

**The Complexity of Interweaving Mathematical and Sociopolitical Content In
and Through the Classroom Space**

BY

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THESIS

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This thesis is dedicated to my father (Oct 4, 1948 – July 7, 2009) who gave me the gift of unconditional love, faith, courage, and trust.

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LIST OF ABBREVIATIONS

ACT:	Originally an abbreviation of American College Testing
ALSC:	Advisory Local School Council
AIO:	Area Instructional Officer
CEO:	Chief Educational Officer
CGI:	Cognitively Guided Instruction
CPS:	Chicago Public School
DDS:	Discrete Dynamical Systems
GLLVSSJ:	Greater Lawndale/Little Village School for Social Justice
IMP:	Interactive Mathematics Program
LSC:	Local School Council
LVLHS:	Little Village Lawndale High School
MiC:	Mathematics in Context
M4SJ:	Math for social Justice
NCTM:	National Council for Teachers of Mathematics
PD:	Poll difference
RFN:	Researcher Field Notes
RME:	Realistic Mathematics Education
TJ:	Teacher Journal
UIC:	University of Illinois Chicago
ZPD:	Zone of Proximal Development

ABSTRACT

Interweaving Mathematical and Sociopolitical Content In and Through the Classroom Space

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This dissertation elaborates the findings of a qualitative investigation of a year-long mathematics classroom in an urban, untracked, neighborhood (i.e., non-selective-enrollment) public high school in Chicago where students (all Latino/a and Black, from low-income families) and teacher co-created a classroom to *read the mathematical word* (learn mathematics) and *read the world with mathematics* (understand social reality using mathematics) using *generative themes* (key social contradictions) from students' lives. It attempts to gain a deeper and more nuanced understanding of the complexities of this classroom where mathematical and sociopolitical dimensions were in a dialectical relationship. Using a theoretical framework synthesized from Vygotskian and Freirean perspectives, this study examines classroom interactions to understand how mathematical and sociopolitical dimensions were interwoven, how the teacher scaffolded these two dimensions, and the classroom features and student-teacher relationships that facilitated this interweaving.

Data including field notes, teacher journals, video and audio recordings of classroom interactions, student work (homework, presentations, journal assignments, unit projects, etc.), and curricula from two of the year's units offer insights into the complexity of the dialectical relationship between mathematical and sociopolitical dimensions in this classroom. The analysis indicates that these two dimensions were interwoven (foregrounded, backgrounded, and interconnected) in multiple aspects of the classroom (content, teacher and student utterances, and teacher pedagogical decisions) across time (daily, over few days, and the

entire unit). Each generative theme offered different possibilities and challenges for mathematical and sociopolitical analysis and connecting the two. Moreover, the relationship between the mathematical and sociopolitical dimension in each unit guided the teacher in making pedagogical decisions on when and how to either foreground one of the dimensions or connect the two. The interaction features that emerged primarily created and sustained a dialogic classroom environment and helped build political relationships between students and teacher, which in turn facilitated the mathematical-sociopolitical interweaving. Several instances from the classroom interactions of the two units are presented to illustrate these themes and the tensions that emerged therein. The findings from this study will inform and inspire practices for teaching mathematics for social justice based on generative themes.

1 INTRODUCTION

Snippet 1

We have been working to prove that something went wrong in the 2004 Presidential Election. We have used statistics, facts, formulas, and different numbers to prove that the results of the election did not happen by chance. There are three main points that we have been working on that helped us: the 10-0 poll difference split of 10 of the battleground states, the 44-6 poll difference split of the 50 states, and Kerry's .542 proportion on the 2004 Ohio exit poll. First off, a poll difference is the difference between the recorded vote and the exit poll. There are really 11 battleground states but only 10 of them had a poll difference (PD)...This [the probability of a 10-0 PD split] comes out to 0.0009766 which rounds to 0.001. This is our first piece of evidence that this 10-0 split did not happen by chance. 0.001 also rounds to zero which show us how impossible it was for this to happen. With our next idea of the 44-6 PD split of the 50 states is similar ... This answer [probability of 44-6 PD split] comes out as 1.411 E-8 or .00000001. This is an even smaller possibility than the other one. This definitely rounds to zero and is a bigger piece of evidence that these events couldn't, shouldn't, and wouldn't happen by chance. (Carlton¹, Op-ed piece, October 2008)

Snippet 2

So, we established that Blacks were disproportionately affected by HIV/AIDS.² But then, Roxanne or Gema or Ann asked "but what about Latinas/os?" since they were 16% of the new cases in 2006. I told them that Latinas/os were about 26% or so of the Chicago population. I also told them that whites were also about 35%, like African

¹ All students names used in this study are pseudonyms.

² In 2006, Blacks represented 56% of the new HIV diagnoses in Chicago, Latinos, 16% and whites, 25%, while in the same year, Blacks accounted for 36.8% of Chicago's population, Latinos 26% and whites 42%. (AIDS Foundation of Chicago, 2009).

Americans. That led to a really interesting discussion. Roxanne said, “Then we’re not right, because we said that poverty was really related to AIDS, but then how can Latinas/os have a lower rate than whites?” This prompted Ann, who said, “Then Jenny and I were right.” Jenny said, “What do you mean?” And Ann responded, “Then it is about promiscuous behavior, not poverty.” (Teacher Journal, 3/25/09)

I start by highlighting these two snippets from the data collected by our research team in a 12th grade classroom to show examples of how students and teacher were engaged in making sense of their social realities, both mathematically and sociopolitically. The first snippet, Carlton’s op-ed piece, was also a part of his response to the final assignment in the elections unit. This assignment asked students to explain the mathematical evidence for possible fraud in the 2004 U.S. Presidential elections. The study of this unit was relevant and timely since it coincided with the run up to the November 2008 elections with Barack Obama (a Black man³) running for President. Moreover, many students in this class (which comprised entirely of Black and Latino/a students) were voting for the first time, campaigning for Obama, and this class was in Chicago, Obama’s hometown.

The second snippet is an entry from the teacher’s journal, where he noted a piece of classroom interaction from the HIV-AIDS unit. Ann and Roxanne, two Latina students, raised doubts about poverty being a possible factor for the racially disproportionate distribution of people affected by HIV-AIDS in Chicago. Students were keenly aware of HIV-AIDS affecting their communities, and tried to make sense of it mathematically and sociopolitically in this unit. This instance of classroom interaction materialized after students engaged in several days of sociopolitical analysis to deepen their understanding of the disproportionality in the infection rates data. I discuss these two snippets in detail in Chapter

³ I use Black and African American interchangeably.

5. Here, I give an overview of this class, the motivation and rationale for this study, my research questions, and the significance of this study.

This year-long class⁴ (September 2008 – June 2009) titled “Quantitative literacy through investigating urban social reality” (commonly referred to as the Math for Social Justice - M4SJ class), was offered to students in their senior year at the Greater Lawndale/Little Village School for Social Justice (GLLVSSJ, henceforth referred to as Sojo). Sojo is one of four small schools in the Little Village Lawndale High School (LVLHS) campus in Chicago. LVLHS is a neighborhood Chicago Public School (CPS) serving the communities of North Lawndale and Little Village that are home to low-income and working-class families of color. The student population at LVLHS is entirely Black and Latino/a. LVLHS was born out of a community struggle that culminated in a 19-day hunger strike in 2001, in which neighborhood residents demanded the construction of a new high school. The school reflects the “values of peace and equity” that came out of the hunger strike and is built on the spirit of “physical, spiritual, and communal struggle it took to achieve justice,” as described on its website (http://sj.lvlhs.org/our_campus.jsp).

There were several purposes for this class, two of which were a) supporting the learning of rich mathematical ideas through an investigation of sociopolitical contexts from students' lives and that of the broader world, and b) supporting the growth of students' sociopolitical analyses and sense of *social agency* through a mathematical investigation of these contexts. Guided and inspired by Paulo Freire's work to *read* [understand] *the world* and *write* [change] *the world*, students and the teacher (Rico Gutstein, a white male University Professor, henceforth referred to as Rico⁵) co-created a classroom where, together, they decided which contexts to study, and when. These contexts were based on *generative*

⁴ The class was listed as a college bridge class. That is, students co-enrolled at their school and University of Illinois at Chicago (UIC). However, they did not receive college mathematics credit for this course because it was listed as a course at the College of Education.

⁵ I use teacher and Rico interchangeably when I refer to the teacher in this classroom.

themes (themes identified from students' lives) suggested by students or proposed by the teacher and accepted by students (Gutstein, 2012a). The units of investigation were designed around the themes of elections, displacement (gentrification, deportations, & immigration), HIV-AIDS in students' communities, criminalization of youth/people of color, and sexism. (See Chapter 3 and 4 for details of this class and these units).

This classroom was one of many efforts reframing the discourse on equity in mathematics education by placing issues of race, language, culture, power, and gender at the center of the curriculum. In the next section, I situate it within the current scenario of mathematics education in the United States for students from low-income communities of color and summarize some of the relevant literature on equity-related efforts in this area.

1.1 *Equity in Math Education in the United States*

Early on in the doctoral program at UIC, I became deeply interested in the current scenario of mathematics education in the US and the ways in which mathematics education can and must take into account students' social realities. Prior to joining the doctoral program at UIC, I spent a couple of years visiting, teaching children, and supporting teachers in various rural schools in India. During this time, I began to understand that the actions and performance of teachers and students were connected to social realities and inequities that existed outside of school. For example, caste and gender were significant factors that influenced the ways a teacher treated and interacted with a child. I also read about the history of the educational system in India, the influence of British colonial rule on it, and educational philosophies from India. One critique of the British influence on the educational system in India (which continues even today) was that it ignored the social realities of the child in the teaching-learning process.

I found that, although reform-oriented⁶ curricula and pedagogy, prompted by the Principles & Standards document (National Council for Teachers of Mathematics (NCTM), 2000) led to improved learning for many students in the United States (Boaler, 1998; Schoenfeld, 2002), scholars raised significant concerns about the widespread inequity in mathematics learning experiences (Martin, 2003; Secada, 1991; Tate, 1994; Tate & Rousseau, 2002). While the standards considered equity in terms of equal opportunity, equal access, equal outcomes, high expectations, strong support, and opportunities for all students, Martin (2003) indicated that they did not contextualize “disproportionate achievement and persistence patterns within a broader conceptual framework of socio-historical, structural, community, school, and intra-personal factors” (p.13).

Several scholars urged teachers to consider the social realities that students of color face outside of school settings, which often limit mathematical opportunities available to them in school (Apple, 1992a, 1992b, 2000; Gutstein, 2006; Martin, 2003; Rousseau & Tate, 2003). Apple (1992a) argued that, for the progressive tendencies of the NCTM (1989) Curriculum and Evaluation Standards to be put into practice, more thought needed to be given to “the realities of differential power, the economic crisis, and the social construction of both what counts as mathematical literacy and the problems it should focus on” (p. 428). Martin (2003) indicated that “equity discussions and equity-related efforts in mathematics education need to be connected to discussions of equity in the larger social and structural contexts that impact the lives of underrepresented students” (p.15), failing which “underachievement and limited persistence may be rational responses to perceptions of the larger opportunity structure” (p.17).

⁶ Reform-oriented mathematics curricula and pedagogy gives little or no emphasis to only rote-learning and procedural understanding, but instead gives importance to the standards and processes mentioned in the NCTM Principles & Standards document (NCTM, 2000).

Others claimed that interactions in mathematics classrooms may not be race, gender, or language neutral and insisted on attending to school and classroom processes that may produce inequity (Boaler, 2002; Khisty, 1995; Rousseau & Tate, 2003). Rousseau and Tate (2003), for example, provided evidence that teacher dispositions towards justice and equity—in particular, blindness to issues of race and diversity—obstruct teacher reflection on equity markers such as patterns of disproportionate failure in mathematics classrooms. In other words, “teachers’ views of equity and race blocked substantive reflections about the nature of their instructional practices and the impact of those practices on students of color in their classes” (p.210).

Gutiérrez (2007) began with the assertion that heterogeneity exists within and between groups and that “under a just system, we could expect to see students achieve in school and aspire to do a variety of things. That is, we would not expect all Latinas/Latinos to perform poorly or exceptionally in school mathematics” (p.41). She stated that any attempt to define equity include a focus on efforts and outcomes that are equitable rather than equal. She suggested a definition of equity as “the goal of being unable to predict student patterns (e.g., achievement, participation, ability to critically analyze data/society) based solely upon characteristics such as race, class, ethnicity, gender, beliefs, and proficiency in the dominant language” (Gutiérrez, 2007, p.41).

One aspect of her definition of equity is the emphasis on student achievement and participation in dominant school mathematics, or “mathematics that is overwhelmingly validated by society. This includes both reform and traditional mathematics” (p.45). Several scholars have suggested equitable approaches that facilitate students’ participation, and positively influence their learning of dominant mathematics. These include teachers’ use of the linguistic and cultural resources that bi/multilingual students bring to the mathematics classroom (Khisty, 1995; Khisty & Chval, 2002; Moschkovich, 2002a, 2002b; Setati, 2005;

Tate, 1994, 1995); instruction that builds on students' and their families' knowledge, culture, and practices as resources for schooling (Civil, 2007; Gutstein, Lipman, Hernandez & de los Reyes, 1997; Ladson-Billings, 1995, 1997; Nasir, 2002; Nasir & Saxe, 2003); and instruction that connects mathematical learning to the current and historical setting of being African American, and builds positive racial and academic identities (Ladson-Billings, 1995; Martin, 2006, 2007; Martin & McGee, 2009; Moses & Cobb, 2001; Nasir, 2002; Nasir & Saxe, 2003; Tate, 1994, 1995).

A second essential aspect of Gutiérrez's (2007) definition of equity is the importance of critical mathematics that "prepares students to analyze world data and to develop a critical eye towards knowledge and a proactive stance on justice" (p.45). Efforts that take this view towards equity and recognize the political nature of mathematics education have emerged from Black liberatory pedagogy (Davis, West, Greeno, Gresalfi, & Martin, 2007; Martin, 2006, 2007; Moses & Cobb, 2001; Moses, Kamii, Swap, & Howard, 1989), critical pedagogy (Frankenstein, 1983, 1998; Gutstein, 2006; Skovsmose, 1994; Skovsmose & Valero, 2002; Turner, 2003; Turner & Font Strawhun, 2005; Valero, 2007), and a combination of the two (Terry, 2010).

Gutiérrez (2007) also noted, "Neither the first nor the second aspects of equity are sufficient to redress injustices in the world. Students need to be able to do both— be able to play the game of mathematics that is currently associated with power and intellectual potential, and be able to change the game of mathematics to serve a better society" (p.49). In other words, equity approaches in mathematics must be directed towards both access and dissent (Morrell, 2008). This literature on equity in mathematics education has (re)framed the purpose of mathematics education to be not only about learning mathematical ideas, but also about using mathematics as a tool for analyzing and transforming the society, and supporting the ongoing struggle for liberation.

This notion of the purpose of mathematical literacy extending beyond the learning of mathematical ideas is also reflected in the African American experience. As Martin & McGee (2009) indicate, “newly freed slaves sought to develop reading and numeracy skills so as not to be cheated in contracts and transactions with former slave owners and other whites” (p. 217), suggesting that the learning numeracy skills was not simply an academic exercise but had a larger purpose in the struggle for survival and living.

In recent times, the Algebra Project (Davis et al., 2007; Moses et al., 1989; Moses & Cobb, 2001), founded on the principles of the Mississippi community organizing tradition in the Civil Rights movement, has suggested that “the ongoing struggle for citizenship and equality for minority people is now linked to an issue of math and science literacy” (p.8). Moses and Cobb (2001) urged people of color to organize around improving mathematical literacy for their communities and suggested that young people find their voice, advocate for themselves, create their demands for equitable education, and organize for those demands.

Our efforts with our target population is what defines the radical nature of the Algebra Project, not program specifics. To make myself very, very clear, even the development of some sterling new curriculum—a real breakthrough—would not make us happy if it did not deeply and seriously empower the target population to demand access to literacy for everyone. That is what is driving the project. What is radical about the Algebra Project is the students we are trying to reach and the people we work with to drive a broad math literacy effort—the Black and poor students and the communities in which they live, the usually excluded. (p.11)

Martin (2003, 2006, 2007; Martin & McGee, 2009) proposed a framework that conceptualizes mathematical learning and participation for all students as racialized forms of experience — experiences that are structured and influenced by racial relations, ideologies, practices, and policies, specifically racist ones, that exist in the larger society. He

emphasized the need for the mathematical research and education community to consider race as a sociopolitical and historical construct in their endeavors and suggested identifying and using classroom practices that support and promote students' positive racial, academic, and mathematical identities.

Skovsmose (1994) offered a re-conceptualization in which critical mathematical literacy or mathemacy, as he termed it, can become the means to “organize and reorganize interpretations of social institutions, traditions and proposal of political reform” (p.39). Frankenstein (1983, 1998) connected Freire’s notion of reading the world (Freire & Macedo, 1987) to mathematics, and argued for the necessity of mathematical literacy in developing critical consciousness. She recommended that critical math literacy simultaneously consider what mathematics is implied in, and would clarify, students’ lived experiences in order for them to develop deeper understanding and to take action.

Frankenstein’s work is one of several emerging from critical pedagogy, which indicate that sociopolitical realities and students’ lived experiences can indeed be powerful and meaningful contexts for students (and adults) to learn mathematics and use mathematics as a tool to investigate social conditions (Brantlinger, 2006; Brelas, 2009; Frankenstein, 1983, 1990, 1998; Gutstein, 2006, 2007a, 2007b; Gutstein, Lipman, Hernandez & Reyes, 1997; Gutstein & Peterson, 2005; Mukhopadhyay, 1998; Tate, 1994; Turner, 2003; Turner & Font Strawn, 2005; Varley Gutiérrez, 2009a, 2009b). For example, Turner (2003) and Turner & Font Strawn (2005) drew upon student's lived experiences to investigate the situation of crowded hallways and space in their school. This investigation in a 6th grade classroom in New York City presented an opportunity for students to not only to learn meaningful mathematics but also to make sense of their social reality. In another example, students in a 7th grade classroom investigated the cost of a B2 Bomber and considered what it meant in terms of the number of college scholarships for students like themselves (Gutstein, 2006).

Thus far I have presented a summary of the literature that makes a case and calls for a “sociopolitical turn in mathematics education,” (Gutiérrez, 2010) and the myriad ways in which educators and scholars are envisioning and working towards it. Next, I discuss the rationale for my study.

1.2 The rationale for this study

While the literature summarized in the previous section resonated with me, it raised several questions, some related to the content, pedagogy, and assessment required for equity efforts and others about the teacher, community, and students. When Rico suggested the possibility of engaging in the curricular planning efforts for the M4SJ class he was going to teach the following academic year (2008-2009), I decided to take it up. I had read several examples of projects, mainly at the middle school level, on several websites and in books, such as *Rethinking Schools* (www.rethinkingschools.org), *Radical Math* (www.radicalmath.org), *Reading and writing the world with mathematics: Toward a pedagogy for social justice* (Gutstein, 2006), and *Rethinking mathematics: Teaching social justice by the numbers* (Gutstein & Peterson, 2005). I was excited at the opportunity to develop a curricular outline based on students’ social realities at the high school level. My involvement did not end there but extended through the academic year (September 2008 – June 2009, 38 weeks) as a participant observer in class.

As I spent time in this class and read the relevant research literature, I noticed the dearth of research on everyday interactions in classrooms (like this one) with both mathematical and sociopolitical goals. Research literature from such classrooms mainly did the following:

- Made an argument and gave evidence for student engagement, participation, and agency (e.g., Gutstein, 2006; Turner, 2003; Turner & Font Strawhun, 2005; Varley Gutiérrez, 2009a, 2009b),

- Provided curricular ideas or projects at the middle school level (e.g., Gutstein, 2006; Mukhopadhyay, 1998), and
- Discussed some tensions and limitations of teaching in such classrooms (e.g., Brantlinger, 2006; Brelas, 2009; Gutstein et al., 1997; Gutstein, 2006, 2007a, 2007b; Turner, 2003; Turner & Font Strawhun, 2005).

This literature offered few insights into how the classroom interactions mediated and contributed to the connection of the mathematical and sociopolitical dimensions such as in the two introductory snippets I highlighted. There were some exceptions from the literature, which I discuss later in this section. On the other hand, several research studies investigated interactions in reform-oriented mathematics classrooms that supported mathematical learning. These studies shifted the focus of analysis from individual learners towards the classroom community—its practices, discourse, norms, participation structures, roles, and responsibilities—and elaborated on these. This shift has been referred to as a “social turn in mathematics,” (Lerman, 2000) and a shift from an acquisition metaphor to a participation metaphor in educational research (Sfard, 1998).

For example, Yackel and Cobb (1996) identified two types of norms in a reform-based mathematics classroom—namely social norms and socio-mathematical norms—which influenced participation and interactions. Social norms such as explanation, justification, and argumentation are general classroom norms that apply broadly. Socio-mathematical norms are specific to the mathematical activity in the classroom, and influence and mediate the content of the mathematical discussions. They indicated that these norms are not predetermined explicit criteria introduced into the classroom from outside. Instead, they are negotiated between the teacher and the students in the interactions. Others have suggested that establishing new norms may often require both teacher and students to re-conceptualize what it means to learn, know, and do mathematics (Lampert, 1990; Wood, 1999; Wood,

Cobb, & Yackel, 1991; Yackel & Cobb, 1996; Zack & Graves, 2001).

Some studies illuminated the ways in which the teacher's role changes significantly from providing explicit instructions to facilitating mathematical practices in the classroom. The teacher can provide this assistance in several ways such as eliciting, listening to, differentiating, and expanding on student thinking in groups and whole class discussions; ensuring mathematical richness of the interactions; and attending to student responses in ways that go beyond evaluating correctness of response (Hufferd-Ackles, Fuson, Sherin, 2004; Mendez, Sherin, & Louis, 2007; Nathan & Knuth, 2003; Walshaw & Anthony, 2008; Wood et al. 1991; Zack & Graves, 2001). Facilitating mathematical practices also requires the teacher to scaffold and coordinate at two levels, namely the mathematical content of the task and the social interaction (Hufferd-Ackles et al., 2004; Leinhardt & Steele, 2005; Mendez et al., 2007; Sherin, Mendez, & Louis, 2004; Williams & Baxter, 1996).

Research in reform-oriented mathematics classrooms indicated that teachers could scaffold in several ways such as stepping in and out of conversations; listening closely to student conversations; looking for when interactions do or do not support mathematical learning; balancing individual and collective understanding; anticipating potential directions and confusions; and listening for when students need support in making their mathematical ideas visible to others (Kieran, 2001; O'Connor, 2001; Rittenhouse, 1998; Sfard, 2001; Zack & Graves, 2001). This in turn requires the teacher to be flexible with the mathematical trajectory of the classroom discussion and to be aware of the complexity of mathematical ideas and students' thinking (Leinhardt and Steele, 2005).

Some studies identified interaction patterns other than the common Initiate-Respond-Evaluate pattern⁷ (Cazden, 2001). These studies proposed alternatives like revoicing,

⁷ The Initiate-Respond-Evaluate pattern is a teacher-led, three part sequence where the teacher asks a question (sometimes directed at a student), a student responds, and the teacher evaluates the response before proceeding.

filtering, and focusing, to support the kinds of interactions encouraged by the reform standards such as arguing, disagreeing, and critiquing (Forman & Ansell, 2001; Franke, Kazemi, & Battey, 2007; Mendez et al., 2007; O'Connor & Michaels, 1993; Sherin, 2002). Revoicing offers a way to attend simultaneously to the norms of participation and to the mathematical content by choosing from several options of responding to student contributions instead of only evaluating them. These options include reframing, repeating, expanding, recasting, translating, connecting, and asking for clarification (O'Connor & Michaels, 1993). Sherin (2002) described a filtering tactic where the teacher first solicited ideas from students and encouraged them to elaborate their ideas, and subsequently guided them to challenge, compare, and evaluate others' ideas. Following this, the teacher brought the mathematical content to the fore by choosing a subset of mathematical ideas in student contributions to focus on during the rest of the interaction. In other instances, teachers attempted to understand students' mathematical thinking instead of funneling their thinking towards a particular end (Wood (1998) in Franke et al., 2007).

While the literature on interactions in reform-oriented classrooms (the norms, the teacher role, and the interaction patterns) was abundant, I did find some, albeit limited, research related to the norms and tensions that emerged for a teacher in classrooms with both mathematical and sociopolitical goals. For example, Gutstein (2006) described three interrelated features of a critical math pedagogy that he and his students (7th and 8th graders) co-constructed based on his experience of teaching a reform-based curriculum with frequent "social justice projects." The features included "normalizing politically taboo topics, building political relationships with students, and developing a pedagogy of questioning" (p.132).

Normalizing politically taboo topics meant that students and teacher discussed topics that were generally off-limits in other classrooms. Building political relationships involved the teacher "taking active political stands in solidarity with students and their communities

about issues that matter” (p.132) and thus going beyond building personal, supportive relationships with students. Finally, the pedagogy of questioning implied creating a space for students to pose their own questions, going from one question to the next, challenging responses, and recognizing the power of questioning to make sense of the world.

Additionally, Gutstein (2006) indicated that he and his students at times attended to the mathematics leaving behind the sociopolitical context and vice versa. He described the dialectical relationship between developing mathematical power and using mathematics to study and potentially change social reality as follows:

The two processes can facilitate each other under certain conditions, but there is a tension between them. To learn rich mathematics, students at some point have to leave the situation in which the mathematics is embedded and to focus on the mathematical ideas themselves....conversely to prioritize the sociopolitical contexts, teachers need to draw students into studying reality and at some point leave mathematics to the side.
(p. 108-109)

However, Brantlinger (2007, 2011) argued that sociopolitical themes presented a distraction to the mathematical goals, and limited mathematical learning. He described the recurring disconnect he faced between the sociopolitical and the mathematical in the classroom and shared his discomfort about leaving the mathematics to the side (temporarily) to discuss social realities.

It is important to recognize that the mathematical and sociopolitical dimensions indeed present a tension in such teaching. When Gutstein and his students focused on the mathematical ideas, they did so for students to learn dominant mathematics as well as to develop the mathematical ideas required to make sense of the situation later on, or as Gutiérrez (2007) and Morrell (2008) have suggested, for both access and dissent. Similarly,

when they discussed the social realities, they did so to get a better comprehension of the situation, the mathematics embedded in it, and the mathematics that could illuminate it.

Turner (2003) gave some insights into the ways in which Beatriz, the teacher in a 6th grade classroom, navigated the tensions that arose due to the dialectical relationship between the mathematical and sociopolitical dimensions in such teaching. Turner indicated that Beatriz made pedagogical decisions keeping in mind the need for “a) supporting students with the mathematics that they needed to move forward with their intentions, and at the same time, (b) ensuring that they developed conceptual understanding of the content” (p.246). In other words, Beatriz made pedagogical decisions that supported both reading the world and learning the mathematics.

Based on her study to engage fifth grade Latina girls in critical mathematics activities at an after-school girls’ mathematics club, Varley Gutiérrez (2009b) posited that,

Neither the critical nor the mathematical was necessarily more important than the other; however, they appeared to mutually instantiate and support each other. The presence of both the critical and mathematical was an essential component of their [the Latinas’] meaningful participation in the community movement. (p.203)

In addition, she discussed her role as a facilitator in “pushing the mathematics in order to ensure the development of not only critical but also mathematical agency” and ensuring that “the mathematics was accessible” (p.205). The work of Gutstein, Turner, and Varley Gutiérrez suggests a) that there is a dialectical relation between the mathematical and sociopolitical dimensions, and b) that the two dimensions that seem to be irreconcilable can build on, and emerge from each other.

In summary, the literature related to such classrooms gives some insights into the norms, the tensions that the teachers may face in bringing together the mathematical and sociopolitical dimensions, and the ways in which teachers could navigate these challenges.

However, it did not elaborate on the ways in which mathematical and sociopolitical dimensions interconnected (for example in the two snippets at the beginning of this chapter) and how the trajectory of the interactions in the classroom supported and provided opportunities for this to occur. I chose to investigate and unpack this for my dissertation study.

1.3 Guiding Research Question

My key question became: *How did this classroom space (the teacher and students, their interactions, and the artifacts such as videos, newspaper articles, personal stories, etc.) mediate the development and interweaving (foregrounding, backgrounding, and interconnection) of sociopolitical and mathematical dimensions by students?* Specifically:

- In what ways do the sociopolitical and mathematical dimensions interweave in this classroom?
- In what ways did the teacher scaffold the sociopolitical and mathematical content and support their interweaving?
- What features emerged as students and teacher co-constructed this space for interweaving sociopolitical and mathematical dimensions?

I investigated these questions to understand the complexities of the interactions in this classroom and the ways in which sociopolitical and mathematical aspects were fore-grounded or backgrounded in this classroom, by whom, and how. These two dimensions that were at times distinct and at other times intertwined were mutually interrelated and influenced the trajectory of the interactions in the classroom. In other words, understanding the complexity of the “dance” between the mathematical and the sociopolitical dimensions in this classroom space from multiple perspectives (across time, norms, teacher-student relations, and teacher-student acts) became the emphasis of my dissertation.

1.4 Significance and limitations of the study

This study is significant for the following reasons. First, to the best of my knowledge, there is no published example of a year-long, comprehensive effort on teaching students to read the world (investigate and understand social reality) and *read the mathematical word*⁸ (understand the relevant mathematics) at the high school level. For example, Brantlinger's work at the high school level included about 15% of critical math activities (at a nine-week night school program and two three-week summer programs) and Gutstein's work at the middle school was about 20% social justice projects over the entire academic year. Additionally, most critical mathematics pedagogy literature I found was situated at the middle school level or in out-of-school settings with the exception of Brantlinger (2006) and Brelias (2009) who worked with high school students, then again these were not for the entire year.

Second, not many efforts build on generative themes from students' lives in mathematics education. Although Turner's (2003) dissertation based in a 6th grade mathematics class and Varley Gutiérrez's (2009a, 2009b) work in an after-school setting are exceptions, these were neither at the high school level, nor for the entire academic year.

Third, as I mentioned in the previous section, we have little visibility into how the mathematical and sociopolitical dimensions are in a dance in such classrooms, and how the interactions in such a classroom facilitate the interweaving of the two dimensions. While recent studies (e.g., Brantlinger, 2006; Brelias, 2009; Gutstein, 2006; & Turner, 2003) investigated classroom interactions, none provided detailed insights into how the classroom space, the norms, the teacher-student relations, and the teacher-student acts enabled the interweaving of the two dimensions across time in order to support the sociopolitical and

⁸*Reading the world* (with mathematics whenever possible) and *reading the mathematical word* were two of the goals in this classroom that I focus in this study and I define them in the Chapter 2. Gutstein (2006) has suggested other goals for such a classroom including *writing the world with mathematics*, traditional academic success, changing orientations towards mathematics, and developing positive social and cultural identities. Turner (2003) has suggested an additional goal of developing critical mathematical agency.

mathematical goals of the classroom. Understanding this movement between the mathematical and sociopolitical from multiple perspectives, in my view, is essential to support teachers who want to take up similar efforts so they can likewise choreograph this dance within their classrooms.

As with any study, the theoretical lens, the process of data collection, the type of data collected, and the data analysis influenced the kinds of claims I could make. The theoretical lens, and types of data collected did not lend themselves to analyzing changes or growth in students' mathematical or sociopolitical understanding overall or related to specific concepts. I did not use measures such as pre- and post-assessment tests. Assessing individual students' learning was neither the emphasis of the study nor feasible with the available data. Therefore, I do not make any claims about any kind of change, subtle or significant, over time for any one or several students.

Moreover, the questions I asked for my dissertation study led me away from analyzing any one student's mathematical or sociopolitical understanding, whether at the moment or over time. Instead, I focused on the interaction in the classroom to comprehend if and how they facilitated the interweaving of mathematical and sociopolitical dimensions at multiple levels across time. I took the teacher's and students' acts/utterances in classroom interactions that were indicative of interweaving the two dimensions—reading the world, and reading the mathematical word—as evidence that they were engaged in the process of learning through *joint activity*. This is consistent with the participatory metaphor of learning advocated by Sfard (1998) where “the permanence of *having* gives way to the constant flux of *doing*” (p.6) thus allowing for a focus on student utterances, norms, relationships, and ways of participation.

In essence, what this dissertation speaks to is a) the ways in which the mathematical and sociopolitical dimensions were interwoven across time and space in classroom

interactions, and the teacher's actions and pedagogical decisions, as well as the complexities therein, b) the features that emerged in this classroom that facilitated this interweaving, and c) how a) and b) together supported students developing a mathematical-sociopolitical connection as evident in their utterances. Ultimately, a deeper analysis of the mathematical and sociopolitical learning of students in such settings would be a significant direction for future research to make a strong case for this kind of educational experience for students.

1.5 Outline of the dissertation

The rest of this dissertation is structured as follows. In Chapter 2, I share the conceptual framing that guides this dissertation. Drawing on critical pedagogy and sociocultural theory, I consider this class as a space for joint activity where teachers and students are co-constructing a *dialogic* discourse in order to read the world and read the mathematical word (two of the goals of this classroom⁹) by investigating generative themes from students' lives. Chapter 3 discusses the research methodology by giving details of the research setting, and the methods of data collection and analysis. I draw upon ethnographic and discourse methods, and outline the critical stance I have taken throughout this study, and discuss methodological concerns.

Chapter 4 gives an overview of the units studied in this class during the academic year with a detailed description of two specific units that I chose to analyze. It includes a discussion of the mathematical and sociopolitical complexities that emerged in these two units. Chapter 5 gives insights into the ways in which the mathematical and sociopolitical dimensions interwove in this classroom at different descriptive levels—in an interaction, on a given day, over a few days, the unit, and entire year. I discuss the ways in which the mathematical and sociopolitical dimensions were interwoven in the two snippets that I introduced here. I also elaborate the ways in which the teacher scaffolded the two dimensions

⁹ Henceforth, when I use the phrase the goals of this classroom, I mean these two goals of this classroom.

in each unit. In Chapter 6, I detail the ways in which teacher and students co-constructed this classroom to support this interweaving. Specifically I investigate the norms that surfaced in this classroom that facilitated building a dialogic classroom and developing political relationships between teacher and students.

Chapter 7 ends with a summary of the findings of this study, discusses its implications, limitations, and future directions for research. Although I have listed chapters four through six as separate entities, the ideas in these are interrelated. I often refer to a discussion or analysis in a previous or upcoming chapter. The separation of the content in these three chapters is ultimately arbitrary, predicated on my best thinking, and done for analytical purposes. I hope that the organization in this dissertation allows for ease in reading while making the interconnectedness of ideas in these three chapters visible as well.

2 CONCEPTUAL FRAMEWORK

In this chapter, I develop a theoretical outline for my study by drawing from critical mathematics pedagogy and sociocultural theory. I show below that a synthesis of these two theoretical perspectives can provide a basis to investigate the ways in which this classroom space supported the interplay of the mathematical and sociopolitical dimensions.

In the framework that I synthesize below, I consider this classroom as a space for joint activity (between teacher and students) with reading the world and reading the mathematical word as two of the purposes (see Figure 1). This joint activity is mediated by the content (generative themes and mathematical ideas), talk (interaction patterns, and norms), and is facilitated by the teacher. Furthermore, a dialogic stance permeates this activity and is central to this framing. In the following sections, I elaborate on these points.

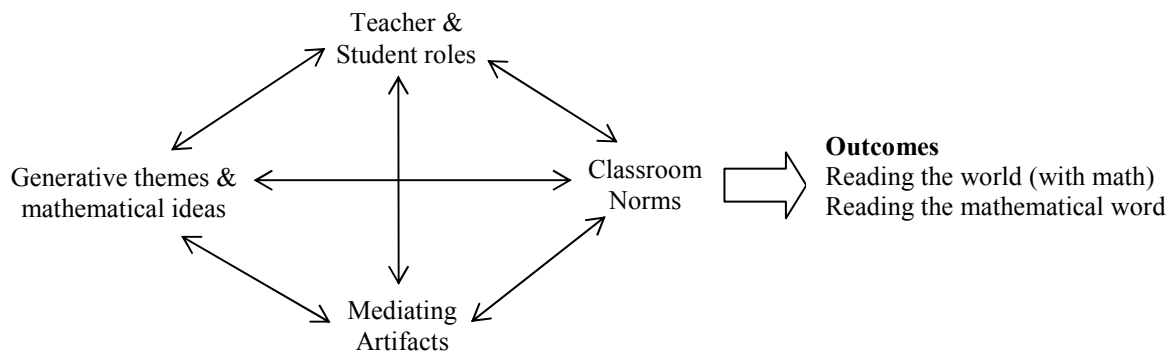


Figure 1: Critical math classroom as a joint activity

2.1 *Reading and writing the world*

Critical pedagogy, as proposed by Freire (1970/2000), is concerned with power and structures that perpetuate oppression and offers a basis for education that is directed towards liberation and the (re)humanization of participants (both teacher and students). It is grounded in the view that education (teaching and learning) is not only an individual, social, and cultural act, but also a political one. Freire critiqued literacy programs that separated the process of learning to read from the process of developing consciousness, because such an

approach, he said, ignored the way “language may either confirm or deny the life histories and experiences of people who use it” (Freire & Macedo, 1987, p.148).

