

Beyond the scores: Mathematics identities of African American and Hispanic fifth graders in an urban elementary community school

by

Paula Jenniver Fleshman

A dissertation submitted to the Graduate Faculty in Urban Education
in partial fulfillment of the requirements for the degree of Doctor of Philosophy,
The City University of New York
2012

© 2012
PAULA JENNIVER FLESHMAN
All Rights Reserved

This manuscript has been read and accepted for the Graduate Faculty in Urban Education in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

1/27/2012
Date

Anna Stetsenko
Chair of Examining Committee

1/27/2012
Date

Anthony Picciano
Executive Officer

Nicholas Michelli

Mary Q. Foote

Supervisory Committee

THE CITY UNIVERSITY OF NEW YORK

Abstract

Beyond the scores: Mathematics identities of African American and Hispanic fifth graders in an urban elementary community school

by

Paula Jenniver Fleshman

Advisor: Anna Stetsenko

Abstract

As mathematics identity affects students' learning and doing of mathematics, it is critical to understand the mathematics identities of African American and Hispanic students as the mathematical performance and pursuits of far too many continue to lag behind. Further, as community schools have been shown to positively impact students in urban communities, it is also critical to understand how mathematics identities are developed within community schools. This study explores the culture, structures, and processes of an urban elementary community school including its afterschool archery program relative to fifth grade students' mathematics identities. It also explores students' math positioning, enactment, and perspectives in the classroom and archery.

The theoretical framework encompasses multiple theories and perspectives: identity theory, cultural-historical activity theory, ecological systems theory, and culturally responsive pedagogy. Ethnography of one urban elementary community school was conducted over one school year plus summer camp using mixed methods. In total, 33 fifth graders and 13 adults participated in the study. In addition to school and community agency artifacts collected, observations inside and outside of the classrooms were conducted along with student brainstorming exercises and student and adult interviews. State math assessment scores were collected for 2009 and 2010 and pre- and post-surveys on students' mathematics beliefs and attitudes were conducted.

While 7 out of 10 fifth graders favored mathematics and considered themselves as mathematicians, as defined in a broader sense that reflects habits of mind as opposed to simply skills, less than four out of 10 saw themselves in careers considered math- or science-related. Interestingly, students who had heard the word "mathematician" scored significantly higher on state math assessments

than their peers who had not. In the classroom, students positioned themselves in different ways relative to their mathematics identity such as leader, helper, independent, math smart, social learner, and agent of their own learning. Outside of the classroom, the afterschool archery program bore positive relevance in students' mathematics identities, including a student with Attention Deficit/Hyperactivity Disorder, through culturally responsive instruction, a culture of respect, and goal-setting. Study results can inform community school processes, cultures, and structures as well as children's media.

Dedication

To God be the glory for all of what He has blessed me to experience, be, and become along this journey.

To my Mother, Susie

Whose faith in God guided her every step. Who poured all of herself into raising her children and making sure we had all of what we needed to face the world. Who planted mathematics seeds and more inside of me. Who brought to life a joy of learning math and all things. Whose greatest joy was raising her children. And for me, her “Knee Baby”, whose greatest honor was being her child.

To my Father, Earl

Who, during my math honors luncheon at undergraduate orientation two days after I graduated from high school, turned to me with a big smile and asked, “So, when are you getting your Ph.D.?” I knew I would. I just didn’t know when. But today, on this day, my Father’s birthday, I answer, with a big smile, “Today, Popsy. Today. Happy Birthday.”

To my Sister, Robin

Who, although never remembers the beautiful, mind-tripping mathematics moment she orchestrated for me when I was five years old, has always supported, encouraged, fought for, and cheered for me in all my endeavors. She is the consummate big sister. Her pressing forward with hope and grace always inspires me. May her love of science continue to burn brighter than the brightest sun.

To my older Brother, Bryant

Who, although didn’t care for math, always encouraged me in my math pursuits. Who saw the beauty of math in music, and first showed that beauty to me. Who epitomized following one’s passions and being more than a conqueror in spite of any and all obstacles. Who lived his love: music. Who embodied limitless musical talent. Who walked by faith and not by sight.

To my younger Brother, Markanthony

Who also epitomizes following one's passions in spite of any and all obstacles. Who takes the sounds and cadences of this world, as harmonious and discordant as they may be, and transforms them beautifully into his own. He, too, lives his love: music. Who encourages and celebrates me along my journey. Whose faith, hope, and perseverance say it all. May the musician in him resonate without end.

To my Grandmother, Jennie Irving

Who laughingly reminded me of my words as a toddler, "Leave me 'lone." She said I would said those words whenever I wanted to do it, whatever it was, by myself. Who still prays and believes without fail. Whose stories and words of advice to me stand grounded in faith in God and the wisdom of her life.

Acknowledgements

This dissertation, this doctoral journey, I could not have done on my own. Many people along the way, from the very beginning of my seriously thinking about earning my Ph.D. to this very day, have contributed in many different ways to this journey: my family, friends, professors, and colleagues. It is a humbling experience to look back and try to take account of how people have graciously given of themselves so that I might achieve my goal. Whether by word, deed, thought, or prayer, others sewed love, faith, and strength into me. I am forever grateful.

I will start by thanking my committee—Dr. Anna Stetsenko, Dr. Nicholas Michelli, and Dr. Mary Q. Foote—for guiding me through this process, especially Anna, who served as a phenomenal advisor. I first came to hear of Anna’s work with Vygotsky’s cultural historical activity theory through Dr. Laurel Cooley with MetroMath. After researching and reading some of Anna’s articles, I made it a point to take her class, Developmental Psychology II, in hopes of securing what I thought to be the most significant and missing key to my research—identity development. This was the last class I needed to take and I was praying things would fall into place. Thank God, they did. Sometime during the course of her class, I asked her to be on my committee.

She gave it some thought and not only agreed to serve but also to chair the committee. Throughout our conversations over the years, she has provided insightful advice, patient guidance, and thought-provoking feedback, thus helping me to understand better not only cultural historical activity theory but ecological systems theory and how my research ideas connect with the theories and could connect better. She has provided judicious reading to enhance my theoretical grounding; constructively listened to and helped me process my questioning and theorizing; and, clarified my misunderstandings. Coming to understand me and my research, Anna connected my identities and encouraged me to write the dissertation in the same way I saw mathematics. She also pointed out something in me that I had not realized and still have a little trouble owning—that I am an evolving theoretician. It is an identity I had never considered. She held up the mirror for me and helped me to see and reflect on my own identity processes as a child learning math and as an adult researching the same—a reflection that she believes and I hope would honor my Mother, in particular, and my Father, and siblings. She cares not only about the work evolving but the person evolving through the work and their contribution beyond. I have grown as a researcher because of her.

Nick, early on in my program and throughout, offered me comprehensive advice and a calming demeanor, which has proved invaluable to me. As a professor and a MetroMath research colleague, he gave me what every student needs along the way—guidance around potential missteps and painful, wrong turns. Mary's straightforward way of communicating helped to keep my research ideas and writing focused at various points in the process. With Mary, there is clarity. I appreciated her style early on from our participation in the MetroMath fellowship, where the experiences I gained under Dr. Laurel Cooley during that time added to my personal and professional growth. I thank Laurel for being open to and supportive of my burgeoning research idea of a math being environment, and pointing the way to Anna for her theoretical perspective and grounding.

Of my co-fellows who came before and after me, I appreciated all of the camaraderie and conversations we shared as we learned to navigate the expectations and demands of a doctoral program and a research fellowship. During and after the fellowship, Laura Adamo has brought clarity and laughter to issues, and kept me on my toes about my research whenever she would ask, "So, are you still doing that math being thing? What is that again?" Christine Saieh, an indispensable spirit in the Urban Education department, brought much needed laughter and calm to my anxious moments over the years, in particular, this last year. I so appreciate her perspective on this process and life.

I cannot forget the Girl Scout Research Institute, led by Dr. Michael Conn, for its enthusiastic and unwavering support of my doctoral pursuit, where the last five years of my being there were partially spent running up and down the avenue, rain or shine, from work to school and back to work for all the right reasons. I carried with me the research knowledge, experiences, and words of wisdom I gained from its brain trust of PhDs, MSs, and most insightful colleagues, with an extra special shoutout to Laurie Newton for keeping me laughing and sane. I also cannot forget the numerous colleagues at Girl Scouts of the USA who also cheered me along the way and continue to cheer me as I step forward onto a new road.

I cannot forget Dr. Klaus Hinkelmann of Virginia Tech, whose belief in me and my budding research goals at the time, helped me into the Urban Education program. I thank Dr. Rebecca Ancheta for encouraging me in my ideas over the years and offering to read my drafts.

I most certainly cannot forget the community school where I conducted my research. The principal, staff, and faculty of the school as well as the community school director, staff, and youth leaders

of the partnering community agency were gracious, supportive, and welcoming, allowing me to be a part of their community, researching, observing, and participating as if I had been a part of their lives already. They brought to life the beauty and joy of this school as well as the reality of its surmountable challenges. I thank them for their candor and opening their doors so I could explore my research. I hope my work will positively inform not only their work in the future but the work of other community schools and similar models of education. I especially thank the archery coach who graciously let me experience the excitement and draw of archery, and start to understand what it means to be an archer. And, the students. I could never forget the students who so generously and excitedly participated and shared their beliefs, concerns, interests, and hopes with me about math and life. I saw myself as a child in a handful of them. Because of them and all the participants and supporters at the school, I thoroughly enjoyed this research endeavor.

My friends are treasures forever. In manifold ways along my journey, Krishna O'Neal supported and encouraged me: at the beginning, reading my personal statement with the critical eyes that I needed to make it better to get into this program; solving my computer problems; and, always encouraging me along the way with notes, gadgets, and meals to ease my path. Jodi Cottongim, with her positive, no-nonsense way, gave me necessary kicks throughout the process to get me out of my ruts, from the beginning of my decision-making about the Ph.D. to after the defense with my revisions. She reminded that I have to let go to start anew. With a critical ear during my early decision-making about the Ph.D., and throughout the journey, Octavia Ford supported my research process and always made me laugh with her high-octane comedy. Laughter is the best medicine. Michelle Rhone endured the reading and coding of interview transcript after interview transcript and had the nerve and heart to make herself available for more.

Desiree Joseph nudged me and boosted me along the way, especially during the writing of this dissertation, giving to me and allowing me to “borrow” whatever I needed from her. Desi has been a steady cheerleader for all of my endeavors over the years and I am eternally grateful. I thank her also for enjoining Sheila Lewis in the process who offered to read transcripts and help me in any way. Tracy Evans, the consummate advocate, supported me in too many ways to name, often seeing and addressing a need I had before I even verbalized it—from getting me different softwares and technologies to ward off carpal tunnel syndrome to effectuating time away for me to rejuvenate my spirit so that I would finish to

helping me think through written pieces to the very end. Additionally, she served as my spiritual ballast along the way but especially after my Mother passed in 2008. I am truly indebted to her and grateful for all those who walked with me along the way, even if but for a little while. For any I have failed to mention by name, please forgive me and know that I carried your smiles, encouragement, love, and prayers with me through it all.

Last but not least, I cannot forget Krishna's happy, energetic, and wanting to know and do everything, 2-year old daughter, Tatiana, who, as she grows, I am inspired more and more to understand better the processes of mathematics identity development in African American and Hispanic children.

