have traditionally relied upon.

I have presented data illustrating an assortment of mathematics teaching practices that do not optimally support bilingual learners as they develop both mathematical understanding and language proficiency. In addition to an unsupportive and short-sighted institutional milieu, I attribute a portion of these teaching practices to inadequate and unfocused planning. The planning that does occur, however, reflects a theory of learning that hinges largely on how an individual interacts with a mathematical task. Furthermore, how an individual interacts with a given task is the product of

their motivation, and willingness to practice and assimilate to the notion of what it means to be a good mathematics student (i.e. faithfully do homework and classwork, and study for quizzes). This conceptualization of what it means to do and be successful at mathematics not only manifests in the rigidity of the sociomathematical norms established in the classroom, but also in the accompanying discourse. As I mentioned in the previous chapter, this approach to mathematics teaching and learning leaves no room to differentiate between learners; rather, the planning, implementation, and reflection upon lessons serves a generic student body, one that is English proficient and has had uniform mathematical experiences up to this point in time. This interpretation is consistent with Ms. Hendrix's belief that Latinas/os do not need anything different instructionally from other students, only "good mathematics teaching," and what she is providing them is just that.

On the other hand, I attribute their approaches to mathematics instruction with bilingual Latinas/os to particular language ideologies. For example, I remain unconvinced that either teacher wants Spanish in their classroom. Though they both publicly announced that Spanish is acceptable in their classrooms, no efforts were made to promote Spanish in critical peer interactions. Similarly, no acknowledgement was made of the low status Spanish held in that it was relegated to use with the few students who did not share English proficiency with the class. In fact, Ms. Lenihan even expressed concern that incorporating Spanish might diminish the mathematical experiences of "more advanced" students. It becomes clear that there are elusive language ideologies permeating the teacher-driven MdC's.

Related to language ideologies is how the teachers interpret their role as language developer. Unmistakably, neither teacher assumes the role of facilitator of mathematics discourse beyond promoting key vocabulary. In the case of Ms. Lenihan, she displays discomfort in engaging in precisely the interactions where English language, and specifically mathematics discourse, would be

developed. Rather, she bemoans the lack of involvement from the bilingual paraprofessional and the Bilingual Lead Teacher, and imagines a bilingual peer tutoring program that (presumably) would take the place of her direct involvement with Spanish-speaking students' mathematical and language development. This position, to some degree, reflects a conceptualization of languages as distinct and impenetrable and has significant consequences for emerging bilingual students in her class.

E. The Utility of Mathematics discourse Communities

Mary Kennedy (2005) reminds us that “although we know a lot about what teaching looks like, we know almost nothing about *why* it looks like this” (p. 1, emphasis original). This study, and particularly the use of MdC's as an interpretive lens to make sense of teachers actions, has allowed us to begin to understand why the two teachers' mathematical teaching practices look the way they do. Paying attention to MdC's requires us to focus simultaneously on the overall mathematics classroom environment, embedded in a school context and nestled in a sociopolitical reality, as well as the micro interactions that make up daily activities. Examining MdC's allows us to see the implicit and explicit messages conveyed to students about the discipline of mathematics and the mathematics teaching and learning process. It allows us to identify what norms and mathematical practices the teachers privilege and intend to establish in their classrooms. It will begin to answer Cobb, Gresalfi, & Hodge's (2009) call to “understand not merely whether but why students have come to identify with their classroom obligations, are merely cooperative with the teacher, or are developing oppositional identities (p. 48).”

For teachers, reflecting on the MdC's we establish makes evident to us what we believe and project about mathematics, how that manifests in classroom instruction and activities, and how vividly our underlying beliefs and assumptions are portrayed in what we say and do. It will help us

clarify what it is that we want our students to be able to do, important among them being able to fluidly participate in sophisticated mathematics discourse communities. Developing and utilizing the framework of MdC's will enable us to implement pedagogical approaches grounded in principles that promote productive micro-interactions, ultimately achieving more of the results we desire (e.g. increased willingness to struggle/persist in problem-solving activities, improved ability to generalize and abstract mathematical ideas, more positively-skewed mathematical identities). At the same time, it will help us weed out counter-productive assumptions – assumptions that contribute to the macro-educational reality Latinas/os endure today – and the corresponding actions (e.g. non-interactions resulting from language bias, emphasis on basic skills as a pre-requisite to meaningful problem-solving activities).

Making these critical connections between assumptions and actions is part of what Bartolome (2003) describes as political clarity – the ability “to effectively create, adopt, and modify teaching strategies that simultaneously respect and challenge learners from diverse cultural groups” (p. 412) – and will increase the probability of establishing an MDC that serves students equitably. This is a continuous process that requires regular and intense reflection, and Ms. Lenihan and Ms. Hendrix are only in the beginning stage. The question becomes, “What approaches to working with the mathematics teachers will help develop their political clarity?”

MdC's is a useful conceptual framework from which we can begin to understand the socialization experiences of Latinas/os in mathematics classrooms. As stated earlier, I am operating on the premise that mathematics learning is a racialized experience (Martin, 2006), which warrants a close look at the patterns of activities, planning and implementation of lessons, and discourse(s) that constitutes the mathematics learning environment. Implicit in these components are the teacher's beliefs about what is appropriate for Latina/o youth. So, while it is easy to get lost in the

complexity of a particular ecology of learning, it is important that we critically examine the intentions and actions of the teacher, a significant actor in the establishment of the MdC, who serves as the primary decision-maker in the classroom.

F. Limitations of this Investigation

It is important to acknowledge that this investigation did not unfold precisely as planned. The relationship with the teachers began because one of these teachers sought out the help of our research Center, acknowledging dissatisfaction with the status quo of her classroom and demonstrating a pro-active position to address the mathematics teaching and learning issues she observed. I interpreted this initiation as evidence of a teacher (and corresponding disposition) that was acutely aware of her shortcomings, intimately invested in the advancement of her Latina/o students, and positioning herself to innovate new approaches to building MdC's, which would result in radically different participatory arrangements for the students. While there were glimpses of innovation, these efforts were often mitigated by external pressures (i.e., Standards, time constraints, conventional wisdom) and ideologies guiding her to return to conventional pedagogy.

Needless to say, I did not get the results that help the field of mathematics education understand better what optimal planning and implementation of MdC's for Latina/o learners looks like. Nonetheless, this investigation provides us with a clear description and analysis of the primary struggles two teachers face as they try to alter their approaches to teaching mathematics with bilingual learners. As I mentioned above, the design of any coaching model or pedagogy intervention aimed at transforming teaching practices is predicated on establishing a solid understanding of the issues and struggles surrounding their conceptualization, implementation, and reflection upon their MdC's. While this study moves us closer to a more comprehensive understanding of the reality and struggles monolingual mathematics teachers endure, there is still a

need to corroborate these findings and develop a sense of how particular teaching practices might be adjusted and what impact these adjustments have on bilingual students' access to mathematical ideas, their participation in mathematical activities, and ultimately, how they are positioned to operate in a specialized and exclusive discourse community, all having direct implications on the mathematical identity that is co-constructed.

This investigation examined only two teachers. It may be that the issues and struggles that emerged from their cases are representative of other teachers in similar positions; however, this cannot be concluded without examining new cases, employing similar methodologies (i.e. co-planning, participant observation, video analysis of teaching episodes), but also innovating better approaches to collecting illustrative data and arriving at sound conclusions.

Related, the theoretical construct of MdC's worked well to help me frame, analyze, and make sense of the teachers' instructional moves and classroom environments, but it did not prove to be a particularly helpful tool in assisting the teachers in "seeing" and adjusting their teaching practices relative to bilingual Latina/o learners. This likely happened for two reasons. First, because I designed and entered this naturalistic study not having a good sense of what I would find; I did not position myself optimally to see and bring attention to critical episodes as they occurred. If I would have, the teachers and I would be more likely to have assumed a shared meaning and functionality of MdC's. Second, when I did witness student exclusion, for example, or the essentializing of mathematics discourse in the classroom, I was uneasy as to how to delicately and professionally handle the conversation and corresponding transformation of practice. This experience has provided me with new insights into how these issues might be broached in future interactions with teachers.