Freire indicated that for a pedagogy to be critical, literacy (reading the word) must be related to reading the world, which is inherently a political act. “It is impossible to carry out my literacy work or to understand literacy by divorcing the reading of the word from reading of the world” (Freire & Macedo, 1987, p.49). Reading the world involves a historical, political, sociocultural, and linguistic examination of our lived experiences and our relationship to the world; dialectically investigating these relationships; and recognizing their transient, contradictory, and inter-connected nature. He argued that most traditional and mainstream literacy programs emphasized reading the word and developed skills for acquiring the dominant standard language in isolation from reading the world. Such a process, he said, negated and ignored people's lived experiences and subjectivities and gave the impression that education could be stripped of sociopolitical dimensions. As Freire (1994) indicated,

There neither is, nor has ever been, an educational practice in zero space-time—neutral in the sense of being committed only to preponderantly abstract, intangible ideas. To try to get people to believe that there is such a thing as this, and to convince or try to convince the incautious that this is the truth, is indisputably a political practice, whereby an effort is made to soften any possible rebelliousness on the part of those to whom injustice is being done. It is as political as the other practice, which does not conceal—in fact, which proclaims—its own political character. (pp. 77–78)

Freire emphasized that liberatory education is not only about reading the word and reading the world, but also about re-creating the world and the knowledge of that world, which he referred to as writing the world. “Reading the word and learning how to write the word so one can later read it are preceded by learning how to write the world, that is, having

the experience of changing the world and touching the world” (Freire & Macedo, 1987, p.49). Although writing the world was one of the goals for this class, in this study I focus on reading the world and its relationship to reading the mathematical word (described below).

2.2 Critical Mathematics Goals

Frankenstein (1983) adapted Freire’s work on adult literacy work to her context of teaching and learning of mathematics for adult learners. In later years, several educators (e.g., Gutstein, 2006; Terry, 2009; Turner, 2003; Varley Gutiérrez, 2009b) built upon both their work, for teaching and learning of mathematics in K-12 school and after-school settings. Similar to Freire's idea of reading and writing the world, and reading the word, Gutstein (2003, 2006), built on Frankenstein’s (1983, 1998) notion of critical mathematics literacy and *reading the world with mathematics*. He suggested six goals for critical math pedagogy (see footnote 8), three of which are reading the world with mathematics, *writing the world with mathematics*, and *reading the mathematical word*. Reading the world with mathematics means

to use mathematics to understand relations of power, resource inequities, and disparate opportunities between different social groups and to understand explicit discrimination based on race, class, gender, language, and other differences. Further, it means to dissect and deconstruct media and other forms of representation. It means to use mathematics to examine these various phenomena both in one’s immediate life and in the broader social world and to identify relationships and make connections between them. (Gutstein, 2006, p.45)

Reading the mathematical word means developing mathematical power, and is a necessary component of reading the world with mathematics. Mathematical power generally means being fluent in dominant school mathematics with respect to both content (numbers & operations, algebra, geometry, measurement, and data analysis & probability) and processes

(problem solving, representations, communication, connection, and reasoning & proof) as described in the NCTM (2000) vision of school mathematics. However, in this critical framework, it is not sufficient to develop mathematical power isolated from the development of sociopolitical consciousness, as may frequently be the case even in reform-oriented mathematics classrooms. Reading the mathematical word must be integrated with reading and writing the world—with mathematics when appropriate and possible—in all its variety and complexity.

Writing the world with mathematics means, “using mathematics to change the world,” (Gutstein, 2006, p.27) and developing what Gutstein referred to as a sense of social agency. It is a process of growing in which students begin to see themselves as capable of making social change and contributing to historical and political processes using mathematics. There are two important aspects to this description of agency. First, it is not an all-or-nothing proposition, but instead points to a gradual nature of students’ growth. Second, it is about seeing oneself as an agent of social change capable of contributing to historical processes and taking initiative to transform school and society towards liberation and humanization.

For the purpose of this study, I center my analysis on the goals of reading the mathematical word, and reading the world (with mathematics whenever possible and appropriate) as it emerges in the classroom interactions, recognizing that there were other goals to this class as well. I also discuss the goal of writing the world (with mathematics) as appropriate, although I do not focus extensively on it in my analysis.

2.3 *The notion of joint activity*

Vygotsky (1978, 1987) proposed that learning and development occurs in joint activity (between children and adults, or teacher and students) mediated through cultural tools (materials, language, text and so on). He posited that the development of higher psychological processes, such as logical reasoning, memory, and attention, has its origin in

the plane of social/cultural activity (interpsychological) and then moves inward to the individual plane (intrapsychological). Vygotsky (1978) further recognized that this inward movement from the social plane to the individual plane (or internalization, as he termed it) is “neither simply invented by children nor passed down by adults” (p.46). That is, learning and development is not simply a matter of transmitting or depositing what adults knew to children. Similarly, Freire (1970/2000) denounced the largely dominant banking approach to education “in which the students are the depositories and the teacher is the depositor” (p.72), thereby leading to dichotomizing the participants as teacher and students.

Both Vygotsky and Freire rejected banking approaches, although they arrived at this from different entry points. For Freire it began with liberation. He wrote, “Those truly committed to liberation must reject the banking concept in its entirety, adopting instead a concept of women and men as conscious beings, and consciousness as consciousness intent upon the world” (Freire, 1970/2000, p.79). Vygotsky, a psychologist, was interested in child psychology, developmental psychology, and education. He proposed that learning and development involved a series of qualitative transformations through which internal psychological activity is reconstructed on the basis of external activity via the mediation of cultural tools such as language and material objects. He posited that external activity (or cultural/social activity) influences internal psychological activity and plays a central role in the development of higher psychological processes.

Vygotsky (1987) also cautioned that not all activity supports learning. He argued that, for to learning to occur in joint activity, there should be some possibility of moving from what a child can do to what he cannot do.

We said that in collaboration the child can always do more than he can independently.

We must add the stipulation that he cannot do infinitely more. What collaboration

contributes to the child's performance is restricted to limits, which are determined by the state of his development and his intellectual potential. (p. 209)

In other words, the joint activity must attend to what individuals can be supported to do with assistance, instead of what they can do independently, or ought to be able to do independently. "In collaboration, the child solves problems that are proximal to his [sic] level of development with relative ease. Further on however the difficulty grows. Ultimately problems become too difficult to resolve even in collaboration" (Vygotsky, 1987, p.210).

Vygotsky defined the *zone of proximal development* (ZPD) as the difference between what a child can achieve independently and in collaboration. The ZPD is a characteristic of neither a child or teacher, nor a strategy to learn a set of skills by engaging in any type of interaction. It occurs in a genuine social context or activity (play, science classroom, mathematics classroom, etc.) and supports learning through the mediation of tools and language in the presence of more capable others.

In other words, for learning to occur, instruction must build on what the student can do in collaboration with others (teachers, adults, peers). Cazden (1981), in agreement with Vygotsky, suggested that this type of assisted performance be considered as "performance before competence" instead of "performance without competence." She also suggested that one needs to distinguish between help that "somehow gets a child to produce the right answer and help from which the child might learn how to answer similar questions in the future" (p.7). To summarize, learning presupposes a specific social nature and "the process by which children grow into the intellectual life of those around them" (Vygotsky, 1978, p. 88), becoming more independent in their functioning. In this process, the teacher and the mediating tools take on a vital role as I discuss in the following sections.

2.4 Dialogic approach

Building on Vygotsky, Wells (2007) suggested that dialogue is an important mediating artifact between participants in joint activity for supporting learning of a kind not generally supported by monologic discourse:

... the development of children's understanding of their world – of themselves and others as well as of the content of the curriculum – needs to be understood in terms of a co-construction of knowledge through jointly conducted activities that are mediated by artifacts of various kinds, of which dialogue is the most powerful. (p.245)

He further indicated that it is not only the form of the interaction but also the overall stance and orientation of the activity that needs to be dialogic in nature. Such an orientation, according to Wells, recognizes the co-construction of knowledge in joint activity, considers students' responses seriously, and explores them with rigor. O'Connors & Michaels (2007), in agreement with Wells (2007) suggested that, "monologic discourse is usually associated with fixed transmission of unchanging ideas and status inequalities. Dialogic discourse connotes social relationships of equal status, intellectual openness and possibilities for critique and creative thought" (p.277).

This is consistent with Freire's emphasis on a dialogic approach to overcome the teacher-student contradiction in banking education. By the teacher-student contradiction, Freire (1970/2000) implied the situation in banking education where, "the teacher presents himself [sic] to his students as their necessary opposite; by considering their ignorance absolute, he justifies his own existence. The students, alienated like the slave in the Hegelian dialectic, accept their ignorance as justifying the teacher's existence" (p.72). He indicated that this contradiction is maintained and often stimulated through the practices and attitude in banking education such as "the teachers talk and students listen," "the teacher chooses the

program content and the students (who were not consulted) adapt to it,” and “the teacher disciplines and the students are disciplined” (p.73).

Resolving the teacher-student contradiction, therefore, means that the teacher “exchange the role of depositor, prescriber, domesticator, for the role of student among students,” (p.75) and act in solidarity and partnership with them. Dialogue, according to Freire (1970/2000), could not exist in the absence of love, humility, faith, and hope, and “cannot occur between those who want to name the world and those who do not wish this naming—between those who deny others the right to speak their word and those whose right to speak has been denied them” (p.88).

He emphasized that the dialogic approach is neither a method to achieve the results one wants nor a tactic to make friends with students. Rather, it is an epistemological position (a stance). “Dialogue is the sealing together of the teacher and the students in the joint act of knowing and re-knowing the object of study” (Shor & Freire, 1987, p.14). Moreover, “through dialogue, the teacher-of-the students and the students-of-the-teacher cease to exist and a new term emerges: the teacher-student *with* students-teachers... They become jointly responsible for a process in which all grow” (Freire, 1970/2000, p.80, emphasis added).

2.5 Generative themes

Freire (1970/2000) also argued that the dialogical process did not “begin when the teacher-student meets the students-teachers in a pedagogical situation, but rather when the former first asks herself or himself *what* she or he will dialogue with the latter *about*” (p.93). In other words, the dialogic orientation began from the time the educator considered the content for the program, which “is neither a gift nor an imposition— bits of information to be deposited in the students—but rather the organized, systematized and developed “re-presentation” to individuals of the things about which they want to know more” (p.93).

A dialogic method, he insisted, began from students' description of their daily life experiences and moved towards rigorous understanding of reality. "The starting point for organizing the program content of education or political action must be the present, existential, concrete situation, reflecting the aspirations of the people" (Freire, 1970/2000, p.95), or people's thematic universe consisting of the complex of generative themes. It is in how people perceive reality, and their view of the world, in which their generative themes are found. Freire (1970/2000) called these themes generative because they "contain the possibility of unfolding into again as many themes" (p.102). These themes exist in a complex relationship with each other, for example, themes that are continental, regional, national, local, and so forth. Some themes, according to Freire, are in a dialectically opposite relationship to each other like the theme of domination and liberation.

2.6 Teacher's role

Freire recognized the importance of teacher's intellectual experience in identifying "an object for study before the students meet in the classroom, and in painting it or presenting it for discussion" (Shor & Freire, 1987, p.14). He said, "At the moment the teacher begins the dialogue he or she knows a great deal first in terms of knowledge and second in terms of the horizon that she or he wants to get to" (Shor & Freire, 1987, p.17). In other words, in suggesting a problem-posing dialogic approach based on generative themes, Freire did not dismiss the teacher's epistemological role. He said,

Precisely because there is an epistemology here, my position is not to deny the directive and necessary role of the educator. But I am *not* the kind of educator who *owns* the objects I study with the students. I am extremely interested in the object for study. They stimulate my curiosity and I bring this enthusiasm to the students. Then both of us can illuminate the object together. (Shor & Freire, 1987, p.15)

He indicated that the teacher has a responsibility to be directive as well as competent in the subject matter and insisted that the teacher bring his or her enthusiasm and interest in studying the subject to the students (Shor & Freire, 1987) and not deny his or her competence to students. “It does *not* mean that the educator first denies that he or she knows. It would be a lie, a hypocrisy. He or she has, on the contrary, to demonstrate his or her competency to the students” (Shor & Freire, 1987, p.16).

Freire’s view aligns with the Vygotskian perspective that emphasizes the importance of the teacher and sees

...the teacher-learner asymmetry as an essential component in the individual’s construction of knowledge and also sees the cultural knowledge brought by the teacher as inevitably involved in structuring the development of the learner’s knowledge in a direct way that is formative and positive. (Becker & Varelas, 1995, p.439)

Becker & Varelas (1995) suggested that one of the roles of the teacher is orienting students implicitly or explicitly to organized structures of knowledge, procedures, and goals achieved in a particular community.

Implicit orienting occurs when a teacher makes materials or situations available to learners to provoke empirical and/or mental activity around a particular question such as why some objects sink and others float but the teacher does not actually ask a direct question. Explicit orienting occurs when a teacher orients the student towards a particular issue by asking a direct question (e.g., why do some objects sink and others float). Such orientation constitutes ways in which the teacher’s pre-existing knowledge may influence the learners’ construction of new knowledge. (p.443)

It is this difference between children and adults knowing (everyday vs. scientific concepts, as Vygotsky termed it) that allows for the possibility of learning and development through assistance in the zone of proximal development. As Bartolini Bussi (1998) wrote,

Even if teacher and students are engaged in the same indivisible activity (the teaching-learning activity in the school setting), their functions are not the same. The roles they play in the drama are different. The teacher is not one among peers, but rather is the guide in the metaphorical “zone of proximal development.” (p.69)

Furthermore, keeping in mind the deep concern and sensitivity to issues of power in education, Becker & Varelas (1995) noted that emphasizing the role of the teacher does not immediately imply a threat to the possibility of autonomous thinking of the child. Instead, they suggested that researchers re-conceptualize other ways to comprehend the (implicit and explicit) role of the teacher’s pre-existing knowledge of the content while assisting the students learning of the same.

Thus far, I have outlined several ideas from critical pedagogy, critical mathematics pedagogy, and sociocultural theory to create a framework for my study. Critical pedagogy and critical mathematics pedagogy offer ideas for the politicization of the mathematics educational efforts beginning with generative themes and emphasizing a dialogic stance and method. Sociocultural theory gives insights into the co-construction of knowledge in joint activity between teacher and students mediated by tools and dialogue. It also suggests an important role for the teacher and the pre-existing organized system of knowledge in the community/culture.

2.7 Summary

In an attempt to bring together Freirean and Vygotskian viewpoints in learning, Trueba (1999) suggested,

In a genuinely Freirean pedagogy (knowing the word and knowing the world),

literacy is an essential instrument to reclaim control on one's own life and full human rights and dignity. In a Vygotskian theoretical framework, literacy is the essential link between the social and the cognitive worlds that permit children to grow intellectually, to learn and develop their talents and capacity; but to acquire literacy children need to enjoy full human rights and supportive relationships with "more informed peers" and with teachers. For both Freire and Vygotsky children need to know the world in order to learn the word. (p.611)

Building on this last statement, I have synthesized ideas from Freirean and Vygotskian views to develop a theoretical outline for this study that considers the critical math classroom as setting for joint activity (Figure 1). To summarize, two of the goals for this classroom were reading the world, whenever possible with mathematics (the sociopolitical/critical dimension), and reading the mathematical word (the mathematical dimension). The objects of investigation were generative themes from students' lives and social reality, and the mediating artifacts were the curricula, texts, video, and the interactions.

The dialogic stance and method was central to this joint activity from the beginning with the teacher identifying the generative themes in discussion with students (see chapter 3 & 4 for details). The participants in this activity (namely the teacher and students) had their specific roles in the classroom, and together develop a set of norms (rules) for interacting with each other and created a dialogic space to achieve the goals of reading the world and reading the mathematical word.

I used this framework as the basis for analyzing how the mathematical and sociopolitical dimensions arose, faded, and intersected with each other in the content, teacher and student acts, teacher pedagogical decisions, and norms that developed in this classroom. I investigated the "coherence between the general motives (or long-term goals) of the teaching activity and the decisions of the teacher about the tasks as well as the communicative

strategies adopted in classroom interaction” (Bartolini Bussi, 1998, p.67). In the next chapter, I describe the setting for this study and the methodology for this study. I also discuss possible methodological concerns in this study related to my role in the classroom, potential conflict of interest, and considerations of race.

3 RESEARCH METHODOLOGY

In this chapter, I elaborate on the research context, the types of data collected, data analysis process, and related methodological concerns. I begin by giving details of the school and community where this study took place. I position this research as qualitative with a critical stance and draw from methods in ethnography and discourse analysis. I also elaborate on the data sources and data analysis process and address some methodological issues.

3.1 Context, Entry, and Participants

Beginning Spring 2008, I was involved in curricular planning meetings for the M4SJ class with Rico and eight other graduate students. Rico was going to teach this class to seniors at Sojo during the school year 2008-2009. All students in this class were from the first graduating senior class and had been with the school since it opened in 2005 after a community struggle.

Community members had demanded a new neighborhood high school for years (the existing one was overcrowded), and when the district allocated funds (in 1998) but then reneged and built two selective, magnet high schools in wealthier, whiter communities, residents intensified the battle. This culminated in the victorious hunger strike in 2001. A new building was built in which four small, neighborhood schools opened in 2005 (Russo, 2003; Stovall, 2005), of which Sojo was one. (Gutstein, 2012a, p.28)

All four schools (namely Sojo; Multicultural Arts High School; Infinity Math, Science and Technology School; and World Languages High School) are open to any student living in Little Village or North Lawndale neighborhood. While each school has a separate building and functions independently, they share the auditorium, gyms, and lunchroom. Sojo has about 375 students almost all of whom are low-income with roughly 70% Latina/o, mainly

Mexican, from Little Village and 30% African American from North Lawndale.

Sojo's mean 2009 ACT [a standardized test for high school achievement and college admissions, originally an abbreviation of American College Testing] score was 16.8, just above the district average for neighborhood schools, and the school's first class (June 2009) graduated about 70% of entering 9th graders, well above Chicago's average (roughly 50%, Swanson, 2008). (Gutstein, 2012a, p.28)

Rico was part of the school's design team since 2003 and had worked with the team of mathematics teachers from 2005 when the school opened. He participated in mathematics classes and collaborated with students and teachers to develop and teach social justice mathematics curriculum. The school primarily uses the Interactive Mathematics Program (IMP, Fendel, Resek, Alper, & Fraser, 1998) curricula for mathematics teaching. From 2005 onwards, the mathematics teachers and Rico implemented several social justice math projects ranging in duration from 1-2 weeks. Examples of projects include simulating the wealth of the world, examining the mathematics of sweatshops, investigating probabilities in the jury selection of the Jena 6, and several others.

This class, however, was different. Instead of using IMP as the basis for mathematical learning and peppering it with social justice projects, the basis of this class was studying social reality. The year-long curriculum entirely used social reality as contexts for learning mathematics and mathematics as a tool for understanding these contexts. Students chose this class in their junior year from the three options available to them: M4SJ (only offered for 2008-2009), year four of IMP, or pre-calculus. Twenty-one students selected to enroll in this class, six were African American, 15 were Latino/a. 15 students were females (of whom four were African American), and six were males (of who 2 were African American).

Students in this class had a wide range of mathematical experiences. Some were mathematically competent, loved working on mathematical problems, and wanted to be math teachers (two in the class). A few of them came into this class with unpleasant experiences of learning mathematics and weak knowledge of basic mathematical ideas, and sometimes spoke of their disinterest in, and fear of, numbers and symbols. Despite these wide differences mathematically, students had several commonalities—their resilience, courage, perseverance, and sense of justice—which allowed them to contribute to and learn through this class. They were, after all, a) high school seniors in a school system in which 50% of students in neighborhood high schools drop out and b) students in the high school for social justice, that was born out of struggle.

Prior to and during Spring 2008, students and Rico met twice and had several other informal conversations to decide on the units of study. They narrowed in on five themes, namely, elections, displacement (gentrification, deportations, & immigration), HIV-AIDS in their communities, criminalization of youth/people of color, and sexism. Students suggested three themes (displacement, criminalization, and HIV-AIDS). Rico proposed two other themes (elections and sexism) and students accepted.

A group of nine graduate students (from UIC and University of Wisconsin-Madison), including myself met several times with Rico from January 2008–July 2008 to develop a curricular outline for these units. Rico, however, developed much of the curriculum for the class, on the go during the academic year. Starting September 2008, the class had four distinct segments—the elections unit spanned 11 weeks, followed by 13 weeks of the displacement unit, 7 weeks of the HIV-AIDS unit, and finally 7 weeks of the criminalization unit, community presentation preparation, graduation, and class wrap-up. Due to time constraints, students and Rico decided to integrate the theme of sexism into the HIV-AIDS and criminalization units (see Chapter 4 for this decision and a description of all units). The

mathematical content for this class included algebraic and quantitative reasoning, data and statistical methods, probability, discrete mathematics, and pre-calculus.

In summer 2008, I expressed interest in continuing my engagement beyond the curriculum planning meetings and proposed to do my dissertation study in the classroom as a participant observer. In addition to the academic requirements, I had two more reasons to continue my participation. First, given my engineering background, I felt I could contribute mathematically during the academic year to the class and in my interactions with the students. Second, I wanted to understand the complexities of enacting critical math pedagogy.

I received permission from both the principal and the students to be in the class¹⁰ (see point 5, Appendix D) as a participant observer and do my dissertation study based on this participation. I was in the classroom for the entire academic year (September 2008–June 2009). My dissertation study was a part of a larger collaborative, participatory, critical action research project designed around the mathematics program at Sojo. The team included the teacher (Rico), those students in the class who elected to be a part of the Crew¹¹, Patricia Buenrostro (another UIC doctoral student), three full-time math faculty at Social Justice High school, and myself.

I was involved in several ways in this class for the entire academic year (September 2008–June 2009, a total of 38 weeks, except 4 weeks of the displacement unit). In addition to my role as a researcher, I was a participant observer in and out of class for the duration of the entire year and had frequent, almost daily, discussions with the teacher about classroom

¹⁰ On the first day of class, Rico asked students for permission to let Patricia Buenrostro and myself to be in class to study with them and the processes in the classroom (See Appendix D). This was consistent with the political framing of this class where teachers and students shared power and authority to create a dialogic space and made several collective decisions (Chapter 6).

¹¹ Nine out of 21 students from the class were or had been a part of the “Crew” at one time or the other since joining Sojo as freshmen. Seven students were in the crew most of senior year. The crew provided a space for students to reflect on their learning experiences and have input into Sojo’s mathematics program. Rico and students in the crew met many times every year for collective reflection and to prepare for conferences and workshops.

observations and his pedagogical directions and decisions. I also developed one-on-one relations with individual students and tutored them after school for ACT preparation. The collaborative research team collected a wide range of qualitative data (described later in this chapter) and I was involved in deciding what data to collect, when, and how.

3.2 Qualitative Research

This study was based on a qualitative approach, drawing from methods in both ethnography and discourse analysis. As I describe below, these were consistent with the conceptual framework I developed (Chapter 2) and helped address my research questions.

Ethnography focuses on studying people's practices and uses methods such as participant observation, interviewing, researcher field notes, and so on to give an interpretive account of how people make meaning of their lives (Anderson-Levitt, 2006). It looks in-depth at the "culture" of a group of people. Culture, as referred to here, is not an object but a set of practices and processes that group members engage in, share, create, change, and/or re-create. Ethnography can additionally include a study of the material and social conditions of the people, and the structure and organization of the group. Defining the "field" of study is an important part of ethnographic research. The field can be a location, a group of people bound by certain characteristics, a persona, an activity, or simply any social situation.

I used the classroom as my field. The choice of ethnography was appropriate for this study as it helped me interpret the classroom interactions in all its complexity and the ways in which students and teacher participated in these. It also helped elaborate on the finer details of the processes in this classroom that supported the interweaving of mathematical and sociopolitical dimensions. Although using ethnographic methods requires some degree of participation in the field to comprehend the "insider's" perspective, it is also necessary to distance oneself in order to notice what "insiders" may not notice. Anderson-Levitt (2006) suggested recording observations by writing on the spot, making distinctions between

“accurate and detailed description, on the one hand, and interpretive comments on the other” as some techniques to “distance ourselves as observers” (p.286). While still in the midst of fieldwork, I periodically read field notes, and discussed with Rico and students to clarify my interpretations as an observer and understand participant interpretations.

The other research methodology I used in this study is discourse analysis, which examines interactions between people (and text), and how participants influence and are influenced by these interactions (Bloome & Clark, 2006; Johnstone, 2002). The first requirement for discourse analysis is a unit of self-contained “text,” such as a letter, student journal, or a teacher journal. Non-written discourse (audio, video) can be analyzed as well by recording and transcribing it in order to give it some semblance of a written text. However, recording and transcribing involves choices about how to record, whom to record, “how to entextualize, how to select and delimit chunks out of the flow of life, make these chunks into texts, and treat them analytically in much the way we have traditionally written texts” (Johnstone, 2002, p.19). While analyzing transcribed discourse or written text, I focused on how the text provided insight into the processes of interweaving the mathematical and sociopolitical dimensions in this classroom and not on its linguistic aspects. Consequently, I did not transcribe in a way that would give visibility into the linguistic structure of the conversations.

Along with the interpretive stance of qualitative research, I took a critical stance in this study. This critical orientation recognizes a) the dialectical relationship between the social and structural constraints on human actors and the relative autonomy of human agency (Anderson, 1989, p.249), b) that social practices are saturated with relations of power (both oppressive and liberatory), and c) that any attempt to participate, observe, analyze, and interpret aspects of a social practice is inherently a political act. It is indicative of my activism and commitment to recognize and analyze the dialectical relation between power

and oppression and engage in action towards social change.

Both a qualitative and critical orientation call for multiple forms of reflexivity to maintain trustworthiness of the narrative so that the “critical framework does not become the container into which the data are poured” (Anderson, 1989, p. 254). Foley (2002) offered two ways of being reflexive, first by considering the relation between data and theory, and second by reflecting on the relationship between the researcher and the researched. Anderson (1989) proposed two more forms of reflexivity—self-reflexivity (reflection on the researcher’s biases) and dialectic reflexivity (reflection on the dialectical relationship between structural/historical forces and human agency). Below, I discuss the ways in which I have tried incorporate these during data collection and analysis.

Data-theory reflexivity acknowledges the dialectical relationship between data and theory—that is, while data informs theory, previously generated theory influences the data generation itself. Throughout this dissertation, I tried to make visible any theory and literature that influenced my entry into this class, the data collected, and the process and outcome of the analysis. Additionally, I also tried to be conscious of intertwining theory and data for more clarity and theorizing from the data available in my analysis and writing.

Lather (1986) described the relationship between the researchers and researched as one of reciprocity, with the intention that research is transformative rather than exploitative. My role as participant observer was essential to this research being critical, transformative, and in solidarity with the researched. I often engaged in discussions with Rico (the teacher, one of the researched, and my thesis advisor), and at times with the co-researcher during the analysis and writing. At the same time, this product of this research is my dissertation and involves primarily my analysis, interpretation, and writing, rather than a full engagement of the students, teacher, and other members of the collaborative team at every stage.

Throughout this process, I sought to be reflexive of my own biases and ideologies (self-reflexivity) by writing memos, and describing emerging themes in the data. Discussions with my chair/advisor also helped maintain researcher-researched reflexivity, self-reflexivity, and dialectical reflexivity, since I often needed more background than what I knew, to form (transformative and appropriate) interpretations.

In summary, I have used a qualitative approach borrowing from ethnographic and discourse analysis methods in this study. This allowed me to investigate the dialectical relationship between the sociopolitical and mathematical dimensions of critical math pedagogy as seen in teacher-student interactions. The methods from ethnography helped with participating, observing, and recording the practices in this classroom. Analyzing the discourse in this classroom gave insights into the the interweaving of mathematical and sociopolitical dimensions in teacher and student utterances, and the role of the teacher in this interweaving. Further, it gave visibility into the dialectical interconnections between the long-term goals of the teaching activity (two of which were reading the world, and reading the mathematical word) and a) the decisions of the teacher about the tasks and b) practices of the classroom (Bartolini Bussi, 1998) and beyond that, to tease out the mutually constitutive and influencing relationships.

3.3 Data Sources

Throughout the duration of this class, I was intimately involved in making collective decisions about what data to collect, when, and how. I had access to (and used in my analysis) a wide range of data that we (the teacher, co-researcher, and I) collected during the 2008-2009 school year. Table 1 gives a summary of the different data we collected.

- Audio and video: During the year we audio-recorded classroom interactions on days that I was present in the classroom. We video-recorded occasionally on specific days predetermined by the teacher. The decision to record video was

based on several factors such as the content for that day, whether students were presenting their work, and the time elapsed since the last video recording.

Towards the end of the academic year, we decided to video-record the classroom interactions of the entire HIV-AIDS unit. Additionally, we videotaped the two community presentations (Chapter 4) and student presentations at several conferences. Since I decided to analyze the HIV-AIDS and elections unit (see the next section of this chapter for details on this decision), I used video data from 40 class days from both units together (16-17 hours), and audio data from 19 days of the elections unit (8-9 hours), although some were not the entire 50 minute period.

- Researcher field notes (RFN): On the days I was in class, I wrote field notes based on my jottings of student and teacher interactions, the topic of conversation, and other discussions with students and the teacher outside of the classroom. The field notes also included conversations I had with the teacher about the curriculum, pedagogy, and student and classroom interactions. In writing my field notes, I followed a style that interspersed observation and commentary in order to capture the “interconnections between participating, writing, and observing as a way to understand another way of life” (Emerson, Fretz, & Shaw, 1995, p.19), and made them interactive, descriptive, and interpretive. I frequently read the field notes and wrote interpretive memos to help make changes with respect to structure, writing style, focus, and content. For the purpose of my analysis, I used 24 field notes from the election unit and 23 from the HIV-AIDS unit.
- Teacher journal (TJ): The teacher recorded reflective journals after almost every class and wrote occasional memos. These included among other things his daily reflections on student interactions, content, and pedagogy. In my analysis, I used 35 teacher journals from the elections unit and 20 from the HIV-AIDS unit.

Table 1: Distribution of main data sources by type across the two units

Researcher Field Notes	Teacher Journals	Video & Audio	Student Work	Miscellaneous
24 from elections unit	35 from elections unit	16-17 hours of video from the two units	2 Surveys, unit projects for the two units, Op- ed piece, and community presentation PowerPoint	20 Classwork Assignments
23 from HIV- AIDS unit	21 from HIV- AIDS unit	8-9 hours of audio from the elections unit		15 Journal Assignments Several news articles, video clips

- Work produced by students such as homework, class work, tests, quizzes, journal assignments,¹² unit projects, a collectively written op-ed piece to the Huffington Post (an internet newspaper with news, blogs, and video, see Appendix C), and an 81-slide PowerPoint presentation students prepared for the purpose of the community presentation. Students also completed two surveys (one in December 2008 and another in May 2009) where they answered several questions related to this class, the teacher, and what they were learning. I used some of this data as required to clarify and extend my analysis.
- Other sources of data (not all of which I used) include all the curricula, some cellphone text conversations between students and teacher, data analysis session notes, the notes of curriculum planning sessions in Spring 2008, focus group interviews, student presentations, miscellaneous student writings, and feedback from individuals outside of class on classroom observations

¹² Journal assignments (see Appendix D) were an integral part of this class. These assignments often had two parts and Rico responded at length to students' writing. In part one, students read and tried to understand news articles mathematically and sociopolitically, and raise any questions they had. In part two, Rico asked students for their thoughts on what they were learning in class, for example, if this class was helping them, how he could support them better, the processes in class, the content they were covering in class, and how to support them to go to college. See Appendix B for an example.

3.4 Analysis and Interpretation

For the data analysis process, I borrowed from techniques described by Emerson, Fretz, and Shaw (1995), and Corbin and Strauss (2008). Both draw from “grounded theory” and give priority to developing analytic propositions from data collected instead of simply coding based upon pre-determined analytic categories. The analysis of data occurred in two phases—during and after completion of fieldwork. The first phase of the data analysis occurred during the academic year and involved an ongoing jotting of analytic notes and questions to follow-up in my field notes. In addition to periodically reading my field notes, I read student work and surveys, and transcribed and analyzed some of the audio and video data (a total of about 2-3 hours across 8-10 days of the entire year). We (the teacher, co-researcher, and I) also met three or four times to analyze some data such as student work, video, field notes, and curricula. This phase of data analysis was less intense and less comprehensive as compared to the next phase.

Once the academic year ended, the in-depth phase of data analysis began, based on my initial research questions. I first made the decision to examine the data from the Elections unit and the HIV-AIDS unit because I was present in class for most part during these two units (out of the four distinct segments for this class mentioned earlier in this chapter). Several interesting events took place outside the time spanned by these two units, and the rest of the year was likewise rich and representative of the ways in which the teacher and students co-constructed the classroom and interwove the mathematical and sociopolitical dimensions.

Next, I sifted systematically through the data to identify threads that could be woven together to produce a coherent analysis in response to my initial research questions. In light of the evidence I could gather from the data that we collected, to which I had access, my research questions also underwent some changes. I used the Atlas.ti qualitative data analysis software (www.atlasti.com) to help me in the process of coding, comparing, and questioning

(Corbin & Strauss, 2008). The software program assisted with keeping track of generated codes in several rounds of coding, revision of coding, and finally, with sorting data for coded instances.

I began with a close reading of the field notes, curricula, and relevant student work available to get a sense of the entire classroom as it evolved over time in the two units. This gave a sense of the macro level flow of each unit that I describe in Chapter 4. I then created a log for video and audio data describing what each day was about and sections of the video/audio highlighting sections that could be investigated further. Based on the reading of the field notes and the audio and video logs, I subsequently identified key classroom events/days for both the units (13 for the elections unit and 12 for the HIV-AIDS unit) and viewed/listened more closely to the audio or video, if available for those days.

I followed it up with *open coding* of a subset of researcher field notes and teacher journals. A few examples of codes included “teacher notes student contributions,” “homework norms,” “teacher struggles,” and “students ask question about math”. I then created categories by combined similar codes. For example, “math content” was a category that included the codes such as “binomial distribution” and “poll difference.” I continued to add codes during a second round until I was confident that the coding scheme I had generated was exhaustive, and I was no longer generating new codes. This was followed by a second stage of a finer analysis using *focused coding* based on categories relevant to my research questions.

Following this, I reviewed the coded instances using Atlas.ti and looked for patterns and relations within and across related codes and categories. During this phase, I tried to triangulate my analysis across data sources. I viewed the video, or listened to the audio for the relevant days again, re-read student work, surveys, presentations, and curricula as the patterns appeared in the analysis of the field notes. I wrote descriptive memos for the

emerging categories, and integrative memos to clarify and link the categories and codes. I also went back to the data to compare different pieces in order to “differentiate one category/theme from another and to identify properties and dimensions specific to that theme/category” (Corbin & Strauss, 2008, p.73) and to ensure that my own outlook was not narrowing my view of the patterns in the data (Emerson et al., 1995).

After identifying these patterns, I did two things. I began to select illustrative cases from the data and began writing descriptive memos on these, which I used later in writing this dissertation. I selectively transcribed portions of the audio/video data to formulate and elaborate on the patterns emerging in the coding (Emerson et al, 1995). I chose clips based on their relevance to my research questions, the emergent coding categories, and what they made clearly visible. While I have listed these as discrete and linear steps, the process of data analysis was non-linear and involved shifting between reading, coding, transcribing, and writing whenever I felt saturated with whatever I was doing at the moment.

Throughout this process, I was aware that the choices I make about what data and data source to include (and exclude) in my analyses influences the conclusions I draw. Similarly, I recognized that texts are not separate and self-contained units but are rather connected to other texts and contexts that influence their interpretation and analysis. Therefore, in my analyses I strived to look across multiple sources of data several times to reflect on the connection therein.

I also recognized that this process involved reconstructing other’s voices and making interpretations. I also tried to be cognizant of tensions between my interpretations and that of the participants (students and the teacher). This was particularly important because participant interpretations were influenced by past and current events and interactions outside of the classroom in which I might not have participated.

The task for researchers interested in the meaningfulness and import of any educational event is to build a data-based argument in ways similar to which interlocutors would use to assign meaningfulness yet knowing that meaning is indeterminate, multiple, and not necessarily fully shared among the interlocutors. (Bloome & Clark, 2006, p.235)

I strived to be sensitive to member-recognized meanings by being reflective of my choices of data sources, units of analysis of discourse and methods for transcription; representing data in different ways (like transcripts, narratives, teacher/researcher notes, student work); engaging in collective data analysis sessions with the teacher and students; being open to changing my interpretations in light of additional background information from participants; and triangulating between different data sources and different data takers (Bloome & Clark, 2006; Eisenhart, 2006; Gravemeijer, 1994).

3.5 Methodological Issues

1. Participant Observer Role: My role in this project ranged from participation in developing a curricular outline, discussions with the teacher on pedagogical aspects, student support in and out of class, and research. My decision to be a participant observer for the entire duration of this class was both personal and related to the research-design. The theoretical framework and the qualitative and critical stance of this study required me to go beyond the dichotomous relation between a subject-object and an observed-observer and recognize that the researcher's presence changes the situation and the researcher, and that some interaction is required to interpret how people make sense of their lives, situations, and practices. Furthermore, being a participant observer seemed for me an act of solidarity in this situation and a way for me to be transparent of my intentions with the teacher and students.

When in class, I tried to be cognizant of my role that was sometimes at one end of the

participant-observer continuum and at other times somewhere in between. There were instances when being a participant became more necessary than being an observer and vice versa. Likewise, my participation took different forms such as being present in class, working with students in groups during class, after school, at meetings outside of school, and so on. Since I did not share the lived experiences of the teacher and students, and the (implicit) common knowledge that existed between them, there were instances I interpreted differently subject to my knowing or not knowing of it. I often discussed my interpretations with Rico and was open to changing them in light of his response.