Table of Contents

LIST OF TABLES	XVI
LIST OF FIGURES	XVII
CHAPTER 1: INTRODUCTION	1
1.1 Background	2
1.2 Research Questions	7
1.3 Situating the Research	8
CHAPTER 2: LITERATURE REVIEW	11
2.1 The Children and Family Empowerment Agency Model of Education	11
2.2 Identity Theories and Perspectives.....	13
2.2.1 Identity	13
2.2.2 Mathematics Identity.....	15
2.2.3 Mathematics Socialization	18
2.3 Sociocultural and Ecological Systems Theories.....	20
2.3.1 Cultural-Historical Activity Theory.....	20
2.3.2 Ecological Systems Theory	22
2.4 Culturally Responsive Pedagogy	23
CHAPTER 3: METHODOLOGY	26
3.1 Pilot Testing Protocols	26
3.2 Study Overview	28
3.3 Study Setting	31
3.4 My Role as Researcher.....	34
3.5 Informed Consent	38
3.6 Survey and Brainstorming Administration.....	40
3.7 Classrooms and Archery Observations	44
3.8 Student Interviews	45
3.8.1 Researcher Defining Mathematician	45
CHAPTER 4: PRE-ANALYSIS.....	50
4.1 Pre-Analysis of Survey Data	50
4.2 Pre-Survey Exploratory Analysis	52

4.2.1	Descriptive Statistics	54
4.2.2	Coding	54
4.2.3	Internal Structure and Reliability.....	55
4.3	Survey Analysis Methods	58
4.3.1	Overall Changes From 2009 to 2010	58
4.3.2	Group Changes From 2009 to 2010.....	59
4.3.3	Correlations and Cross Tabulations	60
4.4	Pre-Analysis of Interview Transcript Data.....	61
4.5	“Quantitizing” of Interview Transcript Data	63
CHAPTER 5: SCHOOL AND HOME ORGANIZATION AND ENCULTURATION		64
5.1	Culture and Structures of Fuentes: “I Felt At home”	64
5.1.1	Outside of the School	65
5.1.2	First Floor, Lobby.....	67
5.1.3	Second Floor, Lobby	69
5.1.4	Second Floor, Outside of Principal’s Office.....	71
5.1.5	Third Floor, CFEA Office	72
5.1.6	Third Floor, Resource Room	73
5.1.7	Fourth Floor, Classrooms	74
5.1.8	Fourth Floor, The Computer Lab.....	77
5.1.9	Back Downstairs to the First Floor, The Gymnasium for Archery.....	78
5.2	Archery—The Gem in the Gym	79
5.2.1	About Archery—From the Students’ View	80
5.2.2	About Coach—From His View	87
5.2.3	About Archery and Mathematics.....	96
5.3	Math Culture and Structures at Home	98
5.3.1	Math Support from Family and Neighbors	99
5.3.2	Home, Digital, Home: Fun and Games...and Learning Still.....	102
5.3.3	Media Influence: Mathematician T.V. and Videogame Characters...Yes and No ...	104
5.4	Classroom Norms and Ideas: Enactment of Mathematical Norms and Ideas	108
5.4.1	Creativity in Math	108
5.4.2	Classroom Management	112
5.4.3	Classroom Tools and Resources	116
CHAPTER 6: STUDENTS’ MATH PEP: THEIR POSITIONING, ENACTMENT, AND PERSPECTIVES		120
.....		
6.1	Students’ Math Positioning in Class.....	120
6.1.1	Helper and Help Seeker.....	121
6.1.2	Dependent.....	122
6.1.3	Independent.....	124
6.1.4	Agent of Own Learning	125
6.1.5	Leader	126
6.1.6	Math Smart and Capable	126
6.2	Classroom Processes.....	130
6.3	Teaching and Learning of Mathematics	133

6.3.1	Less Common Teaching Processes	141
6.4	Learning Processes	143
6.5	Enacting Mathematicians' Skills, Characteristics, and Qualities	148
6.6	Developing a Sense of Belonging and Community.....	157
6.6.1	How Students See Others as Mathematicians—Students and Adults	160
6.7	Students' Mathematics and Immediate Life Perspectives and Their Identity.....	163
6.7.1	Hearing the Word "Mathematician"	168
6.7.2	Students Defining Mathematician	169
6.7.3	Students' Likes and Eases About Math.....	171
6.7.4	Students' Dislikes and Dis-eases About Math.....	176
6.7.5	How Students See Themselves as Mathematicians.....	178
6.7.6	Using Math for One Thing in the World	181
6.7.7	Telling the World Something About Me and Math.....	184
6.8	Students' Future Life Perspective and Their Identities.....	187
6.8.1	Careers: Looking Towards the Future	187
6.8.2	Math-related Careers and Mathematics Identity	191
CHAPTER 7: CASE STUDY—SIDES OF ANTONIO		194
7.1	Choosing Antonio	194
7.2	Attention Deficit/Hyperactivity Disorder.....	196
7.3	About Antonio	197
7.4	Antonio in the Classroom	200
7.5	Antonio in Archery.....	203
7.6	Antonio as Constructed by Others	207
7.7	Antonio's Mathematics Identity.....	210
CHAPTER 8: DISCUSSION		213
8.1	Research Question 1: Organization and Enculturation	214
8.2	Research Quesiton 2: Student's Math PEP: Positioning, Enactment, and Perspectives...	216
8.3	Limitations	218
8.4	Implications	221
8.5	Conclusion.....	223
CHAPTER 9: THE YESTERDAY THAT BROUGHT ME TO TODAY		225
APPENDICES.....		235

APPENDIX A: STUDENTS' MATHEMATICS BELIEFS AND ATTITUDES SURVEY	236
APPENDIX B: INTERVIEW PROTOCOLS.....	242
REFERENCES.....	253

List of Tables

Table 1. Data Collection for Corresponding Research Sub-Questions	30
Table 2. Demographics of Student Study Participants (2009-2010)	33
Table 3. Research Definition Construction of Mathematician From Literature	47
Table 4. Data Collected and Corresponding Analysis	50
Table 5. Subscales with Items, Scoring, and Source	52
Table 6. Subscales, Definition, Reliability	57
Table 7. Items with Significant Differences across Viewing of Math Characters in 2010	107
Table 8. Subscales with Significant Differences across Viewing of Math Characters in 2010	107
Table 9. Students Text, Tools, and Manipulatives Used on Dates Observed 2009-2010	117
Table 10. Teaching processes common across both classrooms	134
Table 11. Learning processes common across both classrooms	143
Table 12. Enactment of mathematicians' skills, characteristics, and qualities	149
Table 13. Processes common across both classrooms for developing a sense of belonging and community	157
Table 14. Codes and Quotes of Students' Brainstorming on "Mathematics" 2009, 2010	164
Table 15. "Mathematician" Brainstorm Coding 2009	166
Table 16. Frequency of Coded Student Definitions of Mathematician With Quotes Expressed During Interview	171
Table 17. Items With Significant Differences Across Favorite Subject in 2010	172
Table 18. Subscales With Significant Differences Across Favorite Subject in 2010	172

List of Figures

Figure 1. Official scoring of target face used in archery	83
Figure 2. Lines of Math Support for Students at Home	99
Figure 3. Math Websites Used Most by the Fifth Graders at School and Home	102
Figure 4. Characters Students Have Seen on T.V. or Cinema They See as Mathematicians	105
Figure 5. Can You Be Creative in Math?	109
Figure 6. Students' Work Style Preference, Spring 2010	123
Figure 7. Students' Beliefs on How People Become Smart in Math.....	127
Figure 8. Are People Born Smart in Math?	128
Figure 9. Major process categories inside the classroom in developing mathematics identities	131
Figure 10. Samples of teacher discourse with students in classroom in developing sense of community/belonging.	158
Figure 11. Samples of student to student discourse in developing sense of community/belonging	159
Figure 12. Mrs. Cruz's Students Named as Mathematicians by Classmates, Spring 2010	161
Figure 13. Mr. Knight's Students Named as Mathematicians By Classmates, Spring 2010	162
Figure 14. Mrs. Cruz's and Mr. Knight's Students' "Mathematics" Brainstorms 2009	165
Figure 15. Mrs. Cruz's Students' "Mathematics" Brainstorms 2009, 2010	167
Figure 16. Students Identifying as Mathematicians, Spring 2010	178
Figure 17. Using Math For One Thing in the World	182
Figure 18. Telling the World Something About Me and Math World.....	185
Figure 19. Students' Desired Career Fields, Spring 2010	189
Figure 20. Students Choosing Math-Related Career and Identifying as Mathematician, Spring 2010 ...	192
Figure 21. Students' Math Identity and Interests Today and Career	192
Figure 22. Synopsis of Antonio in class and in archery	207
Figure 23. Different constructions of Antonio: Others and His.....	212

CHAPTER 1: INTRODUCTION

Mathematics identity of students is an emerging topic even as more and more education and mathematics education researchers investigate what it means for students to become mathematicians or, at the very least, proficient mathematics students from elementary to graduate levels of schooling within and outside of the United States (Boaler & Greeno, 2000; Burton, 1999, 2004; Civil, 2002; Cobb, 2004; Conference Board of the Mathematical Sciences, 2001; Fosnot & Dolk, 2005; Gutstein, 2003; Herzig, 2002; Ladson-Billings, 1997; Martin, 2000; Picker & Berry, 2002; Solomon, 2007). Trying to understand and develop students' mathematics identities calls for a rethinking of how students are to learn, practice, and be within mathematics classrooms; how teachers are to teach within these same classrooms; how the classroom environments are to be structured; and, what are the internal and external school structures that may influence students' mathematics identities, whatever they may be. Even mathematicians in their professional and research communities understand the necessity of student agency and change of praxis and environment within today's schools and mathematics classrooms to allow students to see themselves as mathematicians and do mathematics as professional and research mathematicians do (Burton, 1999, 2004; Herzig, 2002, 2004a, 2004b; Kline, 1973; Lakoff & Núñez, 2000; Lockhart, 2009; Murray, 2000; Smith, 2002).

Researchers have shown the importance of mathematics identity and how it affects how students see themselves learning and doing mathematics (Boaler & Greeno, 2000; Martin, 2000; Nasir, 2002). What is unknown, however, is how students' mathematics identities are developed within community schools, particularly, in urban areas. A search of major databases of journal publications (i.e., EBSCO Host, SAGE, JSTOR, SpringerLink, Elsevier, and GoogleScholar) using the terms "community schools," the Boolean connector "AND", and "math identity" or "mathematics identity" resulted in zero articles located. As community schools are sometimes called "full-service" or "extended-service" schools, I also searched the same databases substituting "community schools" for "full service schools" and "extended service schools" which returned zero articles.

1.1 Background

Community schools are educational institutions that “combine the rigorous academics of a quality school with a wide range of vital in-house services, supports and opportunities for the purpose of promoting children’s learning and development” (The Children’s Aid Society, 2001, p. 16). The community school approach is not new or specific to any area. According to the Coalition for Community Schools and Institute for Educational Leadership (CCS & IEL) (n.d.), this approach first developed in the late 1800s with settlement houses and gained national visibility as a formal community education movement by the 1930s. The community school differs from a traditional public school in that community schools are public schools purposefully structured to meet the emotional, mental, social, and health needs of students as well as their academic needs while traditional public schools are not.

To become a community school, a public school invites a community agency to partner with that already offers social, health, and mental health services to the community. The inviting school and the partnering community agency will then work together “toward common results; changing their funding patterns; transforming the practice of their staff; and working creatively and respectfully with youth, families, and residents to create a different kind of institution” (CCS & IEL, n.d.). The school finds space onsite to house the community agency staff dedicated to deliver its social, health, and mental health services and enrichment programs onsite. Therefore, within a community school are the school principal, leadership, faculty, and staff and the community school director and staff, where the community school director directs and oversees the services and programs of the community agency to be delivered at the school. (As the community agency may partner with several schools, a community school director and staff are located at each of the schools.) Youth leaders are often employed to deliver afterschool and summer camp program. The school principal and community school director work together to meet the academic and non-academic needs of the students. Thus, with this daily, onsite partnership, there lies the potential for students’ academic needs and development to be met without the complexities and negative impact of unmet non-academic needs.

Even though the community school offers these services through its partnering community agency, parents of children in the school have the option of registering their children with the agency to participate in its enrichment programs and receive holistic services, if necessary. These programs may take place during in-school or out-of-school time and may include extended-day instruction and

enrichment, recreational and cultural programs, on-site health and mental health services, social services, holiday programs, summer camp, and teen programs (The Children's Aid Society, 2001). Parents and families can also register to participate in services and programs designed to help adults such as family resource centers, parent support programs, and adult education (The Children's Aid Society, 2001).