Finally, it needs to be acknowledged that the events from these classrooms are filtered through my professional lens, which, ultimately, reflects the compilation of my life experiences and

resulting viewpoints. Certainly, I listened carefully to the teachers' voices in an effort to make sense of the series of events. And, as much as possible, I attempted to foregrounded their voices to corroborate my interpretations. In addition, an effort was made to provide as much context as possible when interpreting their words in order to assure the accuracy of these interpretations. Nonetheless, these are still my interpretations, based on a lense that beholds my particular ideologies, importantly, including my language ideologies. It is important to note that the conclusions I arrived at were not verified by the teachers. It would be compelling to present these conclusions to the teachers and document their reactions and responses.

G. Implications & Directions for Future Research

On this last point, it occurs to me that the field could benefit from a collection of essays written by teachers that highlight their struggles teaching mathematics with Latina/o students and their efforts to improve their practices. This collection might resemble Herbel-Eisenmann and Cirillo's (2009) edited volume *Promoting Purposeful Discourse: Teacher Research in Mathematics Classrooms*. Not only would the voices of teachers be genuinely represented as they articulate their trials and successes, a product-goal like this would engage teachers in intense reflection about their practices and what it means to develop and leverage discourse for learning.

Also, as I alluded to in the previous section, there is a need to select and examine more cases of monolingual teachers, how they come to understand their bilingual Latina/o students, and how they develop MdC's for their students in light of these understandings. Then, the themes that emerge from these new cases need to be compared to the themes presented here. Perhaps the new cases will lead to new considerations and new analyses of this original data. The important idea here is that we move beyond what might be considered a few isolated examples to a more systemic understanding of how the cultural-historical experiences of monolingual teachers contribute to their

design and implementation of MdC's with bilingual, Latina/o students. For those educators feeling that the cases presented here may well be the product of a specific context, the effort to examine and compare across cases would help provide clarity to the most central issues and struggles within these (representative) arrangements of monolingual teachers and bilingual students.

In addition, there is a need to develop theory around the phenomenon of mathematics and language socialization amongst bilingual Latina/o students, driven by the teacher, the de facto mathematical authority in the classroom. I have argued that the theoretical framework of MdC's has the potential to illuminate important considerations for both teaching practices and research; yet, moving to make this framework accessible for teachers – or working with teachers to co-construct its meaning and relevance – is an important step that warrants the investment of time and attention.

Finally, there is a need to develop a model that illustrates what optimal planning for bilingual Latina/o learners in the mathematics classroom might look like. It is known that lesson planning is an under-developed skill amongst teachers (Irvine & Armento, 2001). Furthermore, it is known that the use of the “linear model” for planning, “which begins with the specification of objectives and ends with a lesson evaluation,” is the dominant model and “leads to a limited view of teaching and learning” (John, 2006, p. 483). While there is evidence in this study that confirms these notions, there is also new evidence that the two teachers rarely incorporate a multitude of critical considerations regarding their Latina/o learners when planning mathematics lessons. But, “knowing” these things is not sufficient. Therefore, successful planning practices need to be surveyed, these practices then need to be refined, and then, a model synthesizing these practices can be developed. This work will likely need to be done collaboratively, and the process will need to be closely documented, but the results will lead the field of mathematics education to a more clear vision of what planning for diverse learners might look like and its implications.

H. Concluding Thoughts

I entered this investigation concerned about the mathematics socialization process experienced by Latinas/os in urban schools. I theorized that focusing squarely on the teachers' practices involved in planning, implementing, and reflecting upon lessons – especially how they culminated in micro-interactions with Latina/o mathematics learners – would provide insights into the atmosphere within which bilingual Latinas/os are expected to learn mathematics. In other words, a focus on how teachers thought about and worked with Latina/o learners would allow me to make inferences about the mathematics socialization process experienced by the youth. While there is certainly data to support these inferences, another critical question emerges: How are the teachers socialized to think about, build upon the strengths of, and address the needs of Latinas/os? How did we get to this place where the two teachers do not currently conceive as part of their responsibilities the tasks of directly interacting with newcomers, innovating ways to capitalize on students' native language, and intentionally planning for mathematics discourse development? A sociopolitical analysis of this phenomenon is certainly in order.

Building an understanding of the life, academic, and professional events that contribute to teachers' lesson planning and implementation decisions is a critical step that will help inform the intervention we will develop. At the same time, we can begin to reflect critically on what it is we've been doing in teacher education that has not lead to pedagogical and sustained change. Similarly, where have we found success in helping teachers develop significantly different teaching practices in order to yield significantly different results – not exclusively in terms of standardized test scores, but rather in measures of Latina/o students' disposition towards and affiliation with mathematics? This kind of metric requires us to look carefully at Latina/o learners' mathematical identity formation over time in relation to the normative ways of doing mathematics they have experienced.

Certainly, this work cannot be accomplished exclusively in teacher preparation programs or through professional development. The questions posed above need to be considered vis-à-vis questions about class, race, and power – themes historically considered outside the realm of mathematics teaching and learning. We are long overdue to collectively acknowledge that we live in a highly segregated society – racially, linguistically, and socioeconomically. This sociopolitical backdrop results in highly differentiated life experiences and ways of developing and claiming knowledge. Consequently, we have dramatic linguistic and cultural incongruencies between teachers and learners in the majority of urban classrooms – even, at times, between teachers and students of the same race or language background (Valenzuela, 1999). While efforts have been made to bridge these cultural gaps (e.g., Anhalt, Allexaht-Snider, & Civil, 2002; Gonzalez et al., 1995; Gutstein, Lipman, & Hernandez, 1997), these efforts are often stifled by institutional pressures or a lack of will, or dismissed as an inefficient use of resources under an increasingly scrutinized distribution of education dollars and human hours.

Even with all of the institutional pressures and limitations, how might we help teachers develop a stance of solidarity with those students most in need of their resources? This question warrants a multi-disciplinary examination and casts doubts on efforts in motion that emphasize more rigid, uniform mathematical learning standards and teacher education standards. This is not to say that these efforts will not amount to positive change in the mathematics education of all students – they very well could. However, significant change in the mathematics education of Latinas/os – and African American and other marginalized youth, for that matter – will not occur without accounting for the out-of-school socialization experiences and sociopolitical realities of both students and teachers.