I tried to remain cognizant of my subjectivity at every step and tried to find ways to hear multiple voices. For example, I had informal discussions with students and the teacher about certain instances in the class to better comprehend what had occurred. The joint data analysis sessions with some of the students, the teacher, and the co-researcher also brought in interpretations from multiple viewpoints, and helped me to understand the events better.

2. Teacher-Chair Conflict – My committee chair, Rico Gutstein, was the teacher of the class where I collected data for my dissertation. This may raise some questions with respect to the rigor and credibility of this study. Before I address this concern, I point out that a potential conflict of interest can arise in any advisor-advisee relation. I offer the following perspectives to mitigate concerns that may arise with respect to this study. First, the framing of the research in terms of critique, questioning, and dialogue were the guiding principles in our interactions as well. This meant that we were critical, open to “uncertainties,” and meaningfully negotiated disagreements that arose. While we did have some areas of disagreement between us during the dissertation writing process, we resolved them through dialogue without the use of power vested in the Chair of the committee. Second, given the critical framing of this study, both Rico and I took this up

as an opportunity for learning what worked and what did not. Rico often expressed his discomfort about analyzing his teaching and I could only imagine how difficult his position was. Despite this, we were able to step back from any personal judgment of data and look at it analytically. Third, the committee has also served as independent readers to ensure rigor and credibility of this study in addition to the inbuilt mechanisms of reflexivity as described earlier. Finally, another way to consider his role in my thesis writing is of participant engagement, since he was involved in reviewing my interpretation of the classroom in which he was a (key) participant. He provided a much necessary participant voice during data analysis.

3. Situating race in the study: As a person who grew up in India, I was aware of the construct of caste (historically, culturally, sociopolitically, etc.). This helps me situate issues of inequity within a broad framework and be sensitive of the underlying issues of power—as related to class, caste, gender, or race. A strength that I brought was to view race within this broad global perspective of inequities and somewhat as an outsider (as a temporary immigrant to the United States, a woman of color, and a non-native speaker of English). I was also conscious of the prominence of race as it pertains to this class, the teacher, and students. I often made efforts to comprehend the ways in which race and racism were a part of conversations in and outside the classroom and to make connections to the history of racism in the United States. Nevertheless, my understanding of race was different (and perhaps somewhat limited) compared to another person from this country, such as my co-researcher Patricia Buenrostro. This was indeed a process of learning for me, and I neither found it appropriate nor felt confident and prepared to unpack nuanced aspects of race in this study. Whenever possible, with my limited understanding, I included an analysis of situations related to, or influenced by race, that surfaced in interactions between students (all Black/Latino/a) and the teacher (white).

3.6 Summary

I started this chapter with a description of the context for my study, and proceeded to position this study as qualitative and interpretive with a critical stance, borrowing from ideas and methods in ethnography and discourse analysis. I described the sources of my data and the process of data analysis. I ended with a discussion of some of the methodological issues in this study. In the next chapter, I give an overview of the units studied in this classroom with an emphasis on the elections and HIV-AIDS unit, the two units that I focus in my study. I also describe the mathematical and sociopolitical complexities that surfaced (independent of each other) in these two units.

4 CURRICULAR OVERVIEW

People might think math is too hard or is overwhelming, but the key is if a person knows math and knows what they're talking about we can fight many issues. (Student response, mid-year survey)

In this chapter, I give an overview of the generative themes studied during the academic year and the main mathematical and sociopolitical ideas in each unit. I specifically focus on the Elections and HIV-AIDS unit and give a week-by-week account of the main events in class during these two units. Further, I discuss the complexities of the mathematical and sociopolitical content that came to the fore in the classroom interactions in both units. As Frankenstein (1998) says, "Real life is messy, with many problems intersecting and interacting. Real life poses problems whose solutions require dialogue and collective action" (p.307). Before I get into the description of each unit, I give a summary of how the generative themes were identified.

4.1 Context drives the curriculum

The contexts for investigating social reality in this class came from informal surveys, interviews, focus groups, discussions with students, and from current issues/events meaningful to their lives. In October 2006, when Rico and other teachers at Sojo held focus group sessions with students about topics they wanted to study and understand, students mentioned HIV-AIDS, neighborhood displacement (gentrification), and immigration. Further, in Spring 2008, Rico met twice with the students who selected the class and had several informal conversations to identify themes for the units of investigations. During these conversations, one student suggested studying the criminalization of youth of color/people of

color because of personal connections to this theme, and Rico proposed two topics – Elections and Sexism.

Rico put forward the theme of sexism for two reasons. One, because the K-12 literature indicated that classes rarely study it, and two, because the class was majority female (15 out of 21 students), he wanted to build on, support, and be relevant to, students' identities. He also recommended studying statistical anomalies related to the 2004 presidential election to be prepared for the upcoming 2008 presidential election (Gutstein, 2012a). Subsequently, students and Rico narrowed on five generative themes of study for this class (elections; displacement, which included gentrification, deportation, and immigration; HIV-AIDS in their communities; criminalization of youth of color/people of color; and sexism).

As I mentioned in Chapter 3, the curriculum development team (Rico and nine graduate students from UIC and University of Wisconsin-Madison, including myself) met several times in the period from January 2008–June 2008. In these meetings, we tried to identify what (challenging) mathematics could be learned within these generative themes to understand them better and, how studying these themes could provide opportunities and motivation for learning the challenging mathematics required. Rico used other smaller contexts (sub-contexts) throughout each unit to facilitate the learning of mathematical ideas.

To an extent, preliminary work such as developing an overall plan, bolstering one's mathematical knowledge as required, identifying resources to use in the classroom, etc., are essential components of preparing to teach any class. That said, creating a curricular framework and a curriculum for this class was not trivial, since there are no known guidelines available (to the best of my knowledge) for doing so when learning to read the world and read the mathematical word based on generative themes. In addition to the preliminary work done for this class, the teacher developed much of the curriculum on the go.

This class had four distinct segments. The election unit lasted 11 weeks and segued into 13 weeks of the displacement unit, followed by 7 weeks of the HIV-AIDS unit. For the remaining 7 weeks of the academic year students worked on preparing for the community presentation and the criminalization unit. Towards the end of the displacement unit, Rico and students collectively decided to integrate the theme of sexism into the HIV-AIDS and criminalization units. Here I briefly share the process of this collective decision. Refer to Chapter 6 for a detailed discussion on the feature of making collective decisions in this class.

On the last day of the displacement unit (2/27/09), Rico asked students to do some free writing to tell him what they were interested in and committed to doing in the limited time that remained (14 weeks). He laid out details of three other units they had originally planned to study for this year (viz., HIV- AIDS, sexism, and criminalization), their potential interconnections, and the mathematical ideas involved (RFN, 2/27/09). Students wrote for a few minutes and handed their responses to Rico, which he summarized the next day. Most students wanted to work on the criminalization unit. Responses split equally between HIV-AIDS and sexism, and most students were willing to roll sexism into the criminalization and HIV-AIDS units. So he suggested that they start with the HIV-AIDS unit, follow it up with the criminalization unit, and weave the role of and the effects on women within these two units, and students agreed to this (RFN, 3/3/09).

Next, I give an overview of the displacement and criminalization units, and the community presentations, followed by a description of the Elections and HIV-AIDS units—the two units that I chose to analyze in this study.

4.1.1 Displacement Unit

The displacement unit lasted 13 weeks and focused on a mathematical and sociopolitical understanding of the forces that push people out of their communities—gentrification and foreclosures in North Lawndale, foreclosures in Little Village, migration

from Mexico to Little Village, and reverse migration from Little Village to Mexico due to deportation from the U.S. Some of the mathematical work that students did included predicting housing prices using linear regression; comparing price predictions with actual prices; recognizing the limits of mathematical modeling; solving difference equations to calculate payment on various types of housing loans and mortgages (including predatory loans); calculating the price of “affordable” housing; interpreting graphs and data related to median housing income and median housing values; calculating the amount of corn subsidies to farmers in the US and Mexico; interpreting data related to prices of corn and tortillas; and cubic regression for predicting immigration trends. All students in class had graphing calculators available for the entire academic year and this greatly facilitated the mathematical work they could do in class in all the units.

Sociopolitically, the emphasis of this unit was to understand the similarities between the forces (gentrification, deportation, and foreclosures) that drove people out of their communities in both Little Village and North Lawndale. Monica, a Latina student, had the following to say about the connection between the forces that displaced people in the African American and Latino communities, in her final assignment for the displacement unit:

In both communities [African American & Latino], people are being forced out of their homes. Of course, it is different situations but similar causes. African Americans are being forced out of their homes because they cannot pay their loans. The taxes go up so much that they cannot afford to keep living in those communities. So they are forced to look for another place to live. For Mexican people the problem is that they don't have jobs in Mexico because the corn isn't being sold, because it is cheaper to import subsidized US corn than to grow their own. That forces Mexicans to leave their family and homes to come to the US to look for a job. This is how the unit connects. They face similar situations but different causes. (Video, 4/13/09)

4.1.2 Criminalization Unit

The criminalization unit was brief (2 weeks) compared to the other units. Instead of developing a plan for this unit, Rico asked students to “collectively figure out what mathematics they would need to make sense of what is happening with respect to criminalization and how they would connect the mathematics with the critical and sociopolitical awareness” (RFN, 4/27/09). He shared information about incarceration and crime rates, crack versus cocaine possession laws, and handed out several articles related to this theme. He asked them to dig into the sheets that he gave and to pull out the mathematics they saw and think of what more they wanted to find out or learn (RFN, 4/27/09).

Mathematically, students discussed the disparity in the crack and cocaine possession laws and its effect on people of color and the disproportional incarceration rates for men and women of color in US prisons, and compared the number of people incarcerated in the US to the rest of the world.¹³ Students used the rest of the time available during the academic year to prepare for presentations in the two communities of North Lawndale and Little Village. Due to various reasons such as time constraints, the pressure of exams, and the excitement of graduation, students did not explore the role of, and effects on, women in this unit, although Rico and students had collectively agreed to do so.

4.1.3 Community Presentation

As an effort to write the world (or act on the world), teacher and students had considered presenting their work in the community while they were identifying generative themes. The syllabus for the class laid out two community presentations, one after each semester (see Appendix D), but students only made one community presentation at the end of the year. In Chapter 6, I elaborate on the collective work done by students and decisions they made leading up to the community presentation. Here I give a brief overview of the decision

¹³ According to a New York Times article, *Inmate Count in U.S. Dwarfs Other Nations*, “The United States has less than 5% of the world’s population. But it has almost a quarter of the world’s prisoners” (April 23, 2008).

on the topics to include. Ann suggested that they focus on the displacement and AIDS unit and probably draw on the criminalization unit, but leave out the elections unit.

Ann: I think that we should present on the displacement unit and then the AIDS unit and tie them in together and if we want we can draw on the criminalization unit [Carlton or someone says no]. Just tie in how they all connect and what are similar factors in how those things happen. But for the elections unit, I don't think we should talk about that. I think that should just be like a quick sentence like about what we did. (Video, 4/30/09)

Roxanne added to it by saying, "That's why I said just hand them the thing [the op-ed piece that the class collectively worked on] we did." Rico suggested that they could include the elections unit to build on the intuitive knowledge of the impossibility of an event with 10 heads and 0 tails occurring in 10 coin tosses. Students, however, felt that it was sufficient to talk about the work they did in the displacement, HIV-AIDS, and criminalization units (with an emphasis on sexism). They decided to leave out the work done in the elections unit and unanimously agreed that it would suffice to share the English and Spanish version of the op-ed piece to inform people of the work they had done (RFN, 4/30/09).

In groups of three to five, students prepared presentation material on one of the following topics: HIV-AIDS, criminalization, gentrification, mortgages, and immigration and deportation. Amidst the excitement and stress that surrounded the last few weeks, students prepared an impressive 81-slide PowerPoint presentation. Each section ended with a conclusion summarizing the main ideas for that topic.

For example, the section on mortgages concluded as follows:

We as a people need to inform ourselves and others about these predatory loans. We should be conscious about the decisions we make when dealing with the banking system. People need to be educated on this matter. Some ways we could make this happen is by doing workshops, understanding the fancy writing, using internet sources and mortgage calculators to your advantage.

The section on HIV-AIDS, that I describe next, ended as follows:

- Women of color are proportionally more impacted than white women
- People of color are more proportionally impacted than whites
- Young people of color are hit harder than older people of color, compared to whites
- Social forces—racism, sexism (“survival sex”), poverty—strongly influence the data!

4.1.4 HIV-AIDS Unit

The HIV-AIDS unit lasted 7 weeks of the academic year and had 25 classes of fifty minutes each, after accounting for school holidays, days of non-attendance and teacher professional development. (Sojo had only 4 days of core academic classes per week as students and teachers followed a different academic schedule on Wednesdays.) I was present for 23 class days. The purpose of this unit was to support students in understanding the HIV-AIDS epidemic in their communities and Chicago, through mathematical and sociopolitical analysis. Rico and two graduate students from the curriculum development team contacted health professionals and researched medical journals to get more information related to the

spread, prevention, and treatment of HIV-AIDS and to develop a curricular outline for this unit.

Based on these efforts, the plan for this unit was for students to model the spread of the disease and create a system of difference equations that would represent the situation in their communities. To model the spread of HIV-AIDS, teacher and students used *discrete dynamical systems*¹⁴ (DDS), which students had used in the previous unit to study mortgages. Students also shared their initial ideas about HIV-AIDS— the disease and its spread, and read the second chapter (henceforth referred to as the myths chapter), titled “Myth two: Dangerous Behavior,” from the book *Global AIDS: Myths and facts* (Irwin, Millen, & Fallows, 2003). They also saw a short video clip called *Russian Roulette* performed by a Hip Hop Group known as APOSTLEZ hailing out of St. Louis, MO, portraying the importance of HIV-AIDS awareness. I give a week-by-week overview of this unit in Table 2.

Mathematically, students worked on the following: creating a DDS with one and two variables; finding equilibrium values (algebraically and graphically); creating a DDS for disease spread (SI models¹⁵); simulating disease spread using DDS on calculators; interpretation of graphs, statistics, pie charts and other visual representation of data; proportionality and disproportionality; and prediction using linear and cubic regression. The sub-contexts used included the following: a farm where trees were being periodically cut and replaced at a certain rate (henceforth referred to as the trees sub-context); a rental car system between Chicago-Milwaukee; the human body blood-liver system; and data on HIV-AIDS infection and spread in Chicago and United States (see Appendix A for details of sub-contexts used in the HIV-AIDS and elections unit).

¹⁴ Discrete dynamical systems can be used to model and analyze many real-world problems such as population growth, compound interest and annuities, radioactive decay, pollution control, and medication dosages.

¹⁵ SI models are simple models that use two variables (each representing the susceptible and infected populations) to simulate the transmission of a disease. Later on, students developed a model using three variables - the susceptible population, population infected with HIV population, and population with AIDS.

Table 2: A week-by-week overview of the HIV-AIDS unit

Week 1	<ul style="list-style-type: none"> • Review of Discrete Dynamical Systems (DDS) with one variable. • Discussing what HIV-AIDS is and how it spreads. • Reading and discussing an article from a local newspaper about the forced resignation of the principal of their school. See Chapter 6 for more details.
Week 2	<ul style="list-style-type: none"> • Solving DDS with two equations graphically and algebraically to find equilibrium values. • Creating a DDS for the amount of Vitamin A in the Blood-liver system • Rico bringing in news about student loans.¹⁶
Week 3	<ul style="list-style-type: none"> • Finding a solution to the blood liver system algebraically and graphically. • Modeling disease spread using SI models. • Reading the myths chapter from <i>Global AIDS: Myths and facts</i> (Irwin, Millen & Fallows, 2003).
Week 4	<ul style="list-style-type: none"> • Summarizing and presenting sections read from myths chapter. • Watching the video <i>Russian Roulette</i> by APOSTLEZ. • Interpreting HIV-AIDS related data and graphs from the PowerPoint sent by Yaa Simpson, a local HIV-AIDS activist and epidemiologist.
Week 5	<ul style="list-style-type: none"> • Using linear and cubic regression to predict number of new HIV-AIDS cases with data from previous years. • Simulating change in SI systems and finding state of equilibrium.
Week 6	<ul style="list-style-type: none"> • Rico sharing his reflections on the class so far and how best to use the last 8 weeks of the academic year to support them in reading the world with mathematics. • “Crew” goes to AERA conference and shares presentation with entire class on returning. • Completing work on SI systems.
Week 7	<ul style="list-style-type: none"> • Working on disproportionality in preparation for community presentation. • Interpreting data on infection and death rates in their communities.

Sociopolitically, a key focus of this unit was to get students to think about social forces, in addition to individual behavior, as a factor that influences the rates of HIV-AIDS spread, infection, and recovery. The theme of sexism was also integrated into this unit in two ways. First, Rico pushed students to develop a sociopolitical analysis of why Black women had significantly higher HIV-AIDS prevalence rates nationally as compared to white women, 18:1 for the year 2006 (Centers for Disease Control and Prevention, 2006), instead of demonizing them for the same. Second, students looked at how various social factors such as cultural attitudes, gender roles, and economics, implicitly or explicitly, limited women’s

¹⁶Bringing in news articles relevant to the generative themes and student lives was a regular feature of this class (Chapter 6).

individual choices for safe sex practices. (I discuss the second point in detail later in this chapter and the first point in the next chapter). Towards the end of this unit, students considered how to present the work done in this unit in the community presentations. Rico also distributed a final take-home exam for this unit.

4.1.5 Elections Unit

The Elections unit covered 11 weeks of the academic year with 36 classes of fifty minutes (due to school holidays, days of non-attendance, and teacher professional development). The central question of this unit was whether the 2004 presidential election was stolen. The goal was to investigate and understand the evidence (mathematical and sociopolitical) to argue for the possibility of fraud in the 2004 elections (in preparation for the upcoming 2008 Presidential elections). Most of the mathematical evidence was based on the arguments made in the book *Was the 2004 presidential election stolen?* (Freeman & Bleifuss, 2006). The sociopolitical content came from the movie *Uncounted* (Earnhardt, 2008), *Stealing America: Vote By Vote* (Fadiman, 2008), and several assorted newspaper and magazine articles. Students watched clips from *Uncounted* (Earnhardt, 2008) in class and a number of them borrowed both movies, watched them fully, and reported on what they saw. I give a week-by-week overview of this unit in Table 3.

Table 3: A week-by-week overview of the Elections Unit

Week 1	<ul style="list-style-type: none"> • Asking students if the 2004 Presidential elections were stolen and evidence for it. • Discussing Ohio exit poll data and the ideas of poll, sample, survey, exit polls, representative sampling, opportunity sampling. • Revisiting mathematics of Jena 6 and 3M3F sub-context.
Week 2	<ul style="list-style-type: none"> • Solving the problem of “how many combinations” in Jena 6 and 3M3F sub-contexts using nCr (n choose r). • Multiplying probabilities – why. • Introducing coin toss sub-context, using tables and probability trees to solve various problems.
Week 3	<ul style="list-style-type: none"> • Replacement vs. non-replacement and its effect on probability values in cubes and Jena 6 sub-contexts. • Using combinatorics (instead of tables or trees) to find the number of favorable sequences and the probability of getting a particular sequence in Jena 6 and coin toss sub-context. • Connecting units with a news item on a move to disenfranchise people whose homes have been foreclosed and convicted felons in some states.
Week 4	<ul style="list-style-type: none"> • A conversation with students to get a sense of how this class was going. • Using a sub-context of 15 and 50 coin tosses to introduce the idea of sample variation and poll difference. • Students call out teacher contradiction on independent vs. dependent events. (see Chapter 6 for a discussion on this “bogus incident”)
Week 5	<ul style="list-style-type: none"> • Rico apologizes to students on his bogusness during the “bogus incident.” • Students watch clips from the movie <i>Uncounted</i> (Earnhardt, 2008). • Probability problems in the White Sox sub-context.
Week 6	<ul style="list-style-type: none"> • Connecting the mathematical and sociopolitical analysis of 2004 elections. • Working on 44-6 split coin toss and connecting to 44-6 split of the PD. • Rico shares elections related news.
Week 7	<ul style="list-style-type: none"> • Students present work done so far to UIC personnel and professor visiting class for observation. • Begin working on normal distributions, mean, standard deviations, and confidence intervals. • Rico shares elections related news.
Week 8	<ul style="list-style-type: none"> • Continuing work on normal distribution, standard deviation, and confidence intervals and the third piece of evidence. • Rico shares elections related news.
Week 9	<ul style="list-style-type: none"> • Collective work by students to put together op-ed piece to be circulated to online news sources. • Students initiate discussion about the event that occurred in the staffroom when a teacher made a derogatory comment about students with special needs. (See Chapter 6 for more details).
Week 10 (Election Week)	<ul style="list-style-type: none"> • Students prepare for monitoring exit polls. • Discussion after the day of elections about polls, student experiences as poll watchers and the meaning of Obama’s win for people of color. • Continuing work on normal distributions and the third piece of evidence.
Week 11	<ul style="list-style-type: none"> • Finishing up work on normal distributions and the third piece of evidence.

Students worked on three pieces of mathematical evidence to make a case for election fraud. Two of these were based on the idea of poll difference, which is the difference between the proportion that went for a candidate in the exit poll¹⁷ and the actual recorded vote.

Students found the probability of the following three events occurring—

- a) 10-0 split of the poll differences in the 10 battleground states in 2004.
- b) 44-6 split of the poll differences in the 50 states in 2004.
- c) The difference between the actual recorded vote for Kerry in Ohio (48.7%) and his exit poll proportion (54.2%).

The idea of poll difference was central to the first two pieces of evidence and the third piece of evidence required the use of normal distributions and confidence intervals. In this study, I focus on the first two pieces of evidence and the idea of poll differences.

There were 11 battle ground states in the 2004 elections and one did not have a poll difference (Wisconsin). The 10-0 split refers to the remaining 10 poll differences favoring Bush. Fifty-one states went to polls (the 50 states plus Washington D.C.), but Oregon did not use exit polls. The 44-6 split refers to 44 of the remaining 50 poll differences shifting in favor of Bush.¹⁸ There are two key points that allow for a mathematical analysis using poll differences. First, that a poll difference potentially *exists* because of sampling from a large population, and second, that the poll difference favors either candidate *randomly* because of sample variation and lack of bias in the sampling methodology. I discuss the complexity of making these two points visible in the classroom in Chapter 5.

¹⁷ Freeman & Bleifuss (2006) point out the historical importance and accuracy of exit polls in predicting election results over a period of 40 years in the history of United States. Additionally, in most cases, the poll difference is non-zero and favors one of the candidates.

¹⁸ Freeman & Bleifuss (2006) used the standard exit poll data and analysis that showed Wisconsin did not have a poll difference, thus getting a 10-0 poll difference split for the battleground states. For the 44-6 split of poll differences for 50 states plus D.C., they used a different statistical methodology that showed Wisconsin to have a poll difference. So out of the 50 poll differences (Oregon did not have a poll difference since it did not use exit polls), 44 shifted in favor of Bush.

Rico worked through and significantly borrowed from the Integrated Mathematics Project (IMP) units on probability,¹⁹ namely Pollster's Dilemma (Fendel, Resek, Alper, & Fraser, 1999c) and Pennant Fever (Fendel, Resek, Alper, & Fraser, 1999b). Mathematically, students engaged with the following ideas, representations, and models in this unit: the meaning of nCr (n choose r); use of tree diagrams and tables to find probability of an event; equivalence of using tree diagrams and combinatorics for finding probability; independent events; multiplication of probabilities for multiple events; equivalence of finding probability of a multiple event (coin toss, picking people, etc.); using combinatorics or by multiplying individual event probabilities; developing the binomial formula when an event has only two possible outcomes (H or T, M or F, Bush or Kerry etc.); binomial formula for equally vs. unequally likely outcomes; distinction between theoretical and experimental probability distribution by simulation on the calculator; and the ideas of sample/poll, sample variation, population, standard deviation, and normal distributions (including confidence intervals). Students were engaged in college level work what I mentioned above are usually part of advanced placement statistics syllabus in high schools (e.g., http://www.kusd.edu/media/pdf/math/high_ap-stats/syllabus.pdf).

A total of seven sub-contexts were used during the course of the unit—selecting 2 females from a group of 3 males and 3 females (henceforth referred to as 3M3F²⁰ context); selecting jurors in Jena 6; number of 2 person combinations of 4 people; the White Sox team winning/losing games; coin toss (tossing a coin 2, 4, 10, and 50 times); picking cubes from a bag; and the poll differences in the 2004 elections (see Appendix A for details of these). Some sub-contexts were used several times throughout the unit (Jena 6, coin toss) while

¹⁹ Although IMP has four probability units, one every year, students had only done the 9th grade unit on probability titled *The Game of the Pig* prior to entering this class. Therefore, students had a very weak probability background by 12th grade.

²⁰ The 3M3F sub-context was actually the starting point for the Jena 6 unit that students had worked on in their junior year. Students began with the 3M3F sub-context (a smaller problem) to develop the mathematical generalization for nCr for the Jena 6 context (a larger problem). See Appendix A for the Jena 6 context.

others were short-lived (picking cubes). There were days when only one was the focus of class work (such as on 9/18/2008), while on others days students and the teacher moved between three or four sub-contexts (such as on 9/25/2008).

Towards the end of the unit, students wrote a collective op-ed piece for the Huffington post, an online newspaper and blog community (Appendix C). They also submitted a final assignment addressing the question: Was the 2004 presidential election stolen?

4.1.6 Context-Content Continuum

Creating a curriculum based on generative themes (contexts) that supports reading the world, reading the mathematical word, and reading the world with mathematics has its challenges. Contexts (and sub-contexts) have the potential to support the learning of content that is mathematical (reading the mathematical word) or sociopolitical (reading the world) or a combination of the two to various degrees.

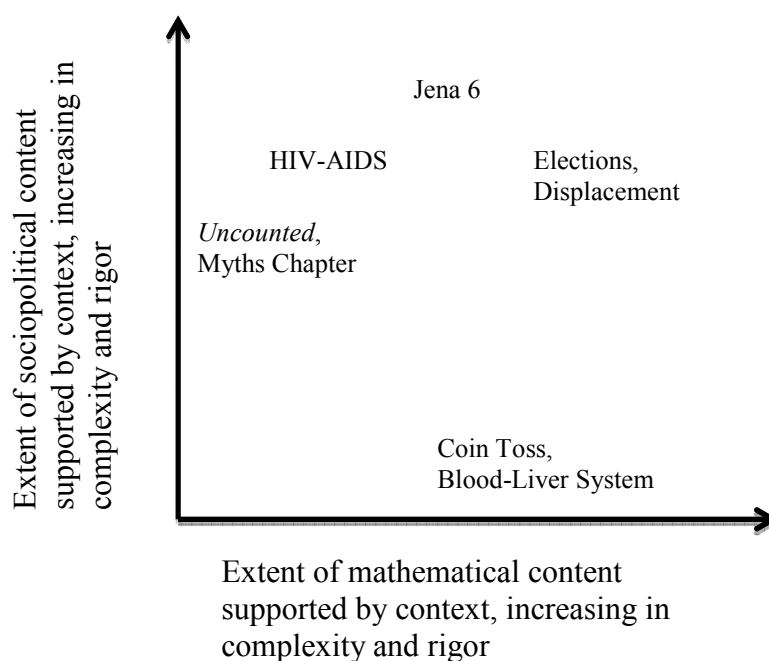


Figure 2: Content-context continuum

At one end are contexts that support reading the world with little opportunities for reading the mathematical word. I term this as “purely” sociopolitical contexts. In this case the context may either not require mathematics (or require little math, or less challenging math) to understand it better or not offer much possibilities for mathematizing. Here, one might argue that the focus on reading the mathematical word is diluted. At the other end are contexts that support the learning of rich mathematical content with little or no opportunity for reading the world, in which case the emphasis on reading the world is diluted. I term these as “purely” mathematical contexts. In between is the continuum where the mathematical and the sociopolitical dimensions are in a dance with respect to context and content. Somewhere in this continuum are contexts (like the elections and displacement unit) which offer opportunities for both mathematical and sociopolitical learning and require the learning of challenging mathematical ideas for the sociopolitical analysis. Elsewhere in this continuum are contexts like HIV-AIDS, which offer opportunities for both mathematical and sociopolitical learning, but do not necessarily require challenging mathematical ideas to understand the context better. (See Chapter 7 for further discussion on this point).

Similarly, some sub-contexts used in the units supported both sociopolitical and mathematical dimensions to a significant extent (like the Jena 6 sub-context from the elections unit). Others like the coin toss or blood-liver system were mainly mathematical sub-contexts and helped develop the mathematical ideas required for the analysis of social reality. At other times, students and the teacher left the mathematical sub-contexts and discussed texts like myths chapter (Irwin, Millen, & Fallows, 2003) in the HIV-AIDS unit, or a movie like *Uncounted* (Earnhardt, 2006) in the elections unit. While these texts mainly offered opportunities for learning sociopolitical content with little mathematical analysis, they provided the grounding and motivation to engage in mathematical analysis.

Although it is important to identify generative themes (and sub-contexts) that support both reading the mathematical word and reading the world, based on the complexity of the mathematical and sociopolitical ideas involved, this can be more or less challenging. Sometimes contexts (and sub-contexts) may offer opportunities for learning rich mathematical ideas without necessarily leading into or requiring a deeper knowing of the context. On the flip side, the context (and sub-contexts) may present opportunities for a deeper reading of the world without leading into or requiring the development of rich mathematical ideas.

Being cognizant of this interplay between the mathematical and sociopolitical dimensions as it relates to the context and content is essential to make pedagogical decisions to move between the two dimensions and support students in reading the mathematical word as well as reading the world. I discuss this in detail in Chapter 5 and 7, because, here, I first want to give an idea of the mathematical and sociopolitical complexities independent of each other. In the rest of this chapter, I describe the challenges that emerged in the classroom interactions related to each dimension.

4.2 Mathematical complexity

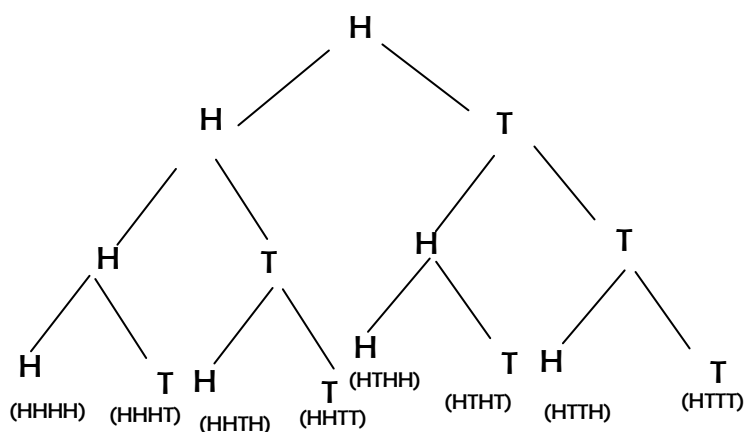
While critical mathematics pedagogy provided an overall orientation for the necessary interweaving of the mathematical and sociopolitical themes, the direction for the mathematical work in this classroom drew on reform ideas in mathematics education (NCTM, 2000) and curricula (Fendel, Resek, & Alper, 1998; Garfunkel, Godbold, & Pollack, 2000). Given this orientation, the teacher and researchers were sensitive to the intricacies that surfaced during reading the mathematical word and I describe some of these below.

4.2.1 Elections unit

One area of mathematical complexity in this unit was making sense of and using mathematical models (appropriately) across sub-contexts. For example, when students were working on the tree model for charting out the sample space in a coin toss, I wrote,

With the probability tree model, what does the H and T denote, and what the different levels denote needs to be made sense of to be able to extend the tree in a meaningful way to calculate probability. Also, the tree model as a way to chart all the possibilities (without skipping any) is another connection to make. So the tree is a tool to charting the possibilities of either one coin tossed 5 times, or 5 coins tossed once ... While students had used tree diagrams in Jena 6 last year, they gave names to the people (ABCD) and then used the tree model to trace out all the possibilities. Here they were using H and T and it was more abstract to see that each level in the tree represented a new toss. (RFN, 9/11/08)

Rico's intent was to build on and extend the work students had already done in the Jena 6 unit. He wanted students to consider how the tree model could be used to chart out the possible combinations in both sub-contexts. However, the tree model from Jena 6 could not be seamlessly transferred to the elections context as I indicate below.



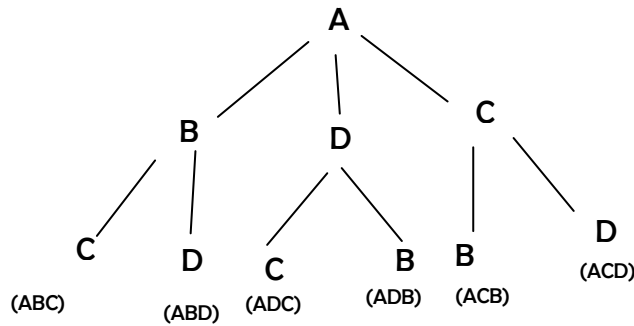


Figure 4: A part of the tree diagram for 3 person combinations out of 4 (Jena 6)

Students had to not only understand the meaning of the tree model for the coin toss situation (See Figure 3), but they also had to connect this new way of using it with their previous use of tree models in the Jena 6 problem (see Figure 4). In the coin toss scenario, each level in the tree model represented a new toss with the same possibilities (H or T). In the Jena 6 scenario, each level represented a new pick and did not include the previous persons picked. Moreover, the tree model for the coin toss could be extended for any number of tosses, but the Jena 6 tree model ended when the last person was picked. Although building on previous mathematical work is sound reform math pedagogy, making sense of and using mathematical models (appropriately) across sub-contexts is not trivial. Similarly, complexities occurred while connecting the coin toss with the poll differences in the elections context and I discuss those in Chapter 5 (since there were both mathematical and sociopolitical dimensions involved).

The meaning and equivalence of various mathematical representations presented a second complexity. In one instance, students were finding the probability of events in a multi-coin toss situation in two different ways. First was using the formula they had derived the previous year in the Jena 6 project, [no. of favorable outcomes/sample space], that is, $nCr/2^n$ where n is the number of tosses. Second was using the binomial formula they derived in this unit, [no. of favorable outcomes*probability of favorable event], that is, $nCr * (0.5)^r * (0.5)^{(n-r)}$, where n is the number of tosses and r is the favorable number of tosses.

Recognizing the equivalence of these two methods to finding probability in this sub-context is perhaps necessary to be able to use it in other situations as well. As I wrote, not all students found this straightforward. “Carlton, Julie, and perhaps a few others made the connection that one can also get the number of sequences by using combinatorics [and not just by the tree model and listing], but it is a leap, a big idea” (RFN, 9/18/08).

A third complexity was related to the appropriateness (or acceptability) of mathematical solutions when a problem could be solved in multiple ways. Students had to realize solving a problem more efficiently by making some assumptions that maybe mathematically appropriate in some contexts and inappropriate in others. This surfaced when Rico asked students to think about the “difference between the two situations (of Jena 6 and the cubes problem) and two ways of calculating the probability with and without replacement” (RFN, 9/16/08).

The Jena 6 problem could be solved in two ways—with and without the replacement assumption. The replacement assumption meant replacing the juror (or cube) selected back into the sample space before selecting the next juror (or cube). Students had to recognize that it would be mathematically acceptable and appropriate to solve the Jena 6 problem either way but not the cubes problem in which students were using only 25 cubes or so. In other words, with Jena 6, the accuracy of the mathematical solution was acceptable even when it was obtained with the assumption of replacement because the size of the total population (2144) was much larger relative to the size of the jury (12) and the population of whites in Jena 6 (310). Therefore, one could use the simpler expression of $(.856) * 12$ to find the probability of finding an all-white jury. That is unlike the specific cubes scenario here with smaller numbers (25 cubes in all), where making the replacement assumption does not lead to an approximation.

Sometimes difficulty arose in understanding the sub-context itself. In one instance, students were simulating an experiment with graphing calculators of tossing three coins 100 times to find the experimental (not theoretical) probability distribution of tossing three coins. Rico had them do this exercise to infer that experimental and theoretical probability distribution were not the same due to sampling and sample variation. In my field notes, I wrote,

Again, while doing this, we are dealing with a lot of different things/ideas here - each time we toss 3 coins, we then do this 100 times, how many different outcomes/sequences are possible for a 3 coin toss, how often can we get these sequences if we did this 100 times, and so on. (RFN, 9/19/08)

Despite this, Rico did not *tell* students that theoretical probability and experimental results would be different. They learned it experientially. This is a key pedagogical point consistent with the IMP and NCTM reform math pedagogical orientation. Thus far, I have discussed some of the intricacies that emerged in class with respect to the mathematical dimension of the content/context in the elections unit. I now turn to the HIV-AIDS unit where the mathematical challenges were no less apparent.