Therefore, in community schools, it is common to have students who are registered with and participate in the agency services and programs and students who are not registered and do not participate. It is akin to a traditional public school where some students sign up for extracurricular activities and some do not. Parents may decide not to register their children for various reasons such as family commitments afterschool or participation in other off-site extracurricular activities. However, since the school and the agency work to transform practice at the school, it is not uncommon to see enrichment activities taking place during in-school times to benefit all students including non-registered students. Therefore, students who participate in the agency services and programs directly benefit while those who do not participate may benefit indirectly. The shared benefits depend on how the principal and community school director come together with respect to academic and enrichment program design and planning, service delivery, and time and resource structuring and management, among other issues.

With respect to funding, partnering community agencies are driven by their missions to serve and, thus, have service and participation goals to achieve. Therefore, funding patterns and goals are mutually considered, negotiated, and sought by the school and agency to benefit the registered students and thus, the school. Both school and agency seek outside funding through federal grants such as the 21st Century Community Learning Centers¹ grant, which supports the creation of community learning centers to provide academic enrichment and youth development opportunities during non-school hours for children, particularly students who attend high-poverty and low-performing schools, for the purpose of helping students meet state and local core academic standards. The agency, in its provision of social, health, and mental health services to students and families, can be financed in part by Medicaid and other public and private sources. The agency, in particular, aggressively seeks broader and deeper support from foundations, corporations, and private supporters. Thus, although traditional schools may also seek and receive funding from various sources (district, state, federal, private) for their programs and needs, such

¹ 21st Century Community Learning Centers. <http://www2.ed.gov/programs/21stccclc/index.html>

funding efforts and outcomes may differ from those of the community school, where funding from the community agency provides additional support.

The Children and Family Empowerment Agency² (CFEA) is just one network of community schools of a larger coalition of local and national community school networks that spans the United States. Nationally, there are over 5,000 community schools³, with particular models having been adopted in over 1,000 schools, nationally and internationally, primarily in eastern and western Europe (Quinn, 2005). Research on community schools has explored how they serve students' holistic development and its effectiveness on student learning (mathematics and reading performance/proficiency, attendance and graduation rates), family engagement, school effectiveness, and community vitality (Blank, Melaville, & Shah, 2003; Keith, 1996; Quinn, 2005; The Children's Aid Society, 2001). However, what is missing in this and other investigations of community schools is the question of students' mathematics identities.

This seeing and embracing of oneself as having a positive or strong mathematics identity is necessary today as the mathematical pursuits and performance of far too many students, especially students of color and students in urban environments, continue to lag behind. As children transition from elementary to middle school settings and preadolescent to adolescent stages, such positive identity is crucial. Late childhood/early adolescence is a turning point in the educational pathways of many youth across ethnicities (Eccles, 1999), where some sustain high aspirations and school engagement while many others become increasingly disengaged, perform more poorly, or engage in more disruptive behavior (Azmitia, Cooper, & Brown, 2009).

As African American and Hispanic students transition from elementary school to middle school, a disturbing, incoherent image, painted by national and international test indicators, looms. While African American and Hispanic students showed improvement from the 1995 to 2003 Trends in International Mathematics and Science Study (TIMSS) for fourth and eighth grades, they continued to score behind White students (National Science Teachers Association, 2004). In 2007, White students scored on average 26 points higher than African American fourth graders in national mathematics and reading assessment (Vanneman, Hamilton, Anderson, & Rahman, 2009), and 21 points higher than Hispanic students (Hemphill & Vanneman, 2011). For eighth graders, the gap remained for both African American

² Pseudonym for the community agency and community school network involved in this research.

³ Coalition for Community Schools. http://www.communityschools.org/aboutschools/faqs.aspx#_13

and Hispanic students relative to White students (Hemphill & Vanneman, 2011; Vanneman et al., 2009). In 2008, on-time graduation from high school differed across ethnicities with Black and Hispanic students still having the lowest percentages: Asian/Pacific Islander students (91.4%), White students (81.0%), American Indian/Alaska Native students (64.2%), Hispanic students (63.5%), and Black students (61.5%) (Stillwell, 2010).

As these students age, the picture does not get any better. Higher education attainment levels were also lowest for Hispanic and African American students. Among young adults ages 25 to 29, the percentage of non-Hispanic Whites who attained at least a bachelor's degree in 2004 was more than three times that of Hispanics (35% compared with 11%) and more than twice that of African Americans (17%) (Child Trends, 2004). For the study of mathematics, the picture becomes even bleaker. According to the United States Department of Education's National Center for Education Statistics (NCES, 2008), only 1,327 of the 45,596 doctoral degrees conferred in 2005-2006 were in mathematics, of which 84.0% were earned by Whites, 6.5% by Asians, 4.3% by Hispanics, and 3.0% by African Americans. With respect to sex, 70.4% were earned by men and 29.6% were earned by women. With respect to citizenship, 41.4% were earned by people of U.S. citizenship and 55.3% were earned people of non-U.S. citizenship.

In 2007-2008, of the 63,712 doctoral degrees conferred, 1,360 were in mathematics and statistics, of which only 13 doctoral degrees were earned by African American men and 28 by Hispanic men, and 12 by African American women and 5 by Hispanic women (NCES, 2008). According to the United States Department of Labor's Bureau of Labor Statistics (BLS, 2009), there were 2,900 mathematicians employed in the U.S. in 2008 and a projected 3,600 will be employed in 2018 in the U.S. I am not sure how this 22% increase will happen since the number of mathematics and statistics doctoral degrees conferred across the years has not changed significantly at all while the Hispanic population is projected to nearly triple from 46.7 million to 132.8 million during the 2008-2050 period (U.S. Census Bureau, 2008).

In mathematics education, signs of hope are not apparent as the number of doctoral graduates has been too low to meet the demand of doctoral faculty. From 1980 to 1998, only 1,326 doctorates in mathematics education were conferred (Reys, Glasgow, Teuscher, & Nevels, 2007) and in 2005-2006, over 40% of institutions of higher education searching for mathematics education faculty were

unsuccessful in filling those positions (as cited in Reys, 2006). The mathematics education community recognizes the shortage and expects it to continue across the decade throughout the 2010s. Additional reasons for shortages in this field may be age and financial sacrifice. Doctorates in mathematics education average 18 years between earning their bachelor's and doctoral degrees, meaning that they are around 40 years of age before they earn a doctorate in mathematics education unlike doctorates in mathematics, science, and other non-education fields that earn their degree while in their twenties (as cited in Glasgow, 2000). Financially, it may not make sense or be feasible to earn the doctorate in mathematics education if students have already acquired a tenured and longstanding career as a teacher:

In mathematics education, the majority of doctoral students acquire teaching experience prior to entering doctoral programs. That means these students must make significant financial sacrifices in their income to return as full-time graduate students. Every year spent as a full-time graduate student multiplies this financial sacrifice (Reys, Glasgow, Teuscher, & Nevels, 2007, p. 1290).

Historically, female students and students of color have been excluded from mathematics and science at all levels (Burton, 2004). In addition to outside influences, their poorer performance may also be related to their negative perceptions and images of scientists and mathematicians. Research on students' drawings of scientists (i.e., the Draw-A-Scientist Test) and mathematicians reveals stereotypical and negative perceptions and images of scientists and mathematicians (Fadigan & Hammrich, 2004; Picker & Berry, 2000; Steinke, Lapinski, Crocker, Zietsman-Thomas, Williams, Evergreen, & Kuchibhotla, 2007). Such images and perceptions emerge during elementary school levels and persist throughout secondary levels. Children's perceptions of scientists and engineers are likely to be influenced by a number of social and cultural factors, including parents, schools, teachers, peers, media, and out-of-class factors (Chambers, 1983; Fort & Varney, 1989; Hammrich, Richardson, & Livingston, 2000; Mead & Metraux, 1957; Parsons, 1997; Steinke et al., 2007).

Researchers, though, have shown the positive influence of focusing on students' images of mathematicians and the relationship that those images have on their current and future mathematics interests (Picker & Berry, 2000, 2002; Rock & Shaw, 2000). Further, researchers have shown how female students' mathematics and science interests, and thus, their career outlook can be positively influenced by incorporating mathematics and science in after-school activities—programs, in particular, that address students' academic performance, understanding, and self-concept among other skills and

characteristics (Fadigan & Hammrich, 2004). Some after-school sports activities that contain mathematical and scientific components related to the practiced sports have been shown to positively impact girls' understanding and resilience in learning of science and mathematics, and to see the relevance of science and math in their everyday lives (Hammrich, Richardson, Green, & Livingston, 2001).

1.2 Research Questions

With this upwelling of attention on student mathematics performance, agency, and identity inside and outside of the traditional school and the dearth of research on mathematics identities in community schools, I find it timely to explore how African American and Hispanic students attending an urban elementary community school see themselves mathematically through in-class and out-of-class activities. Specifically, I intend to explore and describe the culture, structures, and environments of an elementary Children and Family Empowerment Agency⁴ (CFEA) community school; explore and understand the development and enactment of students' mathematics identities at this elementary CFEA community school; and, examine how their mathematics identities hold potential relationship with their mathematical performance and their current and future life perspectives. This will be explored through the following guiding research questions: What are the processes at the intersection between students' mathematics identities and students' images of mathematicians? What particular processes account for the development of students' mathematics identities inside and outside of the classroom within an urban elementary CFEA community school?

Specifically, the following sub-questions will be explored:

1. What processes of organization and enculturation relative to students' mathematics identities exist inside and outside of the classroom?
 - 1a. What are the culture and structures of this urban elementary CFEA community school that bear potential relevance for the development of mathematics identities in students? How is mathematics a part of the culture and structures of this particular community school?
 - 1b. How are mathematical norms, ideas, ideals collectively enacted inside and outside of the classroom?
2. How do students position themselves inside and outside of the classroom relative to the mathematical activities and identities? How do they participate in enactment of mathematics identities?

⁴ Pseudonym for the community agency and community school network involved in this research.

- 2a. What are the specifics and characteristics of the following processes inside and outside of the classroom: learning mathematics; enacting skills, characteristics, and qualities of mathematicians; and, developing a sense of belonging?
- 2b. Do students' immediate and future life perspectives have any relation to their mathematics identities? If so, in what way?

The theoretical framework for this exploration encompasses identity theory, cultural-historical activity theory, ecological systems theory, and culturally responsive pedagogy. This multi-pronged framework is necessary as each theory or perspective independently does not fully address the elementary CFEA community school, nor the development and engagement of students' mathematics identities within this school.

1.3 Situating the Research

The purpose of this research study is to explore the mathematics identities of African American and Hispanic students in an urban elementary community school. As some research exists specific to this student population and the community school setting with respect to their mathematics performance and not their mathematics identity, I situate this research in understanding the community school. The community school movement continues to grow and find larger platforms for discussion, implementation, and support. Therefore, situating this research in understanding the community school will contribute to the larger conversation on education reform.

However, in spite of the larger conversation of education reform, this research is not a comparative study of community schools versus non-community schools. Understandably, it is tempting to want to draw comparisons and contrasts of preference, performance, properties, and the like when discussing different models or types of anything, whether schools, religions, or cars. It was tempting for me. Every model has its pros and cons, advantages and disadvantages, and should be understood at all levels, in particular, the ground level, most particularly for education models, where students and teachers daily are impacted by decisions made at higher and sometimes disconnected levels.

It is qualitative education research through contextualized exploration of one school—an urban elementary community school. It is an up-close view of some of the processes, environs, structures, and cultures vis-à-vis quantitative and qualitative methods, in particular, participant observation, of this one

school. It is a situated ethnography with sociocultural grounding to illuminate the what, who, why, and how and those interrelationships of this school. Even though the study is about mathematics identity, it is so within a particular context. Deep understanding through exploration is necessary first before comparisons to other models can or should be made. This research incorporates case studies, which, through their inherent particularization, adds to the texture and situatedness of the research. Even still, what is found in this community school may very well reflect ways of being and doing at other community schools, as community schools share common philosophy. Such shared and particular ways of being in these contexts may add missing pieces of the bigger picture of mathematics identity development and education reform.