VI. CITED LITERATURE

- Adler, J. (1999). The dilemma of transparency: Seeing and seeing through talk in the mathematics classroom. *Journal for Research in Mathematics Education*, 30(1), 47-64.
- Adler, J. & Davis, Z. (2006). Opening another black box: Researching mathematics for teaching in mathematics teacher education. *Journal for Research in Mathematics Education*, 37(4): 270-296.
- Anhalt, C. Allexaht-Snider, M. & Civil, M. (2002). Middle school mathematics classrooms: A place for Latina parents' involvement. *Journal of Latinos and Education*, 1(4), 255-262.
- Anthony, G. & Walshaw, M. (2007). *Effective pedagogy in mathematics education/Pangarau: Best evidence synthesis iteration (BES)*. Wellington, NZ: Ministry of Education.
- Anzaldúa, G. (1993). Chicana artists: Exploring *Nepantla, el lugar de la frontera*. *NACLA Report of the Americas*, 27(1), 37-43.
- Apple, M. W. (2005). Doing things the 'right' way: Legitimizing educational inequalities in conservative times. *Educational Review*, 57(3), 271-293.
- Atkinson, P., & Hammersley, M. (1994). Ethnography and participant observation. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 248-261). Thousand Oaks, CA: SAGE.
- August, D., & Hakuta, K. E. (1997). *Improving schooling for language-minority children: A research agenda*. Washington, D.C.: National Academy Press.
- Ayers, W. (1997). *A kind and just parent: The children of juvenile court*. Boston: Beacon Press.
- Azmitia, M., Cooper, C. R., & Brown, J. R. (2008). Support and guidance from families, friends, and teachers in Latino early adolescents' math pathways. *The Journal of Early Adolescence*, 29(1), 142-169.
- Baker, C. (1993). *Foundations of bilingual education and bilingualism*. Clevedon, UK: Multilingual Matters
- Bartolome, L. (2003). Beyond the methods fetish: Towards a humanizing pedagogy. In A. Darder, M. Baltodano, & R. D. Torres (Eds.), *The critical pedagogy reader* (pp. 408-429). New York: RoutledgeFalmer.
- Bell, M. (1988–1996). *Everyday Mathematics*. Chicago, IL: Everyday Learning Corporation.
- Brandist, C. (2002). *The Bakhtin circle: Philosophy, culture and politics*. London: Pluto Press.
- Brenner, M. E. (1998). Development of mathematical communication in problem solving groups by language minority students. *Bilingual Research Journal*, 22(3 & 4 Spring, Summer, & Fall).
- Carpenter, T. P., Fennema, E., Peterson, P. L., Chiang, C.-P., & Loef, M. (1989). Using Knowledge of Children's Mathematics Thinking in Classroom Teaching: An Experimental Study. *American Educational Research Journal*, 26(4), 499-531.
- Cazden, C. B. (2001). *Classroom discourse: The language of teaching and learning*. Portsmouth, NH: Heineman.
- Chapin, S. H., O'Connor, C., & Anderson, N. C. (2009). *Classroom discussions: Using math talk to help students learn* (2nd Ed.). Sausalito, CA: Math Solutions.
- Chicago Public Schools' Office of Language and Cultural Education. (2008). [Online]. Available: <http://www.olce.org/pdfs/OLCE.A.%20A.Glance.February2008.pdf>
- Chval, K. (2009). Facilitating the participation of Latino English language learners in mathematics classrooms: What will it take? Presentation at the *CEMELA Research Symposium*. Albuquerque, NM.

- Chval, K. B. & Khisty, L. L. (2009). Bilingual Latino students, writing and mathematics: A case study of successful teaching and learning. In R. Barwell (Ed.), *Multilingualism in mathematics classrooms* (128-144). Clevedon, UK: Multilingual Matters.
- Civil, M. (2007). Building on community knowledge: An avenue to equity in mathematics education. In N. Nasir & P. Cobb (Eds.), *Improving access to mathematics: Diversity and equity in the classroom* (pp. 105-117). New York: Teachers College Press.
- Cobb, P., Gresalfi, M., & Hodge, L. L. (2009). An interpretive scheme for analyzing the identities that students develop in mathematics classrooms. *Journal for Research in Mathematics Education*, 40(1), 40-68.
- Coggins, D., Kravin, D., Coates, G., & Carroll, M. (2007). *English language learners in the mathematics classroom*. Thousand Oaks, CA: Corwin Press.
- Cohen, E. G. (1994). *Designing groupwork: Strategies for the heterogeneous classroom*. New York: Teachers College.
- Cohen, E. G. (1996). A sociologist looks at talking and working together in the mathematics classroom. Paper presented at the American Education Research Association, NY.
- Cohen, E. G., Bianchini, J. A., Cossey, R., Holthus, N. C., Morphew, C. C., & Whitcomb, J. A. (1997). What did students learn?: 1982-1994. In E. G. Cohen & R. A. Lotan (Eds.), *Working for equity in heterogeneous classrooms* (pp. 137-165). New York: Teachers College Press.
- Cohen, E. G., & Lotan, R. A. (1995). Producing equal-status interaction in the heterogeneous classroom. *American Educational Research Journal*, 32(1), 99-120.
- Cohen, E. G., & Lotan, R. A. (2004). Equity in heterogeneous classrooms. *Handbook of research on multicultural education*, 736-752.
- Corbin, J. M. & Strauss, A. L. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. 3rd Ed. Thousand Oaks, CA: Sage Publications.
- Crawford, J. (2004). *Educating English learners: language diversity in the classroom*. Los Angeles: Bilingual Education Services, Inc.
- Darder, A., Torres, R. D., & Gutierrez, H. (1997). Introduction. In A. Darder, R. D. Torres, & H. Gutierrez (Eds.), *Latinos and education: A critical reader* (pp. xi-xx). New York: Routledge.
- De Avila, E., Duncan, S. E., & Navarrette, C. (1987). *Finding out/ Descubrimiento*. Northvale, NJ: Santillana Publishing Co.
- DeWalt, K., & DeWalt, B. (1998). Participant observation. In H. R. Bernard (Ed.), *Handbook of methods in cultural anthropology* (pp. 259-299). Walnut Creek, CA: AltaMira Press.
- Diaz, S., Moll, L. C. & Mehan, H. (1986). Sociocultural resources in instruction: A context-specific approach. In California State Department of Education's Bilingual Education Office (Ed.), *Beyond language: Social and cultural factors in schooling language minority students*. Los Angeles: Evaluation, Dissemination and Assessment Center, California State University, Los Angeles.
- Donato, R. (1994). Collective scaffolding in second language learning. In L. C. Moll (Ed.), *Vygotskian approaches to second language research* (pp. 33-56). Norwood, NJ: Ablex.
- Donato, R. & McCormick, D. (1994). A sociocultural perspective on language learning strategies: The role of mediation. *The Modern Language Journal*, 78(4), 453-464.
- Echevarria, J., Short, D., & Powers, K. (2006). School reform and standards-based education: A model for English language learners. *The Journal of Educational Research*, 99(4), 195-210.
- Echevarria, J. A., Vogt, M. J., & Short, D. J. (2009). *Making content comprehensible for English learners: The SIOP model* (3rd Ed.). Boston: Pearson Allyn & Bacon.

- Engeström, Y. (1994). Teachers as collaborative thinkers: Activity-theoretical study of an innovative teacher team. In I. Carlgren, G. Handal & S. Vaage (Eds.), *Teachers' minds and actions: Research on teachers' thinking and practice* (pp. 43-61). London: The Falmer Press.
- Fennema, E., Franke, M. L., Carpenter, T. P., & Carey, D. A. (1993). Using Children's Mathematical Knowledge in Instruction. *American Educational Research Journal*, 30(3), 555-583.
- Fernandez, C. (2005). Lesson study: A means for elementary teachers to develop the knowledge of mathematics needed for reform-minded teaching. *Mathematical Thinking and Learning*, 7(4), 265-289.
- Fernandez, C. & Yoshida, M. (2004). *Lesson study: A Japanese approach to improving mathematics teaching and learning*. Mahwah, NJ: Erlbaum.
- Foley, D. E. (1990). *Learning capitalist culture: Deep in the heart of Tejas*. Philadelphia: University of Pennsylvania Press.
- Franke, M. L., Kazemi, E. & Battey, D. (2007). Mathematics teaching and classroom practice. In F. K. Lester (Ed.), *Second Handbook of Research on Mathematics Teaching and Learning* (pp. 225-256). Charlotte, NC: Information Age Publishing.
- Fry, R. (2007). *How far behind in math and reading are English language learners?* Washington, D.C.: Pew Hispanic Center.
- Fry, R. (2008). *The role of schools in the English language learner achievement gap*. Washington, D.C: Pew Hispanic Center.
- Fry, R. & Gonzales, F. (2008). *One-in-five and growing fast: A profile of Hispanic public school students*. Washington, D.C.: Pew Hispanic Center.
- Gandara, P. (2006). Strengthening the academic pipeline leading to careers in math, science, and technology for Latino students. *Journal of Hispanic Higher Education*, 5(3), 222-237.
- Gándara, P., & Contreras, F. (2009). *The Latino education crisis: The consequences of failed social policies*. Cambridge: Harvard University Press.
- Gauthier, (2009). Creating anxiety: Setting the stage for intercultural communication. *Race, Ethnicity, and Intercultural Communications*, 34(4), 721-723.
- Gee, J. P. (2004). *Situated language and learning: A critique of traditional schooling*. New York: Routledge.
- Gee, J. P. (2005). Semiotic social spaces and affinity spaces: From The Age of Mythology to today's schools. In D. Barton & K. Tusting (Eds.) *Beyond Communities of Practice: Language, power and social context* (pp. 214-232). Cambridge, UK: Cambridge University Press.
- Gee, J. P. (2008a) *Social linguistics and literacies: Ideology in discourse* (3rd Ed.). New York: RoutledgeFalmer.
- Gee, J. P. (2008b). Essay: What is academic language? In A. S. Rosebery & B. Warren (Eds.), *Teaching science to English language learners* (pp. 57-70). Washington, D.C.: National Science Teachers Association.
- Ginsburg, H. P. (1982). The development of addition in the contexts of culture, social class, and race. In T. P. Crarpenter, J. M. Moser & T. A. Romberg (Eds.), *Addition and subtraction: A cognitive perspective* (pp. 191-210). Hillsdale, NJ: Erlbaum.
- Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory*. New York: Aldine de Gruyter.