4.2.2 HIV-AIDS Unit

Rico's initial intent for this unit was to develop mathematical models for the spread of HIV-AIDS in students' communities. In Chapter 5 I describe how, as the class progressed, Rico recognized that this approach was not only difficult but also impractical in this situation. Initially, however, Rico began with a review of

Some of the work they had done with the dynamical system in the gentrification unit - the combining of the terms. They went over why $x + 0.2x$ is $1.2x$ and similarly why $u(n-1) + 0.005u(n-1) = 1.005u(n-1)$. This continues to be challenging for students at two

levels. One to see the combining in the first instance, and secondly to see $u(n-1)$ as a term, a function. (RFN, 3/3/09)

While combining terms was difficult for some students in class, understanding $u(n)$ or u_n as a function was difficult for many more, as has been suggested by Sfard & Linchevski (1994). Seeing $u(n)$ as a recursive function was an additional layer of challenge since recursion is mathematically a more difficult idea when compared to a simple function. This challenge related to recursive functions continued while trying to solve for the equilibrium value $(E)^{21}$ of the given dynamical system in the HIV-AIDS unit.

First, students empirically saw (by graphing on their calculators) that the DDS for the trees sub-context had an equilibrium value. Then they tried to find the equilibrium value (an unknown quantity) analytically using the system of linear equation(s). This required setting the values of $u(n)$ and $u(n-1)$ to be same, implying no change in the system from then on. Students now had to shift their thinking from the domain of the recursive functions (DDS) to the domain of linear equations with an unknown variable. For example, the DDS equation for the trees sub-context $u(n) = 0.8u(n-1) + 640$ became $E = 0.8E + 640$. In this instance the initial number of trees was 640, and 80% of the trees cut were being replaced every year. The solution to this equation gave the value of the equilibrium point for the DDS.

There were many challenges in this process. While students solved the dynamical system graphically and identified the equilibrium value (RFN, 3/4/09), difficulties surfaced while trying to make sense of the algebraic process of finding the equilibrium value. Two students, Monica and Guillermo, presented the algebraic process of finding the equilibrium value for the trees sub-context on the board to the class. When Rico asked why $u(n)$ and $u(n-1)$ were both the same thing (i.e., E), Monica responded, “They represent the same thing”

²¹ The equilibrium value E of a DDS is defined as the value of $u(n)$ after which there is no change in the subsequent periods, i.e., $u(n)$, $u(n+1)$ and so on are the same value, E . In other words, the DDS is stable and reaches equilibrium. In general, dynamical systems may be unstable without any equilibrium value or stable with a unique equilibrium value.

(Video, 3/5/09). Rico clarified his question by saying, “In general we see $u(n)$ and $u(n-1)$, they are not the same,” and asked students to think about what $u(n)$ and $u(n-1)$ represented in this scenario. Ellen said, “So then, $u(n-1)$ is what you had [at the start of] the previous year so it’s the same thing [as $u(n)$, which was the number of trees at the start of year n].” For several students the meaning of these variables, what they represented, and why and when they would be the same was not easy to make sense of.

Rico pushed students to connect this to the work they had done empirically and asked, “Is it always the same thing, is it never the same thing, when is it the same thing. Think of the graph there that Vanessa put up on the calculator yesterday [referring to the graphical solution of finding the equilibrium value for a different scenario the previous day],” and Antoinette immediately replied, “it was the same thing after the 80 years [in Vanessa’s scenario].” A little later Carlton made the connection between the graphical and algebraic processes by saying “it [the solution to the equation] gives you, where’s the line is when it levels out, the value [showing the leveling of the line by his horizontal hand movement]” (Video, 3/5/09).

The challenge of using the algebraic approach to solve for the equilibrium value(s) continued when students segued to working on a DDS with two variables. Here students had to think in terms of solving simultaneous equations. They had worked on solving a system of simultaneous equations in the IMP unit *Cookies* (Fendel, Resek, Alper, & Fraser, 1999a) previously. Nevertheless, finding the equilibrium values ($E1$ and $E2$, corresponding to each variable in the DDS) was a challenge. As I wrote in my field notes

The rest of the class [time] was spent on figuring out how to solve the system of linear equations [in two variables]. Rico asked Minerva to make an attempt. She simplified the first equation to get $E1 = (0.01E2 + 1)/0.7$ Ann and a few others said that now to get

the equilibrium values they would simply need to put in a value for E1 and get a value for E2. (RFN, 3/16/09)

Students initially did not consider the second equation to solve for the values for E1 and E2. Rico traced all the way back on how to solve the system of equations graphically and algebraically (RFN, 3/16/09). He journaled,

It was a pretty dismal affair, with students tuning out and me teaching at them ... students' intuitions and conceptual understandings of math are not that developed and their knowledge of integers is weak, and their knowledge of how to manipulate algebra is weak, etc. (TJ, 3/16/09)

In my field notes, I wondered about the relationship between finding graphical and analytical solutions and what counted as mathematical learning, and wrote,

How important is it for students to know how to find the solution analytically. Given that Calvin had graphed the two equations, could they have found the solution graphically? Would that count as mathematics? Or is it only mathematics when one can solve something analytically even if it means that one is following procedures? (RFN, 3/16/09).

From the standpoint of reform-based mathematics, understanding the graphical or algebraic solution is insufficient by itself. It is important to be able to understand and use multiple modes of representation or solving equations and connect them with each other. This is what Rico tried to do in class often, as in this instance, but it posed difficulties. To move on, Rico took up an option I suggested in our conversation after class, which was "to teach how to solve it graphically, w/ our yellows [calculators]" (TJ, 3/16/09). The next day he gave students a homework sheet on how to use the calculator to find a graphical solution for the equilibrium values of the Liver-Blood dynamic system and shared with students that instead of pursuing the path of finding the analytic solution, he made a pedagogical decision to move

forward. I wrote in my field notes, “He told them while he was concerned that they did not know how to find an analytical solution, and that there are lot of things he was concerned about for them, he decided to move forward” (RFN, 3/17/09).

Although most students found it easier to solve equations graphically algebraically, there were some difficulties along the way in using the calculator. I wrote in my field notes, Windowing still seems to be a problem. I think perhaps spending some time understanding how the window limits correspond to what we want would be useful - a mathematical idea. Calvin had all four quadrants on his window, was not sure what x_{min} , x_{max} , and y_{max} should be and so on. (RFN, 3/19/09)

Later, when students were looking at graphs and working with the idea of disproportionality, the complexity of interpreting data and creating proportions from data emerged. Disproportionality, setting up proportions, and interpreting graphs are relatively easier mathematical ideas for many of us and should probably be for students in high school. Nevertheless, it posed significant challenges to some students and I argue that it speaks to the profound mis-education of students of color in the public education system (Ladson-Billings, 1997; Martin, 2006). In a few instances, there were challenges with fractions, decimals, and percentages as evident in a question from one student, “why is $1-0.2$ the same as 0.8 ” (RFN, 3/4/09). As I wrote, “So these difficulties start way before, not just with fractions, decimal but with the number system, is what Rico said [in our conversation after class]” (RFN, 3/4/09). While Rico addressed some of these issues in class as needed, he often tutored students who needed the extra support to learn the mathematical ideas that they were expected to know as seniors.

In summary, both the elections unit and the HIV-AIDS unit had mathematical complexities. These emerged due to several factors such as the usage of models and representations, equivalence between contexts, and representations, and efficiency and

acceptability of solutions. Both units brought to the fore the issue of weak mathematical understanding from previous units and their previous 12 years in school. Most often, Rico persisted in supporting students (either in class or through one-on-one tutoring) to overcome challenges that emerged in both units while reading the mathematical word. However, at times he made a pedagogical decision to move forward (e.g., analytical vs. graphical process of solving linear equations in the HIV-AIDS unit) in the interest of the overall mathematical and sociopolitical goals of the unit (I discuss this further in Chapter 5). In addition to the challenges involved in reading the mathematical word, each unit had its share of complexities related to reading the world (the sociopolitical dimension) which I describe next.

4.3 Sociopolitical complexity

By sociopolitical complexity, I mean the intricacies that exists in a situation or challenges that occur while making sense of a situation (reading the world) when analyzed or viewed through the lens of race, class, gender, economic factors, nationality, sexuality, and so on. In this section, I discuss the nuances that surfaced in the Elections and HIV-AIDS units due to the intersection of primarily race, class, and gender.

4.3.1 Elections Unit

The sociopolitical intricacy of the elections unit was significantly different from the HIV-AIDS unit. Students were tuned into the election debates and many of them were campaigning for Obama in neighboring areas. All students who were eligible and who voted, voted for the first time, and some had been poll watchers earlier in local races and were going to be poll watchers. Students felt invested in the entire electoral process and often had questions or made comments about election-related news that Rico brought in. (See chapter 6 for a discussion on bringing the world and self in, a recurrent feature in this class).

During the run-up to the elections, at one of his rallies, McCain had responded as follows to a woman who thought Obama was an Arab man: “No ma’am, he is a decent family

man...[a] citizen, that I just happen to have disagreements with on fundamental issues” (Henry & Hornick, 2008). This was widely circulated in news channels and radio. Rico brought this comment for discussion in class after he shared election news related to provisional ballots and the following conversation ensued.

Rico: The other thing that happened is, let me ask you this. Let’s say, Carmen, you heard somebody say uhm, Anita, speaking of Anita, somebody says Anita is Mexican, and somebody then says no, no, no, no she is not. She’s a decent person. How do you interpret that? (Students giggling)

Anita: That’s really, uhm/

Several students (Ss): She’s alright

Anita: No

Roxanne: Meaning that Mexicans are not decent people.

Anita: Uhm hmm, that’s what, that’s the thing.

Rico: Is that how you interpret that?

Roxanne: Yeah.

Rico: She’s Mexican. No, no, no, she’s not, she’s a good person, she’s a decent person, she’s a family person.

Roxanne: Oh my gosh.

Rico: Okay, that happened in a McCain rally.

Roxanne: Ohhhh.

(Audio, 10/17/08)

Roxanne, a Latina from Mexico, shared her interpretation of this hypothetical statement about Mexicans. Rico then connected it to what McCain said at the rally. Roxanne was visibly shocked by McCain’s statement. Rico restated what happened at the McCain rally and the discussion continued for a few more minutes.

- Rico: Somebody said, [to] McCain, a woman, I am not going to vote for him [Obama] because he is an Arab.
- Greg: Who?
- Rico: Obama. At a McCain rally somebody said Obama was an Arab. John McCain said, no ma'am, no, no, he is a good person, he is a decent person, he's a family man. (Students speaking simultaneously)
- Roxanne: They are not saying that Arabs are decent people or good people.
- Ss: What?
- Roxanne: Because this lady, she is not voting for Obama because he is an Arab. And then McCain told her, no ma'am, he is a decent person, good person, family guy?
- Rico: He's a family man.
- Roxanne: He's a family man, meaning that like Arabs are not decent people and they are not good.
- Greg: But he is. Did they boo him or something?
- Rico: Boo McCain when he said that?
- Anita: No.
- Rico: I don't know.
- Roxanne: Did anybody catch that?
- Rico: So who caught that? McCain was praised for defending Obama's character.
- Roxanne: But then he is insulting Arabs.
- Anita: And now insulting Arabs
- Roxanne: Yeah.
- (Audio, 10/17/08)

Roxanne particularly was quite vocal about how she interpreted McCain's comment. Both Roxanne (a Latina student) and Greg (a Black student) wondered what the reaction of other people present (and the media) was to this statement. Rico pointed out, "McCain was praised for defending Obama's character" by some (people in the media). Roxanne was quick to point out how inappropriate it was because (implicitly) he was insulting Arabs.

Students were keenly aware of the issue of race and racism in the 2008 elections, with Obama being a Black man running for the presidency (and if elected the first Black President of the country). Several lies were propagated about his background such as his being a Muslim (and therefore to be wary of in the backdrop of the 9/11 attacks), and his birthplace being in Africa and not the USA. Roxanne's reaction to McCain's statement is evidence of her being perceptive and sensitive to the implicit racist underpinnings of such statements.

Besides such serious and insightful conversations, there were also lighter conversations in the classroom around race and racism. Earlier on the same day (10/17/08), Julie (a black student) mentioned that she had taken her school ID and voted (early voting). Greg (another Black student) asked whom she voted for. Julie responded that she voted for Obama and asked him why he wanted to know. Greg in his usual casual manner said he was just checking to make sure she (Julie) didn't like the white people and immediately said, "not in that way or those white people [perhaps referring to Rico]" (Audio, 10/17/08). Later, on this day, Carmen (a Black student) jokingly asked Rico why he was not voting for McCain. Rico knew Carmen since she joined school as a freshman and from her being in the Crew, and responded to her in a jestful tone, "I am only going to vote by skin color and you know better than to ask that" (RFN, 10/17/08).

Greg's interaction with Julie, Carmen's question to Rico, and Rico's response to Carmen and other discussions about race and racism in this class have to be understood in light of the relationship that students and Rico shared with each other. The sense of

camaraderie that existed in this classroom allowed the space for intense as well as humorous conversations around race. There were some instances in class that I initially interpreted as being racist or disparaging, such as casual comments made by Renee (who is a Latina) to Carmen (who is Black). After being in class for a few days, interacting with students, and discussing with Rico, I came to know the strong friendship that these strong women shared (which everybody in class knew about) across racial lines and soon realized that it was only bantering and teasing. Similarly, both Carmen and Greg knew Rico from their freshman year at Sojo, and both had been a part of the Crew (see footnote 11) in previous years. Rico knew Carmen's mother and grandmother and visited her family a few times, including before the start of this class to get permission to share their story for the displacement unit.²²

Furthermore, Rico raised the following question to students in the year-end survey²³: I am a 56-year old white male, not from your community and don't experience what you do- and I'm the person teaching you to use math to understand racism, sexism, criminalization of youth of color, etc. What do you think about that? Carmen said, "I think that it's amazing and it shows me that not all white people are racist. It really proves that you care about our situation especially since you don't stay here." She indicated that she valued Rico's commitment to their communities. Carmen's (and several other students') response indicates that she shared a strong sense of solidarity with Rico despite differences in their racial identities.

Throughout the elections unit, Rico also made connections (one of the C's in this classroom, see Chapter 6) between this unit and others they were going to study in this class. These connections were sometimes not obvious to students prior to these discussions. Early

²² Carmen's grandmother had bought a house in North Lawndale and had fully paid off the 30-year mortgage. With increases in property prices, the house tax increased as well and she had to take an adjustable-rate home-equity loan to pay for the house taxes. Unable to keep up with the payments on this new loan, Carmen's family was forced out of their home.

²³ This was an anonymous survey, and Rico told them they did not have to sign their names, but students chose to anyway.

on (9/11/08) he asked them to think about the potential connection between issues of deportation and the election. Greg said, “The different views of each candidate in the election and the deportation depends on that.” Roxanne added that “whatever president gets chosen what they say about deportation is going to happen”, but Vanessa noted, “Both candidates have the same ideas on deportation, both want big borders, more walls. I am not sure what they are saying exactly, they are going to make a decision. But I don’t think it matters which one gets elected” (RFN, 9/11/08). Rico left this discussion open ended by asking students to think:

If someone is powerful enough to steal elections, what does it say about their ideas about people who have the right to vote? What does that mean to people who have no rights in this country as citizen? Would they be respectful of people who are not documented? (RFN, 9/11/08)

A week later, Rico brought in two pieces of news that he had heard on the radio. One was McCain’s suggestion to disenfranchise people with foreclosed properties and another was disenfranchisement of convicted felons in most states (except Vermont and Maine). After sharing these he drew on the connection between the elections unit and the displacement unit (in the first case) and the criminalization unit (in the second case). Calvin wondered aloud, “Even if it is a small thing, you cannot vote?” and Rico clarified the difference between felony and misdemeanor (RFN, 9/18/08).

So far, I have shared some of the sociopolitical discussions around race and racism in the elections unit. Understanding the idea of exit polls and poll difference presented other challenges due to the interweaving of mathematical and sociopolitical ideas and I elaborate on those in Chapter 5. Here I want to suggest that these interactions around race and racism that sounds like a social studies class indicates students’ investment and engagement. Second, these conversations contextualized and provided rationales for the mathematical

investigations for the unit question (Was the 2004 presidential election stolen?). Third, they reflect students' primary concern of ensuring that the campaigning and the elections in 2008 were fair and honest given the possibility that the candidate who they saw as representing them, Obama, a person of color from Chicago, might have the election "stolen" from him.

4.3.2 HIV-AIDS Unit

The sociopolitical complexity in the HIV-AIDS unit was different in nature. It began to surface clearly when reading the myths chapter from the book *Global AIDS: Myths & facts* (Irwin, Millen & Fallows, 2003) three weeks into this unit. This chapter presented scenarios of people affected with HIV-AIDS with details of the social, economic, cultural, and other factors that constrained the individual choices they could make (e.g., for safe sex practices or jobs) and in turn made them more susceptible to HIV-AIDS infection. During the course of the three-four days that students read and presented sections of this chapter, the tension between the perspective of individual responsibility (and behavior) and social factors influencing individual behavior emerged explicitly.

On the day Rico introduced this chapter in class (3/20/09), students read different sections of this chapter in their groups, summarized key ideas on a sheet of paper, and posted it on the wall. Over the next two class days, students presented the summary of each section to the entire class. The complexity of understanding the social factors discussed in this book chapter and the difficulty of going beyond the discourse of individual responsibility came to fore in the interactions that followed these presentations. Greg and Jenny presented first by and talked about Rakhi, a woman in India, infected with HIV-AIDS because of unprotected sex with her husband. A very interesting conversation ensued, mainly between students.

A quick point to note, before I include parts of the video transcript, is that the teacher in this class was male whereas majority of the class was female (15 out of 21). Gender power differential was one of the issues raised in this book chapter (and in Rakhi's situation), but in

this conversation the voices of the female students were strong. There were several instances where the young women in class respond to the teacher or to each other to refute/defend their positions. For example, at one point during the class Ann said to Rico, “you are the one who don’t understand what we are saying” (RFN, 3/23/09). Going back to the presentation, Greg started by reading from their poster.

Greg: Alright, well the section we read was mostly like a story giving examples. And the story we got was of a girl named Rheki [Rakhi]. (Reading from the poster)
Rheki was forced to marry at 10 and start having sexual relation with her husband at 15. Um, Rheki’s husband left to Mumbai

Jenny & others: Mumbai (correcting his pronunciation of Mumbai)

Greg: Oh, Mumbai to make more money in drug trading, so he left by himself. Then her husband’s family blamed her for contaminating in other words for giving their son AIDS when her son actually gave him AIDS. Rheki was afraid that she would be put out on the street before she could reach her main family.
(Turning to Jenny for clarification) that’s ‘coz they was too far away right?
That’s what that is.

Jenny: Mm hmm. (Agreeing with him)

Greg: Rakhi’s husband refused to use condoms with any female. And Rakhi and her son had HIV because of him and cause he was having sex with a lot of prostitutes while he was out of town or whatever. The problem with society is that a lot of people cannot afford to buy condoms. That was like their main point was some people just choose not to.

Rico(to class): Ask some questions.

Julie: How come they cannot afford to um buy condoms?

Jenny: They ain’t got no money, obviously. (Laughter)

Julie: I know some don't. Like do they have like organizations so that they can help them? You did just say choose not to, some choose not to

Jenny: 'coz this specific reason, they couldn't afford to use condoms and her husband didn't want to use condoms. She didn't have no money so she couldn't go buy condoms. And of course she can't just force it and put it on him.

(Video, 3/23/09)

Julie raised questions about two of the points that Greg made—affordance and choice. Her persistence to understand led Jenny to respond with a nuanced response. She pointed out that one, “her [Rakhi's] husband didn't want to use the condoms,” two, “she [Rakhi] didn't have no money to go buy condoms,” and three, that “of course she [Rakhi] can't just force it and put it on him.” Jenny's voice is a strong evidence of student initiation, engagement, and agency. She took the conversation in the direction of the power differential that exists between men and women to different degrees in all societies (below she refers to “boys our age”), and influences what individuals can afford and choose (which is what Julie tried to make sense of). Rico then asked Jenny to say more about why she (Rakhi) could not force her husband. Jenny responded,

Jenny: He doesn't want to use condoms just like other boys our age don't want to use condoms. He didn't want to use condoms and she got AIDS. She couldn't force him, that was her husband.

Greg: Probably she want some too.

Jenny: No, it ain't even that. She, he forced her to have sex with him.

Greg: So you saying he raped her?

Carlton: They was married.

Jenny: Don't say that he raped her but they married so it's not rape.

(Video, 3/23/09)

Several students in the class simultaneously disagreed and said, “Yes, it is” to indicate they considered it rape. Jenny, however, persisted and responded, “No it’s not. She’s obligated to have sex with him. In other cultures, that’s how it is. She doesn’t have a choice. She’s a woman.” Greg on the other hand disagreed and continued to suggest, “She wanted some too.” Rico picked up on this issue of choice and the power differential in Rakhi’s relationship with her husband by revoicing Jenny’s contribution (O’Connor & Michaels, 1993) and steered the conversation in the direction of a discussion about choice and power instead of whether it was rape or not.

Rico: So what Jenny is just saying, she doesn’t have a choice. She’s a woman, what is she talking about?

Marisol: Once you get married you have an obligation to have sex with your husband.

Rico: So where does the power reside in the relationship?

Many students respond: With the man (voice of female students clearly audible)

(Video, 3/23/09)

Jenny seemed to indicate (strongly) that Rakhi was limited in her power to choose because of social and cultural factors. However, later on the same day, Jenny raised the concern that the authors “seem to be saying that poverty is the issue without really saying that individual choice is also important to consider and that there are some people who are promiscuous and that behavior cannot be excused” (RFN, 3/23/09). When Rico asked Jenny if she thought “for example the woman from their reading [Rakhi] having 100% choice, some choice or no choice at all.” Jenny said, “sometimes women have no choice, but that women should be able to refuse if their partner does not want to use condoms, knowing well that they are at risk and that this book does not address that” (RFN, 3/23/09).

Jenny felt that the book emphasized social factors and seemed to excuse individual behavior. Nevertheless, she connected to Rakhi’s situation of having no choice and was of the

opinion that social and cultural factors were the reason for her being infected with HIV-AIDS. As Rico noted in his journal that day, “she is conflicted, it appears, because she believes both that the point the book is making is valid, but feels that it is probably too strong” (TJ, 3/23/09). Not only Jenny, but other students felt conflicted as well, as seems from the conversation that followed.

Jenny then read from Antoinette and Vanessa’s sheet posted on the wall since both were absent from class that day. One line read, “Survival sex is necessary for women in poor [economically] situations.” Renee asked if survival sex meant prostitution. Rico drew Antoine and Calvin into the discussion.

Rico: In this, in this section, do they use that term? Antoine and Calvin, in your section, survival sex?

Calvin: They use sugar daddy. (Students laugh).

Rico: Ok, so, is there a relationship between survival sex and sugar daddy?

Although sugar daddy was not used in the section that Antoine and Calvin read, they perhaps interpreted some parts of the text to mean or relate to sugar daddy, a term perhaps familiar to them. Rico asked them if there was a relationship between survival sex and sugar daddy. Calvin thought that sugar daddy was about *wants* while Antoine seemed to indicate that it was about *needs*. Later in the conversation Ann, Roxanne, and Carmen indicated that survival sex (or prostitution) was everywhere with Roxanne adding, “That’s not what it’s called here.” Rico drew students back to the issue of sugar daddy. Ann suggested that sugar daddy is different; Calvin added that it related to needs, and Roxanne said it was about satisfying wants and not needs. Rico pushed students further.

Rico: Are people, are women ever, I ask this of the women in the class in particular, are women ever in an economic position that they have to rely on whatever

you want to call it, a man, a sugar daddy, something (Roxanne nods her head saying yes), to provide for them because they are at home with children etc.

Roxanne: yeah, that's why a lot of women who are in like say abusive relationships and stuff stay with their husband instead of moving because they can't afford to leave them. Because they don't know where to go or have money to feed their kids.

Calvin: That's, but that's not sugar daddy right there.

Ann: That's survival.

Calvin: That's needs. (In contrast to what he said earlier)

(Video, 3/23/09)

This connection between survival sex, sugar daddy, and prostitution is quite complex and nuanced since the line between needs and wants is neither universal nor obvious.

Students did not reach any clear conclusion on it (either that day or later) and that was all right by the teacher since these are complex issues to think about and one cannot expect these to be resolved in a single conversation. As Gutstein (2012a) wrote and I agree,

We never totally settled this matter at the time, which is not necessarily a problem in my view. One should not expect that youth (or adults!) easily resolve so complicated an issue, and critical (mathematics) pedagogy should allow for ambiguity, open questions, and contradiction. (p.34)

Ellen and Gema then shared an example from their section about Carlos, who left his low paying job to get into the drug trade and subsequently got infected with HIV-AIDS. Rico asked students if, in this case, they thought it was due to individual choices. In his field notes, he wrote,

They [Roxanne & Ann] argued that the story of Carlos in the text was *his* decision to get a better paying job (selling weed, which quadrupled his earnings and gained him

his family's respect). They said that he already did have a job, and it was a bad decision to chuck it and do something like sell weed, that eventually got him HIV. (TJ, 3/23/09)

This tension of unpacking the relationship between individual behavior versus social factors and their influence on susceptibility to HIV-AIDS infection continued into the next day. Students at times felt frustrated about differentiating the nuances related to race, economics, gender, and cultural stereotypes. Greg verbalized it by saying, "I think you should've given us other different chapters to read 'coz it sounds like everybody is saying the same thing," namely, "that men who support the house, then the women, if they [men] say so, have sex" (Video, 3/24/09). Ann said that the point of the chapter was that

Men assume power and in assuming power they assume certain responsibilities and perks that come with that. And one of those would be that men feel that the women is their's and it's their property and in that process women get a mentality that they are helpless and that they belong to the man. (Video, 3/24/09)

Gema, however, suggested a potential connection among all these stories and shared her sense of how social factors constrain individuals in different ways,

Everybody's stories are like different, but then they collapse at a point where they are all pressured by society. Like men are pressured by society to feel like they are in power and many people in low-income neighborhoods are pressured to get a job. (Video, 3/24/09)

This juxtaposing of the two contrasting discourses was a central part of reading the world in this unit. As Rico wrote, the question was,

But how do we understand the many who follow Carlos? Is it a character flaw, something innate, something attributed culturally, or do we look at the sociopolitical

context that constrains his choices, gives him and those like him so few options, lack of respect, humiliation, etc.? (TJ, 3/23/09)

I also wondered why this discussion on the relationship between social factors and individual behaviors did not occur in the classroom interactions in previous units (specifically displacement) or even early on in this unit. “This tension and conflict between individual blame [and behavior] versus social blame [and factors] has not surfaced before and I wonder why” (RFN, 3/23/09). For example, in the displacement unit students did not discuss the choices that families made with the loans or blame families for it, but instead explored the role of banks in giving predatory loans. There were no discussions (to my and Rico’s knowledge) in the displacement unit like what I discussed above in the HIV-AIDS unit, around individual behavior versus social factors influencing or constraining individual decisions.

As a possible explanation, I suggest three factors that may have allowed these conversations to occur explicitly in this unit. First, one of the explicit sociopolitical goals for this unit was for students to recognize the ways in which social factors limit individual choices. Second, given this goal, Rico decided to bring this piece of text into the classroom for reading, which made this viewpoint (on social factors) explicit and opened up a space to dialogue about it. Third, his role in facilitating the entire conversation of social factors constraining individual choices and considering the dialectical relationship between social factors and individual choices was crucial for this discussion to unravel as it did.

This, I indicate, is one of several instances (I discuss in this study) where the role of the teacher becomes evident and visible from the Vygotskian perspective (Chapter 2). Rico used this text and dialogue to explicitly direct students’ attention to social factors (Becker & Varelas, 1995). He brought the relatively abstract idea of social factors constraining individual choices in direct contrast with the everyday notion of individual behavior into the

classroom and facilitated conversations around it. Rico not only chose a piece of text that would bring students' attention to this point, but also pushed students to consider this perspective in several ways. He raised pointed questions (such as "where does the power reside in the relationship"), revoiced student responses (such as Jenny's), provided counter examples to challenge students' statements and perspectives (e.g., in response to Jenny's concern that the chapter excused individual behavior), asked questions to connect different ideas in student responses (such as survival sex and sugar daddy), and so on. All of this required him to think from the perspective of social factors discourse (and be aware of the individual behavior view as well). As Vygotsky posited, it was this difference (between teacher and students thinking), that created the possibility for these conversations to unfold in joint activity around this piece of text (within the zone of proximal development). In other words, a zone of proximal development emerged in these conversations where students and the teacher engaged in making sense of the role of social factors and individual behavior in HIV-AIDS infection rates.

In summary, both the elections unit and the HIV-AIDS unit presented sociopolitical complexities. Race and racism were issues that were key in the elections unit while race, class and gender, intersected with each other in the HIV-AIDS unit. Although I did not discuss (here) how race intersected with issues of class and gender in the HIV-AIDS unit, Ann and Roxanne's attempt to understand the reasons for differences in infection rates for Black and Latino communities in Chicago (snippet 2 highlighted in the introduction and discussed in detail in Chapter 5) speaks to this point. Moreover, the question of power and individual choice as related to gender differential surfaced strongly in the discussions in the HIV-AIDS unit, and this was one way of folding the theme of sexism into this unit.

4.4 Summary

In this chapter, I gave an overview of the various units studied in this class with special attention to the elections and HIV-AIDS units. I discussed the interplay of the mathematical and sociopolitical dimensions as related to the context and the content. I shared the mathematical and sociopolitical complexity and difficulties that existed, independent of each other, in both units. Mathematically, intricacies emerged due to the intersection of complex mathematical ideas (modeling, probability etc.), use of multiple representations, equivalence between contexts and representations, acceptability of mathematical solutions, and students' weak mathematical understanding from previous grades. The sociopolitical complexity surfaced due to the intersection of race and racism in the elections unit, and race, class, and gender in the HIV-AIDS unit. Moreover, the question of who has power to choose and how social forces severely constrain individuals' (women and men's) power to make choices appeared explicitly in the HIV-AIDS unit.

In addition to these, there was an added layer of complexity in bringing the mathematical and sociopolitical ideas together. The ways in which this classroom space (the teacher, the videos, the articles, and the norms of this classroom) provided opportunities for this to occur is the focus of the next two chapters. In Chapter 5, I discuss the ways in which the mathematical and sociopolitical dimensions were interconnected in these two units and how this connection materialized and was facilitated in the classroom by the teacher and his pedagogical decisions. In Chapter 6, I describe the features that arose in this classroom in the process of creating a space for interweaving the two dimensions in order to read the world (with mathematics whenever possible) and read the mathematical word.

5 THE MATHEMATICAL-SOCIOPOLITICAL DANCE

Before, I saw math as a class about numbers and formulas irrelevant to the lives of those other than math majors and teachers. In this class, I have grown from that, and I now see math as something we can apply to real life situations to help make arguments on why something is wrong. (Student response, mid-year survey)

In the previous chapter, I outlined the mathematical and sociopolitical ideas that students worked on in the elections and HIV-AIDS units. I discussed the complexities that surfaced in both units in the classroom with respect to the mathematical and sociopolitical dimensions (distinct of each other). The week-by-week overview and the details of the sub-contexts and content of these units gave an idea of the interweaving of the two dimensions at the macro level (unit level). To recap, my main research question was “*How did this classroom space (the teacher, students, their interactions, and the artifacts such as videos, newspaper articles, personal stories, etc.) mediate the development and interweaving of sociopolitical and mathematical dimensions by students?*”

In this chapter, I revisit the two snippets I introduced in Chapter 1, one from the elections unit and another from the HIV-AIDS unit. I do not reproduce the snippets here but suggest going to the beginning of Chapter 1 to re-read them before proceeding. I show that these two snippets are instances of students connecting both mathematical and sociopolitical dimensions in their utterances and demonstrate two ways in which these dimensions can be interconnected. I then traverse the classroom interactions over time to give a sense of the ways in which the mathematical-sociopolitical interweaving emerged in classroom interactions and the conditions that supported or hindered it. In essence, I show that the mathematical and the sociopolitical dimensions are intertwined in the classroom at multiple

levels, bringing together coherence in the classroom activity with respect to its goals, content, and classroom interactions, and thus providing a space of joint activity for students to begin to connect the two dimensions as well.

5.1 Two ways of connecting

In snippet one, Carlton laid out the mathematical analysis to argue for the possibility of fraud in the 2004 U.S. Presidential elections. When Rico asked students at the beginning of the election unit whether the 2004 elections were stolen based on the values of the exit poll and actual recorded vote proportions in the state of Ohio, students stated that there was insufficient evidence to argue so. They suggested that a) there could have been problems with the exit polls with people changing minds, b) the exit poll could have been too small in size to make predictions of voting patterns, or c) the difference between the actual recorded vote and exit poll percentages of Kerry votes was too small to consider much of a difference at all.

About three or four students indicated that they needed to do some more mathematics with the given numbers to see if this was enough evidence. For example, one wrote, “I believe that the election was stolen but do not have numbers to back up, so maybe this information is enough but needs more mathematical work,” while another said, “I know that polls have everything to do with mathematics. It is mainly probability that we are working with. We have to find the chances of the votes turning out the way they did.”

Snippet 1, Carlton’s op-ed piece, became a part of his response to the final unit assignment, which asked students to write an opinion piece addressing the question: Was the 2004 presidential election stolen? In response to the final unit assignment, almost all students combined mathematical arguments with sociopolitical analysis from the movie *Uncounted* (Earnhardt, 2008) or *Stealing America: Vote by vote* (Fadiman, 2008) to make a stronger case that the results of the 2004 elections could not have happened by chance. Students did two things. They used mathematics to argue that the 2004 could not have happened by chance,

and then used sociopolitical analyses (from the movie clips they saw, and texts they read) to argue what might have happened (e.g., votes switched, etc.). In other words, students connected the mathematical idea of statistical impossibility with the sociopolitical factors such as long lines, bogus flyers, and computer generated errors (which led to large scale disenfranchisement) to argue for the possibility of election fraud in 2004 (mathematical-sociopolitical connection).

This was not trivial since students needed to begin to understand several mathematical ideas (Chapter 4) as well as make several other connections that brought together the mathematical ideas and the sociopolitical context. First, they had to recognize that the mathematics of *sampling* (usually) contributed to a difference in the values of the exit polls and actual recorded vote. Second, they needed to make the connection that although the exit polls may not be the same as the actual recorded vote (due to the mathematics of sampling), historically, exit polls were close enough to be statistically accurate, and therefore used to predict the actual recorded vote. Third, they had to understand that the poll difference (i.e., “the difference between the actual recorded vote and the exit polls”), when non-zero, would *randomly* favor either Bush or Kerry (B or K), due to *sample variation* in the exit polls and the *unbiased* nature of the exit polls (Freeman & Bleifuss, 2006).

In snippet 2, both Roxanne and Ann made a mathematical-sociopolitical connection while trying to understand if poverty or promiscuity were significant factors influencing the racially disproportionate HIV-AIDS infection rates for Latinas/os and African Americans. Roxanne wondered why the infection rate for Latinos was less than that for whites if poverty is a factor influencing HIV-AIDS infection rates, since students knew that Latinos were overall poorer than whites. Ann further argued that if Latinas/os were disproportionately under-represented (16% of new HIV-AIDS cases in 2006 in Chicago when constituting 26% of the population) and African Americans disproportionately overrepresented (56% of new

HIV-AIDS cases in 2006 in Chicago when constituting 36.8% of the population, according to a report from AIDS Foundation of Chicago (2009)) then the disproportionality could not be based on income, and was instead, as Ann said, “about promiscuous behavior and not poverty.”

Ann’s statement required not only an understanding of the mathematical idea of disproportionality and the sociological idea of individual (promiscuity) and social (poverty) factors but also bringing them together (mathematical-sociopolitical connection). As I mentioned in Chapter 4, some students (including Ann and Jenny) suggested that the disparity is influenced by promiscuous behavior, and while doing so they were thinking in the framework of the individual behavior discourse, which is marked by statements such as “It was his fault, she made bad choices, etc.” Rico, however, introduced a piece of text (the myths chapter) which argued that poverty and other sociological factors constrained individual choices (and therefore influenced the rates in different communities).

Ann reasoned that if the (over-)disproportionality in the African American rates of HIV-AIDS was attributable to social factors, there must be similar disproportionality for HIV-AIDS infection rates for Latinos. Perhaps her implicit assumption here was that both Latino and Black communities are affected by similar sociopolitical factors such as poverty and are generally poorer than whites. However, according to the HIV-AIDS infection rates available, Latinos were disproportionately underrepresented. This led to a dissonance for Ann (and Roxanne) in accepting the argument that sociopolitical factors like poverty contribute to disproportional distribution of HIV-AIDS cases. Ann (and Roxanne) could not have made this statement without interweaving the mathematical idea of disproportionality and the sociopolitical discourse of individual behavior versus social forces.

While both units involved a mathematical and sociopolitical investigation of the social reality (2004 elections and HIV-AIDS), and the snippets are examples of the

mathematical-sociopolitical connection in each unit, there is a significant difference. In snippet one, a mathematical analysis of the situation (the elections) was necessary to explain the skewed poll differences in the 2004 elections and argue for possible fraud. Using the mathematics in this case made for a stronger argument, which would not have been possible by considering only the sociopolitical factors (such as long lines and vote switching). On the other hand, in snippet two students were trying to tease out the sociopolitical factors influencing the situation (HIV-AIDS in communities) to explain the disproportional distribution of infected cases across communities. Bringing in the sociopolitical factors (poverty, economics, migration etc.) was essential to get insights into the possible contributions to the disproportionality in infection rates (the mathematical data), since this disproportionality could not be explained without the use of complex mathematical ideas like chaos theory that were outside the scope of this class.²⁴ As Rico wrote in his notes towards the end of the HIV-AIDS unit,

So something that is really interesting to me is this: in the elections unit, as we've talked about (me, Anita, Patty²⁵), we've said that that was a unit in which you had to do a mathematical analysis of a political situation to understand whether or not the election was stolen. Here, you have to do a political analysis of a mathematical situation (i.e., the data) to understand the data, the question of "why is there the disproportionality?" It's the flip side. (TJ, 4/21/09)

This is an important point that was not very obvious during the phase of developing the curriculum, but surfaced during the classroom enactment. Frankenstein (1998) discussed this relationship between mathematics and political knowledge as the twin goals of

²⁴ In trying to steer away from a focus on individual behavior, Morris, Kurth, Hamilton, Moody & Wakefield (2009) indicated that a network theory perspective might help understand the influence of social factors on the disproportionately high prevalence of HIV and other sexually transmitted infections in African American communities. They suggested that the racial segregation of Black communities from other communities might result in higher sexual interconnectivity within the Black community, resulting in an explosion in infection rates. One of the authors, Morris, sent this article to Rico *after* this class was over.