With respect to studying mathematics identity of students in a school setting or cultural activity, I am not alone in employing a situated, contextualized approach. Ogbu (1981) and Eisenhart (1988) have shown ethnography essential in exploring cognitive, social, political, and relational aspects of school and its participants. Further, researchers grounded in sociocultural theories, including cultural historical activity theory, explored identity using situated approaches within contextualized settings. Martin's (2000) seminal work explored the sociocultural contexts—classroom, school, home, and community—of African American junior high school students significant to their psychological, academic, and mathematical development. Solomon (2007), in studying advanced mathematics classes in high school, saw students' discourse as one aspect of their perception of others' mathematics identities. Nasir (2002), in studying the mathematics identity of African American youth via cultural practices, brought to the surface the cultural context as well as the situatedness and bidirectionality of identity. Roth, Tobin, Elmesky, Carambo, McKnight, and Beers (2004) situated their work in the urban classroom to explore identity construction and transformation of student and teacher.

Even though the research may be grounded in sociocultural theories, a closer look reveals proximal processes within the contextualized settings of the research. Ecological systems theory supports the exploration of the student-to-student and adult-to-student relationships and activities found within the student's micro- and mesosystems and the outer systems (community and national) that may impact the student. Such processes are illustrated such as students setting goals, learning rules of the game, and playing the game (Nasir, 2002); and, student and teacher working together to resolve misunderstandings (Roth et al., 2004). The relationship between systems (school and community) with a

sociocultural perspective is also illustrated in Martin's (2000) work. The community school, a system in and of itself, brings to light the mutability or extensive reach of systems relative to the individual.

In studying this community school, I attempted to conduct this study from a pragmatic, interpretivist perspective. Pragmatism compels the researcher to see research as a holistic endeavor that always occurs in social, historical, political and other contexts; to be flexible and employ qualitative and quantitative approaches for collecting, verifying, and analyzing data; and, to use both quantitative and qualitative approaches to inform and explain findings from each other (Creswell, 2003; Feilzer, 2010; Onweugbuzie & Leech, 2005a). Interpretivism is centered on the idea that "all human activity is fundamentally a social and meaning-making experience, that significant research about human life is an attempt to reconstruct that experience, and that methods to investigate the experience must be modeled after or approximate it" (Eisenhart, 1988, p. 102). Such perspectives seemed appropriate for exploring and understanding the research questions in this situated, contextualized setting of rich cultures and systems.

CHAPTER 2: LITERATURE REVIEW

In this section I will review literature that addresses the following areas: community schools, in particular, the Children and Family Empowerment Agency (CFEA) model of education; identity, mathematics identity, mathematics socialization, and definitions of mathematician; cultural historical activity theory; ecological systems theory; and culturally responsive pedagogy. Reviewing and understanding these theories, definitions, and perspectives will inform the research process in exploring students' mathematical processes, positioning, enactment, organization, and enculturation inside and outside the classroom; the mathematics within the elementary community school culture, environment, and out-of-class activities; and, the systems of the community school, inclusive of family, staff, and partnerships, that bear potential relevance to students' mathematics identity development.

2.1 The Children and Family Empowerment Agency Model of Education

The community school model of education in the United States has existed as a formal model of education since the 1930s. Community schools continue to take root in communities throughout the United States and abroad. A basic and widely accepted premise of the community school is that "current social circumstances in inner cities militate against the ability of urban schools and families to provide, unaided, enough support to stem student failure" (Keith, 1996, p. 238). Serving elementary and secondary levels, community schools were established to deliver a multitude of services—educational (first and foremost), social, and economic—to disadvantaged urban students and their families. They were established to help students deal with the "adverse effects of modern-age sex, drugs, violence, depression, and stress" (Dryfoos, 1995, p. 148-149). Dryfoos (1995) stated the obvious: "Schools cannot educate children who are 'too stressed out' to concentrate. Teachers are not trained as social workers and cannot possibly attend to their jobs if they must spend all of their time trying to remedy problems" (p. 149). Dryfoos (1995) also argued the need for a full-service integration model—a model that integrated the best of school reform with all other services (medical, social, human) whether prevention, intervention, treatment, or support that children, youth, and families need.

The community school model was supposed to overcome the three main blockages of efficient service delivery to students and families: problems within the urban community; bureaucratic and administrative weaknesses or irrationalities; and, politics of school improvement and partnerships (Keith,

1996). In addressing these blockages Keith (1996) proposed that the potential of community schools lived in a community development model as opposed to a service provision model. As various models of community schools became established, integrated service to meet the needs of the students was a key aspect of its system. For the CFEA, integrated service, as suggested by Dryfoos (1995), participant empowerment, and attention to students' whole being became the focus, thus addressing five outcome areas: students, families, school, community, and education policy (Quinn, 2005). Therefore, what distinguishes the CFEA model is participant empowerment, joint planning, and decision-making between the school, CFEA, and parents.

Locally⁵, over 20 CFEA community schools operate within four densely populated neighborhoods. As diversity is a constant in urban areas, attention to cultural context and surroundings is necessary in establishing collaborations and partnerships within different neighborhoods as each neighborhood differs from the next. Community schools take into great consideration the culture of the students and their families and “how that culture characterizes the ways in which students and families interact with schools, professionals, authorities, and each other” working from “detailed knowledge of who the children are, what emotional and social make-up defines them, who they live with, and what defines the lives of the adults with whom they live” (Agosto, 1999, p. 61).

Therefore, there is flexibility of programming in the CFEA model as CFEA community school programs may vary from school to school, neighborhood to neighborhood. However, each school follows the following interconnected, comprehensive framework: a strong, standards-based core instructional program; enrichment activities designed to support holistic development; and, a full range of health and mental health services, which are located, in part or whole, on-site at the school (Quinn, 2005). Services that are off-site are arranged by the CFEA with its facilities or partnering agencies. Community economic development, as suggested by Keith (1996), is also part of the focus of the CFEA model as CFEA community schools employ “community residents in its partnership schools, support community businesses, partner with financial institutions, and offer entrepreneurial classes for parents and other adults” (Quinn, 2005).

Research has shown the during-school and after-school benefits of community schools with school-based integrated services (Grossman & Vang, 2009). The well-being of the whole child—

⁵ Location of research not included to maintain anonymity of community school studied.

academic, social, emotional, and mental—is the objective of the overall community school model.

Nonetheless, I contend that students' mathematics identities can be supported through the community school model, and that such support can lead to change in how students engage mathematically inside and outside of the classroom.

2.2 Identity Theories and Perspectives

This section will Identity, in general, and mathematics identity and socialization are important constructs that inform how students can enact mathematical norms, beliefs, and characteristics of mathematicians and experience mathematics more successfully inside and outside of the classroom.

2.2.1 Identity

Before defining mathematics identity, it is necessary to define identity, in and of itself, as best as possible, as identity reflects the core of whom we are and what we do as human beings. Scales and Leffert (2004), in their work with the Search Institute⁶ studying developmental assets in youth, defined identity as “an integrated view of oneself encompassing self-concept, beliefs, capacities, roles, and personal history” (p. 193). From that definition, identity is not an isolated characteristic or something that develops within a vacuum, unaffected by factors from the outside macro-world. It is a multi-layered variable that is influenced, directly or indirectly, by the self and the other, whatever that other may be—family, friends, school, individual or shared lived experiences, print and digital media, cultural signs, or communications. Positive identity develops gradually over the course of childhood and adolescence and it occurs if youth have a sense of personal power, self-esteem, sense of purpose, and positive view of the future (Scales & Leffert, 2004).

Although Scales and Leffert (2004) defined identity in terms of adolescent development, Holland, Lachicotte, Skinner, and Cain (1998) defined identity in terms of position and practice within situated, socially enacted, or cultured worlds. At a more basic level, Holland et al. (1998) defined identity as “self-understanding, especially with strong emotional resonance” (p. 3) or “sense of self” (p. 8) where students' self-understandings or senses of self are “produced socially and culturally from the generic personae and scenery of our figured worlds as they are positioned in the hierarchies of power and privilege that relate

⁶ The Search Institute is an independent non-profit organization whose mission is to provide leadership, knowledge, and resources to promote healthy children, youth, and communities. <http://www.search-institute.org/> Retrieved September 12, 2007. The Search Institute is well-known within the youth development field for its “40 Developmental Assets” of youth.

fields of activity” (p. 192). Through this recognition of social life and its influence on identity in position and practice is also the acknowledgement of socially distributed power—an important tenet when examining the development of mathematics identities of students, especially in urban settings, where inequitable distribution of resources and power are always a factor.

To Holland and the other authors, identities are always forming and behavior is mediated by identity. This point is important in looking at students’ mathematics identity—their being and becoming strong mathematics students and mathematicians—in the classroom and how activity—discourse and action—along with classroom participants and the environment mediate students’ identity development. Youths’ identities are practiced through the contexts of figured worlds (the mathematics classrooms), positionality (how students positions themselves among others), space of authoring (how students construct their own spaces), and children’s play (how students socialize with each other). This idea of activity influence and mutability of identity within an environment, whether through students’ serious work or play, resonates with Roth, Tobin, Elmesky, Carambo, McKnight, and Beers (2004) and their work on identity construction and transformation in the urban classroom.

In their study of how identities of students and teachers are made and remade in the praxis of urban schooling, Roth et al. (2004) detailed a collaborative, longitudinal investigation on making and remaking identities of teachers and students in their praxis or process of enacting, engaging, applying, or practicing what is taught and learned. The framework of this research on identity was based on Lev S. Vygotsky’s cultural-historical activity theory and connected agency, structure, and historical change with the evolution, transformation, and co-construction of teacher and student identities. This making and remaking of identities via activity is illustrated through the case study of two participant-authors—a teacher and a student. Because learning can take place in various environs and activities, operating with the understanding that students’ identities are not static and that they affect and play off of one another and off the tools of the environs is crucial in examining more closely students’ mathematics identities and their development.

With a lens of critical discourse and capacity building for impoverished communities, James Paul Gee (2001) used a simpler definition of identity and showed that it can be used as an analytic tool for researching issues of theory and practice in education. Gee (2001) categorized identity—what it means to be “a certain kind of person”—in four ways: nature-identity (a state); institution-identity (a position);

discourse-identity (a trait); and affinity-identity (experiences). These categories addressed process, power, and source of power. Gee illustrated the intersections of these identity categories with critical aspects of youths' lives—their demographic background; familial, educational, religious, and political institutions; biological and natural capacities; and social networks. Gee implicates the use of identity as a viable research tool for the being and becoming of students in urban mathematics classrooms.

2.2.2 Mathematics Identity

Moving from identity to mathematics identity calls for an understanding of how mathematicians, mathematics educators, and researchers define or characterize how mathematicians see themselves and what they do and what they do not do—the truth and mythology of mathematics, per se. Far too many people, especially girls, students of color, and students of lower socioeconomic status have fallen victim to and prey of the oppressive and destructive mythology of mathematics. Burton (2004), a strong advocate for girls and women in mathematics, built and validated an epistemological model of mathematics that illustrated what is knowing mathematics for mathematicians: it is not objective but rather a socio-cultural artifact; not homogeneous but rather heterogeneous; not impersonal but holistic; not incoherent but coherent with connections; it is also aesthetic and intuitive.

Linguist George Lakoff and psychologist Rafael Núñez examined the origins of mathematics and how the human mind brings mathematics into being and explicated the romance or mythology of mathematics that has developed and persisted throughout the ages. This mythology fallaciously sets up mathematics to be something reachable and understandable only by the “naturally-gifted” few or society's elite; an objective, rational truth never impacted by culture or human beliefs; a representation of universal truths never to be challenged or changed. According to Lakoff and Núñez (2000), the romance or mythology “serves the purpose of the mathematical community. It is part of a culture that rewards incomprehensibility...it is not an entirely harmless myth—that at least indirectly it is contributing to the social and economic stratification of society” (p. 341). That mythology is advanced by people across generations and professional levels, wittingly and unwittingly. According to Jacqueline McGlade, a mathematics professor in London, “unfortunately, there is an air of arrogance, smugness, intimidation, pressure, isolation and competition that needs to be overcome by the mathematics community itself before any progress can be made” (Burton, 2004, p. xiv).

Refuting the mythology calls for an understanding of what mathematicians do and really expect from students learning mathematics at all levels and those wanting to enter mathematics as advanced study or as a profession. Frank Smith (2002), a professor who studies human intellectual accomplishments from language to mathematics, stated the following about being a mathematician:

Being a mathematician is a state of mind rather than a repertoire of skills and knowledge... Mathematicians can be distinguished by their constant readiness to learn more about mathematics; they are open to mathematical experiences, are unafraid of mathematical environments, and have a continual feeling and fascination for relationships among numbers (p. 124).