- Goetz, J. P., & LeCompte, M. D. (1981). Ethnographic Research and the Problem of Data Reduction. *Anthropology & Education Quarterly*, 12(1), 51-70.
- Goldenberg, (2008).
- González, R. D. & Melis, I. (Eds.) (2000). *Language ideologies: Critical perspectives on the Official English movement. Volume 1: Education and the social implications of official language*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Gonzalez, N., Moll, L. C., Tenery, M. F., Rivera, A., Rendon, P., Gonzalez, R., & Amanti, C. (1995). Funds of knowledge for teaching in Latino households. *Urban Education*, 29(4), 443-470.
- Gonzalez, N., Moll, L. C., & Amanti, C. (Eds.) (2005). *Funds of knowledge: Theorizing practices in households, communities, and classrooms*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Gutiérrez, K. D., Asato, J., Pacheco, M., Moll, L. C., Olson, K., Horng, E. L., Ruiz, R., & Garcia, E., & McCarty, T. L. (2002). "Sounding American": The consequences of new reforms on English language learners. *Reading Research, Quarterly*, 37(3), 328-343.
- Gutiérrez, K., Baquedano-Lopez, P., & Tejeda, C. (1999). Rethinking diversity: Hybridity and hybrid language practices in the third space. *Mind, Culture, and Activity*, 6(4), 286-303.
- Gutiérrez, K. D., & Stone, L. (2000). Synchronic and diachronic dimensions of social practice: An emerging methodology for cultural-historical perspectives on literacy learning. In C. Lee & P. Smagorinsky (Eds.), *Vygotskian perspectives on literacy research: Constructing meaning through collaborative inquiry* (pp. 150-164). New York: Cambridge University Press.
- Gutiérrez, R. (1999). Advancing urban Latina/o youth in mathematics: Lessons from an effective high school mathematics department. *The Urban Review*, 31(3), 263-281.
- Gutiérrez, R. (2002). Beyond essentialism: The complexity of language in teaching Latina/o students mathematics. *American Educational Research Journal*, 39(4), 1047-1088.
- Gutierrez, (2008). A "gap gazing" fetish in mathematics education?: Problematizing research on the achievement gap. *Journal for Research in Mathematics Education*, 39(4), 357-364.
- Gutiérrez, R. (2009). Embracing the inherent tensions in teaching mathematics from an equity stance. *Democracy and Education*, 18(3), 9-16.
- Gutierrez, R. (2009). Personal communication.
- Gutiérrez, R. (2010). The sociopolitical turn in mathematics education. *Journal for Research in Mathematics Education*, 41(0), 1-32.
- Gutiérrez, R. & Dixon-Román, E. (2011). Beyond gap gazing: How can thinking about education comprehensively help us (re)envision mathematics education. In B. Atweh, M. Graven, W. Secada, & P. Valero (Eds.), *Mapping quality and equity agendas in mathematics education* (pp. 21-34). New York: Springer.
- Gutstein, E. (2006). *Reading and writing the world with mathematics: Toward a pedagogy for social justice*. New York: Teachers College Press.
- Gutstein, E., Lipman, P., Hernandez, P., & de los Reyes, R. (1997). Culturally relevant mathematics teachers in a Mexican-American context. *Journal for Research in Mathematics Education*, 28(6), 709-737.
- Gutstein, E., & Peterson, B. (2005). *Rethinking mathematics : teaching social justice by the numbers*. Milwaukee, WI: Rethinking Schools.
- Halliday, M. A. K. (1978). *Language as social semiotic: The social interpretation of language and meaning*. London: Edward Arnold.

- Hansen-Thomas, H. (2009). English language learners and math: Discourse, participation, and community in reform-oriented, middle school mathematics classes. Charlotte: Information Age Publishing.
- Heath, S. B. (1983). *Ways with words*. Cambridge, UK: Cambridge University Press.
- Heinle, T. (2004). World-class instructional design and assessment ELP 1, 2, 3, 4 for grades 6-8 to access for ELLs.
- Herbel-Eisenmann, B. & Cirillo, M. (Eds.) (2009). *Promoting purposeful discourse: Teacher research in mathematics classrooms*. Reston, VA: NCTM.
- Hodge, (2006).
- Irvine, & Armento (2001).
- John, P. D. (2006).
- Jorgensen, D. L. (1989). *Participant observation: A methodology for human studies*. Newbury Park, CA: SAGE.
- Kersaint, G., Thompson, D. R., & Petkova, M. (2009). *Teaching mathematics to English language learners*. New York: Routledge.
- Khisty, L. L. (1995). Making inequality: Issues of language and meanings in mathematics teaching 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.
- Khisty, L. L. (1997). Making mathematics accessible to Latino students: Rethinking instructional practice. In J. Trentacosta & M. J. Kenney (Eds.), *Multicultural and gender equity in the mathematics classroom: The gift of diversity, 1997 yearbook* (pp. 92-101). Reston, VA: National Council of Teachers of Mathematics.
- Khisty, L. L., & Chval, K. (2002). Pedagogic discourse and equity in mathematics: When teachers' talk matters. *Mathematics Education Research Journal*, 14(3), 154-168.
- Khisty, L. L. & Willey, C. (2008). *The politics of language and schooling in the mathematics education of bilingual Chicana/o students*. Paper presented at the International Congress of Mathematics Education, Monterrey, México.
- Khisty, L. L. & Willey, C. (2012). After-school: An innovation model to better understand the mathematics learning of Latinas/os. In B. Bevan, P. Bell, R. Stevens, & A. Razfar (Eds.), *LOST opportunities: Learning in out of school time*. Springer.
- Kieran, C., Forman, E., & Sfard, A. (Eds.) (2002). *Learning discourse: Discursive approaches to research in mathematics education*. Dordrecht, The Netherlands: Kluwer Academic Publishers.
- Krashen, S. (1981).
- Ladson-Billings, G. & Tate, W. F. (2006). Toward a critical race theory of education. In A. D. Dixon & C. K. Rousseau (Eds.), *Critical race theory in education: All God's children got a song* (pp. 11-30). New York: Routledge.
- Lambdin, D. V. (2003). Benefits of teaching through problem solving: Prekindergarten-Grade 6. In F. K. Lester (Ed.), *Teaching mathematics through problem solving* (pp. 3-13). Reston, VA: NCTM.
- Lampert, M. & Blunk, M. L. (Eds.) (1998). *Talking mathematics in school: Studies of teaching and learning*. Cambridge, UK: Cambridge University Press.
- Lantolf, J. (Ed.) (2000). *Sociocultural theory and second language learning*. Oxford: Oxford University Press.