²⁵ Rico used Patty to refer to Patricia Buenrostro.

“understanding the mathematics of political knowledge,” (the mathematical analysis of a sociopolitical situation as in the elections unit) and “understanding the politics of mathematical knowledge” (the sociopolitical analysis of the mathematical situation as in the HIV-AIDS unit). For example, Frankenstein (1983) discussed the possibility of exploring “not merely how statistics are non-neutral, but why and in whose interest,” (p.325) by “examining interests, and underlying methods of collection, description and inference, and by considering historical, political and other theoretical insights along with the statistical knowledge,” (p.326), thus suggesting a sociological analysis of a mathematical situation like in the HIV-AIDS unit. In another instance, Frankenstein (1990) indicated that, “critical mathematical literacy involves the ability to ask basic statistical questions in order to deepen one’s appreciation of particular issues. It also involves the ability to present data to change people’s perceptions of those issues,” (p.336) pointing to a mathematical analysis of a sociopolitical situation as in the elections unit. I discuss this again in the concluding chapter.

A potential guideline for teachers while developing the curriculum and enacting it in the classroom, is therefore, to explore the mathematical-sociopolitical connection both ways. That is, consider if and how the mathematical analysis better explains the sociopolitical situation and if and how the sociopolitical analysis better explains the mathematics. In summary, the two snippets make visible the interconnection of the mathematical and dimensions, and suggest two ways in which they can be interwoven. These two instances that I highlighted emerged after students and teacher spent a significant amount of time working on both the mathematical and sociopolitical dimensions. In the next two sections I show how this conversations in class moved between these two dimensions, foregrounding one over the other at times, thus creating a dance (or interweaving) between them in both units.

5.2 Elections Unit

Rico borrowed from Freeman & Bleifuss (2006) for developing the mathematical argument for the possibility of a stolen election. As specified in Chapter 4, I center my analysis on two of the three pieces of mathematical evidence students worked on, that is, the 10-0 split of poll differences in battleground states, and the 44-6 split in the 50 states. To develop the mathematical ideas required for these two pieces of evidence, students first worked extensively with the coin toss sub-context. Then they tried to understand and use the mathematical equivalence between a coin toss and a poll difference, as I describe below.

A (non-zero) poll difference and a coin toss have two equally probable outcomes. A (non-zero) poll difference could favor Bush or Kerry (B, K) in the 2004 elections and a coin toss could turn out to be heads or tails (H, T). A poll difference favoring Bush meant that the recorded vote proportion for Bush was more than the exit poll proportion for Bush. The poll difference in each state could favor B or K equally and randomly, since the exit polls are historically known to be unbiased, and any errors distributed (fairly) evenly between the candidates (Freeman & Bleifuss, 2006).

Consequently, the situation of a 10 coin tosses where each toss can be H or T *randomly* is mathematically equivalent to the situation of the poll difference in 10 states where each state's poll difference could favor B or K *randomly*. Once this equivalence is established, the mathematical results of a binomial distribution of H-T from the coins sub-context can be correlated with that of poll differences for B or K for the elections context. If a certain split of H-T is statistically improbable, then the corresponding split of poll differences is equally improbable. However, this mathematical equivalence was neither straightforward nor was the idea of poll difference and the (mathematical) reason for it to exist clear and obvious as I discuss below.

5.2.1 Equivalence of coin toss and poll difference

After 3 weeks of working towards developing the mathematical ideas of probability and combinatorics in the Jena 6 and coin toss sub-contexts, Rico started to make the equivalence between a coin toss and poll difference. Here is a piece of interaction from 9/23/08 (the 4th week, school started 9/2/08).

Rico: If I did it (tossed a coin) 50 times and it came up 50 heads, what would you say?

Vanessa: That you are lying.

Rico: If it came, if I did it 50 times and it came up 50 heads, Tuan, what would you say?

Greg: There was something wrong.

Carmen: You cheated, there's a trick to that.

Rico: Oh, you don't trust that coin, do you?

Vanessa, Carmen: Uh-Uh, No

Rico: How about if I did it 50 times and it came up 49 heads? What would you say?

Carmen: Bogus Coin.

Rico: Bogus coin? How about if it came up, if I did it 50 times and it came up 26 heads and 24 tails? What would you say?

Carmen: That's more realistic.

Rico: Where's the line?

Carmen, Greg: Close to half.

Rico: Close to the half. What does close mean?

Greg: 6-7 range. (No wider than a 28-21 or 21-28 split)

(Audio, 9/23/08)

In this conversation, which focused on the mathematical dimension, Rico brought to the fore students' intuitive sense of the acceptable range of heads and tails in 50 coin tosses.

Following this, he asked them to simulate 50 coin tosses on their calculator, which had programs that allowed them to do this. Students reported the number of heads and tails they got and Rico wrote these on the board. The numbers ranged between 19 heads-31 tails to 24 heads-26 tails or vice versa. Ann questioned why everybody was getting different numbers. Carlton and Vanessa responded that it was due to the random nature of the coin toss, and Vanessa added that one could get anything. Ann wondered if she would get different numbers on repeating this experiment on the calculator.

Rico introduced the idea of sample variation by saying, “If you repeat the sample, if you do it more than once, you are likely to get something that is not necessarily the same. You will get variation, you will get some change” (Audio, 9/23/08). He rephrased this in several different ways while students asked questions to understand it. He also connected sample variation to Greg’s notion of “close to half” mentioned earlier, thus building on his contribution. Ann had another question, “So is 50-0 not possible?” Rico revoiced this question to the class and referred to students’ earlier responses of “cheating,” “lying,” “tricky,” and “bogus” if they saw a 50-0 split of heads and tails. He extended this by asking, “So you’re not buying the 50-0 split. Right? So if I did this and I got 44 heads, what would you say?” Vanessa responded, “You’re lying” (Audio, 9/23/08).

Rico recognized the importance for students to consider two key and interrelated questions—what is close and whether a 50-0 split is possible—to develop the mathematical analysis. He used revoicing to accomplish several different things such as reframing students’ contributions mathematically, expanding and extending them, and drawing connections between student contributions and the mathematical ideas being studied (Hufferd-Ackles, et al. 2004; O’Connors & Michaels, 1993; Walshaw & Antony, 2008). While this conversation is indicative of a mathematical discourse that may have occurred in a reform-oriented mathematics classrooms, a few minutes later, Rico foregrounded the sociopolitical context

for this unit, and thus shifted to a discourse that was considerably different (I return to this point later in this and the concluding chapter).

He reviewed the idea of exit polls to connect the elections context with the coin toss sub-context. Students raised concerns about people possibly lying in exit polls and Rico reiterated that exit polls were anonymous, confidential, and historically accurate. To show that the poll difference could go in favor of either candidate, he gave examples of exit poll values and actual recorded vote results from the 2004 elections in Massachusetts and West Virginia. Students saw that the poll difference went in favor of Kerry in Massachusetts and in favor of Bush in West Virginia. By giving this example, he foregrounded the sociopolitical context for this unit (the 2004 Presidential elections) and raised a question.

There's 50 polls, there were 49 states²⁶ and Washington D.C. There were 50 exit polls. Based on our data here with flipping 50 coins, what would you expect to be the split between how many of the poll differences favored Bush and how many of the poll differences went against Bush? What would you expect? (Audio, 9/23/08)

This question did two things. First, it connected the mathematical ideas involved in the coin toss scenario with the poll differences in the elections context. Second, it foregrounded the sociopolitical context for this unit (the 2004 Presidential elections), thus interweaving the mathematical and sociopolitical dimensions.

Vanessa responded that it would range from 20-30 favoring Bush or vice versa. Gema said that it could be any of the numbers on the board from their simulation on the calculator. Rico indicated that in the real world 44 of the poll differences favored Bush. Vanessa expressed surprise at the result and Greg wondered if people were lying. Rico asserted again that exit polls were done anonymously after the voting and historically accurate and close to the official count.

²⁶See footnote 18 on page 62.

Rico: If you saw 23 favoring Bush and 27 favoring Kerry, Renee, would you be suspicious?

Renee: No.

Rico: Julie, if you saw 44 favoring Bush and six favoring Kerry would you be suspicious?

Julie: Yes

Rico: Okay, so what we have been trying to figure out is kind of Ann's question. Could this happen, could we toss 50 coins and get 44 heads, or a better way to say this is what the probability of getting 44 heads when you flip 50 coins. What is the probability, if you have these exit polls and the amount that it is off, split 44-6 in favor of Bush. What is the probability? The reason for doing the work that we are doing is to get the answer to this question.

(Audio, 9/23/08)

What Rico did so far is important to note. He built on students' intuitive sense of fairness, what to expect in a coin toss, and connected these to the mathematical ideas of sample variation in the coin toss sub-context and poll difference split in the elections. In other words, the teacher explicitly directed students' attention to the mathematical ideas and the sociopolitical context in the classroom discourse for them to see the mathematical-sociopolitical connection. Additionally, by bringing in the sociopolitical context into the conversation, the nature of the discourse shifted from a purely mathematical discourse to one that invited a mathematical-sociopolitical connection. This was one way in which Rico provided the assistance (Vygotsky, 1978; Cazden, 1981) in this classroom for the interweaving (foregrounding, backgrounding, and connecting) of the two dimensions (which are often disparate). The class on 9/23/08 ended shortly after and students continued to work on the problems related to probability from the coins sub-context over the next two days.

5.2.2 Understanding the sociopolitical context

On 9/30/08, students watched a few clips from the movie *Uncounted* (Earnhardt, 2008). The movie documented the many ways in which fraud occurred in the 2004 U.S. presidential elections, how election integrity was undermined, and citizens were disenfranchised. Students watched the clips intently and had a brief discussion on long lines and waiting times due to disproportional distribution of voting machines in inner-city areas. Students then worked on the ideas of probability using the White Sox sub-context (Appendix A) thus shifting from the sociopolitical (the movie clips) to the mathematical dimension.

The next class period (10/2/08) students watched another clip from *Uncounted* (Earnhardt, 2008) and raised several questions and comments. Julie wondered what actions people took to counter the various ways in which they were disenfranchised (like bogus flyers that were distributed asking Democrats to vote the day after, vote switching, long lines, etc.). She asked who counted the votes and this led to a discussion where Antoinette, Marisol, Renee, Roxanne, and Monica (all of whom had been poll watchers in local elections in Chicago) shared their experience and Rico added to it by mentioning the problems encountered with electronic ballots.

Julie had other questions, such as who was in charge of the locked box and where could one complain if the votes changed. Rico informed students that in the Ohio precinct, the co-chair of Bush's re-election campaign was in charge of the voting process, and this was a conflict of interest. Rico then offered students the movie *Stealing America: Vote By Vote* (Fadiman, 2008) to take home and watch if they were interested in finding out more. Calvin, Gema, and Julie took a copy.

During this intense sociopolitical discussion (a sociopolitical discourse that barely had any resemblance to a mathematical discourse), Ann asked, "Could we not have pushed Bush out of office if there is so much evidence that he won it falsely?" (RFN, 10/2/08). It is unclear

whether Ann was referring to the sociopolitical analysis in the movie clips or the mathematical evidence they were developing. Rico, in his response, foregrounded the mathematical evidence and clarified that what they knew is that it was statistically improbable to get the poll difference split the way it did in 2004, but that did not tell them how or why it happened. Ann persisted in her effort to read the world and asked why Bush was not kicked out of office. Rico indicated that the issues raised by people like Freeman and the movie *Uncounted* (Earnhardt, 2008) were being downplayed by the corporate media as conspiracy theories or internet hackers, and that one of Freeman's articles was rejected in a magazine and one of his interviews cancelled. He asked students to think how many people would believe the information from movie if they [students] showed it to them. Roxanne and Ann responded as follows:

Roxanne: Only people who voted for people who didn't win.

Ann: Impossible to have happened.

Rico: Yes, impossible to have happened by chance.

Ann: So everyone should believe.

Rico: But you have been working a lot of math and how to understand life situations through math. Someone could look at the differences and say, oh that is only 4%, that is not a big deal. People don't know what sample variations mean and people don't know what impossible means mathematically.

(RFN, 10/2/08)

Rico did two things in this conversation. First, he brought attention to the mathematical work students had been doing to understand this situation and made the complexity of the mathematical-sociopolitical connection explicit in this conversation. He indicated that students have been "working on a lot of math and how to understand life situations through math" before they could make this connection which is not trivial,

straightforward, or obvious to everyone. Second, he emphasized that the mathematics only suggested impossibility of the results but did not tell them why or how it could have happened (expressing caution about what they could claim, a point I discuss later in this chapter). Rico's statement here also speaks to the multiple opportunities needed for individuals to "grow into the intellectual life of adults around them" (Vygotsky, 1978, p.88). He emphasized that students at Sojo and in this class were in a unique position to be able to read the world with mathematics since they had opportunities to learn mathematical ideas, and learn "how to understand life situations through math" by being immersed in such experiences for three previous years in high school.

Ann had other questions, as she continued to read the world, such as "Did it only happen the second time or also the first time also when Bush ran?" and "Why did they stop the Supreme Court recount [in the 2000 elections]?" (RFN, 10/2/08) Julie asked if they had evidence for election fraud in Florida, and Calvin wondered if what happened in Ohio happened elsewhere (the exit polls in Ohio showed Kerry winning and the actual recorded vote declared Bush winning). Rico responded that the poll difference shifted in favor of Bush in other states as well, and that more states shifted in favor of Bush than Kerry. He continued,

There were a total of 11 battleground states, 10 where the poll difference favored Bush. Statistically this should not happen. We know that. What do we know can happen statistically, if we have 10-coin toss, how many heads and tails we can get? (RFN, 10/2/08)

In doing so, he again connected the poll differences and coin tosses and transitioned from a sociopolitical to a mathematical discourse. Over the next two days (10/3, and 10/6) students continued to work on the mathematical ideas of probability and binomial distribution in the White Sox sub-context (Appendix A) with interspersed discussions about the sociopolitical context (again a fluid movement between the two dimensions). Students found

the probability distribution for the number of games won in five games (0, 1, 2, 3, 4, or 5 wins), given that the probability of winning a game was 0.6. Julie and Calvin shared some thoughts from the movie *Stealing America: Vote by Vote* (Fadiman, 2008) and Rico distributed copies of *Uncounted* (Earnhardt, 2008) for those who wanted to watch the entire movie.

5.2.3 Bringing it all together

On 10/6/08 after solving problems in various sub-contexts using the binomial formula, Rico switched to the elections context (foregrounding the sociopolitical aspect of the context and connecting it to the mathematical work done so far) for the last five minutes of the class and began by reviewing the poll difference idea.

Rico: So here's a question for you. There were 11 battleground states from the film, this is a review for you. 11 battleground states. Remember the poll difference idea. Greg, can you tell us what the poll difference idea is, 'coz this is significant. What is the poll difference idea?

Greg: I don't know.

Carlton: It's the difference between the recorded vote and the exit polls.

Rico: It's the difference between the recorded vote and the exit polls. Exit poll comes out first and then we have the recorded vote and we look at the difference.

Greg: Wait, (unclear, but seems like he expressed confusion about the order of the exit poll and the recorded vote)

Rico: No, the exit poll comes, the exit polls are done after you vote, their results are released before the vote is fully counted.

Greg: What?

Carlton: The exit poll results come first, then the recorded vote results come in.

Ann: They use it to compare.

Rico: And they use it to predict. The exit polls are released the evening of the election. And during the day, the exit polls are being put out on the websites during the day. That's what happens. Okay, the recorded vote doesn't come in until you know later, because you know the polls haven't finished.

(Audio, 10/6/08)

Greg was puzzled about the chronology of the exit polls and the actual recorded vote, but Rico, Ann, and Carlton's response clarified it for him. Rico then foregrounded the mathematical ideas by reminding students of the sample variation they saw with the 50 coin tosses a few days ago (on 9/23/08). He urged them to use the equivalence between the coin toss and the poll difference to solve two homework problems—a) what was the probability of the poll differences in 10 battleground states favoring Bush and b) what was the probability that the poll difference in 44 states favoring Bush? Both problems connected the mathematical analysis to the sociopolitical context.

Rico started the class the next day (10/7/08) by referring to the conversation he had with Tuan and a few other students the previous evening (10/6/08) about the homework.

I had a phone conversation with Tuan last night, I talked to people around this idea of poll differences, and so it became clear to me that it [the idea of poll differences] wasn't clear to you ... You [Tuan] had an idea of poll difference that was very different from my idea of poll difference. Okay, I didn't know that. So I am giving you all homework based on talking about poll differences, thinking you know what I am talking about poll differences, [and] you got a very different idea. (Audio, 10/7/08)

Ann requested that they discuss and create a definition for all the words needed for the unit so everyone knew what was being talked about when a word was used. Rico took up her suggestion and started by reviewing the words sample, survey, poll, population, and poll

difference, even though these had been discussed early on in this unit. He used the following example to clarify the meaning of these words in the elections context. In a population of 100 people, 60 voted for Kerry, and 40 voted for Bush. In the exit poll of 10 people, five said they voted for Kerry and five said they voted for Bush. The actual proportion of votes for Kerry and Bush were 0.6 and 0.4 respectively, and the exit poll proportion of votes for Kerry and Bush were 0.5 and 0.5 respectively.

He asked students what the difference in proportion between the exit poll and actual recorded vote for Kerry was. Students responded 0.1 and Rico indicated that this was referred to as the poll difference. He then defined poll difference as follows, “It is the difference between the proportion or percentage that went for a candidate in the election as compared to the percentage or proportion that went for the candidate in the exit poll” (Audio, 10/7/08).

Rico suggested that students take a minute to write it down so everyone was on the same page and understood the meaning of the mathematical words as they relate to the real world.

He revisited the discussion on the chronology of the exit polls and actual recorded vote:

Rico: Ok, the exit poll happens immediately after the vote, but the results of the exit poll

Greg: Are supposed to give you a closer view on what the real vote might look like.

Rico: And are released before the actual tabulated vote.

Calvin: How can that be? Like, wouldn't that be equal to the actual vote, why would people lie?

(Audio, 10/7/08)

Greg suggested that exit polls are “supposed” to be close to the actual recorded vote.

Calvin wondered why the exit polls would be “close” and not equal and asked why people would lie. He implicitly assumed that exit poll proportion was different from the actual recorded vote because of people lying in the exit polls. Calvin thus problematized the existence of poll difference, leading the class into a discussion of the reasons for the poll

difference to exist. Rico recognized the importance of Calvin's question and revoiced it (O'Connors & Michaels, 1993) in a way that brought students' attention to the large number of people involved in polling, and the relatively lesser number of people sampled in the exit poll, and this having something to do with the difference mathematically.

Rico: That's a really really good question, Did you hear Calvin's question? Okay, say it again Calvin, and Marisol, I know you guys are doing math there, but, ask your question Calvin.

Calvin: Why, wouldn't the results be the same? Why would there be a reason to lie?

Rico: Why does the exit poll not the same as the actual vote. After all if 0.6% if the proportion is 0.6 that actually voted for Kerry in the state of Ohio of five and half million, when you do an exit poll of 2500 people how could you not get 0.6. What's going on?

(Audio, 10/7/08)

Rephrasing Calvin's question this way, Rico pushed students to begin to think mathematically about the poll difference. Several students responded. Calvin persisted in his argument that exit polls were incorrect (because of people lying). Greg said that the results of the actual vote might not match with those of the exit polls because of computer-generated errors in the actual voting (as seen in the clip from the movie *Uncounted* (Earnhardt, 2008)). Calvin then asked whether exit polls were optional and Rico responded in the affirmative. Calvin reiterated that the reason for the mismatch in the exit poll and actual recorded vote values was due to people not responding in exit polls since they are optional or lying if they responded.²⁷

While one could attribute several (sociopolitical) factors for the difference between the exit polls and the actual vote (computer errors, people lying, refusal to participate, etc.),

²⁷Freeman & Bleifuss (2006) examine and debunk these quasi-explanations (and more) in their book using mathematics.

Rico pushed students to recognize the mathematical reason (namely sampling) for the existence of the poll difference. He rephrased the question as follows to shift students' attention from the sociopolitical reasons to thinking mathematically about why there would be a poll difference.

Rico: Let's say that people, everybody you asked did say yes, let's say they all told the truth, let's say that every person that you exit polled agreed to respond, I voted for Bush, I put in I vote for Bush. Would you necessarily get 0.6 and 0.6?

Calvin: You should.

Greg: You should get close.

Rico: You should get close, why don't you think you will get exactly 0.6?

Ss: I don't know.

Ann: 'Coz, you are not asking everyone.

(Audio, 10/7/08)

Calvin was convinced that there should be no poll difference mathematically. Greg, however, believed that the results should be close. Rico asked Greg why he thought it would be close and not exactly 0.6 to draw out the mathematical difference between being "close" and exactly the "same." Ann immediately pointed out that "you are not asking everyone," and went on to say the exit polls and recorded vote will not be the same since "You are still only getting a percentage of the people that actually did vote. You are not asking every single person that already voted, you are asking a certain amount of people" (Audio, 10/7/08).

Rico extended Ann's response and summarized the discussion by suggesting that the poll difference is due to sampling and sample variation, and not due to other factors such as lying or non-participation. He reiterated that most people did not lie on the exit polls since the polls were anonymous and although the polls did not give the same values as the actual vote

(“there is usually a little leeway, disparity”), they were historically accurate. Students seemed to accept his reasoning since there were no further questions.

There are three points to note in the conversation above that relate to the ideas I developed in Chapter 2. First, Rico’s knowledge of the mathematical reason for poll differences and the need for students to understand the same in order to do a mathematical analysis, helped recognize the importance of Calvin’s question and facilitate this conversation based on that. Calvin’s question made explicit (to Rico) the difference in the way he thought about the reason for poll difference vis-à-vis the teacher’s and Rico recognized it when he referred to his question as “a good question.”

Second, Rico did not immediately use his authority to answer Calvin’s question, but instead facilitated a discussion where others (Ann, Greg) students responded and he reframed and refocused Calvin’s question. After Ann stated her intuitive (mathematical) reason that “you are asking a certain amount of people” for why the exit poll proportion and actual recorded vote would be close, Rico built on her statement to summarize this conversation by connecting it to sampling.

Third, although (later in this unit) students simulated sample proportions on their calculator using normal distributions with a given actual recorded vote proportion and sample size and saw the variation in the values they obtained, they did not work to show how unbiased sampling from a large population (sample space) contributed to the poll difference. Students seemed to have accepted the (logic for) mathematical reason for poll difference based on this conversation. However, I argue that this is in direct contrast to a banking approach because of the previous two points mentioned (the teacher’s role and overall stance of the conversation).

Subsequently, Rico brought students’ attention to the question they were trying to figure out in the unit namely, “How big of a difference before we starting saying that there

was something bogus here.” (Audio, 10/7/08) In other words, the question was to find out what is the mathematically acceptable leeway, before stating that there were factors (other than chance) contributing to the difference.

Greg rephrased Rico’s statement by saying, “So wait people would think that, when they see the exit polls and they look at the real votes, and the exit polls are way off, they think somebody has to mess with the actual votes the count” (Audio, 10/7/08), and captured the mathematical and the sociopolitical connection. He connected the idea of the “exit polls being way off” (mathematical) with “something happening with actual votes, the count” (sociopolitical). Rico affirmed his statement and responded:

That is the question that we are trying to address, some people would say that yes. If the exit polls are way off from the real vote, then we need to figure out what the heck went on here. Because mathematically the exit polls should be relatively close and we are trying to understand how close mathematically and how far away from the real vote does the exit poll have to be before we can say statistically this could not have happened by chance. Let me say that again. What we are trying to investigate is how far away from the real vote the exit poll has to be before we can say we know the mathematics to say that statistically, that is, using mathematics to analyze it, it is not possible that this happened by chance, randomly. (Audio, 10/7/08)

Throughout this day, the teacher pushed students towards the mathematical-sociopolitical connection and Greg voiced his understanding of it. Rico and students then worked to find out the probability of 50 heads occurring in 50 coin tosses (0.5^{50}) on the calculator. This turned out to be 8.88E-16 or 0.0000000000000000888. Rico indicated that it would statistically be impossible to get 50 heads in a row by chance since this number rounds to 0 and further said that if there were 50 heads then,

Something is rotten in the cotton. That means something else happened. We don't know what happened, we have seen a lot of evidence about different types of voter suppression and all that, but we know this couldn't have happened by chance. (Audio, 10/7/08)

He again emphasized the mathematical-sociopolitical connection by saying,

We are trying to figure out what we can say about poll difference in the 2004 election, is it far enough away from the real vote so we can say ah-uh this didn't happen by chance. But you cannot make that charge, which is a political charge, unless you have the mathematical knowledge to back it up. This is the relationship between the mathematics and the political analysis. You have to have the mathematical knowledge to make a political argument here. (Audio, 10/7/08)

A week later (10/14/08) when a few visitors from the UIC College Bridge program visited the classroom, students explained clearly the questions they were trying to address in this unit, the mathematical ideas they were working on, and the sociopolitical evidence they had seen from the movie *Uncounted* (Earnhardt, 2008). I wrote in my field notes,

Carlton started off by saying that we had been talking about poll differences, which is the different between the actual recorded vote and the exit polls, asked someone else to take it away from there. Roxanne and Vanessa added that they were investigating the 2004 elections and finding out what the probability was of the states going for Bush or Kerry, and what the probability was for Bush getting all 10 of the swing states and then 44 of the 50 states, that this probability was quite small, almost 0 and so the election was stolen. There was some silence and Carlton said - ask some questions [which was exactly my thought at that moment!]. Rico said that he did not feel the explanations were sharp and asked them to make it sharper and referred to what Carlton was saying about poll differences. He asked, "Are we talking about the

states going for Bush or the poll difference going for Bush. What was the random event here?” More students pitched in - Monica, Greg - in addition to everyone who was contributing before. J (the visitor) asked them if the exit polls are usually spot on. Vanessa responded by talking about sample variation and Carlton elaborated by giving an example from the coin toss experiment. The other visitor asked if what they were talking about was that usually there is a difference between exit polls and actual recorded vote and that it favors Bush or Kerry. And students affirmed that. Someone (Carlton?) added that you would expect it to go 25-25 (50-50), but that was not the case in the 2004 elections. (RFN, 10/14/08)

About ten days later Rico gave students a culminating assignment for the unit that asked them to explain the mathematical evidence for possible election fraud in 2004. Students also worked on developing the third piece of evidence, namely the probability of the actual recorded vote for Kerry in Ohio being 48.7% when the exit poll predicted a proportion of 54.2%, using the mathematical idea of confidence intervals in a normal distribution.

In summary, Rico focused on the following ideas to support students developing mathematical evidence for possible election fraud—exit polls and poll differences; poll difference and its equivalence to coin toss; and sampling and sample variation. He also made visible the mathematical reason for the poll difference to exist and thus pushed students from an everyday to a mathematical analysis (i.e., acceptable range of the poll difference split) of the elections context.

Although Freeman & Bleifuss (2006) discuss several counterarguments to the mathematical argument they developed, and Rico did bring in some of these into class, due to time constraints there was limited discussion on these. Rico emphasized the limitations of what claims one could make based on this evidence. He often reminded students that although the evidence suggested that the 2004 election results could not have happened by

chance, they do not tell what happened to skew the results this way, and therefore one could not claim the elections were stolen. In their response to the final assignment, students also expressed similar caution. They made statements such as "...although we can never really prove the presidential election was stolen," "We are trying to find out if the election was stolen or was it a lucky break for Bush," and "I cannot explain to you what really happened in the 2004 presidential election, but I can give hard evidence that shows it was tampered with."

The analysis further indicates that the discourse in the classroom moved between mathematical and sociopolitical dimensions. At times, students made the mathematical-sociopolitical connection (as Greg and Ann did), but often Rico made this connection and initiated the shift from one to another based on his sense of where he wanted students to go both mathematically and sociopolitically. While there were several factors (such as the teacher's pedagogical acts, students' questions and engagement, peer-peer responses, and the movie) that mediated the interweaving of the mathematical and sociopolitical aspects in this unit, the teacher's role in facilitating the classroom discourse was an essential component.

Questioning, building on and challenging students' intuitive sense (like with the coin toss, and Calvin's question on people lying), revoicing student contributions, revisiting important ideas (like sample, polls, exit polls, the chronology of exit polls and actual vote, population, sample variation etc.), stressing the difference between "close" and exactly the "same," were some ways in which the teacher pedagogically facilitated a discourse that interwove the mathematical and sociopolitical dimensions in this unit. In the next section, I discuss the ways in which this interweaving emerged and was facilitated in the HIV-AIDS unit.

5.3 *HIV-AIDS Unit*

5.3.1 **Creating a model for HIV-AIDS spread**

Rico's initial thought for this unit was

...to have[students] create math models of AIDS transmission, and then think about tweaking them based on more (for example) gender equity so to reduce “survival sex,” or better/more accessible HIV testing or full free access to condoms everywhere. The idea would be to make a mathematical argument that we'd have less deaths if we did one or more of these things. (TJ, 3/19/09)

He was aware that this was “a bit contrived because we are just playing with numbers here and cannot know how to change the parameters to affect the number of deaths” (TJ, 3/19/09). Further, this approach of creating mathematical models for HIV-AIDS transmission was impractical for several reasons (as Rico realized in the process of enacting this unit). First, creating a model for disease spread was mathematically very complex and beyond the scope of this class. The class worked on SI systems (Chapter 4), but these were too simplistic to model the kinds of scenarios related to HIV-AIDS transmission in communities. Second, data specific to students' communities for creating the model was scarce and rather difficult to obtain. Third, the mathematical-sociopolitical connection through this method was not very obvious or clear.

After the first two weeks of working on the mathematical ideas of developing a system of linear equations for a few dynamical systems such as trees sub-context, car rental sub-context, blood-liver sub-context (see Appendix A), and modeling of disease spread (a simple SI model), I wrote in my field notes:

At this point I don't know if students see the mathematics as being connected to social reality. Yes, (the spread of) HIV-AIDS can be modeled this way, so what? How does understanding this model help me make an argument to change the discourse on AIDS? Can I use the model to make an argument for increased social responsibility in

how we are dealing with AIDS? Can I use this model to make an argument to show that our current approach to dealing with this epidemic is futile and so on? We need to tie the mathematics as being helpful in understanding and changing the social reality.

(RFN, 3/19/09)

On the same day, Rico journaled:

After class, Anita contrasted what we're doing in the AIDS unit with what we did in the Elections unit. Students are not clear about why we're doing what we're doing! And that's my responsibility. I'm not even super sure...but she pointed out that we need to one, frame it more clearly in terms of the sociopolitical and economic context, and two, make it clear what we're doing mathematically that relates to the sociopolitical context.(TJ, 3/19/09)

Both Rico and I were struggling to figure out (or nail down) the mathematical-sociopolitical connection in this unit, which was clearer in the elections (and displacement) unit. Apart from a brief discussion on what HIV-AIDS is and how it spreads, there was neither clarity on how the mathematical ideas connected to the sociopolitical context nor much discussion on the sociopolitical context of HIV-AIDS itself. What began to emerge is a different nature of the mathematical-sociopolitical connection in the HIV-AIDS unit from the elections unit, the difference that I discussed at the beginning of this chapter.

5.3.2 Understanding sociopolitical factors

In order to engage students in a sociopolitical analysis, Rico decided to have students read from the book *Global AIDS: Myths & facts* (Irwin, Millen & Fallows, 2003). He wanted to provide different viewpoints to the dominant HIV-AIDS discourse and support students to recognize the sociopolitical forces that strongly constrained individual choices. He specifically chose a piece of text from this book (the second chapter, the theme of which was

to debunk the myth of bad behavior) to push students to think about the sociopolitical factors that influence individual choices which then affect their susceptibility to HIV-AIDS.

Starting 3/20/2009 Rico brought in this text for students to read (Chapter 4). Over the next two days students made presentations and there were several conversations with respect to the relationship between individual behavior and social factors. On all three days (20th, 23rd, and 24th) Rico continued to push students to think about how social factors influence HIV-AIDS infection rates by raising questions, revoicing, and reframing specific points raised in the presentations by students, providing counter examples to challenge students' statements, and so on. In this process, a clearer and pragmatic mathematical-sociopolitical connection and the kind of mathematics required to read the world in this unit came to the fore. After the first day of discussing this chapter, Rico journaled:

Do they need to know how to write a DDS to be able to read the world with mathematics? No, not necessarily. Do they need to know how to model AIDS to know that African Americans are disproportionately affected by it? No. So what are we doing and why? Is this just an academic exercise, and if so, is there a problem with that? I am toying with the idea of chucking the dynamical systems. Or rather, I think I want to try to somehow, IF we still do them, make them North Lawndale specific, or at least Chicago specific, and specific to African Americans and Latinas/os. Otherwise, it's not that clear to me what is the value of the DDS with AIDS. Yes, I like the mathematics [DDS]...but why and what are they really learning? This is my hangup, if that's what it is, that I want students to learn the "rigorous" math. (TJ, 3/20/09)

Although Rico did not see a direct connection between learning the mathematics of DDS (reading the mathematical word) and understanding the sociopolitical context of HIV-AIDS (reading the world), his journal entry here indicated that he wanted to find a way to

connect learning the “rigorous” mathematical ideas with learning to read the world. This relates to the discussion of the content-context continuum in Chapter 4 and the tensions that exist while trying to connect the mathematical and sociopolitical content within a context. Rico tried to make sense of what mathematics students need to be learning and for what purpose within the context of HIV-AIDS and continued to try to tease out the coherence in the mathematical and sociopolitical goals for this unit and the content. He noted in his journal,

How do we tie this whole conversation to mathematics? One thing is clear, we can try to explain the disparity rates on so many things, but this one, for AIDS, is particularly important. The 18 times as much issue [The HIV prevalence rates for Black women was 18 times higher than white women in 2006, (Center for Disease Prevention and Control, 2006)]...I asked this in class and a couple people (Ann, for one) explained it as poverty. But she could not clarify how and why poverty contributed to high rates of AIDS. She did say (and someone else?) that we could not answer the question about the rate disparity. This becomes a class in sociological investigation of things like high rates of AIDS among African Americans. At times, we use mathematics to explain social things (like the election being stolen), at other times, we use social analysis to explain mathematics (like high AIDS rates). (TJ, 3/23/09)

Subsequently, Rico focused on the mathematics of disproportionality for a few weeks. However, this decision was not an easy one for him since he wanted students to learn the “rigorous” mathematics of the DDS. Despite this concern he made this shift, which ought to be seen in light of the following points. First, although the mathematics of creating DDS for modeling HIV-AIDS transmission was definitely more challenging and rigorous, it did not support a better sociopolitical understanding of HIV-AIDS infection and death rates. Second, Rico wanted to “provide students with perspectives that differ from dominant narratives so

they can develop their own... to ensure that students did not leave class demonizing Black women for their HIV/AIDS rate” (Gutstein, 2012a, p.33). In order to do so, he chose to bring to the fore the disproportionality in HIV-AIDS infection and transmission rates and find ways to explain these data.

Third, the mathematical idea of disproportionality was not easy for many students (as would have been expected). Rico would have liked students to learn mathematical modeling of disease but this was impractical for reasons elaborated in Chapter 4 and out of reach for many of students due to their profound mis-education in the racialized public education system (Ladson-Billings, 1997; Martin, 2006). Shifting to the mathematics of disproportionality was not dumbing it down for students, despite Rico’s concerns. Instead, this was an appropriate decision in this instance, because mathematically it turned out to still be challenging for students, and began from where they were at, which is also sound reform math pedagogy. The mathematics of disproportionality was required for reading the world as well. In other words, this decision to shift supported both reading the world and reading the mathematical word, and was indeed necessary to create coherence between the goals, and the content in this joint activity.

5.3.3 Making the connections

On 3/24/2009, after students finished presenting the key ideas from the sections of the myths chapter assigned to their groups, Rico asked them to think about the relation between racism, poverty, and high rates of HIV-AIDS infection. By doing so, he tried to emphasize the mathematical-sociopolitical connection. Ellen and Gema respond as follows.

Ellen: Isn’t that kind of, it’s like, if you live in poverty then, well, AIDS and poverty connect, because, like, when you’re poor, you don’t have as much resources and stuff like that. And you are more closed out and, like, you know white people, well I am not saying they are rich or whatever, but, like, they have

more resources and more places to go, and more information to know and stuff.

Gema: Well, then it also fits in, like the stereotypes, like, many people that live in minority communities are mostly are living in poverty, and they tend to watch television. And sometimes they tell that they should act as the way people, as they are being portrayed in the media. And that tends to lead into, like this, they start thinking that that's the way they should live, leading them to do stuff that they wouldn't do otherwise.