Smith is not alone in his conceptual focus of mind and habits over skills and knowledge.

Mathematics professor Margaret Murray (2000) examined the development of mathematics identity across the life span, from childhood through adulthood and into retirement, of 36 women mathematicians. The author focused on the process by which women who are actively involved in the mathematical community come to “know themselves” as mathematicians. One of the women mathematicians that the author interviewed said that “a mathematician is someone who is drawn, again and again, to the process of creating something new in mathematics, someone who enjoys ‘the crystal moment of great discovery’ when a new idea first takes hold” (Murray, 2000, p. 201). Another interviewee asserted that there are many different “ways-of-being in the mathematical world...for her, being a mathematician has to do with ‘the way I look at the world, more than what I have achieved.’ She is a mathematician because of certain ‘analytical, critical’ habits of mind” (Murray, 2000, p. 222).

Operating from a constructivist standpoint, mathematics education researchers Catherine Fosnot and Maarten Dolk (2005) suggested that youth should learn from an early age “to recognize, be intrigued by, and explore patterns, and as they begin to overlay and interpret experiences, contexts, and phenomena with mathematical questions, tools, and models, they are constructing what it really means to be a mathematician” (p. 187). The author suggested that youth do not see mathematics as creative but instead as something to be explained by their teacher, then practiced and applied. Unfortunately, far too often, students are socialized into seeing mathematics as a bifurcated task of finding what is right or wrong with disassociated problems thrown at them not knowing that creativity is the essence of what mathematicians do (Fosnot & Dolk, 2005; Mann, 2006).

Mathematician Morris Kline, in the 1970s, believed in the creative process and stated in his book, *Why Johnny Can't Add: The Failure of the New Math* (1973), that “in the creative work [are] imagination,

intuition, experimentation, judicious guessing, trial and error, the use of analogies even of the vaguest sort, blundering and fumbling” (p. 58). In the 2000s, mathematician Paul Lockhart believed that schools were cheating people out of the most fascinating and imaginative art form—mathematics. He believed that this art form is “about problems, and problems must be made the focus of the students’ mathematical life” (2009, p. 60-61). More specifically, Lockhart (2009) asserted the following about the process of problem devising and solving in which teachers and students should be engaged:

Painful and creatively frustrating as it may be, students and their teachers should at all times be engaged in the process—having ideas, not having ideas, discovering patterns, making conjectures, constructing examples and counterexamples, devising arguments, and critiquing each other’s work. English teachers know that spelling and pronunciation are best learned in the context of reading and writing. History teachers know that names and dates aren’t interesting when removed from the unfolding backstory of events. Why does mathematics education remain stuck in the 19th century? (p.61)

Operating from the framework of Wenger’s community of practice, Herzig (2004b) asserted that “to become mathematicians, then, students need to learn to think, act, and feel as mathematicians do” (p. 389). Thus, in school from elementary to graduate level, students need to have learning experiences that reflect the three dimensions of community of practice in mathematics: to learn mathematics, to behave like mathematicians, and to develop a sense of belonging within the discipline (Herzig, 2004b). However, if this participation in the mathematics community of practice is constrained by the perceptions of others (faculty, guidance counselors, advisors) about the student on interpersonal and community planes, especially female students and students of color, it will indeed be difficult for them to appropriate the knowledge, practices, and identity of a mathematician (Herzig, 2004a).

African American mathematics professor Danny Martin (2000) specifically referred to mathematics identity as the students’ beliefs about “(a) their ability to perform in mathematical contexts, (b) the instrumental importance of mathematical knowledge, (c) constraints and opportunities in mathematical contexts, and (d) the resulting motivations and strategies used to obtain mathematics knowledge” (p. 19). Investigating the mathematics success and failure of African American students vis-à-vis mathematics learning, teaching, socializations, and curricula experienced by these students at Hillside Junior High School, Martin deemed the sociocultural contexts—classroom, school, home, and community—of the students’ lives significant to their psychological, academic, and mathematical development.

Cultural context as well as the situatedness and bidirectionality of identity were also evident in Nasir's (2002) study of mathematics identity and the cultural practices of basketball and dominoes of African American youth. Through a two-part qualitative study, Nasir (2002) explored the relation between goals, identities, and learning and argued for their utility as a model by which to understand the nature of learning in general and to better understand the way in which race, culture, and learning become intertwined for minority students in American schools. Nasir (2002) hypothesized that the cultural and cognitive goals that students construct in practice is critical to understanding how students construct and negotiate mathematical knowledge in cultural settings both in and out of school. She illustrated the multifaceted, bidirectional relationships between identity, learning, and goals of mathematics. Further, Nasir (2002) deemed imagination crucial in structuring learning, goals, and identity; forming those practice-linked identities; taking up the goals of the cultural practice; and tying individuals to larger, global communities of practice.

2.2.3 Mathematics Socialization

The focus on socialization is necessary as it serves as an explanatory concept to account for both the sociohistorical and present day mathematical experiences of African-Americans (Martin, 2000). Mathematics socialization describes the "processes and experiences by which individual and collective mathematics identities are shaped in sociohistorical, community, school, and intrapersonal contexts" (Martin, 2000, p. 19). Students' readiness to learn, their openness to mathematical experiences, their affect regarding mathematics, especially fear, and their level of curiosity, fascination, and imagination with mathematics can be negatively or positively impacted by social and cultural forces surrounding them and developmental forces within them. The impact of socialization on the development of students' mathematics identities is implied by Smith (2002): "Everyone has a mind capable of mathematical thinking. Whether or not particular individuals develop their potential depends largely on their initial encounters with the world of mathematics, and with the glass wall [of academic and professional advancement]" (p. 135). With the capable mind of each student in the mathematics classroom, the teachers' goal, according to Villegas and Lucas (2002), should be to "help students learn to think like experts, not merely to memorize the answers previously generated by experts" (p. 77).

Painfully, most students are not socialized to see themselves as mathematics experts, or even to think or act like mathematics experts, but to cower and flee from mathematics, never seeing themselves

as even remotely capable learners or contributors to the mathematics classroom and body of mathematics knowledge at large. This seems to be the case particularly for women, in general, and especially women and men of color as they mature in the United States as mathematician is not a common profession at all for them. Although one cannot know all of the reasons people choose or do not choose a particular field of study, statistics highlighting the drastic difference in rates of participation in a field must raise the question, “Why?”

Not only are students of color and lower socioeconomic status socialized out of mathematics, so, too, are students already taking advanced mathematics courses. Boaler and Greeno (2000) used the concept of “figured worlds” espoused by Holland et al. (1998) to explore identity, agency, and knowing in mathematics worlds, and challenge the tired yet seemingly eternal notion that mathematics is attainable only by some. Through this lens, they also showed the negative, exclusionary socialization practices of mathematics teachers on students deemed capable. According to Boaler and Greeno (2000), the figured worlds of “many mathematics classrooms, particularly those at higher levels, are unusually narrow and ritualistic, leading able students to reject the discipline at a sensitive stage of their identity development” (p. 171). Advanced Placement Calculus students in their study lamented the teaching of mathematics as contrary to their identities: “They talked not about their inability to do the mathematics, but about the kinds of person they wanted to be—creative, verbal, and humane...They wanted to pursue subjects that offered opportunities for expression, interpretation, and agency” (Boaler & Greeno, 2000, p. 187). Sadly, the pedagogical practices of their teachers precluded them from experiencing just what they wanted—ironically just what is found and practiced by mathematicians in mathematics.

Part of a student’s identity is their sense of power (Scales & Leffert, 2004). This power extends to students’ mathematical power. According to Gutstein (2003) students with mathematical power can invent their own solution methods, solve problems in multiple ways, generate multiple solutions when appropriate, reason mathematically, communicate findings orally and in writing, and develop mathematical and personal confidence. With a sense of power, students take control and responsibility for their own mathematics learning and doing. Mathematicians and mathematics professors share that “a crucial difference between mathematicians and most learners is that mathematicians see themselves as the agents of their own learning” (Burton, 2004, p. 187). Martin (2000) also concurred with the notion of individual agency in the development of mathematics identity:

The important factors fueling success were their abilities to think about school and mathematics learning in broader contexts, to develop goals that take advantage of this knowledge, and to invoke the kind of individual agency that was necessary to help them achieve their goals (p. 168).

2.3 Sociocultural and Ecological Systems Theories

As mathematics is a cultural practice, it is important to understand the social and cultural contexts and practices that students experience inside and outside of the classroom. According to Nasir and Saxe (2003), cultural practices are “socially patterned activities organized with reference to community norms and values [and thus] are important for the enactment and formation of identity” (p. 14). The authors’ argument emphasized the need to understand not only the surrounding cultures in which students are experiencing mathematics, but how students’ mathematical norms, ideas, beliefs, and hence, identities are being shaped, developed, and enacted. Since mathematics is a cultural practice and the CFEA model involves student, family, school, and community, I intend to explore the mathematics identities of CFEA students via sociocultural learning and ecological systems theories.

2.3.1 Cultural-Historical Activity Theory

Identity development is supported by sociocultural learning theories since “the sociocultural conception of identity addresses the fluid character of human being and the way identity is closely linked to participation and learning in a community” (Packer & Goicoechea, 2000, p. 229). Participation and learning occur in social contexts through practical activity and discourse—two critical aspects of cultural-historical activity theory (CHAT), a theory first formulated by Lev S. Vygotsky and later developed by his students Aleksandr Luria and A. N. Leont’ev (Packer & Goicoechea, 2000). Activity, therefore, involving a complex interplay among cultural tools, and sociocultural, institutional, and individual contexts and processes, shapes one’s identity (Penuel & Wertsch, 1995). Simply, such activity and discourses between students helps inform who they become (Wells, 2007).

As human development cannot be studied in isolation from the sociocultural contexts in which it is embedded (Stetsenko, 2005), CHAT is well suited to explore how the mathematics identities of African American and Hispanic students develop within an urban classroom where “psychological processes develop as a result of continuous interactions with ...people who do things with and for each other, who learn from each other and use experiences of previous generations to meet successfully the continuously changing demands of life” (Stetsenko & Vianna, 2009, p. 43). This approach can be translated into

educational practice in different cultural contexts—a necessary element for the diverse cultures in urban settings (Kozulin, 2004). Roth and Lee (2007) demonstrated how it is a theory of learning, for praxis, and for understanding identity development within participation in social practices as “learning in a broad sense presupposes both what we *become* and how we *act* as knowers [emphasis by Roth and Lee]” (p. 215). These and other authors (c.f., Stetsenko & Arieivitch, 2004) assert the dialectical nature of identity in that it “continuously produces and reproduces in practical activity, and are constituted with and by the social and materials resources at hand” (Roth & Lee, 2007, p. 216).

This seemingly inseparable connection of individual identities with surrounding context is echoed by Williams, Davis, and Black (2007a) as they agreed that “analyzing identity in relation to any ONE [emphasis of author] community or practice tells a very abstract, unrealistic story. In reality our identification with any one community is always inflected by our relationship with other communities and practices” (p. 105). They also agreed on the importance of discourse in explicating identity. These same discursive practices share a dialectical relationship with students’ subjectivities and their agency within the classroom (Williams, Davis, & Black, 2007b) yet with an understanding of the equal importance and emphasis on the subject and object (Stetsenko & Arieivitch, 2004).

Standing on a broad CHAT perspective, Yvette Solomon took a neo-Vygotskian focus on language and identity development within a community of practice. Solomon (2007), through Wenger’s conception of identity, views identity as cumulative, dependent upon students’ participation and the interpretation of their participation within the classroom or community of practice, and not fixed. Identity mediates practice and emerges as a product of repetitive classroom processes of teacher pedagogy, student discourses, and activity. In Solomon’s (2007) research, students’ discourse revealed one aspect of their perception of others’ mathematics identities. These students were ages 14 to 15. Although Sue described herself as quite good, she described Harry as much more advanced: “You know, Harry’s a very good mathematician so his [coursework] is really good...he is more advanced, he knows more things that we have to do...” (Solomon, 2007, p. 17).