- Lappan, G., Fey, J. T., Fitzgerald, W. M., Freil, S. N., & Phillips, E. D. (1991–1997). *Connected Mathematics*. White Plains, NY: Dale Seymour Publications.
- Lee, O. (2005). Science education with English language learners: Synthesis and research agenda. *Review of Educational Research*, 75(4), 491-530.
- Lemke, J. L. (2003). Mathematics in the middle: Measure, picture, gesture, sign, and word. In M. Anderson, A. Sáenz-Ludlow, S. Zellweger & V. V. Cifarelli (Eds.), *Educational perspectives on mathematics as semiosis: From thinking to interpreting to knowing* (pp. 215-234). Brooklyn, NY and Ottawa, Ontario: Legas.
- Lerman, S. (2000). The social turn in mathematics education research (pp. 19-44). In J. Boaler (Ed.) *Multiple Perspectives on Mathematics Teaching and Learning*. Westport, CT, Ablex Publishing.
- Lipman, P. (2004). *High stakes education: inequality, globalization, and urban school reform*. New York: RoutledgeFalmer.
- Martin, D. B. (2000). *Mathematics success and failure among African American youth: The roles of sociohistorical context, community forces, school influence, and individual agency*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Martin, D. B. (2006). Mathematics learning and participation as racialized forms of experience: African American parents speak on the struggle for mathematics literacy. *Mathematical Thinking and Learning*, 8(3), 197 - 229.
- Martin, D. B. (2007). Beyond missionaries or cannibals: Who should teach mathematics to African American children? *High School Journal*, 91(1), 6-28.
- Martin, D. B. (2009a). Researching race in mathematics education. *Teachers College Record*, 111(2).
- Martin, D. B. (2009b). Liberating the production of knowledge about African American children and mathematics. In D. B. Martin (Ed.), *Mathematics teaching, learning, and liberation in the lives of Black children* (pp. 3–38). New York: Routledge.
- McLeod, D. B. (2002). From consensus to controversy: The story of the NCTM Standards. In J. Kilpatrick & G. Stanic (Eds.), *History of mathematics education* (pp. 753-818). Reston, VA: National Council of Teachers of Mathematics.
- Menchaca, M. (2001). *Recovering history, constructing race: The Indian, Black, and White roots of Mexican Americans*. Austin, TX: University of Texas Press.
- Mendoza-Denton, N. (1999). Sociolinguistics and linguistic anthropology of US Latinos. *Annual Review of Anthropology*, 28(1), 375-395.
- Miles, M., & Huberman, M. (1994). Data management and analysis methods. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research*. Thousand Oaks, CA: Sage Publications.
- Moll, L. C. (1992). Bilingual Classroom Studies and Community Analysis: Some Recent Trends. *Educational Researcher*, 21(2), 20-24.
- Moll, L. C. (2001). The diversity of schooling: A cultural-historical approach. In M. de la Luz Reyes & J. J. Halcón (Eds.), *The best for our children: Critical perspectives on literacy for Latino students* (pp. 13-28). New York: Teachers College Press.
- Moll, L. C. & Diaz, S. (1987). Change as the goal of educational research. *Anthropology & Education Quarterly*, 18(4), 300-311.
- Moll, L. C., Amanti, C., Neff, D., & Gonzalez, N. (1992). Funds of Knowledge for Teaching: Using a Qualitative Approach to Connect Homes and Classrooms. *Theory into Practice*, 31(2), 132-141.

- Moschkovich, J. N. (1999). Supporting the participation of English language learners in mathematical discussions. *For the Learning of Mathematics*, 19(1), 11-19.
- Moschkovich, J. N. (2002). A situated and sociocultural perspective on bilingual mathematics learners. *Mathematical Thinking and Learning*, 4(2), 189-212.
- Moses, R. P. (2001). *Radical equations: Math literacy and civil rights*. Boston: Beacon Press.
- Nasir, N. S. (2002). Identity, goals and learning: Mathematics in cultural practice. *Mathematical Thinking and Learning*, 4(2-3), 211-245.
- National Council of Teachers of Mathematics. (1989). *Curriculum evaluation standards for school mathematics*. Reston, VA: National Council of Teachers of Mathematics.
- National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: National Council of Teachers of Mathematics.
- Nemirovsky, R., Roseberry, A. S., Solomon, J., & Warren, B. (Eds.) (2005). *Everyday matters in science and mathematics: Studies of complex classroom events*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Nieto, S. (1992). *Affirming diversity: The sociopolitical context of multicultural education*. New York: Longman.
- Neves, H. A. (1997). The relationship of talk and status to second language acquisition of young children. In E. G. Cohen & R. A. Lotan (Eds.), *Working for equity in heterogeneous classrooms: Sociological theory in practice* (pp. 181-192). New York: Teachers College Press.
- Ochs, E. & Schieffelin, B. B. (1984). Language acquisition and socialization: Three developmental stories and their implications. In R. Shweder and R. LeVine (Eds.), *Culture theory: Essays on mind, self, and emotion* (pp. 276-310). New York: Cambridge University Press.
- O'Connor, M. C. (1998). Language socialization in the mathematics classroom: Discourse practices and mathematical thinking. In M. Lampert & M. L. Blunk (Eds.), *Talking mathematics in school: Studies of teaching and learning* (pp. 17-55). Cambridge, UK: Cambridge University Press.
- O'Halloran, K. L. (1999). Towards a systemic functional analysis of multisemiotic mathematical texts. *Semiotica*, 124(1/2), 1-29.
- Olsen, L. (1997). *Made in America: Immigrant students in our public schools*. New York: The New Press.
- Paley, J. (2001). *Marketing democracy: Power and social movements in post-dictatorship Chile*. Berkeley, CA: University of California Press.
- Pennycook, A. (2001). Lessons from colonial policies. In R. D. Gonzalez and I. Melis (Eds.), *Language ideologies: Critical perspectives on the official English movement, Volume 2* (pp. 195-220). Mahwah, NJ: Lawrence Erlbaum Associates.
- Razfar, A. (2005). Language ideologies in practice: Repair and classroom discourse. *Linguistics and Education*, 16(4), 404-424.
- Razfar, A., Khisty, L. L., & Chval, K. (2011). Remediating second language acquisition: a sociocultural perspective for language development. *Mind, Culture & Activity*, 18(3), 195-215.
- Resnick, L. B. (1992). From protoquantities to operators: Building mathematical competence on a foundation of everyday knowledge. In G. Leinhardt, R. Putnam & R. A. Hattup (Eds.), *Analysis of arithmetic for mathematics teaching* (pp. 373-429). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Rogoff, B. (1991). *Apprenticeship in thinking*. New York: Oxford University Press.

- Rogoff, B. (2008). Observing sociocultural activity on three planes: Participatory appropriation, guided participation, and intent participation. *Pedagogy and Practice: Culture and Identities*.
- Ruiz, R. (1984). Orientations in language planning. *NABE: The Journal for the National Association of Bilingual Education*, 8(2), 15-34.
- Santa Ana, O. (2002). *Brown tide rising: Metaphors of Latinos in contemporary American public discourse*. Austin: University of Texas Press.
- Schaffner, L. (1999). *Teenage runaways: Broken hearts and bad attitudes*. New York: Hayworth Press.
- Schleppegrell, M. J. (2007). The linguistic challenges of mathematics teaching and learning: A research review. *Reading and Writing Quarterly*, 23, 139-159.
- Scribner, S. & Cole, M. (1981). *The psychology of literacy*. Cambridge, MA: Harvard University Press.
- Secada, W. G. (1995). Social and critical dimensions for equity in mathematics education. In W. G. Secada, E. Fennema & L. B. Adajian (Eds.), *New directions for equity in mathematics education* (pp. 146-164). New York, NY: Cambridge University Press.
- Sfard, A. (2001). There is more to discourse than meets the ears: Looking at thinking as communicating to learn more about mathematical learning. *Educational Studies in Mathematics*, 46, 13-57.
- Shannon, S. (1995). The hegemony of English: A case study of one bilingual classroom as a site of resistance. *Linguistics and Education*, 7, 175-200.
- Sherin, M. G. (2002). A balancing act: Developing a discourse community in the mathematics classroom. *Journal of Mathematics Teacher Education*, 5, 205-233.
- Solano-Flores, G. & Trumbull, E. (2003). Examining language in context: The need for new research and practice paradigms in the testing of English-language learners. *Educational Researcher*, 32(2), 3-13.
- Stein, M. K., Smith, M. S., Henningsen, M. A., & Silver, E. A. (2000). *Implementing standards-based mathematics instruction: A casebook for professional development*. New York, NY: Teachers College Press.
- Suárez-Orozco, M. M. P., M. M. (2002). Introduction: The research agenda. In M. M. Suárez-Orozco & M. M. Páez (Eds.), *Latinos: Remaking America* (pp. 1-37). Berkeley, CA: University of California Press.
- Sztajn, P. (2003). Adapting reform ideas in different mathematics classrooms: Beliefs beyond mathematics. *Journal of Mathematics Teacher Education*, 6(1), 53-75.
- Tedlock, B. (1991). From Participant Observation to the Observation of Participation: The Emergence of Narrative Ethnography. *Journal of Anthropological Research*, 47(1), 69-94.
- Tedlock, B. (2003). Ethnography and ethnographic representation. In N. K. Denzin & Y. S. Lincoln (Eds.), *Strategies of qualitative inquiry* (2nd ed., pp. 165-213). Thousand Oaks, CA: Sage Publications.
- Tejeda, C., Espinoza, M., & Gutierrez, K. (2003). Toward a decolonizing pedagogy: Social justice reconsidered. In P. Pericles Trifonas (Ed.), *Pedagogies of difference: Rethinking education for social change*. New York: RoutledgeFalmer.
- United States Census Bureau. (2005). Press Release. [Online]. Available: http://www.census.gov/PressRelease/www/releases/archives/facts_for_features_special_editions/005338.html