(Video, 3/24/09)

Here, Ellen and Gema were beginning to consider the possibility of poverty influencing HIV-AIDS infection rates in communities. The next day (3/25/2009) Rico brought in data related to HIV-AIDS diagnoses in Illinois and Chicago for 2006 and students spent a significant portion of the class investigating this data and working on the idea of disproportionality. It was then that the conversation highlighted in snippet 2 ensued where both Roxanne and Ann raised the counter argument that poverty could not be a factor to explain the disparity in HIV-AIDS infection cases in 2006 in Chicago (see footnote 1). It may seem that Ann and Roxanne went back to their original position of considering individual behavior as influencing HIV-AIDS rates. What is important to note is that Ellen, Gema, Ann, and Roxanne were indeed trying to make sense of the mathematical-sociopolitical connection (each in their own way).

Over the next week, students continued to work on interpreting the data related to new HIV-AIDS diagnoses for Black women in Illinois and Chicago for 2006. They spent two days graphing the data available (1990 through 2002 and a data point for 2006) on the calculator and used linear and cubic regression to predict the number of newly diagnosed HIV-AIDS cases for Black women in 2009, with and without the data point for 2006.

Subsequently, Rico picked up from where they left off, before reading the myths chapter from the book *Global AIDS: Myths & facts* (Irwin, Millen & Fallows, 2003), and students created a SI model for the spread of the disease. They wrote the equations for the system, graphed it, and changed the probabilities of infection to see corresponding changes in the graph. However as I wrote in my field notes, it was “not yet clear why this matters - sociopolitically? Yes, mathematically it is important, but what is the connection sociopolitically? What is the connection of the mathematics with the sociopolitical analysis here?” (RFN, 4/14/09)

A few days later (4/20/09), Rico brought in a sheet with HIV-AIDS data from North Lawndale and students worked on it in class to create a dynamical system for HIV-AIDS spread in North Lawndale. The next day, after completing the work given in this sheet, Rico asked students to consider how they could talk about the disproportionality in the community presentations.

Ann: How are we supposed to, how are we supposed to explain, when we don't know.

Rico: Know what?

Ann: Answering why it's disproportionate.

Rico: Okay, so why did we do all this work with these, why did we spend a week discussing this [referring to the myths chapter]? What was the, all that, you know, do you have any sense what, how looks your explanation for that [pointing to the pictorial representation of the disproportionality, a pie chart of the infection rates and the population distribution in Chicago]?

Ann: But an assumption is an assumption

Rico: What do you mean an assumption is an assumption?

- Ann: Like, it's, I mean, I don't think there's a certain fact that we can say this has to be the reason for it to exist. That's basically an opinion.
- Rico: Basically what?
- Ann: Opinion.
- Rico: So what is your opinion? And does your opinion matter?
- Ann: May not, but
- Carlton: We only convince other people [inaudible] facts.
- Rico: Okay, so what facts do we have?
- Ann: Numbers, statistics, but you are, that is going to the math, that was we explaining what is happening, but you are asking to ex, tell you why.
- Jenny: You want us to explain to them that AIDS is not how [inaudible], you don't want us to explain, you want us to go beyond stereotypes?

(Audio, 4/21/09)

Rico wanted students to provide some sociopolitical analysis for the disparity visible in the data to ensure that people did not walk out with the bad and dangerous behavior myth. However, Ann was emphatic that they cannot explain the disparity. She said so here, and later on Vanessa too stated, "But I don't think you can explain it". Ann's comment "that's basically an opinion," and Carlton's view that we can convince people only with facts such as numbers, and statistics indicate the tension that students were facing. Perhaps they meant to say that the disparity cannot be explained based on facts or that a (mathematical) reason be attributed to it and therefore, as Ann suggested, that what they offer would be an opinion and not an explanation or analysis (in contrast to perhaps the work they did in the elections and displacement unit). Nevertheless, Rico continued to push them to extend their analysis by asking them to think about the chapter on myths that they read.

The conversation towards the end of the class ended abruptly with the ring of the bell and Rico wound up the class saying, “obviously there is more conversation to be had here,” implying that work was in progress to make sense of this connection for students. Whether all students had some sense of the mathematical-sociopolitical connection is unclear from the available data from this class. Providing a simple explanation for why Latinos are disproportionately underrepresented while Blacks are overrepresented is neither possible nor was the aim of the teacher here. Moreover, it is not possible to expect that students or the teacher resolve such a complex issue within a few days (Chapter 4). As I mentioned earlier in this chapter, Rico continued to explore this connection by continuing to communicate about this with the epidemiologist who pointed him to an article (See footnote 24).

Allowing space for uncertainties, ambiguities, and open questions is an integral part of a dialogic problem-posing approach (as I discussed in Chapter 4 as well). The space that the teacher provided to let students struggle to make sense of the world and the data as opposed to giving answers (which he anyway did not have) was vital for this conversation to unfold. However, Rico felt that this was perhaps a missed opportunity and I agree with his reflection.

While I believe, in general, that students have to learn to handle ambiguity as part of learning how to remake the world, this oversight was a missed opportunity...At the very least, a teacher in this situation could have had students examine whether this was a trend/pattern and asked them how might they investigate this further and what else did they need to know. (Gutstein, 2012a, p.39)

So although students never fully settled this question of individual behavior versus social factors, this class provided them with opportunities to think about the HIV-AIDS infection data across different communities and the complexities of explaining it. The teacher’s decision to shift to the mathematics of disproportionality, the choice of the myths

chapter, the discussion that ensued in class, the teacher's role in pushing students to think beyond individual factors and yet allowing them the space to work through the tensions that arose for them, and students' participation, were all ways in which the mathematical and sociopolitical dimensions interwove during these few days of the unit.

A key point to note here is that the teacher facilitated the interweaving of the two dimensions based on what he considered the potential mathematical-sociopolitical connection in this unit to be, and at the same time continued to refine and be open to changing it. Although Rico started out with a different mathematical-sociopolitical connection, it changed during the course of the unit, and he made pedagogical decisions to bring coherence between the long terms goals, the content, and the classroom interactions. In the summary below, I discuss this in relation to the framework that I developed in Chapter 2.

5.4 Discussion

I started this chapter by describing the ways in which the mathematical and sociopolitical dimensions connected in the snippets introduced in Chapter 1. I then traversed the classroom discourse to get a sense of how this mathematical-sociopolitical connection materialized and was facilitated in the interactions. Throughout this analysis, I focused on how the mathematical and sociopolitical dimensions were foregrounded, backgrounded, and inter-connected, and by whom. I also investigated the teacher's pedagogical actions and decisions and its coherence with the goals of this classroom and tried to understand the teacher's role in trying to ensure that this joint activity provided a zone of proximal development for interweaving the two dimensions. Several points surfaced in this chapter.

First, the analysis gives insight into how the mathematical and sociopolitical were interwoven at different times/levels. One form of the interweaving was in a particular utterance by either student or teacher that brought together the mathematical and sociopolitical dimensions in a single utterance (for example the two snippets, or Rico's

questions connecting the two dimensions). Another form of the interweaving was seen over the course of a day (or few days) as a movement between mathematical and sociopolitical discourse.

Yet another form of interweaving was seen when the teacher made pedagogical decisions to foreground, background, or bring together these dimensions keeping in mind both the mathematical and sociopolitical goals for this class. An example is the teacher's decision to shift to the mathematics of disproportionality, or deciding to bring in a movie clip to emphasize the sociopolitical factors in the elections unit. Finally, there is the interweaving at the entire year and unit level, when all of these (the individual utterances, the pedagogical decisions, and the daily dance) come together in order to read the world and read the mathematical word. That is, my analysis suggests that the interweaving of these dimensions, at multiple levels in several ways in the classroom discourse, facilitated the mathematical-sociopolitical connection to emerge in the classroom interactions.

Second, the teacher facilitated the interweaving of these two dimensions. Through his pedagogical acts in the classroom and his pedagogical decisions, the teacher orchestrated the movement between a classroom discourse that is mathematical and sociopolitical. Students in turn participated in and contributed—by asking questions, responding to the teacher and peers, bringing in their awareness of the world and mathematics, and by beginning to connect the mathematical and sociopolitical (as we saw Ann, Roxanne, Greg, and others do, in this chapter).

Third, part of the teacher's role in interweaving the two dimensions was to decide when to make a shift and be willing to leave one dimension to go to the other and return to it later. Rico's awareness of the mathematical-sociopolitical connection was one reason why he was able to interweave the two dimensions in the classroom. This suggests that the mathematical-sociopolitical connection of each unit is (and must be) a central consideration

in the teacher's pedagogical decisions, at various temporal levels, to shift between the two dimensions and the content/context to focus on. The teacher needs to have a sense of the (potential and possible) connection at the unit level and/or at least be open to them emerging, as happened in the HIV-AIDS unit.

Fourth, the coherence between the teacher's pedagogical decisions and the dual goals for the class is key to develop the mathematical-sociopolitical connection (which may be different for each unit) in the classroom. In the HIV-AIDS unit, the sociopolitical analysis was necessary to make sense of the mathematical data. Although it might have seemed that the teacher was giving up the opportunity for students to work on challenging mathematics when he shifted from DDS to disproportionality, this willingness to let go and make the shift provided opportunities to read the world and read the mathematical word as well. It is important of course to note that the teacher made this shift despite his hesitation (of giving up the learning of DDS for disproportionality) and the mathematics of disproportionality was *still* challenging for many students.

However, unlike the HIV-AIDS unit where students did not have to do the DDS to understand the situation better, in the elections unit, one could not have investigated the impossibility of the poll difference split without the mathematics of probability and statistics. Therefore, the teacher persisted with the challenging mathematics for this reason as well. I elaborate on this difference in Chapter 7, but here I also point out that the nature of the mathematical-sociopolitical connection is related to the context-content continuum described in Chapter 4.

The analysis in this chapter also shows evidence of student engagement and participation both mathematically and sociopolitically, foregrounding one dimension over the other or bringing the two dimensions together in their utterances, influencing the trajectory of the classroom (as Calvin, Ann, Roxanne, Greg did through their utterances). I suggest that

this is consistent with Sfard's (1998) perspective of the participatory metaphor of learning (in this scenario, learning to read the world and read the mathematical word). Although I did not analyze the data for students' mathematical or sociopolitical learning, their responses in the year-end survey indicated changes in their orientation towards mathematics and the world.

Several students said that this class helped them to see the power of mathematics.

Antoine said, "Yes, I now see math and education as a tool to fight for social justice."

Guillermo wrote, "I still think math is *ok* but I have learned that math can do more than you think." Gema said, "My views on math have drastically changed because before I used to think that math was pointless but now I see that it is really needed to figure out many things that are going on around the world." Miriam, who struggled with many basic mathematical ideas indicated that, "My views have changed because if a person understands mathematics real well then he/she will understand that mathematics is the power and key to success," perhaps implying that she did begin to understand several basic mathematical ideas through the work done in this class.

Indicating their changing outlook towards the world, a few students said that this class revealed to them many issues that existed in their communities of which they were unaware. Carlton said, "This showed me how my people are oppressed and it's sad because it's happening in my community." Minerva said, "I wasn't aware of all the injustices in the world prior to this class. I was aware that some things were messed up, but this class actually let me see the facts so after learning about the elections, the prison systems, etc. I started seeing just how bad things really are." Others displayed a sense of social agency and hope despite the problems. Ann said for example, "Now, I know that there is something that I can do about the problems in our community and the world. Before I knew about issues and that was just it." Miriam said,

This class help me change my perspective about the world. Before I was in this class, I didn't care about the problems that were going on in my community. But after taking this class I care more about my community and in the future I will find a way to get involved in my community to help my people but specially my family.

Ellen said,

This world needs a change. This world shouldn't be racist to minorities. This world should be fair. I never imagined that this world was so corrupt. We need to unite to fight for some common goals. We need to fight the cause!

Finally, students' participation in this class also relates to the notion of performance before competence as suggested by Cazden (1981), where students performed (interwove the two dimensions) in the presence of the teacher who had experiences mathematically, socio-politically as well as in bringing the two together. The teacher's mathematical and sociopolitical knowledge (what Gutstein (2006) referred to as classical and critical knowledge) was important in assisting students in this joint activity. At the same time, Rico was aware of the tension between letting students develop their own meanings and bringing in what he knew. Rico captured this in one of his journals (about the mathematical dimension and it is perhaps relevant to the sociopolitical dimension as well).

So this is a decision that the teacher, trying to teach in a way that "honors students' own productions" (again, drawing on, using RME's [Realistic Mathematics Education] philosophical tenets), has to make about when she/he intercedes to provide explanations. How long do you let students go? This is always a question. I made the decision, and I agree with Patty on this point, that even if you provide an explanation, students still have to work with it, over time, to make it their own. I provided one way to think about it. Minerva said something like, "I think I have to work with it for a while," which is exactly Patty's point. (TJ, 9/19/08)

As Becker & Varelas (1995) suggested, emphasizing the role of the teacher's knowing does not immediately take away from students' autonomy. Instead, in this relationship between the teacher and students, the teacher's role is like that of a choreographer. He suggests the content, usually decides when to move from one dimension to another and pushes for both mathematical and sociopolitical learning and connecting the dots. While the teacher created and initiated this space, the students decided to take it up, worked with the content, and participated in the process. The teacher and students fed off and supported each other in order to make the dance between mathematical and sociopolitical dimensions possible at multiple levels over time. In the next chapter, I discuss four key features of interactions that arose in this classroom to facilitate this dance.

6 CO-CONSTRUCTING THE CLASSROOM SPACE

I like the collectiveness between us students. I like that we had built enough trust and honesty to where we can say anything and not be afraid of harsh criticism. (Student response, mid-year survey)

In this chapter, I discuss the ways in which the teacher and students co-created this classroom space for interweaving the mathematical and sociopolitical dimensions. Four unique features emerged in the analysis of the teacher student interactions in this class namely proclaiming competence, building solidarity with students, bringing the world and self into the classroom, and making collective decisions. These four aspects helped develop teacher-student relationships based on a dialogic stance (O’Connors & Michaels, 2007), allowed for opportunities to overcome the teacher-student contradiction that discussed in Chapter 2 (Freire, 1970/2000) and supported the joint activity in this classroom by allowing space for the sociopolitical dimension to arise, fade, or connect with the mathematical dimension.

Before I discuss these in detail with examples, I share a few thoughts on how the teacher’s experiences (both sociopolitical and mathematical) supported the evolution of this class. Mathematically, Rico had the experience of working with the Cognitively Guided Instruction (CGI) team, and developing curricula with the Math in Context (MiC) team.²⁸ Rico had taught several units from the MiC curricula to middle school students (Gutstein, 2003, 2006; Gutstein et al. 1997). At Sojo, he supported teachers in the process of teaching IMP units as well. He tried to actualize aspects of reform pedagogy in this class from his wide experience of working with CGI, MiC, and IMP curricula. He attempted to build on a)

²⁸ Both CGI and MiC were reform-oriented mathematics projects developed at University of Wisconsin-Madison.

what students knew, or had worked on before, b) students' informal mathematical knowing, and c) aspects of their community knowledge and experiences, guided by a Freirean search for generative themes as the starting point of liberatory curriculum. Whenever possible he used contexts that were familiar to students because of their prior mathematical work or their life experiences (such as the Jena 6 and White Sox sub-contexts). Rico also facilitated interactions through many of the ways indicated in the research literature in reform-oriented mathematics classrooms (e.g., Hufferd-Ackles et al., 2004; Mendez, et al., 2007; Walshaw & Anthony, 2008).

Although Rico was less vocal about his journey as a mathematics educator, he frequently shared his personal history, struggles, and experiences with respect to race and gender. In one instance, early in the academic year (9/29/2009), he read a letter he wrote to students sharing how his being Jewish, living in Harlem—a black and brown community, and participating in social movements in the U.S. in the 1960s all contributed to his personal and political history. Towards the end of the year (4/27/09), Rico shared a photograph in class for everyone to look at. It was a picture taken in 1970 when he and his classmates (in high school) occupied the school for 3 days because the school authorities said that there was nothing by or about people of color that was worth including in the curriculum. He told students that he sent the picture around to demonstrate the kinds of actions young people their age were capable of taking. He reminded them that it was a different time and setting, and he was not making a judgment about what should be done, or what counts as action, but instead shared the photograph to emphasize that young people were capable of engaging in powerful social action. Rico's involvement with Sojo went beyond the role of a mathematics teacher. After the CPS board approved the school, following the community struggle, Rico joined the design team in 2003. Since then, he has been involved in this school in various roles including his role as a mathematics teacher and a mathematics educator.

Understanding the teacher's journey—mathematically and sociopolitically—is essential to see how these two dimensions are integral to the teacher's thought and actions. The mathematical-sociopolitical dance is internalized for him and he switches between them, interconnects them with ease, and is able to assist others in doing so (to some extent). This does not mean that teachers wanting to do such work in their classroom need to have similar sociopolitical or mathematical experiences. It, however, does suggest that it is necessary to have experiences in both domains and be able to do this dance for ourselves.

While the teacher's experiences and efforts were important to create this classroom environment and facilitate the interweaving of the mathematical and sociopolitical dimensions, it would have been insufficient if students did not take it up and take it forward as well. The teacher's initiation and students' taking it up is evident in every feature I describe in this chapter. Student voice and the ways in which it manifested itself in class, mathematically and sociopolitically, was a theme that strongly surfaced in the analysis of the elections and HIV-AIDS unit data.

The presence of student voice in the classroom did not mean all students spoke at all times. Instead, it meant that students participated in the classroom in several ways (including being silent) that felt appropriate to them. Students who were silent in class often showed their engagement and participation through their journal writing, coming up to the board to present their work, or during after-class tutoring. Contrary to interpreting students' silence in class as non-participation or disengagement, in some instances in my analysis I interpreted students' silence to Rico's decisions to shift between the two dimensions as acceptance of the decision, knowing well that they had the power to question and change the decision if they so felt. The key point here is that the teacher (and the researcher) constantly raise the question, "what does the silence mean in this case?" and ensure that students get opportunities to participate in myriad ways in class, as was the case here.

In the rest of this chapter, I elaborate on the four features of interactions that emerged as unique to this classroom and facilitated the joint activity between teacher and students for the purpose of reading the world and reading the mathematical word.

6.1 Proclaiming competence

Based on empirical evidence, Cohen (1994) suggested that teachers who proclaim competencies are able to “mitigate existing status inequalities” and contribute to creating equitable classrooms. Ladson-Billings’ (1995) study of the practices of “expert” teachers indicated that they consciously made efforts to create equitable and reciprocal teacher-student relationships. She identified several ways in which teachers did so, such as allowing students to act as teachers, highlighting expertise of various students, and encouraging a collaborative community of learners emphasizing collective success in addition to individual achievement. Naming students’ contributions in this class was a regular feature of the teacher’s actions and I share examples to illustrate how Rico frequently did so.

On the first day of class, Rico distributed two documents. The first one contained the syllabus for the course and the second one included the ground rules for the class. In the second document (Appendix D), Rico suggested that students persist to Cuestion, Critique, Challenge, and Create (in Spanish, *cuestionar*, which means “to question”). He termed this as the 4C’s for the class. Over the next few weeks, these become the 7C’s—“Connect and cuestion, critique and challenge, collaborate and communicate, so you can then create” (Audio, 10/6/08). Rico posted these on a large chart on the back wall of the class.

Connecting involved making connections between mathematical ideas, between sociopolitical contexts, and between the two. It also involved making connections between the self, the world, and the mathematical ideas. *Cuestioning* involved raising questions about the mathematics, and the sociopolitical contexts (including mathematical questions about them). Students *critiqued* and *challenged* the social realities, and each other’s and the

teacher's statements (both mathematical and sociopolitical). They *collaborated* and *communicated* with each other, and with the teacher on mathematical and sociopolitical ideas. And, *created* for themselves a deeper understanding of the world, as well as a better world.

Rico regularly referred to students' actions, questions, or comments on the previous day and connected them to one of the 7C's. In this way, he positioned students as capable contributors and competent participants. Sometimes he referred to how students contributed to the mathematical or sociopolitical discussion in the class, and at other times, he mentioned students' initiative to challenge, critique, or support each other. While there were several instances of this throughout both units, I share a key incident that occurred in the classroom at the end of the fourth week of the elections unit, that is, four weeks into the academic year.

6.1.1 The Bogus Incident

On 9/25/08, after a brief conversation about homework and what he could do to support students completing it, Rico began where the class ended the previous day, namely understanding the expression $20C10/2^{20}$ which gave the probability of getting 10 heads when tossing 20 coins. After discussing the meaning of this expression, Rico shifted the conversation towards the idea of multiplying probabilities. He connected it to the work they had done in the 3M3F, and Jena 6 sub-contexts in this class and in previous years.

In the 3M3F sub-context, students calculated the probability of choosing two females from a group of three males and three females by multiplying the probability of getting a female in the first pick and the probability of getting a female in the second pick. Rico (incorrectly) said that they could do this since the two events were *independent*, in other words, "when events are independent and you want to know the probability of both of them occurring you multiply the probability of each occurring" (RFN, 9/25/08).

In the Jena 6 sub-context, students calculated the probability of getting a jury of all white people in two ways. First, they multiplied the probability of getting a white person as

the first juror, a white person as the second juror and so on until the 12th juror, i.e. $1844/2154$ * $1843/2153$ * * $1833/2143$. Second, they made the assumption of replacement (i.e., replacing the first person back into the population) and calculated the probability of getting a white person twelve times as $(1844/2154)^{12}$. Rico had discussed the appropriateness of the replacement assumption in this scenario, since the number of jurors (12) was significantly less than the number of white adults in the population (1844). On this day (9/25/08), however, Rico suggested,

If you remove a juror of color, let's say the first pick is a juror of color, you no longer have the exact same number of jurors of color in there, you have three hundred and nine. So it slightly changes the probability...Okay, so technically those are not independent. (Audio, 9/25/08)

Ellen rephrased her understanding of what Rico said as follows.

Ellen: So if we change the probability they are not an independent event?

Rico: That's right, okay. Because,

Patricia: I am confused.

Rico: Okay, so yeah, okay, go ahead.

Patricia: Well, because when you gave the example of the female and the male, and you said well you remove her and now they are independent, but in this case you are saying they are not independent [and therefore cannot be multiplied, contradicting the work they had done earlier].

(Audio, 9/25/08)

Patricia raised a question about the inconsistency here concerning the independence of the events and multiplying probabilities. Rico shifted to the cubes sub-context to try clarifying the connection between independent events, multiplying probabilities, and the replacement assumption. I wrote in my field notes, "As this discussion went on, it dawned on

me that [the] independence and dependence [of events] was different from why we were replacing or not replacing and connecting that to multiplication was causing confusion. We multiply probabilities no matter what” (RFN, 9/25/08). For the next 30 minutes, the inconsistencies continued and students raised several questions to make sense of what Rico was saying and indicate the inherent contradictions.

Carlton: So we’re going to change [inaudible], since, since we changed the probability, it’s still independent?

Rico: Okay, good question. If you take a Black juror out of Jena, pick, first person picked is you. The first juror we pick, we put you out of there, now we only have 309 jurors of color. You’ve changed the probability in there, alright. Now 309 out of 2154 instead of 310 out of 2154.

Greg: So they are no longer independent.

Rico: That’s not an independent

Greg: So the fact that one went out makes it dependent?

Ann: (with emphasis) It is independent.

Rico: Okay, so, yeah, yeah, yeah, so, okay. When is it independent and when is it dependent?

Patricia: So, I mean you’ve changed the probability, but it’s still an independent event. That’s possible?

Rico: Yeah, so you’ve changed the probability. So here’s, here’s the deal okay. That’s, this is a very good question. This points out the difficulty in understanding, so helps me clarify my thinking. When is it independent and when is it dependent?

(Audio, 9/25/08)

Ann emphasized that the Jena 6 situation was independent and again pointed out the inconsistency. Although Rico seemed baffled (and perhaps recognized the tension here), he attempted to clarify his thinking further but Ann remained unconvinced and said so.

Ann: Because you just said the same thing over again and you kinda contradicted yourself again and that they could be independent and then we asked you does it matter how big the size is

Rico: Yes, it does.

Ann: And you were like, well yeah but, it's not the size.

Rico: No, definitely.

Ann: So it's the size of whatever the combinations are going to be, the only thing that affects whether or not they are independent?

Rico: The relationship of the size of the number you are picking to the size of the population is what matters.

(Audio, 9/25/08)

Rico clarified the point about when it would be appropriate to make the replacement assumption, but did not resolve the contradiction of when events are independent and when to multiply probabilities. Towards the end of the class, Ellen raised a question that brought the attention to the underlying problem in the discussion (the connection between replacement, independence, and multiplying probabilities).

Ellen: With the males and the females, uhm, we multiply the events because like with three males and, the probability, probability of uh, getting uh one male, I mean one female was $3/6^{\text{th}}$ right and then it went down to one third.

Rico: Uh $1/3^{\text{rd}}$? $2/5^{\text{th}}$, no?

Ann: She's just reducing the fractions.

Rico: Oh, oh okay.

- Ellen: And for the other one it was $2/5^{\text{th}}$ like if we got two girls and so then you multiply both events which is gonna equal 6 over 30.
- Rico: Right.
- Ellen: So then you if don't replace them you don't multiply?
- Rico: If you don't replace them you don't multiply.
- Carlton: You do multiply.
- Ellen: You do multiply?
- Rico: Well, if you, so if you, now that's a really good question. So if you take the female
- Ann: Out
- Rico: If you put, if you do, if you replace the female, right, yes, then you still multiply. You still multiply because having picked the first female you're gonna put her back in the bag, in the, in the group. Now the probability of picking a female is the same $\frac{1}{2}$ as it was the first time. So in that case picking and replacing, it would be $\frac{1}{2}$ times $\frac{1}{2}$.

(Audio, 9/25/08)

The class ended a minute or so after this. I wrote in my field notes, "What a class, persisting to understand and unfold the contradictions/illogicality of the whole thing. Their [students] agency, persistence was all evident in today's class" (RFN, 9/25/08). Ellen, who was usually quiet in class so far and not very comfortable mathematically, persisted in understanding this clearly, in addition to Ann and Carlton who were both more vocal and mathematically competent. Rico recognized that he had misled students and wrote in his journal, "We then moved onto the idea of multiplying probabilities. And here's where I did not get things straight...you always multiply probabilities" (TJ, 9/25/08). Further, he described how students "stayed on" him to clarify and recognize the contradictions.

They stayed on me, despite my (because of?) contradictions and waffling and unclarities. Carlton was the first to point out that I had said one thing in one situation and something else in a different situation...and Ann caught me as well! And, I think, although I cannot specifically remember who said so, that others pushed me as well (Ellen, obviously, maybe also Roxanne, Gema? Greg?). What a class...that Ellen spoke out was also great, because she is a relatively quiet person, still finding her voice. (TJ, 9/25/08)

The next day Rico apologized to students for his “bogusness” and told them

... instead of stepping back and saying something like, “you know, I don’t know this, you’re right, I’m confused,” I dug in my heels (even though deep inside I knew something wasn’t quite right) and tried to bluff my way out of it...That I too could learn, and really did learn something from that interaction. No teacher is always right (oh how easy it is to say), but when push came to shove, I didn’t have the courage to back down. (TJ, 9/29/08)

He “gave them tons of props for contributing to our [their] collective knowledge (and my [his] personal knowledge!),” and “named the ones who led on that” (TJ, 9/29/08). This incident was important for many reasons. First, students demonstrated their persistence and perseverance to understand the mathematical ideas and challenge the teacher’s explanations, and in the process found their voice in the classroom (especially Ellen). Second, it also gives an insight into how comfortable and safe students felt (especially Ellen) to engage in this conversation as early as three and four weeks in the academic year and this surfaced in other instances as well (as I show below with Miriam).

Third, the teacher demonstrated his commitment, honesty, and willingness to accept critique. While teachers may not often do this, Rico went in search of students in the lunchroom to talk to them after class and apologize, as what he did in class bothered him

significantly. He apologized to students in class the next day and applauded them for their contributions. Finally, this incident is a rich example of the C's being enacted in the class and was a milestone in the trajectory of this classroom. As Rico wrote in his journal,

Students were *connecting* across the meanings of independent, dependent, picking with replacement, picking without replacement, etc. They were *questioning* the meanings of those different ideas, their interrelationships, and also what I had told them. They *critiqued* what I had told them, took it apart and criticized it. They *challenged*, respectfully, me and my ideas, and finally, they *created* knowledge—both contributing to my own knowledge and to the class as a whole by forcing me to clarify for us all the meanings of these different things, and for the class as a whole to learn the lesson of teacher really not knowing everything and students can question/critique/challenge him/her to move us all forward. (TJ, 9/30/08)

In addition to the 7C's, Rico commented on students' engagement in class in various other ways. In one example, Rico referred to the work students had done the previous day and

...gave lots of props to the class... Gema for leading us off; Miriam for continuing; Julie for struggling through her lack of confidence (she was right, after all!); Carlton for loving her, teasing her good naturedly, and cracking us up; Marisol for struggle [struggling] through the ideas; Calvin for raising his question about "what if we only know the probability of losing?"; Miriam and Vanessa for answering him clearly; Antionette for really engaging what we were doing; and the *whole* class for really working hard to *collaborate* and *communicate*. (TJ, 10/6/08)

Yet another day (which happened to be the next day) he "gave props to Miriam [who was very quiet in class initially and not very comfortable mathematically] for her leadership in stepping out and being willing to demand that she understand" (TJ, 10/7/08).

So I can help your understanding, support your understanding, but you have the responsibility, and I want to applaud this woman right here, Miriam, for being a model in the class, you are a model. Everybody should learn from Miriam, for speaking out if you don't understand things and fighting for clarity and really pushing to make sure and taking the right that you have to understand the mathematics and be comfortable with that. (Students clapping). That's right, props to Miriam. We need to learn from her, because she is really strong on that. She's a model, and there's a bunch of models here. You know you're all models in a different way of different things. (Audio, 10/7/08)

Students often put themselves out there by asking questions about what they did not comprehend, or saying they did not (as Miriam did in this case), thus making visible their weakness (or ignorance?) mathematically or sociopolitically. In applauding Miriam here (and Ellen, Julie, Gema, Marisol earlier), Rico emphasized and indicated the kind of courage and responsibility that students needed to take for their learning and supporting each other (a point he had emphasized on day one of this class in the syllabus, see Appendix D). Moreover, his statement also validated students' public efforts in being responsible and demanding to learn and know (like Miriam's to speak up and asking for help). In other words, proclaiming competence not only positioned students as being capable of taking charge for their learning, but also facilitated creating and sustaining a safe and caring classroom space for individual and collective learning and success. In yet another instance during the HIV-AIDS unit, I wrote in my field notes,

The class began with Rico sharing his thoughts on all that was great about the class on Tuesday [when the class had visitors from UIC], he said – you all were very impressive and I felt very proud. And he went on to name everyone who participated, pushed, challenged, supported, connected, extended and so on. Carlton and Marisol

for going up to the board, the class for challenging and supporting, Ann for extending the mathematics with her “800 idea”, Ellen and Miriam for all the questions they were asking, and Monica for her thoughts. (RFN, 3/12/09)

While the teacher continued to name student contributions through the year and connected them to the 7Cs, this was, perhaps, more important early on for developing teacher-student and student-student relationships that allowed for collaboration, and caring, and opened up possibilities for the interweaving of the mathematical and sociopolitical dimensions. In the year-end survey, Rico asked students, “Do you feel that you will take our 7 C’s – *connect, cuestion, critique, challenge, collaborate, communicate, and create* – with you into the future? If so, how?” All but one said they would take all or some of these 7C’s (especially *cuestion*) along with them in their future experiences.

Miriam, one of the more silent students in this class, said, “I think I am going to take the seven C’s because they’re really helpful and help a student brain storm what’s happening.” “Of course,” said Gema, “since I am planning to be a lawyer ... Then if I don’t become a lawyer I will still need them because I will want and need to be informed about the world around me.” Monica said the 7C’s will help her “analyze the world in a different way,” and will be needed rest of her life while “working with other people in the future and working in groups in college.” Proclaiming students as competent in many different ways and highlighting instances where they engaged in one of the 7C’s was a contributing factor in students appropriating the 7C’s not only as a part of the classroom norms but also for their future lives (although whether and how much students use these is speculative).

In summary, Rico’s consistent effort to proclaim students as competent participants in the classroom discourse in myriad ways was one feature that supported the joint activity in this class. It contributed to creating an equitable classroom space by mitigating existing inequalities in teacher-student relationship in schools (what Freire termed as the teacher-

student contradiction and I discussed in Chapter 2), and creating a reciprocal teacher-student relationship that was more dialogic in nature (Cohen, 1994; Freire, 1970/2000; Ladson-Billings, 1995; Wells, 2007). This in turn allowed for genuine engagement and relationships between teacher and students and between students to develop in this classroom.

6.2 Making Collective decisions

Oyler (1996) indicated that there are two “fairly distinct but interwoven dimensions of authority” namely content authority and process authority (p.149) and suggested that students can share both process and content authority with the teacher, who usually controls what is discussed (content) and the flow of the classroom interactions (process). For example, students in her study enacted content authority through questioning, bringing in personal experiences, connecting between texts and experiences, and reframing one’s understanding of a particular text. Moreover, Oyler posited that, “Providing students with multiple opportunities to speak and act as experts is essential if children are to be encouraged to become producers, not just consumers of knowledge” (p.149). One of the themes that emerged in the analysis of the interactions in this classroom was making collective decisions. I argue that making collective decisions is a way of sharing both content and process authority in this classroom, resolving the teacher-student contradiction (Chapter 2) and creating more dialogic relationships between teacher and students.

From the first decision of what generative themes to study as a part of the class (content authority), several decisions during the academic year were made collectively. These decisions covered a broad spectrum—grading, permitting visitors in the classroom, rolling sexism into HIV-AIDS and criminalization (Chapter 4), writing the op-ed piece, and preparing for community presentations. For example, early on in the academic year, Rico distributed a journal assignment (Appendix B), inviting students to give their inputs on the

“what and how” of grading. Students gave their suggestions in writing, and after a few days, he distributed a grading rubric in class taking into account suggestions given by students.

Some decisions related to permitting visitors to the classroom. Several people visited the class during the academic year. Some came from within Chicago, others from different parts of the US and some from other countries such as UK, Mexico, and India. Rico usually informed students of potential visitors by giving them some background about the people who wanted to come to this class, and their purpose for visiting, and asked students for permission to allow them into class. During one such instance, Rico told students that the class could expect some visitors from UIC and two other folks from Madison in a week’s time and asked students if they were okay with it. “What if we said no [i.e. did not give permission] asked Carlton and Renee [jokingly] and Rico said if they were really serious about not wanting them to come, he would tell him but he knew they were just playing.” (RFN, 3/4/09). Carlton and Renee did not say anything further. Students’ sense of humor here, I suggest, was reflective of the trust that their opinion was important and the decision to allow any particular visitor was open to discussion if they had genuine concerns.

In another instance, a filmmaker, Mr. L from Chicago came to class without any prior notice. Rico refused him and informed Mr. L of the protocol that needed to be followed before allowing him in. The next day Rico checked in with students about permitting Mr. L into the classroom and finally Mr. L came into class another day with students’ permission. In addition to these general instances of making collective decisions, students shared content authority while preparing the op-ed piece and the community presentations, as I illustrate below. In both these instances, Rico positioned students as knowers, having a sense of agency and capable of writing the world.

6.2.1 Op-ed piece

The decision to write and submit an opinion piece to the Huffington post (see Appendix C) and the process that followed exemplified the collective work done by students and teacher. A few days before the 2008 elections (on 10/17/2008), Rico distributed a journal assignment (due to be turned in on 10/20/08) that asked students to share their thoughts on the following question.

What should we be doing about the Obama-McCain election in terms of watching the exit polls? What can we do? How should we plan to “go public?” How well will be able to argue if we think something is not right? Who should we contact? What should we do!!?? (Journal Assignment #6, 10/17/08)

A couple of days later, he suggested that students write an opinion piece to share what they have been doing in class related to the elections. He said he was making this suggestion based on their responses to the journal assignment in which they indicated, “We should do something, we should go public, we should use what we know to do something” (Audio, 10/23/08). The next class period (10/27/08), he asked students, who were interested and had time, to meet him in the library after school to create a draft of the op-ed piece. He also asked them to write a draft op-ed piece as homework. “We talked briefly about the op-ed piece. We’ll see who shows up, but I’m hoping a good number of people. Their HW for tomorrow is to write a *draft* op-ed piece, using what we know” (TJ, 10/27/08). Two days later,

Rico put up the first draft of the op-ed piece (on the LCD projector) that a few students (Ann, Calvin, Antoine, Carlton, Ellen, and Greg) had worked on the previous day... He then asked them what they would like to be included after that. They took a few minutes to write a few lines that they thought should be included after the first paragraph that was up on the board and gave it to Rico as class ended. Rico asked who would like to work on it during the afternoon and some of them raised hands. (RFN, 10/30/08)

The next day, the last day of class before the day of elections (11/4/08), students worked on completing the op-ed piece so Rico could then submit it to Huffington Post. They read the draft that Rico and some students had worked on the previous day out-of-class. Rico mentioned that he had circulated the draft to a few people to get feedback who indicated the need for more passion in the piece and more connections between the mathematics and what happens in the exit polls. He informed students that he had made a few additions to the op-ed piece based on the feedback, and if they agreed to those, he would keep them.