The specific question asked in the interview of the student is not given in the article, so it unknown whether “mathematician” was the interviewer’s word or the student’s. However, it is still an intriguing notion that youth would call each “mathematician,” a troubling word even for adult knowers and doers of mathematics in the United States. What emerges as important is the cultural context of

discourse that lives within the classroom, school, and larger communities. Is “mathematician” a word that teenagers find common and accessible in England only? Does that same word carry different meaning, interpretation, accessibility, and capital for teenagers, and children, in the United States, in particular, urban communities?

2.3.2 Ecological Systems Theory

Ecological systems theory, developed by Urie Bronfenbrenner (2000) in the 1970s, concerns “the processes and conditions that govern the course of human development in the actual environments in which human beings live” (p. 129). Bronfenbrenner (2000) developed his theory even further from an ecological model, which focused on the environment as a context of development in terms of successively nested systems (micro-, meso-, exo-, and macro-), to the bioecological model, which “accords equal importance to the role in development of the biopsychological characteristics of the individual person” (p. 129). Another difference between the two models is that the original ecological model focused on a specific period of development—a person’s formative years—while the later bioecological model focused on mechanisms that produce development—proximal processes.

The ecological model (Bronfenbrenner, 1976), usually represented graphically as four concentric circles, contains successively nested environmental systems, with bidirectional influences within and between them, surrounding the individual student. Starting with the innermost environmental system, the microsystem is the immediate setting containing the student, where the student engages in particular activities in particular roles. That immediate setting could be the student’s home, classroom, school, church, after-school activity, day care center, or youth club. Moving outward from the innermost system, the next system is the mesosystem, or the system of microsystems, which comprises the interrelations among the major settings or simply the interactions that the student has with individuals or entities like family, friends, teachers, activity leaders, and community members within the microsystem. The third concentric circle—the exosystem—contains the social structures that influence the mesosystem and indirectly affect the student (i.e., community services, governmental agencies, parents’ places of employment, transportation facilities and structures). The fourth concentric circle—the macrosystem—represents the larger cultural context and comprises the overarching institutions of the culture or subculture, laws, and societal norms, such as the economic, social, educational, legal, and political systems.

The ecological model reflects to a certain degree the community school model although with exceptions. One exception is that in the ecological model community services (i.e., social and health services) are part of the exosystem; however, following the community school model, the community services would be part of the microsystem because they exist directly within the school itself and directly impact the students. Another exception is that for the ecological model, the parents' place of employment is part of the exosystem. However, for the community school model, students' parents may be involved in the school either as volunteer staff or even employed staff, thus parents' place of employment may actually be in the mesosystem. Part of the objectives of the community school is the inclusion of family in the school environment and structures for the sake of the student's well-being. Although there are points of exceptions in the ecological model in explaining the community school model, it helps to see where students develop within their surroundings and environments and how the interrelationship between these environments may potentially impact the student, in particular, their mathematics identities.

In exploring how the ecological or bioecological model can explain or describe the community school model, it is important to look at not only the structure of the model that impacts students' development, including their identity development, but also the processes that influence such development. Such processes within the bioecological model are called proximal processes—"processes of progressively more complex reciprocal interaction between an active, evolving biopsychological human organism and the persons, objects, and symbols in its immediate environment" where "to be effective, the interaction must occur on a fairly regular basis over extended periods of time" (Bronfenbrenner & Ceci, 1994, p. 572). These processes, these enduring forms of interaction between the student and human and non-human entities within her immediate environment, can be found in adult-child (parents, teachers, caregivers) or child-child activities, group or solitary activities, learning activities and skills (reading, mathematics, painting), problem solving, and performing complex tasks. These processes may be found in the community school, even in the afterschool component.

2.4 Culturally Responsive Pedagogy

To understand further the cultural contexts of identity development within the school one must consider the teacher and praxis within the classroom. The teacher-student and student-student interactions within the classroom are proximal processes that can be affected by not only the resources

that are present in the classroom and the school but also how the students see and position themselves in the classroom. Culturally responsive pedagogy attends to the praxis and proximal processes within the classroom. Gloria Ladson-Billings, in researching African American students and mathematics, found three main aspects that represent successful culturally responsive pedagogy: cultural competence, sociopolitical consciousness, and expectation of and work towards excellence in student learning.⁷

The need for cultural competence is not an isolated or unique idea as numerous researchers support such need for all teachers to effectively teach students with backgrounds different from their own (Banks, Cochran-Smith, Moll, Richert, Zeichner, LePage, Darling-Hammond, & Duffy, 2005). Villegas and Lucas (2002) expounded upon the reasons why culturally responsive pedagogy should be a part of teachers' praxis:

When teachers know little about their students' experiences and perspectives, it is difficult for them to select materials that are relevant to the students' experiences, to use pertinent examples or analogies drawn from the students' daily lives to introduce or clarify new concepts, to manage the classroom in ways that take into account cultural differences in interaction styles, and to use evaluation strategies that maximize students' opportunities to display what they actually know in ways that are familiar to them (p. 19).

Although Villegas and Lucas (2002) asserted these claims, Ladson-Billings (1994; 1997) in her work on culturally responsive pedagogy or culturally relevant teaching would concur, especially with the development of an affirming attitude as she found that "students treated as competent are likely to demonstrate competence" (1997, p. 703). As with urban at-risk youth, the role of the teacher-student relationship is critical to student satisfaction and engagement with school (Baker, 1999). The role of the parent-teacher-student relationship and teacher-student relationship, in particular, with respect to Hispanic students at elementary and middle school levels, is seen as an important factor to students' attitudes, beliefs, engagement, and achievement in school (Alfaro, Umaña-Taylor, & Bámaca, 2006; Woolley, Kol, & Bowen, 2009).

Further, understanding common cultural values embraced by Hispanics is especially salient in helping students develop positive experiences and identities with regard to learning and schooling in the U.S. Researchers have asserted the importance of considering the role of Latino family values to conduct research, and interpret and illuminate research findings on the school outcomes of Latino youth. Such values were the following: *familisimo* (centrality of family relationships and support), *respeto*

⁷ Dr. Gloria Ladson-Billings' talk at Distinguished Speaker Series, Bank Street College, New York, NY, March 9, 2006.

(respect for self and others, especially elders), *educación* (good behavior, moral upbringing, and academic learning), allocentrism (collectivism), and *simpatía* (behaviors that promote smooth and pleasant social relationships, which may lead to conformity) (Azmitia, Cooper, & Brown, 2009; Marín & Marín, 1991; Reese, Balzano, Gallimore, & Goldenberg, 1995). Misunderstandings of cultural differences and values within the classroom can lead to all players making incorrect assumptions and conclusions about the level of participation, resources, desire, and competence of each other and leave adult and student alike frustrated.

Culturally responsive pedagogy, then, would enhance teachers' discussion, questioning, critiquing, and prompting skills, to which they can develop within their own mathematics classrooms with the cultural values, experiences, and knowledge of students at the forefront of their minds, teaching their students the same skills to use during class discussion or collaborative work. It would further develop teachers' listening skills so they can learn how to dissect and respond to students' questions, statements, arguments, and utterances in class, even their expressions of confusion, conflict, anger, and frustration. This, in turn, would develop students' inquiry and critical thinking skills, agency, and sense of power. Effective teachers of students of color "link classroom content to students' experiences, focus on the whole child, and believe that all of their students can succeed" (Banks et al., 2005, p. 245). Research shows the positive impact that culturally responsive pedagogy vis-à-vis cultural artifacts, community resources, and student experiences in their classroom instructions has on student participation and engagement among students (West-Olatunji, Pringle, Adams, Baratelli, Goodman, & Maxis, 2007).

CHAPTER 3: METHODOLOGY

In this section I will review the methods employed to explore the research questions, beginning with piloting the protocols. I will then offer an overview of the study with attention to the data collection methods where some methods were used to explore more than one question as the data collected from observations, participants, and artifacts were rich. I include a reflective look at my role as the researcher, my efforts to define my role as the research progressed, and what that meant for me as I conducted the study. I continue on with informed consent and survey, brainstorm, and student interview administration.

3.1 Pilot Testing Protocols

Before I began the study in the fall of 2009, I piloted the pre-survey and interview protocol with seven African American youth in my church during the late summer. My church, at the time, had a majority of African American members that varied in age from toddler to elder of the church. The purpose of piloting the survey with the youth of my church during the summer was to identify any issues with survey form, presentation, administration in the field, and most importantly, item interpretation (Litwin, 2003). The actual survey itself would be assessed during the research period for validity and reliability with the participating African American and Hispanic 5th graders—certainly not an ideal situation but hopefully still positively contributory to the literature.

I asked for assistance from the youth pastor to which he asked one of the youth leaders to help. The youth leader made herself fully available to me in spreading the word about my study to the youth and parents she knew. She did not think that there were a lot of fifth-graders, so I asked her for children between grades 4 and 6. Also, because I did not know the math achievement scores of the potential pilot participants, I thought children between grades 4 and 6 would possibly be on target for fifth-grade, a year below, or a year above in mathematics and reading level. She was able to gather seven children and their parents. We arranged a meeting time with the children and their parents in the fellowship hall of the church for introductions, discussions and questions about the research; exchanging contact information, and signing consent forms. Six mothers and one aunt stayed in the hall while I started administering the survey to the youth.

For the pre-survey, I made sure that readability was not problematic with the definition. Using the Flesch-Kincaid Grade Level function of Microsoft Word 2007, the survey read easily below the fifth grade

level. The youth took about 12-15 minutes to complete the survey. I then sat with them at the table and we went over each survey item. I asked them to verbalize their thoughts and understanding of each item so that I would know if the intended message or idea for each item was being transmitted to the student (Fink, 2003a), especially since the grade levels for the students ranged from entering fourth-grader to entering sixth-grader. Before the actual research study began in the fall, changes were made to the pre-survey based on the pilot and discussion with my advisor, who suggested adding items regarding math and gender. Psychometric properties of the piloted version of the survey were not assessed as six new questions were added to the survey after the pilot, and there was no Hispanic participation in the pilot.

Since the semi-structured interview protocol was newly developed, it was essential to conduct a pilot test of its content, flow, and clarity of questions with the population of study participants (Bartholomew, Henderson, & Marcia, 2000). Some researchers suggest a two-phase approach to piloting where the first phase tests and refines the interview and the second phase uses the revised interview in conjunction with the coding system to ensure integration of both protocols (Bartholomew, Henderson, & Marcia, 2000). However, time and resource constraints often dictate the administration of the pilot, where testing, refinement, and coding often occur in tandem (Bartholomew, Henderson, & Marcia, 2000). I piloted the interview protocol with six of the seven African American youth in my church with whom I piloted the pre-survey. One girl was out of town during the time of the interviews. Finding a quiet space to conduct the interviews was slightly challenging, however, the staff of the church were quite helpful with opening offices for me to conduct some of the interviews. With the other interviews, the children and I found locations that were not as noisy as others. For one interview, in particular, conducted with a set of twins (brother and sister), we changed rooms three times recording parts of the interview in each room.

Before starting each interview, I explained what it was about and the types of questions I would ask. I put the questions in front of them so they could see them, and read them, if they liked. I then asked them if they wanted to be audio recorded, explaining that even though their parents had consented, they still had the right to say no. Five of the six youth assented to being audio recorded. The sixth child, the youngest boy entering the fourth grade, declined to be audio recorded. I really wished he had not declined. I was taken by his energy, quick mental calculations at the end of the interview, and his bold, unsolicited suggestions on how I should distribute the cash I was going to give to participants as a token of appreciation for their participation in the pilot survey and interview. As he told me his suggestion,

a big smile grew on my face at his nerve and thinking. I was pleased. He certainly exercised his rights and power as a research participant (Christensen, 2004).

Unfortunately, there were a few limitations to the pilot. I was not able to pilot the survey with any Hispanic children as, at that time, there were none in the church. Also, some students did not answer all of the questions because their time was limited. I tried to ask the more important questions up front since their parents told me at the onset of the interview what time they would be returning to pick up their child. Although the average recording time was 23 minutes, 49 seconds, it was not a precise assessment of the time it would really take to conduct the full interview. The longest recording time of 26 minutes, 12 seconds was with a female student beginning her sixth grade year. I saw the longest recording time as the minimum amount of time it should take to conduct the full interview during the study at the school. The students' responses not only informed the revision of the interview questions but also the final definition of mathematician that I used in the study with the school participants.