- U.S. Commission on Civil Rights. (1973). *Teachers and students: Report V. Mexican-American study: Differences in teacher interaction with Mexican-American and Anglo students*. Washington, D.C.: Government Printing Office.
- Usiskin, Z. (1996). Mathematics as a language. In P. C. Elliott & M. J. Kenney (Eds.), *Communication in mathematics: K-12 and beyond* (pp. 231-243). Reston, VA: National Council of Teachers of Mathematics.
- Valdés, G. (2001). *Learning and not learning English: Latino students in American schools*. New York: Teachers College Press.
- Valencia, R. R. (Ed.) (1991). *Chicano school failure and success: Past, present, and future*. New York: The Falmer Press.
- Valenzuela, A. (1999). *Subtractive schooling: U.S.-Mexican youth and the politics of caring*. Ithaca, NY: State University of New York Press.
- Valenzuela, A. (2005). *Leaving children behind: How "Texas-style" accountability fails Latino youth*. Albany, NY: State University of New York Press.
- Valero, P. (2004). Sociopolitical perspectives on mathematics education. In P. Valero & R. Zevenbergen (Eds.), *Researching the socio-political dimensions of mathematics education: Issues of power in theory and methodology* (pp. 5-24). Norwell, MA: Kluwer.
- Varley Gutierrez, M., Willey, C., & Khisty, L. L. (2011). (In)equitable schooling and mathematics of marginalized students: Through the voices of urban Latinas/os. *Journal of Urban Mathematics Education*, 4(2), 26-43.
- Veel, R. (1999). Language, knowledge and authority in school mathematics. In F. Christie (Ed.), *Pedagogy and the shaping of consciousness: Linguistics and social processes* (pp. 185-216). London: Continuum.
- Voloshinov, V. N. (1973). *Marxism and the philosophy of language* (L. Matejka & I. R. Titunik, Trans.). Cambridge, MA: Harvard University Press.
- Vygotsky, L. (1962). *Thought and language* (E. Hanfmann & G. Vakar, Trans.). Cambridge, Mass.: MIT Press.
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge: Harvard University Press.
- Vygotsky, L. S. (1987). *The collected works of L.S. Vygotsky: Vol. 4. The history of the development of higher mental functions* (M. J. Hall, Trans.). In R. W. Rieber (Ed.). New York: Plenum Press.
- Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. New York: Cambridge University Press.
- Willey, C., Viego, G., & Khisty, L. L. (2009). *Teachers of Latinos/as in mathematics: Case studies of the challenges of integrating language and content*. Paper presented at the American Education Research Association, San Diego, CA.
- Yackel, E. (2003). Listening to Children: Informing us and guiding our instruction. In F. K. Lester (Ed.) *Teaching mathematics through problem solving* (pp. 107-126). Reston, VA: NCTM.
- Yackel, E. & Cobb, P. (1996). Sociomathematical norms, argumentation, and autonomy in mathematics. *Journal for Research in Mathematics Education*, 27, 458-477.
- Yosso, T. (2006). *Critical race counterstories along the Chicana/Chicano educational pipeline*. New York: Routledge.

VII. APPENDIX

UNIVERSITY OF ILLINOIS
AT CHICAGO

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
203 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7227

**Exemption Granted
UIC Amendment #1**

August 19, 2011

Lena Licon Khisty, PhD
Curriculum and Instruction
1040 W Harrison
M/C 147
Chicago, IL 60612
Phone: (312) 996-8144 / Fax: (312) 996-8134

RE: Research Protocol # 2009-0886
“Los Rayos de CEMELA After School Mathematics Project (previously UIC Research Protocol #2005-0838)”

Sponsor: National Science Foundation
PAF#: 2005-01583
Grant/Contract No: 0424983
Grant/Contract Title: The Center for the Mathematics Educations of Latino/as

Dear Dr. Khisty:

The amendment to your Claim of Exemption was reviewed on August 19, 2011 and it was determined that your amended research continues to meet the criteria for exemption.

Amendment Summary: UIC Amendment #1 dated April 21, 2011 and initially submitted to OPRS on May 5, 2011 is an investigator-initiated amendment and includes the following:

- 1) Chicago Public Schools Research Review Board Approval Notification dated May 5, 2011
- 2) Submission of the University of Arizona IRB Approval letter.
- 3) Clarification that, while Dr. Marta Civil is the “holder” of the grant that subcontracts to other universities, she will not be involved in the conduct of this research.

Exemption Period: August 19, 2011 – August 18, 2012

The specific exemption category under 45 CFR 46.101(b) is:

(1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

Please note the Review History of this submission:

Receipt Date	Submission Type	Review Process	Review Date	Review Action
05/05/2011	Amendment	Exempt	05/20/2011	Modifications Required
08/09/2011	Response To Modifications	Exempt	08/19/2011	Approved

You are reminded that investigators whose research involving human subjects is determined to be exempt from the federal regulations for the protection of human subjects still have responsibilities for the ethical conduct of the research under state law and UIC policy. Please be aware of the following UIC policies and responsibilities for investigators:

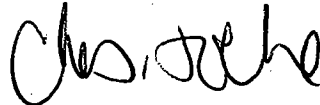
1. Amendments You are responsible for reporting any amendments to your research protocol that may affect the determination of the exemption and may result in your research no longer being eligible for the exemption that has been granted.
2. Record Keeping You are responsible for maintaining a copy all research related records in a secure location in the event future verification is necessary, at a minimum these documents include: the research protocol, the claim of exemption application, all questionnaires, survey instruments, interview questions and/or data collection instruments associated with this research protocol, recruiting or advertising materials, any consent forms or information sheets given to subjects, or any other pertinent documents.
3. Final Report When you have completed work on your research protocol, you should submit a final report to the Office for Protection of Research Subjects (OPRS).
4. Information for Human Subjects UIC Policy requires investigators to provide information about the research protocol to subjects and to obtain their permission prior to their participating in the research. The information about the research protocol should be presented to subjects in writing or orally from a written script. When appropriate, the following information must be provided to all research subjects participating in exempt studies:
 - a. The researchers affiliation; UIC, JBVMAC or other institutions,
 - b. The purpose of the research,
 - c. The extent of the subject's involvement and an explanation of the procedures to be followed,
 - d. Whether the information being collected will be used for any purposes other than the proposed research,
 - e. A description of the procedures to protect the privacy of subjects and the confidentiality of the research information and data,
 - f. Description of any reasonable foreseeable risks,
 - g. Description of anticipated benefit,
 - h. A statement that participation is voluntary and subjects can refuse to participate or can stop at any time,
 - i. A statement that the researcher is available to answer any questions that the subject may have and which includes the name and phone number of the investigator(s).
 - j. A statement that the UIC IRB/OPRS or JBVMAC Patient Advocate Office is available if there are questions about subject's rights, which includes the appropriate phone numbers.