So students read through it and they made several suggestions for changing the words to show their passion. [Rico connected his computer to the overhead projector and typed the changes that students made]. Lots of collective thinking - about whether the text flowed well, specific wordings, some missing ideas, reducing redundancy of ideas and words, etc. Ann made several suggestions about making the purpose of this [the op-ed] clear and bringing out the passion. Ellen made changes to the last few lines that were borrowed from her draft. Gema wondered if they needed to say anything about what how close they expect the exit polls and recorded vote to be. (RFN, 10/31/08)

In summary, the final op-ed piece included contributions from multiple students and was indeed a piece of collective work. Although Rico suggested and initiated the idea of writing the op-ed piece, students took it up and participated both at the process and content level - as authors and editors of this piece, making decisions about what to include and exclude as well making edits related to grammar, format, flow, and so on.

6.2.2 Community presentation

Students spent a significant amount of time towards the end of the year (close to 4 weeks) to work on the different aspects of the community presentation—location(s), logistics, content, groups, etc. The collaborative process between the teacher and students came to the

fore again and students demonstrated authority while deciding the content of the presentation and the process of getting there. As early as the end of January 2009, Rico raised the topic of community presentations (listed on the syllabus, see Appendix D) and students deliberated the content, value, and format of the presentation.

Carlton and Greg questioned the point of presenting gentrification and mortgages since many people had already lost their homes and could not improve their situations with just information. Gema, however, disagreed and suggested that the information they shared about mortgages would be helpful for people to understand what happened to them. Gema's comment exemplifies a point that I discuss in Chapter 7, namely, that a mathematical analysis of people's lived experiences can indeed help develop a deeper understanding of it.

Students also debated the format of the presentations. Greg wondered if the format should be an op-ed piece or a flyer. Ann suggested that it should be through interactions and meetings in their communities. Roxanne and others were skeptical that people would come and believe what students had to say. Renee was positive that once people heard the work students had done, they would believe them. Ann, indicating a strong sense of social agency, agreed with her by saying "...even if a few people come and listen, and we can help one person think about their mortgage the next time they get a house, that would be good" (RFN, 1/27/09).

Later, in the first week of the HIV-AIDS unit, Rico raised the topic of community presentations again and students revisited some of the points from 1/27/09.

Roxanne asked what was the purpose of getting involved or coming to the presentation? Daphne asked how to get people in the community to come to it and why they would want to come. Renee reminded them that other students and teachers could come to see what they did and take it back to their schools and do something similar there [at their schools]. Rico reminded them that they could invite UIC people,

TSJ [Teachers for Social Justice, a Chicago based teacher organization] mailing list in addition to people in the community. Roxanne wondered why not take trips to schools to present our work to get them interested in coming to the presentation? Vanessa wondered if we needed 2 days or could we do 1 day. Ellen wondered what to tell them. Jenny was concerned about whether they would remember the material. Rico reassured them that we would work as a class, review, support each other and Ann said that it would anyway be easier to remember what we learned than learning it for the first time. Jenny also wondered if everybody has to talk. Someone asked if they were presenting in both communities and there was agreement of doing it in both communities, and having it bilingual or with translations in Spanish in Little Village. Calvin said his parents would come if it was in Spanish. Others also said they would be able to get their parents to come. (RFN, 3/6/09)

Following this discussion, students took the initiative, with Rico gently nudging them, to begin preparing for the community presentation. Ann, Greg, and Carlton along with Rico visited a local community center and negotiated a deal to get space for the presentation in North Lawndale.

They were told by the “boss” that in return for no fee to use their space, they wanted students from the class to come and talk to the children *[at the center]* about what it is like to grow up, be in high school etc. (RFN, 3/30/09)

As the HIV-AIDS unit wound up, with about 4-5 weeks left for the community presentations, Rico re-initiated the discussions to prepare for them alongside the work on criminalization unit. He distributed a journal assignment on 4/20/09 asking students to share their thoughts in writing about several logistical items related to the presentation (content, structure, translations, food, their purpose for doing this, etc.). Many details were still missing. On 4/28/09, a unique class unfolded.

Many students (Greg, Gema, Vanessa, Renee, Miriam, Roxanne, [and others]) were on a day of silence, in support of the GLBTQ youth who face silence because of their sexuality [this was a Sojo wide event initiated by few teachers]. Rico had planned for some discussion around the presentations and asked if students were okay having the discussion with everyone going up to the board and writing their thoughts [those who were on silence could write and others could talk]. (RFN, 4/28/09)

Minerva who was talking that day started off the discussion by speaking on several points such as, “content of the presentation (HIV-AIDS too or just mortgages?), who should present (everyone in each or split the class?), should everyone attend both, what could they do if they didn’t present, how much mathematics should be in the presentations” (TJ, 4/28/09). Rico frequently facilitated the discussion by summarizing, paraphrasing, or focusing on particular point made by students (written or verbal). This process of writing on the board presented possibilities as well as challenges. As I wrote,

Going up to the board and writing was quite phenomenal – everyone was reading what was being written. At times there were 3-4 people writing simultaneously. At one point, it seemed to me that those who were not on a “day of silence” were giving full attention and thought to those who were writing and trying to catch up with what was being written. (RFN, 4/28/09)

There was, however, some frustration during this written-verbal conversation and Greg summarized it by writing “u’all some angry ppl” (Video, 4/28/09). As Rico wrote,

People were getting on each other, there was some anger and frustration expressed. Roxanne, in particular, seemed to be blaming others. She wrote that people who were being quiet would not present in the presentations, but there was no evidence of that. Ellen, one of the quieter students, spoke up to say that was not the case, that she would present and speak up (which I am very confident of). (TJ, 4/28/09)

Moreover, as I noted, “While writing slows things down and allows for more thoughtful responses and participation, it seems to also lead to more frustration as things may not get resolved right away.” (RFN, 4/28/09) This discussion continued over the next day with students making decisions about food, the content (Chapter 4), and the groups they would work in, and students slowly began to put together the content for the presentations that were just 3 weeks away. Students put together an 81-slide PowerPoint presentation, well received by those who attended. Students also commented positively about the experience of presenting, although they had some criticisms, such as not enough time for practice, feeling nervous, and not fully prepared for some questions. Many students also said that the first presentation was practice for the second (which was better than the first), this was a new experience of presenting in front of an adult audience, and overall the presentations went well, considering the limited time they had for preparation.

Nevertheless, the journey to get there was not smooth and easy. Some students expressed their displeasure about having to present more than mortgages, resulting in more work than they perhaps wanted to do. Some were discontent about being working with topics they did not want to. As I wrote in my field notes,

Today was spent with Greg and Julie – venting :-). Seems like last three days have been working with each group to let them vent, get them on board. It seemed like students did not feel a sense of ownership and at the same time felt that they had the freedom in this class and with Rico to show their resistance. (RFN, 5/7/09)

Rico was likewise aware of this resistance as he noted in his journal a few days later. “There is some resistance, partially because I pushed people to include a part on criminalization. Also, Julie complained that she had to do extra work, as did Greg, that they had to do a little research before presenting things” (TJ, 5/14/09). Rico’s comment points to an inherent tension with respect to the role of the teacher, the extent to which he or she wields

power and authority, and for what purpose, while making collective decisions. It also speaks to the dialectical relation between authority and liberty that exists in a dialogic approach (see later in this chapter and Chapter 7).

Sometimes teachers have to be hard line and really push (without feeling bad about pushing students), recognizing that it is the right thing to do, and confident that students would rise to the occasion and feel successful about their work, as was the case here, evidenced by students' responses. Rico probably wielded more power here than in other instances, for example, to include more of the content that was representative of the work they had done during the entire year, to insist that students be present at least at one community presentation if not both, and to be involved in preparing the PowerPoint slides.

This question of wielding power has to be understood also in view of the end-of-academic-year pressure with multiple exams and assignments in other classes in addition to students' learned helplessness, and the history of relationships that students and the teacher had developed over the academic year. Several times during the year, Rico struggled with students' learned helplessness. He repeatedly urged students to take ownership for their learning, be responsible for doing quality work in this class, use this opportunity presented to them and support others in the process as well. Students often responded positively.

So, although students resisted and complained, the relationship they had developed with each other and with him in class, perhaps, helped them let go of this resistance and take responsibility to work towards the presentations. All of them ultimately participated in creating the PowerPoint slides, most of them were present for both presentations, everyone presented at least once if not at both presentations, and overall students felt good and positive about themselves, the 81-slide PowerPoint, and the presentations. Ultimately, sharing power and creating a dialogic space is not an all or nothing proposition, but instead a dialectical process between students and teacher, requiring both to take on new roles.

In summary, the teacher initiated a space for sharing content and process authority with students by inviting their participation in making general decisions (such as grading, and visitor entry) and specific decisions (such as generative themes to study, the content of the op-ed piece, and the content and logistics of the community presentations). Students, for their part, took it on themselves to participate in these collective decisions and thus influence both the content and interactions in this classroom. Connecting back to the discussion in Chapter 2, making collective decisions was an important feature that supported the process of creating a dialogic space in this class and resolving the teacher-student contradiction (Freire, 1970/2000; O'Connor & Michaels, 2007; Wells, 2007). In the next two sections, I describe the ways in which the teacher positioned himself in solidarity with students and their communities and this was integral to the process of reading the world.

6.3 *Caring, solidarity and political relationships*

Freire argued, "Education is directive, always. The question is to know towards what and with whom is it directive" (Shor & Freire, 1987, p.22-23). Liberatory education, he said requires "that one enter into the situation of those with whom one is in solidarity" (Freire, 1970/2000, p.49), thus pointing to the importance and need for teachers' commitments to larger political issues involving students, their families, communities, and lives, in order to support the process of reading the world. Ladson-Billings (1995) shared from that the teachers in her study saw themselves as members of students' community, and made conscious decisions to stay or participate in the community. Gutstein (2006) has also indicated that "the strong, well-documented tradition [of education] within African American history" demanded that teachers and students work in solidarity and "be genuine partners in emancipatory education" (p.33). Consistent with this viewpoint, I discuss below the ways in which Rico established a political relationship with students based on caring for and solidarity with them, their lives, families, and communities.

Rico's interest in and concern for students went beyond the classroom. In his journal, he often referred to students' life situations in addition to his assessment of their mathematical learning. He had frequent phone conversations or sent text messages to students to check in with them. Student began to accept getting a phone call or a text message from him as a normal practice of this class. Early on in the academic year, he told students that when he said he will call them he meant it seriously and told them of his phone conversation with Miriam the previous night as an example.

He called Miriam last evening to talk to her about her journal [response to the journal assignment] and they talked for almost 30 minutes about her work. Further he also commented that Miriam said to him "you make me explain everything," and he said that he wants students to own what they are speaking and writing and that he will call them if needed and he was serious about that. (RFN, 9/11/08)

Rico's sense of caring was evident from his actions such as calling students, making them explain everything, wanting them to own what they are speaking, and writing. He stayed after school to tutor students, supported students in preparing for the ACT exams, got involved in the school events, had discussions with parents whenever possible, discussed and followed up with students about their plans to go to college (RFN, 10/23/08). He frequently reiterated the support he could offer students.

I said they knew they could call me, as she [Jenny] had done Sunday evening when they had a test, they could text me, as Monica had done on the test, that I stayed every Tue and Thu after school till 4PM and I was there, and that they could also rely on each other. (TJ, 9/25/08)

At the same time, he emphasized the importance of students coming forward to take responsibility for their learning indicating that, "it goes both ways."

You have to grapple with the material, you have to figure out what it is that you do not understand. You have to figure out what it is that you do not understand. And then try and wrestle with that and make sense of it. (Audio, 9/25/08)

Students for their part took responsibility for their learning and communicated frequently with Rico on things that did not make sense to them in the class as well as things that went beyond the class. For example, in one instance, the following phone text conversation ensued between Ellen, a student in class and Rico.

Ellen: Mr Rico I saw u in TV! ☺

Rico: What channel?

Ellen: 66. A closing in carpenter elementary school.

Rico: Well we lost. Tell you more Monday.

Ellen: It's ok. Perdieron una batalla pero no la guerra. [you lost a battle, but not the war]

Rico: Claro que si [yes yes!]

(3/20/09)

Rico did not keep a log of the conversations that he had with several students through text messages, but often students initiated a conversation with Rico as Ellen did here. In another instance, Rico recalled texting back and forth with a couple of students during election night in 2008. Towards the end of the academic year, Rico distributed a survey for students to fill out. One question was,

I am a 56-year old white male, not from your community and don't experience what you do—and I'm the person teaching you to use math to understand racism, sexism, criminalization of youth of color, etc. What do you think about that?

Renee said, "I think that you're not a racist white man. You try to help fight all these injustices," suggesting that he was different from other whites. Others indicated that they did not give much importance to the racial difference that existed between them and Rico.

Instead, they felt that he was similar to them in some ways while different in others and what was important was that he understood them, their community, their struggles, cared for them as individuals and as a community, and had faced similar experiences in his youth.

Monica – Even though you never live in the community I think you have faced similar problems as many teens here. So you do understand in a way. You didn't have a perfect life and you fought to be where you are. So of course I feel that you are the right person to be teaching us about all these social justice issues.

Miriam – Mr. Rico, you could be old, white and not live in our community but to me it seems that you are from our community because you know more than I do, and you experience some of the things that we as teenager went thru or going thru. You are also one of the fewest adults (teachers) that understand us. I admire you a lot Mr.

Rico and I WILL MISS YOU!! ☺

Furthermore, as I indicated in Chapter 4, students felt comfortable talking about race in this classroom, despite the racial difference between them and Rico. Rico's caring for students reflected the "ethic of caring" that Ladson-Billings (1995) described, which includes but also goes beyond the "caring for individual students" and is concerned with the implications of teaching on "students' lives, the welfare of the community, and unjust social arrangements." The teachers in Ladson-Billings' study spoke of "the import of their work for preparing the students for confronting inequitable and undemocratic social structures" (p.474), and Rico's intent for the work he did with students shared this perspective.

Although the "ethic of caring" was an important aspect of the teacher-student relationship, Rico went an extra step to develop and share a political relationship with students. The syllabus for this class included this point as well (see Appendix D). Political relationships, according to Gutstein (2006) include

...taking active political stands in solidarity with students and their communities about issues that matter. Political relationships also entail teachers sharing political analyses with students as much as possible. Finally, they include talking with students about social movements, involving students them-selves in studying injustice, and providing opportunities for them to join in struggles to change the unjust conditions. (p.132-133)

Below, I describe an incident that illustrates the political relationship that Rico shared with students.

6.3.1 Principal Resignation

During the first week in the HIV-AIDS unit, Rico brought in an article titled “Social Justice High School Star Principal Caught Living Lies” from the local newspaper. The article reported the resignation of the principal of their school, Mr.M who had been with the school since its beginning. Mr.M had announced his resignation the previous day after school in the school auditorium, in front of students and teachers. He said that he had to move to a neighboring district to provide better health care for his family and since Chicago Public School (CPS) policy required principals to stay in Chicago, he was forced to resign. Rico asked if students had read, seen, or discussed the article in their first and second period class and students said they had not. Renee asked if Rico would read the article aloud and Rico did.

Students expressed outrage at the coverage, which they felt was unfair and singled him out. They felt that the media went after him, a man of color who had succeeded in doing many good things for the school. Julie asked who wrote the report and Roxanne wondered how the reporter knew about the meeting in the school since parts of it were mentioned in the article. Jenny wanted to know how long the teachers had known and Rico redirected the question to a student who was a member of the school’s Advisory Local School Council (ALSC). He [the student] replied that the teachers probably knew since February when they

had a LSC meeting. He said, “[at that meeting in February] they took me out and didn’t tell me” (Video, 3/6/09). Rico added that he [this student] was on the radio news that morning and he [the student] shared,

I was telling them all the good stuff since I know he’s going to negative stuff from all of those papers and all the other stuff. I just told them all the good stuff he did and get for us. (Video, 3/6/09)

Gema wondered if there was some sort of an investigation that led to this and Rico said, “Somebody snitched on him, and he [Mr. M] does not know who. He [Mr. M] said that there has been some blogging on him for a while, attacking the school, and talking about him not living in this neighborhood” (Video, 3/6/09). Gema questioned the purpose of the CPS policy requiring teachers and principals to live in Chicago and Rico responded, “It’s supposedly so you have some connection to the place where you teach at.” Roxanne exclaimed “but he does” (Video, 3/6/09). Both she and Ann emphasized the strong connection he had with the community, that he had lived right across the street [earlier], he had been on time despite living far away, and was committed to the school and its students. They wondered why the CPS board could not account for all that he had done for the school in the last three years. Jenny claimed, “They targeted him for a reason,” and used the fact that he was living outside of Chicago as an excuse (Video, 3/6/09).

Patricia raised the question of Mr. M’s commitment to be the principal for 4 years from the time Sojo opened. Rico said that Mr. M told him that he was not ready to leave. Antoine wondered if the neighboring district had better health care than Chicago. Rico and some students said it perhaps did since he moved. Rico referred to Ann’s comment “why stay in Chicago with ***** healthcare” and Ann responded, “Yeah, I would move too” (Video, 3/6/09). Everyone in the class seemed to empathize with his decision to move.

Ann, Roxanne, Calvin and others wondered if the CPS board could relax the rule that Mr.M violated to let him complete his contract for 4 years. Jenny questioned if the LSC had any power to choose the principal. A student who was a member of the school's ALSC responded, "We don't have no power, all we get to do is advise, we are not called Local School Council, we are called Advisory Local School Council" (Video, 3/6/09), and added that CPS board, the CEO, Area Instructional Officer (AIO) made the final decision. Ann immediately said,

I think we should protest, like if we can't have him stay here, at least to get the right to choose who we want. It is our school, it's our education, it's our problem. Like why would they get to decide who teaches us. I mean, if it's going to benefit CPS to have a person they want here how does it benefit us like if we are not learning or getting what we need. (Video, 3/6/09)

Rico agreed with her and added that the school's right to choose the next principal would be an important struggle, and emphasized the need for students to be involved in it. Roxanne wondered, "Why won't the LSC have the power to choose the principal?" and another student responded, "'Coz they [the CPS board] are trying to take power away from the community" (Video, 3/6/09). Rico connected his response to the larger political struggle related to stop school closings, Mayor Daley's move to strip power away from LSCs and get rid of them and the unions, conversion to charter schools, and privatization of education in Chicago. A student who was a member of the school's LSC added, "Now the big, the old schools like, they got, they still got the [Local School Councils], like people can choose why they want. It's just with the small schools and our new schools that we can advise" (Video, 3/6/09).

Rico indicated that it was easier to close schools where the LSCs were weaker and linked it to the future of the school and the community, and displacement, and gentrification

that they had studied in the previously unit. Meanwhile Antoine, Marisol, and Guillermo were reading the article, and Marisol asked, “How come the rule does not apply to charter schools?” Rico responded sharing his political analysis,

Charter schools are a move to privatize public education and take the power away from people. Charter schools are schools that are run with your tax dollars, but are not accountable to the community in the same way that a school with a local school council does. So it is a struggle between power of the people and power of the system. (Video, 3/6/09)

Roxanne wondered, “Aren’t they [charter schools] under CPS?” and Rico pointed out that they were handed over by CPS to private ownership. Ann added that companies put money in charter schools and they get tax write-offs. The discussion continued for a few more minutes with Roxanne and Jenny raising questions about charter schoolteachers not being required to live within Chicago, and not required to be certified. Rico and Patricia emphasized that certification does not directly relate to teacher quality and not all certified teachers are good. Rico mentioned that he was not certified but he was teaching them.

A few points to note in this incident. First, it is evident from the discussion that students were deeply invested in thinking about the future of their school and making sense of this event within the setting of public school education in Chicago. Second, although most students and teachers were aware of the principal’s resignation, no student from this class had seen or heard about this report in the newspaper before this class (3rd period). By bringing in the news article (see next section for a description of this feature), Rico created an explicit opportunity for students to discuss this and they took it up to dialogue, and raise questions about this event that affected the future of their school. Third, in sharing his political analyses, connecting this to the larger struggle of public schooling in Chicago, and validating Ann’s comment about potentially engaging in a struggle to ensure that they get to choose the

new principal, Rico's solidarity and political relationships with students becomes visible. Students also knew of Rico's involvement with Sojo over the years and in the larger struggle related to school closings in Chicago, and this accentuated the sense of solidarity and political relationship shared between them.

As Freire (1970/2000) indicated, the oppressor being in true solidarity with the oppressed is a necessary condition for liberatory education because, "the pursuit of full humanity however, cannot be carried out in isolation or individualism, but only in fellowship and solidarity" (p.85). What this suggests is the importance and necessity of developing solidarity and political relationships *with* students for creating a classroom space that is explicitly political in nature and where one of the goals is to read the world. The next feature that I describe, namely bringing the world and self into the classroom, also contributed to developing solidarity and building political relationships between the teacher and students.

6.4 *Bringing the world and self into the classroom*

The teacher (and sometimes students) brought the world into the classroom in several ways such as bringing in a piece of news read in the paper or heard on the radio, showing videos relevant to the unit being studied or a previous unit, sharing personal stories, and discussing events that occurred in the school or students' lives. Usually a discussion (short or long) would ensue with students raising several questions. These conversations allowed for normalizing politically taboo topics, as termed Gutstein (2006), which meant, "to make topics generally considered as taboo in school part of 'normal' classroom life" (p.132).

Additionally, these conversations provided opportunities to read the world more deeply, to interweave the sociopolitical content with the mathematical ideas they were studying whenever possible, and to develop political relationships and solidarity with students (Freire, 1970/2000; Gutstein, 2006). I illustrate these points through examples of discussions around news articles, personal stories, and a staffroom conversation.

6.4.1 News reports, and personal stories

During the elections unit Rico brought in news related to the elections such as news about voter purges, move to disenfranchise voters with name or address mismatch, racist comments about Obama at McCain rallies, distribution of 28 million DVDs called Obsession created to instill fear of Muslims, vote switching, and the televised debates between candidates. Later in the HIV-AIDS unit, he brought in news articles about how banks make money through student loans, water privatization in Chile, and Puerto Rican – African American resistance to displacement in Harlem. Often a short discussion would ensue with students asking questions to further clarify and understand the article (read the world). For example, on 10/21/08, I wrote in my field notes,

Rico shared some news items related to the election - a few reports of vote switching, the Ohio court ruling etc. Calvin wondered if electronic voting is not accurate then why are they doing it, Marisol asked why not switch to paper ballot? And if they fixed the problem? Renee wondered, “What would happen to their votes (votes that were switched).” Daphne wondered how they knew their vote was switched. Rico answered some of these, and some he said he did not know (RFN, 10/21/08)

In addition to these news reports and articles, students shared personal experiences and stories related to the generative themes and made connections between the themes and their lives during each unit throughout the academic year. They brought their world along with them into the classroom—the world of working multiple jobs, gang violence, working night shifts, parenting one or more children, house on fire, and so on, and the knowledge that came from their experiences.

For example, in the displacement unit, Renee (a Latina student) shared her experiences related to loans as she was intimately involved in her family’s finances and Antoine (a Latino student) talked about gentrification in the neighborhood. During the elections unit, students who were poll watchers shared experiences of canvassing for Obama

in Wisconsin and Indiana. The day after the historic 2008 elections, Rico asked, “what do you think it means for us?” Several students responded. Antoine, a Latino student, linked it to the Civil Rights movement, and the struggle in Mississippi, by bringing in his experience of working with Freedom Schools in Chicago and said,

Me personally, the first thing that came into my mind was like Fannie Lou Hamer, the first thing that came was about Freedom Summer and Mississippi. You know folks who were trying to go out there and get people to vote. Back in those days, you had to take the literacy test to vote and now we have an African American as the President. And then I was thinking about when they went to find bodies, when they killed these three men, they were going down to Mississippi to volunteer for Freedom Summer, and when they were doing all of that they found more dead bodies than they expected and it’s just like, you know 40 years later, there’s an African American as President.
(Video, 11/5/08)

In another instance, a couple of days after elections, Renee shared that a Latina friend she had spoken to in her neighborhood had voted for Obama last minute. Renee said that she (the Latina friend) had originally made a racist comment to Renee indicating that she would rather see a Republican than a Black man in office.

Rico: This was a Latina who you said was racist.

Renee: Yeah, ‘coz she said she would rather see a Republican in office than to see a Black man in office.

Rico: Yeah, so, how did you think you affected her in terms of thinking more deeply, did you have anything to do with that?

Renee: ‘coz, uhm, she told me, she had, she told me, like, well when she said that stupid comment [referring to her friend’s racist comment], I was all like, there’s people who went through what I went through when my brother went

through the Iraq war. I was like, I was like, that was very emotional for me to hear my brother tell me that I was going to get a quarter of a million dollars if he was to die [becoming emotional]. I was like, I don't want the money, I want my brother. Well, she was like, yeah McCain is going to do this that that, and I was like, yeah but, I don't want to see my brother go back to war. 'Coz I have two brothers in Marines and they still active on duty, so if the war keeps progressing then they could both go to war. I was like, I don't want to see my brothers go to war. I was like, that's just me, I was like, I love them too much. She was like, oh, not me. That day I got mad at her. Me and my boyfriend just dropped her off. I was like, you know what, I am not in a mood for this **** to hear right now. We dropped her off. I was like whatever.

Rico: [after a silence of few seconds] I am glad that she was able to hear you. That's the type of one to one work we gotta do.

(Audio & Video, 11/6/08)

As Patricia Buenrostro, another UIC doctoral student in the collaborative research team said, in a conversation with Rico, "We did not ask students to check their lives in at the door when they entered the classroom" (Personal Communication with Rico). In fact, Rico began the displacement unit by sharing a story about Carmen's grandmother (see footnote 22), with her permission. Next, I discuss an incident in the classroom where students initiated a discussion about a conversation that had occurred in the school staffroom.

6.4.2 Staff Room Discussion

On Oct 30th, with only two days left to complete the opinion piece for Huffington Post, students came into the class and demanded to know details of what Rico had heard another teacher say about special education students the previous school day in the staffroom. "So they [students] wanted to talk, and we spent about 30 minutes talking about it" (TJ,

10/30/09). It was an intense discussion where students voiced their anger and frustration at the disparaging comments made by a teacher about students with special needs. Students wanted to know what was said and by whom, and they were all pretty upset that such statements could be made in this school in the presence of other teachers.

Rico indicated that this kind of teacher talk was not unusual and happened in schools across the country. He shared his political analyses by saying,

Teachers are not immune and are raised in this society with all kinds of poisonous ideologies and so they sort people out. They think some people are slow, and some people are gifted, etc. Because that is what they get taught in school, because that is what we all get taught in school. So teachers will reproduce those type of poisonous ideologies and think about students in the same way as they have learned how to think about the society as well. (Audio, 10/30/08)

Greg and other students persisted to identify the person but Rico insisted that he was not interested in calling out a single person. Instead, he wanted students to think of the issues this incident raised such as the contradictions we all hold inside of ourselves, the way we perpetuate these poisonous ideologies, the constant intense work it takes to overcome these, and that none of us is immune to similar contradictions. Students were upset that this statement was said in front of other teachers without anyone responding to it. Carlton wondered what other teachers who were present thought about this statement. Rico said he did not know as he was sitting on the side doing his work and overheard it. Renee asked Rico if he said anything and he responded in the negative. Julie wondered if the silence meant that the rest of them agreed with that conversation.

Rico emphasized that he was extremely upset by what the teacher had said and the teacher was “probably pissed off and just reacting,” “they were not necessarily conscious of it,” but did not excuse it. He also said, “I will raise this as point in the professional

development which I am not a part of. They should know that this is an attitude that lives here and they should deal with it” (Audio, 10/30/08), and tell the administration that he spoke about this with students in this class who were upset on hearing this. Although Rico felt that there was a lot here to unpack and investigate, he told students,

Right now I am torn between the time in getting the op-ed piece out and the importance of you all being able to dialogue on this stuff. I really want to move this conversation, but I don’t want to do that if people are not ready to do that. (Audio, 10/30/08)

Rico waited for a minute or so and interpreted students’ silence as their permission to discuss the opinion piece, which was due to be circulated to various news outlets including the Huffington Post the next day (see Appendix C).

There are several things to note in this conversation. First, while students focused on identifying and blaming an individual, Rico played a very important role in sharing his political analyses and shifting the conversation to the underlying sociopolitical factors that influence individual thinking and behavior (similar to the discussion in the HIV-AIDS unit) . Second, the importance of the teacher having clarity on this incident and the larger sociopolitical analyses becomes visible. While students’ persisted to identify the individual, Rico repeatedly steered them away towards thinking broadly about the sociopolitical factors. At one point in the conversation, Greg argued since they had made the agreement that the conversation in the room remained private Rico ought to reveal the teacher’s name. Rico denied and ensured the person’s anonymity. Instead, he pushed students towards a political analysis of the incident and the statement as opposed to analyzing and blaming the individual who said it.

Third, there remains the question of Rico not confronting the teacher in the staffroom. Rico was to the side, was not part of the conversation, and did not have much of a

relationship with the teacher who made the comment not meant for his ears. In a sense, he would have been intruding if he had confronted the teacher. Nevertheless, the fact was that he did not do so. Carlton, Renee, Julie (and other students) asked him about his (and other teachers) response perhaps suggesting that they expected him (and other teachers) to have countered derogatory remarks about students. Rico replied that he (and other teachers) did not say anything during that conversation despite being extremely upset by the conversation. However, in response to this conversation (and students' expectations and frustration) he offered to raise it with the administration.

Finally, although Rico did ask for students' permission to move to working on the op-ed piece and the transition from this discussion to the op-ed piece is certainly an example of the fluidity with which teachers and students moved between the mathematical and sociopolitical dimensions, in his journal Rico wondered if everyone wanted to move on.

On that note...it's not clear to me if everyone in the class really cares if we do this [finish writing the op-ed piece]. I can't tell. For example, does Guillermo? Julie? Jenny? I think Jenny cares, for example, but she's just so stressed out, what with college, the posse applications, etc. I don't know for sure. I *think* everyone in the class cares about this...but I'm not entirely clear. Of course, judging from what they've written [in their HW journals, assignments, projects], one might assume so, but students will, at times, write what they think teachers want to hear from them.

(10/30/08)

Clearly, no situation is simple and straightforward, and there are always conflicting demands and needs. Rico was aware of the conflicting demands on time – discussing the staffroom conversation and working on the op-ed piece – and raised it in class with students. Although Rico initiated the move to work on the op-ed piece that day, [most if not all]

students took up his suggestion and worked intensely on the op-ed piece for the rest of the 20-25 minutes, pointing to their willingness and interest in completing the op-ed piece.

In summary, bringing in news, sharing personal experiences and stories, and having conversations on events that mattered, contributed to normalizing taboo topics by dissolving the boundaries between the personal, political, and the academic. They created an opening for students to make sense of the situation (read the world), positioned students as competent participants and provided opportunities for making connections between their lived experiences and the mathematical and sociopolitical ideas in discussion. Additionally, they contributed to developing political relationships and a sense of solidarity between teacher and students in this classroom.

6.5 Discussion

Cazden (2001) pointed out “the need for teachers to have a repertoire of lesson structures and teaching styles and an awareness of when one or another will be most appropriate for an increasingly complex set of educational objectives” (p.56). She identified several specific features of classroom discourse that teachers could choose to focus on for bringing changes in their teaching practice. These features include a consideration of speaker rights and listening responsibilities (turn-taking, getting the floor, seating arrangements, gaze), the form and function of teacher questions, and the temporal relation between teacher and student utterances (wait times, and the kind of assistance provided). Analysis of classroom discourse in mathematics classrooms has drawn attention to social norms (Yackel, Cobb, & Wood, 1991), sociomathematical norms, (Yackel & Cobb, 1996), and the role of the teacher in the mathematical tasks (Walshaw & Antony, 2008) for supporting the educational objectives of a reform-oriented mathematics classroom.

The analysis here extends this research by identifying some features that teachers wanting to support students’ reading the world and reading the mathematical word can

consider. I described four inter-related features that emerged in the analysis of the classroom interactions namely proclaiming competencies; making collective decisions; caring, solidarity, & political relationships; and bringing the world and self into the classroom. Proclaiming competencies and making collective decisions facilitated sharing of power and authority in this classroom. An ethic of caring and solidarity, together with dissolving the boundaries of the classroom, the world, and self, facilitated building political relationships with students, which as Freire (1970/2000) indicated is necessary for a liberatory pedagogy.

Although Rico initiated this process of sharing authority and building political relationships, students took it upon themselves to co-create this classroom environment. In the instances described in this chapter, students demonstrated their agency by participating in multiple ways (such as questioning, resisting, sharing personal stories, etc.) in the classroom. As Gutstein (2006) suggests,

Young adolescents have their own ideas, energy, and desires, and should they choose to, they can derail the best plans of the best teachers. I could not force students to talk about politically taboo topics nor participate in a pedagogy of questioning if they did not want to participate. Nor could I make them have political relationships with me.

The decision whether or not to be co-creators was theirs. (p.143)

Nonetheless, building a dialogic space and developing political relationships has tensions and challenges for both teachers and students. The tensions relate to teacher over-influencing students, teacher pushing students too much or too little or not knowing when to back off, students' taking advantage of the freedom, and not making full use of the opportunities in front of them, or giving up when things become difficult. Student responses to the question "What do I need to do to improve as a teacher; what do I do well as a teacher?" summed up the dialectical relationship between freedom and authority that both

teacher and students faced when sharing authority, and building political relationships. In the year-end survey, Antoine indicated that Rico was too demanding. He said,

You have to be more understanding that some people may not care about their community. And that telling them that they have to have some interest is being too demanding.

Vanessa felt otherwise and said, “I think that it’s great that you push us, challenge and critique us. I hate working by myself to understand something, but you make us and me do it.” Carlton and Vanessa added that Rico needed to be an extra bit stricter. As Carlton said in his response,

The only thing that I think you should improve on is a teacher being more strict. There have been plenty of times you have let us pass on a lot of things other teachers won’t. I think this would be hard for you because I know you don’t like being strict but sometimes you do have to. As a teacher you’re more free and you show that you care about our future. You’re more understanding compared to other teachers.

Gema said that Rico “gave people too many chances” and she didn’t like and think it was fair “that some people turned stuff in on time and others didn’t.” While these responses indicated Rico needed to back off or push more, Vanessa indicated that “some students took advantage of the freedom” given to them. Ann felt “everyone complained way too much and even they knew it,” and Calvin did not like that “some people, including myself, when things got hard we sorta gave up a little.” Carmen added, “You don’t need to change anything if yourself you weren’t doing something for one of us, it was because of our own problems.”

Despite these tensions, Carlton and Carmen indicated that they liked the freedom they got in this class, as Carlton said, to “study whatever we wanted. We were actually treated like college students.” Both Daphne and Monica indicated that they liked being able to make collective decisions. Daphne said, “I like that fact that we help created the curriculum. I also

like the fact that our teacher actually worked with us,” and Monica wrote, “What I liked about this class was that we had a say in the decisions made. It was unique!”

In summary, I have described four features (critical features) that emerged in this classroom where students and the teacher were working towards reading the world and reading the mathematical word based on generative themes in students’ lives. These features were in addition to features such as revoicing, focusing, and stepping in and out that existed in this classroom (and were identified in reform-oriented classrooms, see Chapter 1). Although these four features emerged as unique to this classroom, they may not be the only ones that support or emerge in classrooms where the mathematical and sociopolitical dimensions are interwoven. We need further investigations into the discourse in classrooms like this one to expand the repertoire of features that teachers wanting to interweave the two dimensions could choose from.

7 CONCLUSION

Math is still not my favorite or my strongest but I know it's important for my life/future. I know that math can be used as a tool to smack people straight across their faces. (Vanessa, year-end survey)

In the introductory chapter of this dissertation, I outlined the following questions for investigation in this study:

- In what ways do the sociopolitical and mathematical dimensions interweave in this classroom?
- In what ways did the teacher scaffold the sociopolitical and mathematical content and support their interweaving?
- What features emerged as students and teacher co-constructed this space for interweaving sociopolitical and mathematical dimensions?

Subsequently, I laid out the theoretical framework and methodology that guided data analysis and elaborated on themes that emerged in response to these questions. Before I discuss the findings, contributions, and limitations of this study, I make a few points about how I wrote this final chapter from the standpoint of qualitative methodology.

Erickson (1992) indicated that interpretive researchers often fall into the positivist trap of making “claims for the generalization of their findings beyond the local settings in which their observations took place,” and think “of generalization in the usual positivist sense” (p.9). Instead, he suggested taking an empirical perspective where what generalizes from setting to the next depends on the local situation, because “specific contextual circumstances do vary significantly from one setting to the next, albeit in little ways. Yet,

these can be small differences that have big consequences for the qualitative character of the overall pattern that develops in any local setting” (p.10).

An alternative to proposing broad solutions or prescriptions as a way of generalizing from interpretive studies is to consider interpretive research as models that give descriptive accounts of the setting and the process of teaching-learning activity. As Erickson (1992) pointed out,

In reporting the specific of what local actors do, narrative case study is describing patterns of activity that are inherently not generalizable at the same level of specificity as the description itself. The generic and stable processes discovered in case study, however, can be seen at work in multiple settings. (p.10)

In writing this chapter, I have tried to highlight the nature and richness of the interactions and processes that existed in this classroom (and exists in all classrooms in different ways). Consistent with Erickson’s perspective, I suggest that a set of rules or prescriptions is insufficient to capture, comprehend, or reproduce this richness and complexity of the teaching-learning activity in this classroom. Instead, it is important to portray and embrace the joint activity of teaching-learning with all its uncertainty and messiness without reducing it to a set of broad generalizations that may seem to indicate some level of certainty.