3.2 Study Overview

I conducted an ethnography at Fuentes Elementary Community School (pseudonym) over the 2009-2010 school year. I used quantitative and qualitative methods to explore the community school setting, culture, and structures, and to explore the mathematical experiences and identities of African American and Hispanic 5th grade students. Ethnography was chosen for this study to explore cognitive and social contexts in the mathematical lives of students (Eisenhart, 1988), students' mathematics enactment and identities in cultural settings (Nasir & Saxe, 2003), and individual and classroom processes in inner-city elementary schools (Waxman, Huang, Anderson, & Weinstein, 1997). I also wanted to explore the mathematics processes that exist outside of the classroom in the CFEA's afterschool program, and, specifically, in archery practice—a figured world (Holland et al., 1998) where as a sport with a mathematics component it had the potential of enhancing students' mathematics performance (Fadigan & Hammrich, 2004), in particular, girls' understanding and resilience in learning mathematics (Hammrich, Richardson, Green, & Livingston, 2001). As the school attends to the holistic development of its students, so does ethnography as “it should show how education is linked with the economy, the political system, local social structure, and the belief system of the people served by the schools” (Ogbu, 1981, p. 6).

Quantitatively, I examined students' mathematical attitudes, beliefs, life perspectives, and their mathematics assessments over the study period. I administered a pre- and post-survey to the students that elicited their mathematics attitudes and beliefs drawing from the Fennema-Sherman Mathematics Attitudes and Beliefs Scale (1976), and collected their 2009 and 2010 state mathematics assessment scores for comparison. Qualitatively, I conducted participant observations in different settings within the school, face-to-face interviews of students and adults, researcher reflection, and analysis of artifacts and archival records of the community school and its afterschool program—all standard ethnographic methods (Eisenhart, 2001). Interviewing was necessary to explore and understand what teachers, students, and CFEA staff thought and felt about themselves, their students, and their school as failing to do so would not bring about significant positive impact on schools or education (Eisenhart, 2001).

I also developed case studies of students in the archery program to take a closer look at its processes and culture, and students' mathematics identities and enactment inside the classroom and outside the classroom (i.e. in afterschool, archery). Cases can bring together many functions and relationships for study (Stake, 2006) as it is not a methodological choice but a choice of what is to be studied (Stake, 2005). Although the power of case study is particularization and not generalization (Stake, 2006), researchers have an obligation to demonstrate how and in what ways their findings may be transferable to other contexts or used by others (Simons, 2009). This transferability can be demonstrated through generalizations that are naturalistic or situated (similarities and differences to cases or situations are familiar to readers), concept (concept generalizes even when the specific instance does not), or process (the process generalizes even when the content and context may not) (Simons, 2009).

I triangulated the findings with multiple data sources (i.e., survey, field notes, interview transcript) and research events (i.e., artifact review and interview) in efforts to make sure that my interpretation was the meaning of the subjects (Stake, 2006) and to illuminate the different realities that exist in the cases (Stake, 2005). Data triangulation is crucial in qualitative research methods "to be able to consider alternative organizations and interpretations of data" (Eisenhart, 1988, p.110) and not force relationships or interpretations that do not make sense or simply do not exist. I watched videotapes and listened to audiotapes of recorded events several times over a span of time for missed points and nuances. I also had people unassociated with the research site from different backgrounds listen to portions of the recordings to check my interpretations (Stake, 2006).

I did not employ multiple observers for triangulation purposes (as established by Norman Denzin in 1989 and cited in Stake (2006)) as I was the only observer for the research study. However, I used second and third perspectives—the views of the students as well as the teachers, school staff, and CFEA staff. I did not obtain the views of the parents for this study; however, I interviewed the parent coordinator of the school. I could not conduct member checking with the student participants as they were fifth graders and had graduated from the school after the study was conducted. I tried to insure accuracy and understanding during their interviews by repeating their answers at points that needed clarification and asking them if what I repeated or interpreted was correct. Students were not shy in correcting me if I misheard or misinterpreted their responses. See Table 1 below for data collection methods employed for each research subquestion.

Research Sub-Question	Data Collected
1a. What are the culture and structures of this urban elementary community school that bear potential relevance for the development of mathematics identities in students? How is mathematics a part of the culture and structures of this particular community school?	<ul style="list-style-type: none"> • Artifacts of Fuentes such as the school’s mission statement, guiding principles, school report card, student mathematics assessments • Artifacts of the CFEA specific to Fuentes such as academic and non-academic activities and services (social, mental, health) for students and families (during and out of school) • Observation field notes of school components (i.e., assembly, school entrance, hallways, library) • Observation field notes of out-of-class activities (leadership meetings, professional development, archery practice, holiday events) • Semi-structured interview transcripts of school and program administrators, staff on the culture of the school
Research Sub-Question	Data Collected
1b. How are mathematical norms, ideas, ideals collectively enacted inside and outside of the classroom?	<ul style="list-style-type: none"> • Student survey data on attitudes and beliefs about math • Observation field notes of classroom activities, students, and teacher. • Brainstorms on the words “mathematics” and “mathematician” • Video- and/or audio-recorded observations and field notes of archery practice • Artifacts of student, teacher, and classroom work, materials, manipulatives, signage, wall print • Semi-structured interview transcripts of students on their attitudes, beliefs, and learning experiences with math inside and outside of school; perception of mathematicians

Research Sub-Question	Data Collected
2a. What are the specifics and characteristics of the following processes inside and outside of the classroom: learning mathematics; enacting skills, characteristics, and qualities of mathematicians; and, developing a sense of belonging?	<ul style="list-style-type: none"> • Observations of classroom activities, students, and teacher • Brainstorms on the words “mathematics” and “mathematician” • Observation field notes of out-of-class activities, in particular, students’ archery practice • Video and/or audio-recorded observations and field notes of students during archery practice • Semi-structured interview transcripts of students on their attitudes, beliefs, and learning experiences with math inside and outside of school; perception of mathematicians • Semi-structured interview transcripts of student archers on their attitudes, beliefs, and learning experiences with math and archery • Semi-structured interview transcripts of Fuentes staff on how they see themselves mathematically, their own images of mathematicians; how they see mathematics in the culture, environment, and structures of the school • Semi-structured interview transcript of archery coach on how he sees himself mathematically and his own images of mathematicians; how he observes students doing math in archery practice; how he sees mathematics in archery, and the culture, environment, and structures of the school
2b. Do students' immediate and future life perspectives have any relation to their mathematics identities? If so, in what way?	<ul style="list-style-type: none"> • Brainstorms on the words “mathematics” and “mathematician” • Student survey data on attitudes and beliefs about math; current and future math life perspectives • Semi-structured interview transcripts of students on their attitudes, beliefs, and learning experiences with math inside and outside of school; perception of mathematicians; education and career perspective

3.3 Study Setting

The setting for this study is Fuentes Elementary Community School, an urban, public elementary school located in the eastern U.S. Fuentes has partnered with the Children and Family Empowerment Agency since the early 2000s. Considered a small school, Fuentes enrolled nearly 400 PreK-5th grade students in the academic year 2009-2010, primarily Hispanic (70.6%) and African American (26.6%), 54.3% male and 45.7% female, with 89.4% living at or below poverty level. The attendance rate was 94.1%, the highest in its district. There were 57 fifth graders attending the school during this period. The majority of the students live in the neighborhoods surrounding the school, which are working class, low-

income, or below the poverty line. The mission statement of Fuentes Elementary Community School, as posted inside the school, is

“to cultivate a supportive and nurturing environment that fosters a community of lifelong learners. In partnership with families and Children and Family Empowerment Agency we will work collaboratively to empower our students to make informed decisions as productive citizens of a global community.”⁸

In addition to offering a rigorous academic program, Fuentes offers through its partnership with CFEA such services as afterschool academic enrichment with daily homework help and monthly thematic projects; holiday programming for students and family to enjoy; youth development activities; study circles; social work case management for students who need; and, summer camp. Parents register their child with CFEA at the beginning of the enrollment period in the fall of the academic year. Each year the CFEA serves over half of the total student body. For 2009-2010, of the nearly 400 students attending Fuentes, approximately 220 students (nearly 55%) were registered with and participated in CFEA program which begins each year in mid-September and ends mid-June of the following year, approximately two weeks before the end of the academic year.

In addition to homework help, enrichment activities, computer lab, and community learning centers and programs, one of those programs—highly popular and most highly regarded—is the archery program, which was brought to Fuentes nearly seven years ago by Ms. Benton (pseudonym), an African American woman. As the previous community school director, Ms. Benton was in search of new and exciting programs to bring to the students and families at Fuentes. She wanted programs that would attend to the socio-emotional development of the students as well as their academic enrichment. She had already created the Fashion Entrepreneurial Zone, which combined fashion design, creative, business, and math skills with personal development and goal commitment values. However, this program drew mostly girls. (Due to budget cuts, however, the program ended a few years later.)

She shared her search with a colleague from one of the CFEA-college partnerships she created, who told her of his good friend who was a professional archer and coach. After hearing about the coach and his desire to bring archery to young people of color, Ms. Benton interviewed him. She believed his demeanor, personality, and values were a right fit for Fuentes, in particular, in engaging African American

⁸The mission statement posted inside the school is different from the statement that appears on its website, so anonymity of the school and CFEA program is preserved.

and Hispanic youth in an activity that would be foreign to many, if not all, of them. She understood the developmental values that a sport such as archery could inspire and instill in young people. Although she believed archery could enhance students' mathematics skills, she did not have in mind their mathematics identities.

After seeing the success of the program the first year, she quickly instituted it in several of the other CFEA community schools, including middle and high school, where participation has increased each year. Students from third to fifth grade can sign up for archery and participate in at least one session during the year. Their parents, too, and other adults can participate in separate sessions to learn the process and fundamentals of archery. As students learn and practice the sport, they strengthen their coordination and acquire a strong sense of respect, discipline, sportsmanship, and positive competition. Some of the students are award-winning archers at the local and national levels.

Originally, the student participants in this study were to be drawn from a convenience sample of students from the three 5th grade classes that existed at Fuentes in 2008-2009. However, due to city-wide budget cuts, the principal was forced to eliminate one 5th grade class for the 2009-2010 school year, causing a drastic 55% increase in the number of students the remaining two 5th grade teachers normally taught. Consequently, each general education fifth grade class held 25 to 27 students. Although class size of 25 to 27 students may be considered normal for many classrooms in urban areas (or even smaller than many urban classrooms), such size was very unusual for these two teachers.

Therefore, the convenience sample was drawn from these two fifth-grade classes. See Table 2 for demographics of the students who participated in the study. Of the 27 Hispanic students, 51.9% were Dominican (i.e., they, their parents, or grandparents were born in the Dominican Republic), 22.2% were Puerto Rican, 14.8% were Mexican, 7.4% were Honduran, and 3.7% were Guatemalan. Ten of the 21 CFEA students (47.6%) participated in at least one session of archery during 2009-2010.

Demographic	Category	n	%	Demographic	Category	n	%
Sex	Female	15	45.5%	Age	10 yrs.	15	45.5%
	Male	18	55.5%		11 yrs., and older	18	55.5%
Ethnicity	African American	6	18.2%	Teacher	Mr. Knight	15	45.5%
	Hispanic	27	81.8%		Mrs. Cruz	18	55.5%
CFEA	Participated	21	63.6%	Archery	Participated	10	30.3%
	Did Not Participate	12	36.4%		Did Not Participate	23	69.7%

The mathematics curriculum the students used was *Everyday Mathematics* (EM), a comprehensive Pre-K through 6th grade mathematics curriculum developed by the University of Chicago School Mathematics Project and adopted and dropped by many urban cities across the U.S. In addition to the 5th grade students using *Everyday Mathematics* to learn mathematics, they were also able to know diagnostic scores from the Data Assessment Management System (DAMS) (pseudonym)—a new assessment management system that the city’s education department recently acquired. Fuentes first started using the system in the spring of 2008. Students take six assessments throughout the school year. After each assessment the students are able to use a computer to see not only their scores but which problems were correct and which were incorrect, of which they can, at their pace, make their own corrections. Students, parents, and administrators are able to monitor the progress of a child. Teachers receive professional development on how to use the system.