Please be sure to:

→ Use your research protocol number (2009-0886) on any documents or correspondence with the IRB concerning your research protocol.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact the OPRS office at (312) 996-1711 or me at (312) 355-2908. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

A handwritten signature in black ink, appearing to read "Charles W. Hoehne". The signature is fluid and cursive, with the first name "Charles" being more prominent.

Charles W. Hoehne, B.S. C.I.P.
Assistant Director, IRB # 2
Office for the Protection of Research Subjects

cc: Timothy Shanahan, Curriculum and Instruction, M/C 147

VIII. VITA

Craig Joseph Willey

Ph. D. in Curriculum and Instruction (Curriculum Studies–Mathematics Education)

Email: cjwilley@iupui.edu

EDUCATION

2013 University of Illinois at Chicago, Ph.D., Curriculum Studies (Mathematics Education emphasis)

Dissertation: *A Case Study of Two Teachers Attempting to Create Active Mathematics Discourse Communities with Latinos*

2004 Metropolitan State College of Denver, Certificate in Secondary Mathematics

2002 Butler University, B.S., Actuarial Sciences, B.A., Spanish

APPOINTMENTS

Indiana University Purdue University-Indianapolis Assistant Professor 2011 - present

University of Illinois at Chicago Adjunct Professor 2008 - 2010

LICENSURE and CERTIFICATION

Secondary Mathematics Teaching License, Colorado

AREAS OF EXPERTISE and SCHOLARLY INTERESTS

Mathematics Education of Latinas/os in Urban Contexts

Mathematics Discourse Development

Mathematics Teacher Development for Urban Contexts

Language Ideologies in Mathematics Teaching and Learning

Sociopolitical Perspectives of Urban Schooling

PUBLICATIONS

Willey, C., LopezLeiva, C., Torres, Z., & Khisty, L. L. (in press). *Chanzas*: The probability of changing the ecology of mathematical activity. To appear in B. B. Flores, O. A. Vásquez, & E. R. Clark (Eds.), *La nueva generación de La Clase Mágica: Pedagogía transmundial*.

- Khisty, L. L. & Willey, C. (2012). After-school: An innovative model to better understand the mathematics learning of Latinas/os. In B. Bevan, P. Bell, R. Stevens, & A. Razfar (Eds.), *LOST Opportunities: Learning in Out-of-School Time* (pp. 233-249). New York: Springer.
- Varley Gutiérrez, M., Willey, C., & Khisty, L. L. (2011). (In)equitable schooling and mathematics of marginalized students: Through the voices of urban Latinas/os. *Journal of Urban Mathematics Education*, 4(2), 26-43.
- Pitvorec, K., Willey, C., & Khisty, L. L. (2011). Toward a framework of principles for ensuring effective mathematics instruction for bilingual learners through curricula. In B. Atweh, M. Graven, W. Secada, & P. Valero (Eds.), *Mapping equity and quality in mathematics education* (pp.407-422). New York: Springer.
- Willey, C. (2010). Teachers developing Mathematics Discourse Communities with Latinas/os. In P. Brosnan, D. Erchick & L. Flevares (Eds.), *Proceedings of the 32nd annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 530-538). Columbus, OH: The Ohio State University.
- Willey, C. (2008). Immigrant Latina mothers' participation in a community mathematization project. *Adults Learning Mathematics-An International Journal*, 3(2a), 29-40.
- Khisty, L. L., & Willey, C. (2008). The politics of language and schooling in the mathematics education of bilingual Chicana/o students. *Proceedings of Topic Study Group 33: Mathematics Education in a Multilingual and Multicultural Environment, 11th International Congress on Mathematical Education, Monterrey, México, July 8-12, 2008*. URL: <http://tsg.icmel1.org/document/get/612>.
- Willey, C. & Radosavljevic, A. (2007, September). Play and building histories/identities of math competencies for Latinas/os. *Proceedings of the Second Sociocultural Theory in Education Research and Practice Conference: Theory, Identity and Learning*. URL:http://www.education.manchester.ac.uk/research/centres/lta/LTAResearch/SocioculturalTheoryInterestGroupScTiG/SocioculturalTheoryinEducationConference2007/Conferencepapers/GroupFourPapers/_Files/Fileuploadmax10Mb,135250,en.pdf. University of Manchester, Manchester, UK.

UNDER REVIEW

- LopezLeiva, C., Vomvoridi-Ivanovic, E., & Willey, C. (under review). Bilingual Latina/o pre-service teachers preparing to teach mathematics to bilingual Latina/o students: A transformative experience. Submitted to the *Journal of Mathematics Teacher Education*.

IN PREPARATION

- Willey, C. (2012). Moving from “knowing” to “doing”: Monolingual teachers’ commitments and

struggles in facilitating mathematics learning with Latinas/os.

Willey, C., Pitvorec, K. & Khisty, L. L. (2012). Redesigning a written curriculum to maximize bilingual students' mathematics learning.

Willey, C. & Drake, C. (in preparation). Advocating for equitable mathematics education: Supporting novice teachers as they navigate the sociopolitical context of schools.

Willey, C. (in preparation). Language ideologies and mathematics learning with Latinas/os: The role of discussion prompts and questions.

INVITED PRESENTATIONS - REFEREED

INTERNATIONAL

1. *"Bilingual Latina/o pre-service teachers preparing to teach mathematics to bilingual Latina/o students: A transformative experience,"* Annual Meeting of the American Educational Research Association, Vancouver, BC, April, 2012.
2. *"Re-designing a written curriculum to maximize bilingual students' mathematics learning,"* Annual Meeting of the American Educational Research Association, Vancouver, BC, April, 2012.
3. *"Moving from 'knowing' to 'doing': Monolingual teachers' commitments and struggles in facilitating mathematics learning with Latinas/os,"* Annual Meeting of the American Educational Research Association, Vancouver, BC, April, 2012.
4. *"The politics of language and schooling in the mathematics education of bilingual Chicana/o students,"* 11th International Congress on Mathematical Education, Monterrey, México, July 8-12, 2008.
5. *"Play and building histories/identities of math competencies for Latinos/as,"* Second Sociocultural Theory in Education Research and Practice Conference: Theory, Identity and Learning, University of Manchester, Manchester, UK, September, 2007.

NATIONAL

1. *"Re-examining curricula as a means to improve access for Latina/o mathematics learners,"* National Council of Teachers of Mathematics Annual Research Pre-session, Philadelphia, PA, April 2012.
2. *"Teachers developing Mathematics Discourse Communities with Latinas/os,"* Annual Conference of the North American Chapter of the International Group for the Psychology of Mathematics Education, The Ohio State University, Columbus, OH, October 31, 2010.

3. *"Mathematics Discourse Communities and Latinas/os: Teachers establishing normative ways of being,"* TODOS/CEMELA/CPTM conference, *Practitioners and Researchers Learning Together: A National Conference on the Mathematics Teaching and Learning of Latinas/os*, Tucson, AZ, March 2010.
4. *"Grounded but not grounded: A model for doctoral education,"* TODOS/CEMELA/CPTM conference, *Practitioners and Researchers Learning Together: A National Conference on the Mathematics Teaching and Learning of Latinas/os*, Tucson, AZ, March 2010.
5. *"Latina/o student insights on mathematics learning and the role of language in mathematics,"* Meeting of the American Educational Research Association, San Diego, CA, April, 2009.
6. *"Teachers of Latinas/os in mathematics: Case studies of the challenges of integrating language and content,"* Meeting of the American Educational Research Association, San Diego, CA, April, 2009.
7. *"An after-school mathematics club as a model for challenging paradigms,"* Conference of the International Society for Culture and Activity Research, San Diego, CA, September, 2008.
8. *"Immigrant Latina mothers' participation in a community mathematization project,"* Meeting of the American Educational Research Association, New York, New York, April, 2008.
9. *"Changing paradigms for bilingual learners: Teaching and learning mathematics bilingually,"* Conference on Education and the Public Good: Interdisciplinary Trend in Emerging Scholarship, Chicago, IL, March, 2008.
10. *"Multimodal problem solving and probability in an after-school math club: The counters game,"* Meeting of the American Educational Research Association, New York, New York, March, 2008.
11. *"Language and math in an after-school mathematics club: Challenging paradigms of learning and learners,"* 29th Annual Ethnography in Education Research Forum: Going Public with Ethnography in Education, University of Pennsylvania, Philadelphia, PA, February, 2008.
12. *"What works for Latinos and Latinas?: Research and practice,"* Meeting of the National Council of Teachers of Mathematics, Atlanta, GA, March, 2007.