My intent, moreover, is not to highlight this classroom as a “blueprint for the implementation of improvement in other local settings” (Erickson, 1992, p.11), but instead inform and inspire the reinventing of teaching-learning practices locally, as Freire suggested. “When I speak of the impossibility of exporting practices, I am not denying the validity of foreign practices. Nor am I negating the necessity for interchange. What I am saying is that they should be reinvented” (Freire & Macedo, 1987, p.133). Such a reinvention demands a comprehension of the “social, political, historical, cultural, and economic factors relative to

the practice and experiences to be reinvented” (p.133). It is in this “spirit of reinvention,” as indicated by Gutstein (2012a), that I draw some principles related to the practices in this classroom that others might reinvent as well, after having described the interactions and processes in this classroom in previous chapters.

I also indicate that a set of tacit rules for how to do this work is not a substitute for descriptive accounts like this study, which can become a resource for teachers and teacher educators to learn from, as appropriate for their scenario, and support them to see their practices at similar levels of complexity. These accounts can support discussions among teachers, and teacher educators, not for identifying a set of rules, but for engaging in a reflective discourse. Such reflection can deepen the understanding of teaching-learning activity, from which teachers can identify ideas for changing and reinventing their teaching practice. What we need are many more examples of teachers and students working together in similar classrooms to get a better sense of teaching and learning to read the world and read the mathematical word simultaneously.

I now give a summary of the main ideas in response to my guiding research questions and discuss the implications of this study and some directions for future research.

7.1 Findings of this study

I began this dissertation by highlighting two instances from the classroom, one each from the elections and HIV-AIDS unit where students interwove both the mathematical and sociopolitical dimensions in their utterances. Later, I discussed how the mathematical and sociopolitical dimensions were interwoven by teacher and students in and through the classroom space in order to read the world and read the mathematical word. I illustrated that these two instances were two different ways of connecting the mathematical and the sociopolitical. I also elaborated on the ways in which the two dimensions emerged, faded, and connected in the content and the classroom interactions, the conditions that supported this

interweaving, and the complexities involved in this process. Below I discuss key themes that emerged in this study.

7.1.1 The mathematical-sociopolitical relationship

One important theme that surfaced related to the ways in which the HIV-AIDS and elections unit were similar and yet different. Both unit provided possibilities for a mathematical and sociopolitical analysis of the situation (poll differences and HIV-AIDS infection rates) and complexities emerged during the classroom enactment in these two units in both dimensions. What emerged as different was the extent to which the mathematical and/or sociopolitical analysis was crucial to understand the context, and the directionality of the mathematical-sociopolitical connection for each unit. I discuss each of these points below.

Rico was reform-oriented in his mathematics teaching, aware of the difficulties involved in learning mathematical ideas, and had access to several resources (people and materials) available to develop the curricular framework. Nevertheless, mathematical complexities emerged mainly due to a) the inherent complexity and abstract nature of mathematical ideas, representations, models, and processes, b) the profound mis-education of students in the current system of public education, c) the teacher's pedagogical approach, and, d) developing curriculum on-the-go.

The first three factors are present in any mathematics teaching effort and so the mathematical challenges that materialized in this classroom are not very different from what can be seen in any mathematical classroom (including reform-oriented classrooms). What became vital in this context (and is perhaps so in any situation) is learning and growing into the teaching practice by being reflective about the classroom interactions as two of the examples illustrate—the bogus incident and making a decision about shifting the focus of the mathematical content in the HIV-AIDS unit from DDS to disproportionality.

The intricacies in the sociopolitical dimension, however, were unique to this class and emerged because of the intersection of constructs of race, class, gender, and notions such as freedom, and choice, with the generative themes. This appeared strongly in the HIV-AIDS unit while discussing the role of individual behavior versus social factors in influencing susceptibility to infection. Students had different and sometimes contradictory views of whether individuals had power and freedom to make a choice, or if their power to choose was constrained significantly by social factors. A similar tension (focusing on individual analysis vs. sociopolitical analysis) surfaced in the staffroom conversation (see chapter 6).

What became significant when sociopolitical complexities surfaced was the space available for students to deal with differing viewpoints. While it may be impossible to fully anticipate or even resolve these tensions, it is important for teachers to give space for students to grapple with differing viewpoints, provide contrasting views, and “allow space for uncertainties” (Freire & Macedo, 1987). The importance of allowing space for not fully settling contradictions or sociopolitical complexities cannot be emphasized enough. There is no one answer to many of the sociopolitical (or mathematical) complexities that can arise in the classroom and teachers cannot be prepared for everything, but they can always foster the space for students to think about these things, to the extent possible, as afforded by the time constraints.

Although each unit had its share of mathematical and sociopolitical complexities, the extent to which the mathematical and/or sociopolitical analysis was required to understand the context differed. The mathematical analysis in the elections unit was indispensable to making a sociopolitical argument, while the sociopolitical analysis was necessary to make sense of the data on racially disproportionate infection rates of HIV-AIDS. The mathematical analysis in the elections unit, although complex and rigorous, was not out of scope of this class, and was necessary to make a stronger claim for possibility of a stolen election. In the

HIV-AIDS unit, however, the mathematical analysis of disease spread was significantly beyond the scope of this classroom. Rico struggled with several of the limitations of using the DDS in this unit (Chapter 5) and instead chose to focus on the mathematical ideas of disproportionality and sociopolitical analysis as a way to explain and comprehend the disparity in HIV-AIDS infection rates across communities.

There is a further point to note. In the elections unit the mathematical ideas supported a deeper understanding of the meaning of elections, poll differences, and stolen election. In other words, the mathematics led to a deeper comprehension of reality, a point perhaps implied in a statement made by a student from the Crew at a presentation in January 2009. When someone in the audience asked her what they had learned, she responded, “We learnt something we already knew.” Perhaps she meant that she learned about the mathematics of the reality they were already familiar with and this in turn deepened their comprehension of the reality. Gema made a similar statement (mentioned in Chapter 6), in response to Greg who wondered what the point of presenting mortgages (in the community presentations) was when parents could not change what has already happened. Gema replied that going through the mathematics of mortgages could help parents understand what happened to them.

While it is possible to make an argument for stolen elections using all possible sociopolitical factors (long lines, vote switches, disenfranchisement, etc.), it can remain a vague idea. However, recognizing that the question of whether an election was stolen or not can be answered mathematically (or mathematized), and then learning the mathematics, can lead one to make a stronger claim. This gives concreteness to the possibility of the stolen election idea, making it less of a fable, and can in turn catalyze student action (e.g. the op-ed piece) based on the mathematical work done, thus providing the stimulus and possibility for writing the world with mathematics.

There is another side to it that relates to limitations with mathematical models, analysis, and what numbers can tell us. In the elections unit this emerged as caution to claiming that the elections were stolen based on mathematical evidence (as indicated in Chapter 5). In the HIV-AIDS unit, the data on infection rates only informed students that disproportionality existed across communities. The simple mathematical models for disease spread that students worked on could not really help develop a deeper understanding of the data on HIV-AIDS rates and the disproportionality therein. It was important to engage in a sociological analysis of these data, that is, to consider the social forces that constrain people's choices with these disproportional rates. In the same presentation in January 2009 that I mentioned above, another student from the Crew laid out the mathematical limitations related to predicting housing prices. He said,

So, we have to, what we looked at was that there's limits to these graphs,²⁹ to these mathematical models that we make, and that making assumptions and thinking of the future with using these models cannot always be correct. And you should, and when looking at these models, you should always think in reality and not just assume that the house prices will go up. So we have to set limits to where we want to be at. We think that the house prices are going to keep on going up, up to 2016 and thinking that they're going to be that much, and now knowing that they actually dropped, it doesn't really make sense [to overly trust the models]. And so we connect this to our life, by saying that, you know, these models, or some of these models, are some of the models that bankers, these big bankers use to figure out how much would a house cost in North Lawndale or in a low income communities or in any community. But they never took into, you know, reality, that people can't afford them. Or that, uh, they can crash, that the market can crash. (Video, 1/24/09)

²⁹ The graph that he is talking about is the line of best fit for house prices in North Lawndale.

That is, both mathematical analysis (mathematizing) and sociopolitical analysis (contextualizing) have the power to provide insights in to a situation and yet have their limitations when not connected with the other. So although contexts may provide opportunities for both mathematical and sociopolitical analysis, each comes with its limitations and may be helpful (and essential) to different degrees to understand the context (i.e., read the world). Both Turner (2003) and Varley Gutiérrez (2009) describe similar tensions between the mathematical and sociopolitical analysis in their respective settings. The limitations and possibilities of the mathematical and sociopolitical analysis also relates to the notion of context-content continuum that I outlined in Chapter 4, that is, the continuum along which the mathematical and the sociopolitical dimensions are in a dance with respect to context and content. Both the elections and HIV-AIDS unit contexts supported mathematical and sociopolitical content (independently, and in relationship to each other), albeit differently, thus suggesting a different dance between the mathematical and sociopolitical dimensions, and a different location in the context-content continuum in each case.

7.1.2 Interweaving: Essential and non-trivial

A second significant finding of this study is that the interweaving of the mathematical and sociopolitical dimensions pervades all aspects of the classroom—namely the content, the mediating artifacts (the generative themes, the text, articles, videos, etc.), teacher and student acts, and the features of interaction—across time. That this joint activity had both mathematical and sociopolitical goals points to the importance (and necessity) of the teacher-student acts (utterances, the pedagogical decisions), the content, and the interaction features to encompass both dimensions. I discussed this interweaving of the two dimensions across time and multiple aspects of this classroom in several instances in Chapters 5 and 6.

Particularly, I showed that the interweaving occurred in several forms across time. One form of the interweaving was seen in students and teacher utterances when they tried to

bring the two dimensions together or foregrounded one over the other. The interweaving also occurred in the teacher's pedagogical decisions, for example, when the teacher introduced the myths chapter, connected the coin toss to poll differences, showed clips from *Uncounted*, focused on the mathematical idea of disproportionality, and brought students' attention to the op-ed piece from the discussion of the staff room conversation. In all these instances, the teacher's decision foregrounded either the sociopolitical or the mathematical dimension or connected them together. Yet another form of interweaving was seen on a given day or over a few days when the discourse in the classroom shifted between mathematical and sociopolitical dimensions. This occurred through participant utterances or teacher pedagogical decisions that foregrounded or backgrounded one dimension over another, or brought the two together. And finally the interweaving was also visible in the content as the mathematical-sociopolitical connection of the unit, which in turn guided the teacher's pedagogical decisions, and emerged in student work or utterances towards the end of the unit.

The teacher and students were active participants, across time, in both dimensions and brought one of the dimensions to the fore, pushed it to the background, or connected them. Students posed questions about and engaged in making sense of the mathematical and sociopolitical ideas in both the units, and I gave several examples of this in Chapters 4, 5, and 6 (e.g., when discussing the disproportionality and SI models in HIV-AIDS unit, the poll differences in the elections unit, the sociopolitical factors in HIV-AIDS unit). Further, the teacher drew on students' prior experiences mathematically and sociopolitically (e.g., deciding the generative themes to study, using the White Sox, Jena 6 sub-contexts, asking poll watchers to share experiences).

The four features of interaction that emerged in this classroom also facilitated the interweaving of these two dimensions in the discourse. Proclaiming competence and making collective decisions allowed for creating a dialogic space, thus opening up space for students

to participate in myriad ways both mathematically and sociopolitically. Developing political relationships and bringing the world and self into the classroom allowed for not only normalizing sociopolitical conversations, but also normalizing the *shift* between sociopolitical and mathematical discourse. As I indicated in Chapters 5 and 6, this shift from a sociopolitical to a mathematical discourse or vice versa, became a normal and recurring feature in the class.

At times, students made the mathematical-sociopolitical connection (usually toward the end of the unit), but often Rico made this connection and initiated the shift from one dimension to another as appropriate and necessary (on a given day or from one day to another, see examples in Chapter 5 and 6). He often made this decision keeping in mind the mathematical and sociopolitical goals of the classroom and the mathematical-sociopolitical connection of each unit.

Further, this interweaving was seamless at times and tension-ridden at other times as indicated in the trajectory of the classroom interactions in both the units, in Chapter 4 and 5. Tensions arose due to several reasons such as time constraints (as in the staffroom discussion), lack of clarity on the mathematical-sociopolitical connection (as in the HIV-AIDS unit), and the complexity (or simplicity) of the mathematical or sociopolitical ideas required (in the elections and HIV-AIDS unit). In summary, what this study suggests is that reading the world and reading the mathematical word requires more than a piecemeal approach of interweaving mathematical and sociopolitical dimensions in the content alone. Instead, it indicates that teachers need to consider how these two dimensions can be interwoven across all aspects of the classroom, with awareness of the mathematical and sociopolitical goals for the class and the mathematical-sociopolitical connection of the unit (and being open for it to change). For example, both in the elections and HIV-AIDS unit, the interweaving occurred not only in the content or the curricula developed, but in the classroom

enactment as well (like when developing the equivalence between poll differences and coin toss, discussing the movie clips from *Uncounted*, making the connections between the sociopolitical factors and disproportionality in the HIV-AIDS unit) . The discourse in the classroom in both these units moved between mathematical, sociopolitical, and a combination of the two. In addition to the content and teacher pedagogical decisions, the teacher and students participation in both dimensions on a daily basis and the features of interactions were factors that that facilitated the mathematical-sociopolitical interweaving in multiple ways across time.

7.1.3 Teacher's role

Although the generative themes came from students' lives and in discussions with them, Rico provided the voice of a capable other and it would be naïve to dismiss his role as a teacher either mathematically and sociopolitically. In addition to assisting the learning of mathematical content (as is expected in mathematics classrooms), he facilitated the mathematical-sociopolitical dance in the interactions in this class with both mathematical and sociopolitical goals (as distinct from a reform mathematics classroom with only mathematical goals). Rico did this in several ways based on his awareness of the mathematical sociopolitical connection of each unit (and yet being open to changing it during the course of the unit as in the HIV-AIDS unit). He decided when and how to move between the two dimensions, reframed and revoiced student contributions mathematically or sociopolitically, and pushed students from everyday intuitive ideas to more mathematical and sociopolitical ideas. As discussed in several instances in Chapter 5 and 6, this relates to the role of the teacher in the Vygotskian perspective of bringing more abstract ideas to the dialogue, and supporting the movement from the concrete and the intuitive to the abstract and scientific, in this case, in both mathematical and sociopolitical dimensions (Becker & Varelas, 1995, Vygotsky, 1978).

The decision to move between the two dimension often involved the teacher having to consider multiple factors such as time, awareness of the mathematical-sociopolitical connection of the unit, what could be reasonably accomplished, what needed to be done for the day, and students' mathematical understandings (Chapter 5 and 6). In both the elections unit and the HIV-AIDS unit, the decision to move between mathematical and sociopolitical dimensions built on each other, and supported students' interweaving the two dimensions. Nevertheless, this decision to shift (sometimes) was accompanied with a sense of missed opportunities, leaving things unfinished, and not reaching conclusions (as in the staffroom discussion, the discussion on sociopolitical factors in HIV-AIDS unit, the decision to not pursue the analytical solution for solving a system of linear equations and so on).

What this study also suggests is that when teaching mathematics based on generative themes, the boundaries between the personal, political, and academic that often exist in schools and classrooms may begin to fade away. In addition to being reflective of the pedagogical reasons for shifting between the two dimensions (Turner, 2003; Varley Gutiérrez, 2009b), engaging, continuing, or ending a conversation on a sociopolitical idea also requires teachers to overcome any discomfort about discussing sociopolitical topics in the classroom and opening up the classroom space for politically taboo topics as Gutstein (2006) suggested. However, this may not be trivial. Bartell (2010), for example, in her study indicated that some teachers were hesitant to discuss "racial" topics in mathematics classroom.

In addition to teachers being cognizant and reflective of their pedagogical decisions and the reasons for making them, and ameliorating the discomfort of discussing sociopolitical topics, they also need to share authority and build solidarity with students and facilitate a dialogic environment in this classroom. While all of these may be necessary for any effort to teach (well), it is particularly so for teaching that supports students reading the world. Part of

the political framing of this class was for students to participate as students-teachers and the teacher as teacher-student (Freire, 1970/2000). Although Rico frequently initiated the foregrounding or backgrounding of the mathematical or sociopolitical dimension, students took it up on themselves (to participate and at times resist) and steered the course of classroom interactions (like when students demanded to talk about the staffroom conversation).

What this meant was Rico wielded power (for better or worse) to get students to take on more responsibility for their learning (both mathematically and sociopolitically), to participate in decision-making processes, and to engage in collective actions. As Freire said,

Dialogue does not exist in a political vacuum. It is not a “free space” where you may do what you want. Dialogue takes place inside some kind of program and context. These conditioning factors create tension in achieving goals that we set for dialogic education. To achieve the goals of transformation dialogue implies responsibility, directiveness, determination, discipline, and objectives. Nevertheless dialogue implies an *absence* of authoritarianism. Dialogue means a permanent tension in the relation between authority and liberty. But in this tension, authority continues to be because it has authority vis-à-vis permitting student freedoms which emerge, which grow and mature precisely because authority and freedom learn self-discipline. (Shor & Freire, 1987, p.16)

Although there were instances where the classroom interaction resembled the monologic structure (with Rico lecturing or students presenting), the critical stance of this class, the sharing of authority (content and process), and the relationships of caring and solidarity between students and teacher led to an overall discourse in this classroom that was dialogic in nature (O’Connors & Michaels, 2007).

7.2 Implications

This study is significant for several reasons. First, it is based on a unique year-long comprehensive effort to teach high school students (all Black and Latino/a from low-income families) at an urban, neighborhood public school (with no selective-enrollment) in the US, to read the world and read the mathematical word using generative themes from students' lives. Second, this study investigates the interactions in this classroom to understand the ways in which the mathematical and sociopolitical dimensions interwove at a level not described extensively in the research literature on critical mathematics. Third, it brings together the Vygotskian and Freirean perspective in the data analysis, which is not common in the research literature in mathematics (and critical mathematics) education. Several implications arise from this study and I discuss them below.

7.2.1 Learning to read the world and the mathematical word

A noteworthy implication of this study is that it is possible to use generative themes from student lives to provide opportunities to read the mathematical word and read the world (with mathematics whenever possible). The two snippets at the outset of this dissertation where two separate and distinct disciplinary "conversations" (one mathematical and another sociopolitical) come together are evidence of this. Moreover, when reading the world with mathematics, at its best, the separation between the two dimensions does not exist. For example, in the two snippets, Ann, Roxanne, and Carlton were simply engaged in a process of sense-making without necessarily a conscious interweaving the mathematical and sociopolitical aspects.

What is also significant is that this was a class in a neighborhood public school, with no selective-enrollment whatsoever. Although I did not analyze the specific mathematical learning and understanding of students in this class, this study suggests that students (all of whom were Black and Latino, from low-income families, and had limited access to rich mathematical experiences) took up this opportunity to participate and collaborate in

meaningful and rigorous mathematical activities and deeply understand their social realities. My analysis indicates that students were deeply engaged in several ways in the classroom mathematically and sociopolitically, and were making meaning of the mathematical and sociopolitical ideas and the interconnections, suggesting evidence of a participatory metaphor of learning (Sfard, 1998), and performance before competence (Cazden, 1981).

This study, however, does not propose that this is the only way to learn mathematics or read the world. There are many ways to do so, including without linking them together. This and other studies in the research literature indicate that it is possible for the two goals (reading the mathematical word and reading the world) to facilitate and build on each other to offer meaningful mathematical learning (and sociopolitical learning) opportunities for low-income students of color. What then becomes important is to understand the ways of doing so, the challenges that arise in the process, and ways in which to navigate them, which I discuss next.

7.2.2 Teaching to read the world and the mathematical word

This study has several implications for teachers wanting to teach mathematics for social justice. First, this study suggests that while developing the curriculum and enacting it in the classroom, it would be useful and helpful for teachers (and students) to explore the mathematical-sociopolitical connection both ways. That is, it recommends that teachers consider the extent to which the context supports and requires mathematical and sociopolitical analysis, the extent to which the mathematical analysis helps understand the sociopolitical situation, and the extent to which the sociopolitical analysis is necessary to understand the mathematics.

A second point emerges from the analysis in Chapter 5 for teachers wanting to support students to read the world and read the mathematical word using generative themes. That is the importance of interweaving the mathematical and sociopolitical dimensions in all

aspects of the classroom (content, processes, norms, and acts), across time, to the extent possible within the constraints of the setting.

Third, this study indicates that the teacher's awareness of the mathematical-sociopolitical connection, his/her decisions to let go of one dimension and shift to the other temporarily, initiative in creating a dialogic classroom environment, and building political relationships are conditions that facilitate the interweaving of mathematical and sociopolitical dimensions in the classroom. Moreover, it also indicates the importance of teachers having experiences both mathematically and sociopolitically when trying to do this kind of work.

Although the interactions and artifacts in this classroom space mediated the process of reading the world and reading the mathematical word, there were other facilitating factors as well. The school had an explicit orientation towards social justice and Rico had a long-standing relationship with the school. He had been a part of the design team of the school, had worked with students and teachers in the school since its inception, and knew the students in this class over four years at Sojo. Rico also had a fellowship for the entire year to pursue this class full-time and did not have other teaching responsibilities either at school or at the university. Additionally, Rico was able to bring together several resources (material and people, mathematical and sociopolitical) to support this class.

In this scenario, these factors to some degree offset the constraints of the high-stakes testing and accountability regime of public education (Lipman, 2002, 2004) that most teachers and schools regularly experience. The intent of this study is not to set this classroom or this teacher's practice as a benchmark or the norm, but to inspire others to take similar steps and reinvent it (as Freire termed it) to their setting, being aware of the affordances, challenges, and constraints that exist and can arise.

7.2.3 Connecting Vygotsky and Freire

Finally, a significant contribution of this study is the way it brings together Freirean and Vygotskian viewpoints in the analysis. This study suggests that these two perspectives complement each other and can indeed offer a synthesized framework to deepen the analysis of the joint activity in such classrooms (Chapter 2). Both Freire and Vygotsky's theoretical frameworks move away from the banking and transmission approach to education.

Freire began with a focus on the question of power (in society, in school, and so on), and suggested that learning processes be dialogic and based on generative themes. Frankenstein (1983) and Gutstein (2006) extended Freire's work in literacy (reading the word and world) to mathematics (reading the mathematical word and reading the world with mathematics). Vygotsky, a psychologist, began by trying to understand the process of learning and the role of culture and social activity. He proposed that learning and development occurs in joint activity in the presence of capable others through the mediation of cultural tools including language. Wells (2007), and O'Connor & Michaels (2007) drew on the centrality of language in his work to emphasize the importance of a dialogic stance and structure to the discourse and an inquiry-oriented approach (where the topic of inquiry engages students and emerges from their interests) to facilitate learning in joint activity.

In the synthesized framework, I drew from Freire, Gutstein, and Frankenstein's work for ideas related to generative themes, reading the world, reading the mathematical word, reading the world (with mathematics whenever possible), the dialogic method, and the role of the teacher in identifying generative themes. I also drew from Vygotsky, Wells, and O'Connor & Michaels' work for the notion of joint activity, zone of proximal development, dialogic stance and structure in interactions, and the role of the teacher in joint activity. Together, these ideas made it possible to analyze the intricacies of the interweaving of the mathematical and sociopolitical dimensions in this classroom in relation to the coherence of the goals of the joint activity, teacher students actions and roles, and the interactions.

7.3 Limitations and future directions

In this study, I emphasized students' interweaving mathematical and sociopolitical dimensions in the classroom interactions and its connections to the teacher's role, the norms, and the curriculum. As I mentioned in Chapter 1, a limitation that arose out of this choice is that I did not provide an in-depth analysis and assessment of mathematical or sociopolitical learning of students in this classroom. This could be a future direction of research.

Although Rico initiated the process to share authority and create a dialogic space, the question of what prompted students to take it up and participate in the classroom in the many ways they did remains unanswered. How this class influenced students (and their identities) is a topic for future research that Patricia Buenrostro, co-researcher on this team, is beginning to investigate. The implication of this class and this study for teacher education and teacher educators is another direction for future direction of research.

7.4 Concluding thoughts

This study gives an insight into the complex, rich, and fascinating interactions between students and teacher in a classroom where teacher and students were engaged in reading the world and reading the mathematical word. As Daphne and Miriam's statements below indicate, (some) students indeed began to consider the possibility of interweaving mathematical and sociopolitical dimensions whenever they could to read the world with mathematics. In response to the question, "Do you feel that you are now better able to understand the world using math? Examples?" in the mid-year survey, Daphne said,

Yes. By finding an issue that concerns me and figuring the math about it. For example, if I were to do a project on teen pregnancy. I would look at how much money organizations who are opposed to teen pregnancy used on advertisement. To put out an image that teen pregnancy is bad.

I think that our math class did meet our goals and more. I'm not only talking about me but also my peers. We as a class learnt a lot of math and hard math, that sometimes we just want it to drop the class for the same reason. We also learn how to read and write the world with math. To be honest with you, now every time I read or heard about an issue I always think, "Can we use math to solve it."☺ (Miriam, year-end survey)

Statements like these, by students, speak to the power of presenting such opportunities to students. I hope that this study will not only inspire more teachers to create opportunities within their classrooms to interweave the mathematical and sociopolitical dimensions, but also persuade researchers to investigate the richness of the interactions, and teacher-student relationships and roles, in such classrooms.

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APPENDICES

APPENDIX A

Sub-contexts used

Elections Unit

Jena 6

Following a school fight in which Justin Barker, a white student was beaten, and suffered a concussion and multiple bruises, six Black students at Jena High School, Louisiana, were arrested and charged with attempted murder and conspiracy on December 4, 2006. The fight took place amid mounting racial tension after a Black student sat under a tree in the schoolyard where only white students sat. The next day three nooses were hanging from the tree. The Jena Six case sparked protests across the US. Those viewing the arrests and subsequent charges termed it racially discriminatory. Mychal Bell, the first of the Jena 6 to be tried, was convicted by an all-white jury. Joyce Sia (one of the math teachers at Sojo) and Rico developed a mini unit where the mathematical goal was to find the probability of selecting an all-white jury in Jena which was 85.6% white (1,844 people) and 14.4% people of color (310 people). See <http://www.nycore.org/newsite/wp-content/uploads/revealingracistroots.pdf> for more details.

White Sox

The White Sox are a professional Chicago baseball team from the Southside, and Lawndale is in the south part of Chicago. Many youths (including females) are White Sox fans and because of the geography of Chicago, being a fan of the Northside Chicago professional baseball team (Chicago Cubs), while living on the Southside, is a no-no. The White Sox were nearing the end of their sports season and were vying for the playoffs after having won the World Series in 2005. Most students, even the female soccer-playing Latina students in the class were aware of this. The White Sox were also in the tabloid media a lot and Sox clothing (shirts, hats, jackets, etc.) was fairly popular. So, although it was an ostensibly apolitical context, it resonated with students who worked on problems such as the following. Suppose the Chicago White Sox have 5 games left to play, and suppose the probability that they will win any game is .6.

1. What is the probability that they will lose all 5 games? 4 games?
2. List all the sequences that have them winning 4 of the 5 games (each sequence will have 5 letters, W or L, just like w/ heads & tails).
3. How many different ways can they win 4 games?

Cubes from a bag

This scenario included problems such as the following.

1. There were 6 red cubes, 9 white, 9 black, and 1 yellow in the bag. Picking with replacement, if the first 5 picks were black, what's the probability of the 6th cube being black? If you did not replace, and the first 5 were black, what's the probability of the 6th cube being black?
2. Assume you have 3 bags, each with 5 cubes. The first has 1 black cube, the second has 2 black cubes, the third has 4 black cubes. What's the probability of randomly picking one cube from each bag and all being black?"

APPENDIX A (continued)

3M3F

Students worked on problems such as the following.

1. What's the probability of picking a female pair from a group of 3 males and 3 females?
2. Assuming that you did pick a female on the first pick, what's the probability of picking another female on the second pick?

HIV-AIDS Unit*Tree Farm*

This scenario involved a tree farm, where 20% of all the trees were cut down and 640 new trees planted each year. Student responded to questions such as

1. If you let $u(n)$ be the number of trees at the start of year n , what would the difference equation be? How can we create a dynamical system to model this situation?
2. Try some different values of $u(1)$ that range from 0 trees up to 10,000 trees. What is happening? Why do you think the system acts in this way?
3. In a difference equation, if $u(n)$ and $u(n-1)$ are eventually the same, can you solve the equation to find the equilibrium value? [HINT: use E to represent both $u(n)$ and $u(n-1)$]. Will this always work? Try out some different scenarios with the trees (for example, cutting a different percent each year). What do you learn?

Car Rental System

This scenario involved a major car rental company renting cars from two cities, Chicago and Milwaukee. The company has a fleet of 840 cars and wants to split the cars between the two cities. The company finds out that of the cars people rent in Chicago, each week 60% are returned in Chicago, and the other 40% are returned in Milwaukee. They also find out that of the cars rented in Milwaukee, 70% are returned in Milwaukee each week, and 30% are returned in Chicago. In this situation, you need to find out how many cars each city has each week.

1. Create the dynamical systems for each city assuming all cars are in Chicago the first week. Graph the dynamical system. What did you learn?
2. Decide some other ways to split up the 840 cars between the two cities to start and create the dynamical systems to model that situation and graph them. What did you learn?
3. Now that you have found the equilibrium values for the system with the graphs, try to find them analytically.

Blood-liver system

Doctors know that vitamin A (which is essential to health) is stored mainly in our blood and our liver. Approximately 40% of the vitamin A in the blood is removed by the kidneys each day; about 30% of the vitamin A in the blood each day goes into the liver; about 1% of the vitamin A in the liver goes back into the blood each day; people often take a vitamin A supplement of 1 mg (milligram) a day. Two difference equations need to be set up. If you let $u(n)$ be the amount of vitamin A in the blood at day n , and $v(n)$ be the amount of vitamin A in the liver at day n ...what would the difference equations be? See if you can solve for the equilibrium values of this system (if they exist!).

APPENDIX B

Mathematics for Social Justice—Sojo, 2008-09—Mr. Rico, Journal #3, Due 9/23/08

Part I. Hello math and social justice scholars! On the back of this paper are two graphs. One is of the increases of health insurance spending and energy costs (gasoline, heating, electricity) for the people in the US from 2000 to this year. The other is a graph of median income for households in the US (people less than 65) from 1989-2007. If you look at the increases in health insurance and energy costs, which of the two grew at a faster rate? If you just look at the period in which the graphs overlap (2000-2007), what do the two graphs together tell you? What is the story here? Write about what sense you make of these graphs, what story they tell, and your thoughts about this situation.

Part II. I am having a difficult time thinking about how to grade this class. I talked w/ Patty and Anita, and we had some thoughts, but also want your input. Let me say that I hate grades and I hate giving them because they do very little in capturing what you really know and they can make people feel bad if they're not great. Also, it can set up a competition between students, and this class is about us in solidarity together learning to read and write the world, so competition has little value in that. I am happy to give lots of feedback on what I see you learning, but that's not the same as a "grade," and I do have to give grades.

The grade you will earn in this class is a UIC grade, so you can think creatively about this, and not be stuck in "CPS mode." Normally, when I teach at UIC, I don't teach mathematics (I teach people to teach mathematics), so this is new for me as well. So some questions to think about, but please don't limit your thoughts to our questions, think broadly!

- Should HW count? How much?
- Should tests count? Take-home? Quizzes? How much?
- Should we have in-class tests?
- Projects? Since we will have projects...how to count them in the grades?
- Portfolios—good idea or bad? Why? Should we use them? What should go in them?
- Class participation? Should that count? How much?
- Public presentations? Should they count? In-class presentations?
- How well you work with others?
- What other things do you want to be graded on?

I realize you don't often get the opportunity to have input on this, so please be open and honest and fair in your thinking. We value it, a lot.

APPENDIX C

Op-ed piece published in Huffington Post on October 31, 2008

Students Ask: Are Our Elections Fair?

Chicago High School students question the fairness of U.S. elections. The students in Eric (Rico) Gutstein's math class over at SoJo -- Social Justice High School, a school born out of a 2001 hunger strike in Chicago's Little Village neighborhood -- have been "investigating social reality using mathematics," as Rico told me recently. That is, they are "learning good math and learning about the world. The realities we are studying this year: the elections, neighborhood displacement, the spread of AIDS in North Lawndale (a low-income Chicago neighborhood), the criminalization of youth/people of color, and the mathematics of sexism. The math itself is an eclectic blend of pre-calculus, probability/stats, discrete mathematics, algebra, with the emphasis on mathematical modeling of social reality."

Their unit on the mathematics of fair elections -- making use of the recent book by Steve Freeman and Joel Bleifuss, *Was the 2004 Presidential Election Stolen?: Exit Polls, Election Fraud, and the Official Count* -- has ended just as the 2008 presidential campaign is ending, and the students, some of whom will be first-time voters in this election, were concerned enough about the evidence of fraud four years ago they wanted to tell the world.

Here is their editorial, written by the whole class, with Channing Redditt and Amy Maldonado the principle authors:

Will This Presidential Election Be Stolen? It Didn't Happen By Chance

We are seniors at the Social Justice High School in Chicago, and in our math class, we have been working to understand whether or not something went wrong in the 2004 presidential election. We have used statistics, facts, and formulas to demonstrate that some of the election results did not happen by chance. During our analyzes, we discovered that the differences between the exit polls (random confidential surveys done immediately after voting) and the recorded votes did not match. Although we expect some differences, due to sample variation, the numbers were mathematically improbable or basically impossible!

Exit poll results should be close to the recorded vote (as they have been in past elections). When this is not the case, we have a "poll difference" between the two. There is a 50/50 chance that the difference will favor one candidate or the other. We would have expected some to favor Bush and some to favor Kerry. But, according to Steven Freeman in his book, *"Was the 2004 Presidential Election Stolen,"* in the 10 battleground states, all 10 differences favored Bush. The chances of that happening are about 1 in 1,000. And across the US, in all 50 exit polls, 44 of the differences favored Bush, and only 6 favored Kerry. The chance of that happening is about 1 in 71,000,000—very close to zero. Our last point is that in Ohio, Kerry won the exit poll with 54.2%. But, as Freeman reports, in the actual vote, he only won 48.7%. The chance of that happening is about 1 in 1,000,000,000. Possible? You decide!

We do not know exactly what happened to explain why the exit polls were so far off in 2004. But we know that in the 2004 election, there were reports of votes flipping from Kerry to

APPENDIX C (Continued)

Bush, “undervotes” (where people did not vote for president but voted for other positions), polling stations with more votes counted than people registered, and many other very strange things with the electronic voting machines. We also know that there were fliers with false information about when to vote, long lines, not enough machines, and voter suppression.

Some of us are 18 and are voting for the first time. As first time voters, we cannot stress enough how important it is to be educated about the past elections and the things that went wrong. Our class is writing this to inform *everyone* about previous problems in the elections and to warn people to watch for similar troubles. We want to ensure that in this election, the same problems do not occur. We are already seeing problems with voting this year. Be prepared to pressure your representatives and senators to *immediately* investigate and *challenge* the election if something appears wrong!

In this election, it is up to all of us to question the results and to hold officials accountable for fairness. If the vote changes on the electronic machine, call for assistance. Let your vote be counted for the candidate of your choice. Let your voice be heard, and don’t settle for less!

Remember—it didn’t happen by chance!

APPENDIX D

Mathematics for Social Justice—Sojo, 2008-09—Syllabus, Part II—Mr. Rico (Gutstein)

- 1) *Question, Critique, Challenge, & Create!* (*C⁴* for short)
- 2) *Building a family—solidarity!* We are in this struggle together.
- 3) *“Reading and writing the world with mathematics”*
 - Community, critical, and classical knowledge
- 4) *Community Education*
 - Little Village & North Lawndale presentations: January & May/June
 - Chicago-area conferences and universities/schools
- 5) *Studying the class—being “co-researchers”*
 - “Site for learning”—move Sojo math as a whole from IMP —>Social justice math
 - Anita B., Patty B., videotape, others—only w/ your permission!
 - Curriculum: developing it, learning from it. Is it engaging? Meaningful? Do we learn?
 - Mathematics content knowledge: conceptual (i.e., understanding) and procedures
 - My teaching: strengths/weaknesses/improvements
 - “Community knowledge”: what/where? How to build on it to make it critical/classical?
 - Reading/writing the world
 - Development of strong, rooted identities: cultural, political, social, individual
 - Feedback from ourselves & others: community/conference presentations, etc.
- 6) *Action*—as needed, as we collectively decide. But always, “study your enemy!”
- 7) *Writing*—weekly journals, *private*, *word-processed*. Standard college practice!
- 8) *Expectations*
 - How hard will you push yourselves? How hard do you want me to push you? Are you ready?
- 9) *Acuerdos* (classroom agreements, “norms” of working together)
 - Level of *mutual commitment to each other*, shared responsibility/authority
 - Homework
 - Talking and listening, raising hands, etc.
 - Frustration and persistence
 - Communication is key
 - Support—after-school/lunch tutoring, cell phone numbers, etc.
 - Others???
- 10) *Five Units—plus others?*
- 11) *Grading*
 - Projects, tests, journals, homework, presentations
 - Understanding, communication, effort, correctness (procedures)
- 12) *Goals for the year*—yours and mine!
- 13) *Binders*. These should have four sections:
 - HW assignments and turn-ins
 - Journals
 - Vocabulary
 - Classroom Notes
- 14) *Groups*. Who should you work with? When? Why?