REGIONAL

1. *"The influences of race on teacher identity development in second career teachers in alternative teacher certification programs,"* Indiana Mathematics Education Research Symposium, Indianapolis, IN, March, 2012.
2. *"Families uncovering mathematics in the community,"* Conference of the National Council of Teachers of Mathematics (NCTM), Kansas City, MO, October, 2007.

LOCAL

1. *"How do you know if what you're doing is good for ELLs?"* First Annual Conference of the Chicago Mathematics and Science Initiative, Malcolm X College, Chicago, IL, May 2009.
2. *"Mathematics discourse communities and Latinas/os: Teachers' struggles to leverage discourse to promote learning,"* Indiana University, Bloomington, November 5, 2011.

INVITED PRESENTATIONS – NON-REFEREED

NATIONAL

1. *"Mathematics D/discourse communities with Latinas/os,"* Lecture given to Ph.D. course at the University of New Mexico, November 2012.
2. *"Strengthening mathematics curriculum for bilingual Latina/o learners,"* Workshop presented at the CEMELA Dissemination Conference, Connecting Theory and Practice: Lessons Learned about Latin@s and the Learning of Mathematics, Chapel Hill, NC, June 2012.
3. *"Leveraging discourse to maximize mathematical development of Latinas/os,"* Workshop presented at the CEMELA Dissemination Conference, Connecting Theory and Practice: Lessons Learned about Latin@s and the Learning of Mathematics, Chapel Hill, NC, June 2012.

LOCAL

1. *"Inquiring minds want to know: Why do things fly?"* Presentation prepared for Pro 100 Seminar, Indianapolis, IN, July 2012.
2. *"Strengthening mathematics curricula for bilingual learners,"* Lecture given on behalf of Indiana Center for Intercultural Communication (ICIC) to visiting Vietnamese professors, November 2012.

3. “*Curriculum Design that Supports Math and Language Development for ELLs*,” University of Chicago School Mathematics Project, January 15, 2011.
4. “*Curricular Recommendations To Maximize Mathematics Learning for ELLs*,” University of Chicago School Mathematics Project, February 14, 2011.
5. “*Latina/o parents’ and children’s resources: Uncovering the mathematics of community practices*,” Chicago Symposium Series on Excellence in Teaching Mathematics and Science: Research and Practice, DePaul University, Chicago, IL, March 2008.

RESEARCH ACTIVITY

Privilege & Oppression in Mathematics Teacher Education (PrOMPTE)

Beth Herbel-Eisenmann, Vicki Hand, Anita Wager, Mary Foote, Arthur Powell, Joel Amidon, Carlos LopezLeiva, Courtney Koessler
Research Design and Grant Writing
2012 - present

District and School Case Study of Dual Language Programs, Great Lakes Equity Center, Lead Investigator

Thu Suong Nguyen, Marsha Simon, James Kigamwa, Indiana University Purdue University-Indianapolis
Research Design, Data Collection and Analysis
2012 - present

Mathematics Teacher Change Through Coaching Intervention with Pedagogical Standards

Annala Teemant & Gina Borgioli Yoder, Indiana University Purdue University-Indianapolis
Research Design, Data Collection & Analysis
2012 - present

Los Rayos de CEMELA After-School Mathematics Club

Carlos Lopez Leiva, UNM & Eugenia Vomvoridi-Ivanovich, University of South Florida
Data Analysis
2011 - present

Mathematics Curriculum Modification for Bilingual Learners

Kathleen Pitvorec & Lena Licon Khisty, University of Illinois at Chicago
Book Chapter, Presented Recommendations to Curriculum Developers
2008 – present

Indiana Department of Education’s Innovation Grant program

Annala Teemant, Indiana University Purdue University - Indianapolis
Contributor to funding proposal (10%)

December 2012

GUIDED STUDENT RESEARCH

Science and Mathematics Teacher Identity Development: Woodrow Wilson Fellows

J.T. Snipes, HESA Doctoral Student/CUME Research Assistant

Outcomes: Reviewed Literature, Developed of Interview Protocol, Scholarly Presentation

October 2011 – July 2012

AWARDED GRANTS/FELLOWSHIPS

Dissertation Fellowship	Office of the Chancellor, UIC	\$8,000	2009 – 2011
STaR Fellowship	NSF program, University of Missouri		2013

SUBMITTED GRANT PROPOSALS

Teemant, A., Willey, C., Yost, R., Yoder, G., Mutegi, J., & Morton, C. *Scaling Teacher Professional Development to Increase Student Achievement*. Indiana Department of Education.

Co-Investigator/Faculty Collaborator; 10% effort; \$484,146.00; Submission Date: December 28, 2012.

TEACHING

TEACHING ASSIGNMENTS

UNDERGRADUATE

E343	Teaching and Learning Mathematics in Elementary School (Grades 3-6)
E345	Teaching and Learning Mathematics with Young Children (Pre-K-2)
ED342	Teaching Math in Elementary School (Grades K-8)
ED194	Mathematics Concepts in Elem. & Middle Grades

GRADUATE

CI571	Integrating Math, Science, & ESL
CI482	Instruction & Assessment: Multilingual Approaches
CI481	Foundations in Teaching English Learners
T531	Organizational Change in Culturally and Linguistically Diverse Schools
C675	Apprenticeship to University Teaching

APPRENTICESHIP IN UNIVERSITY TEACHING – C635

Teaching and Learning Mathematics in Elementary School

Kari Carr, ELPS Doctoral Student/CUME Research Assistant

Outcomes: Statement of Teaching Philosophy, Continued Partnership
August 2012 - present

SERVICE

PROFESSIONAL SERVICE

NATIONAL

International Journal of Qualitative Studies in Education	Associate Editor	2012 – present
Teaching for Equity and Excellence in Mathematics Journal	Reviewer	2011 – present
Journal of Urban Mathematics Education	Reviewer	2011 – present
Indiana Mathematics Teacher	Reviewer	2012 – present
AERA Division G	Reviewer	2012 – present
Psychology of Mathematics Education-North America	Reviewer	2012 – present
Association for Mathematics Teacher Educators	Reviewer	2012 – present

UNIVERSITY SERVICE

SCHOOL

Committee on Research, Development, & External Partnerships	Member	2012 – present
Committee on Teacher Education	Member	2012 – present
Structure and Governance Working Group	Member	2012 – present
Ph.D. Admissions Committee	Member	2011 – 2012
Ph.D. Program Working Group	Course Developer	Fall 2011

PROFESSIONAL HONORS AND AWARDS

RESEARCH

STaR Fellows Program	NSF	2013
Chancellor's Graduate Research Fellowship	UIC	2009 - present
Fellow, Center for the Mathematics Education of Latinas/os	UIC	2006 - 2011

SERVICE

Nominee, Board of Directors	TODOS	2010
Member, Indiana Education Leadership Cadre	IN Dept. of Ed.	2012-2015

GENERAL

Travel Award to ICME, Monterrey, Mexico	NSF	2007
Travel Award to Japan, Thailand	Fund for Teachers	2005

PROFESSIONAL ORGANIZATIONS

American Educational Research Association	Member	2006-present
National Council of Teachers of Mathematics	Member	2006-present
TODOS: Mathematics for All	Member	2006-present
Critical Race Studies in Education Association	Member	2007-present
International Group for the Psychology of Math Education	Member	2008-present
Hoosier Association for Mathematics Teacher Educators	Member	2011-present
Innovate Indy	Member	2012-present