3.4 My Role as Researcher

It was critical for me to choose and understand my role(s) in this study as a researcher—as researcher of mathematics identities of African American and Hispanic students. As an African American woman, educator, and mathematician, it was challenging to choose and understand my role(s) as my own background, experiences, and beliefs around education, mathematics, childhood, and adulthood surfaced in my thoughts before, during, and after the study. Although I am an educator, I am not an elementary educator. I am not credentialed in elementary education. Although I have taught students from K-12 in public and private schools and adults in mathematics in an adult General Education Diploma (GED) program, and have taken education and developmental psychology courses along my academic journey, how am I qualified to observe an elementary classroom? What exactly should elementary teachers know specific to mathematics? Should I or they know only what is offered in their education program or beyond? Or, specific to elementary mathematics, should we know much deeper as suggested by Liping Ma (1999) in her study of elementary teachers’ understanding of fundamental mathematics in China and the United States?

One of my struggles in observing teachers in their classroom was to not become fixated on their teaching. I had to remind myself often that this study was not about the praxis of teachers in and of itself but the mathematics identities of their students relative to their teaching. Researching children’s

mathematics identities inside and outside the classroom requires exploration of their attitudes and beliefs about mathematics, their approaches to learning, as well as the processes that socialize them into or out of mathematics. I say “identities” as opposed to “identity” as students’ identities may differ from one setting to the next. These processes live inside the classroom, the school, the home, and beyond with their many different players, adult and children alike.

I came to understand that the role I take in documenting my research, in particular the case studies, would be connected to the type of research or case study I conduct, my personal preferences relating to people and collecting data, and even my audiences for the study (Simons, 2009). Thus, I would need to explore how my values and actions shape the data collection, interpretation, and analysis, and how the people at the community school impact me (Freeman & Mathison, 2009; Simons, 2009). This brings to mind Freeman and Mathison’s (2009) admonition for researchers to know themselves:

Researchers should explore their own biography regarding the roles of adults and children within the particular researcher context, an especially important task when the context is one the researcher has lived through. Although adult researchers may believe their experiences in schools are in the past and not relevant to the research moment, their own experiences of schooling will well up within that context. Was the researcher a good student perceived positively by teachers or a troublesome student frequently in the principal’s office? Was the researcher a participator or leader or a follower or alienated? (p. 57).

I questioned myself—my thoughts, my actions, my responses—for very particular moments during the study, moments of classroom and behavior management as I knew my own worldview, predilections, and values would influence my interaction with the research (Simons, 2009). When I was a fifth grader in elementary school, what did I do in instances of students’ misbehavior that distracted me? Could I expect the same thing from these students? Could I expect the same thing from these teachers and principal? Notions and codes of discipline have changed over the decades since I was a fifth grader in 1980 in Virginia.

Such an issue—classroom and behavior management—has always been a critical issue for me as a fifth grader then and as an educator now. It speaks directly to my sense of responsibility and accountability of learning instilled in me as a child by my mother and father. Further, can I as an African American lower-middle class woman relate to these children, my students, the majority of whom come from low-income or poverty-level households? Although I asked myself that question, I did not find it difficult to answer. Although there were some clear differences in our backgrounds, I believed that I could

relate to these children, my students. I grew up in a low-income, government-subsidized apartment project community in Virginia. All of the families were African American except for one White family, who seemed exceptionally poor.

My parents worked hard to provide for their children—four of us. My father, who had a telegraphic memory, was the lead telecommunications supervisor at General Electric, and my mother, who was wise beyond measure, stayed at home to raise us. For her, raising her children was her greatest joy. My mother's frugality allowed me and my siblings to experience a wide range of exceptional in-school and afterschool activities from camp, gymnastics, swimming, track, and baseball to chorus, orchestra, band, and then some. Education, respect, and moral upbringing and comportment were key to my parents. They are still key to me and my siblings.

They are also key to Hispanic families as a cultural value, regardless of nationality. The Hispanic cultural value of *educación* is a holistic value as it encompasses the heart, mind, and soul; it deems inseparable the moral upbringing, good behavior, and academic learning of the child (Azmitia, Cooper, & Brown, 2009; Marín & Marín, 1991; Reese, Balzano, Gallimore, & Goldenberg, 1995). Although we share similar values of education, how those values play out in the classroom and at school is important to explore and understand with respect to students' mathematics identities.

Initially, I wanted to be as neutral, invisible, and unaffected as possible. I hoped I could be that fly on the wall but I soon realized that was unreasonable to think that could happen. Other researchers, too, have found the metaphoric "fly on the wall" to be problematic in trying to position the researcher self within classrooms or playgrounds to observe children (Woodhead & Faulkner, 2000). Flies are not invisible. As a matter of fact, once they are seen, all attention seems to fixate on them with the sole purpose of destroying them. And I did not want to be destroyed. I had come to enjoy my research journey so far. So I gravitated towards Tudge and Hogan's (2005) perspective on invisibility: the aim is not invisibility but "a desire to change children's regularly occurring behavior in as minimal a way as is possible" (p. 117).

There were several possible researcher roles to consider: pure observer, complete participant, supervisor, leader, participant observer, and friend (Edmond, 2005; Fine & Sandstrom, 1988). However, participant observer seemed the most reasonable role in the beginning for not only my research goals but the observation settings—in and out of the classroom. A basic requirement for a participant observer is

emotional empathy with her subjects and not feeling excessive personal anxiety over becoming close to her subjects (Fine & Sandstrom, 1988). I never felt anxiety over becoming close to any of my subjects; I only felt anxiety when I observed students grossly misbehaving in class. Yet since my primary focus was on the identity processes, participation, and positioning of students during math class, the role of participant observer allowed me to see and interact with their verbal and physical interactions, games, conversations, behaviors, and routines in constructing a cultural space and thus in turn shaping the way they interact and behave (Freeman & Mathison, 2009).

Cultivating rapport with the teachers, school staff, and CFEA staff was important and had started the year before (2008-2009) during informal visits to the school and had continued this year during the research. The principal, an older white Irish woman, full of energy, very gracious, and child-focused, introduced me to teachers and staff she thought would be helpful to me in the conduct of my research. Negotiating rapport became easier as my presence and communications with everyone increased. Frankly, as time went on, my role took on “elements of both teacher and mother figure as disciplinarian and carer [caregiver]” (Mauthner, 1997, p. 21-22).

The researcher role I finally negotiated was that of participant observer-friend. As the year went on, friend became part of my role as students would run up to me in the hallway and give me hugs. I couldn't resist. How could I resist giving children hugs even when they misbehave in class? How could I not listen to their stories about what they did over the weekend? How could I not share in their successes whether it was archery practice, a swim meet, a baseball game, or a high math score they earned? I started greeting the staff with hugs, too. It was almost expected—the familiar greetings, my presence. It was part of the culture of the school. I had become a very familiar face in the school even to teachers who were not involved with the study.

Interestingly enough, even though I took the role as participant observer-friend and not complete participant, my presence became expected and at times my contributions, too, such that I think people, students and staff alike, either forgot that I was “the researcher” or did not see me as “the researcher”. Even though the CFEA director and I were friends and she understood and fully supported my research, she treated me like staff at times and would ask me to answer phones and help children who were doing homework at the communal table. The children were at the table either because they were not feeling well or because they were in trouble and were taking a “time out” from their afterschool class. It almost

felt like my role had expanded to complete participant as it felt to me that I was “becoming unidentifiable as a researcher” (Edmond, 2005, p. 124-125). To excuse myself from doing some office-related functions, I sometimes reminded CFEA staff, with a big smile, that “I don’t work here. I’m just the researcher.” However, I very much enjoyed the closeness and camaraderie of the school and CFEA staff and enjoyed creating the First Annual Math Bee for the CFEA afterschool program.

3.5 Informed Consent

“Informed consent, of course, implies informed rejection. Children must be given a real and legitimate opportunity to say that they do not want to participate in the research.”—
Fine & Sandstrom, 1988, p. 31

I kept Fine and Sandstrom’s (1988) admonition of informed consent in mind as I entered the classroom of each teacher for the first time to meet the children. I decided to wait until the beginning of the second week of school to visit the classrooms. I wanted to give the teachers time to get to know their students, familiarize the students with scheduling, and talk about class rules and expectations. I remembered what it was like for me as a teacher during the first week of school. As I entered each room, the teacher asked the students for their attention and introduced me as Ms. Fleshman. They both reminded their class of who I was. I smiled and stood at the front of the class as the teacher talked. I then greeted the class, said my name again, and started explaining my project in child-friendly language (Fine & Sandstrom, 1988). I told the class that I was a student just like them but a little older and was working on a research project about what students their age like and do not like about math and how they learn math. I told them that their participation would help me complete my project and that they would also help other students like them learn math better and in fun ways.

I passed out two consent forms in English and Spanish stapled together for students whose parents needed either version (Marín & Marín, 1991). I let the students know that participation was voluntary, meaning that they did not have to participate but could if they wanted to. Either was okay. I let them know that their grades would not be affected one way or the other if they participated or not. I went over both forms for the survey and videotaping. In both classes the students sat and listened quietly, some smiling at me. Some students said that they wanted to do the survey while some students shook their head and immediately voiced that they did not want to be in the video. Although I was a little disappointed to hear that, I let them know that whatever they decided was okay and that I still needed

them to take the forms home to their parent or guardian to read the front and back, circle “yes” or “no”, and sign and date the form. I also let them know that they could always ask me questions about the research anytime they saw me whether in class, the hallways, or even at lunch and I would gladly answer them.

I allowed two weeks for collecting informed consent forms, and returning partially completed forms to be completed. Teachers collected the forms and handed them to me upon my return. They also encouraged the students to have their parents complete the form. I did not include an incentive for returning the consent forms because participation in this research in any form was optional. I believed that if a student repeatedly failed to return the form then either she or he really did not want to participate or their caregivers did not want them to participate. Students who did not return the form at all were not allowed to participate in the survey or interview activities of the study but were included in the field notes as a collective and to the extent to which they affected students that participated in the study (Fine & Sandstrom, 1988). Students who returned forms with only one side completed were allowed to participate only to the extent of what their parents or guardians permitted.

I was happy with the number of students who received permission from their parents to participate—32 of 54 general education students (or 59.3% of the general education fifth grade study body) as enrolled by mid-September of 2009. However, I was disheartened that parents of students from one class who seemed a little boisterous or had been in trouble early on did not allow their children to participate. I wanted to understand their children’s mathematics identities especially since they reflected a population that is often misunderstood because of their behavior or perceived behavior. I was disheartened also because I noticed, while observing the class early on, that a number of these same students were very bright and quick in mental math. Nonetheless, I could understand parents’ concern and did not want them to feel pressured, suspicious, or anxious about an adult observing their child.

I knew that informed consent was not simply a step to be completed at the beginning of the research but a process that continues throughout the study and not only protects but also helps to minimize power differences between child and adult (Freeman & Mathison, 2009). Students were clear about their right to participate or not. One student, although his parents gave permission to be interviewed and videotaped, declined to be interviewed. This student, in seeing his time options, declined the interview because he “wanted to go out and play during lunch.” I was a little bothered by his decision

since he was one of the few African American males in the study but I understood and respected it. The weather had been nice over the weeks and that day was nice, too. Under blue skies and warm weather he exercised his rights under informed consent.

3.6 Survey and Brainstorming Administration

I conducted the pre-survey and pre-brainstorming activity in the first week of October 2009 with Mrs. Cruz's students first, and then one week later with Mr. Knight's students. For each time, Mrs. Kappas was most helpful in collecting and quieting the students, after which she sat off to the side of the room during administration. To be sure they understood why they were with me, I explained my research briefly and the survey once again. I reminded them of the consent forms they took home to their parents. Some of them had even forgotten the consent forms, asking me, "What consent forms?" "When did we get them?" A few students chimed in and reminded the ones who forgot when the consent forms were sent home and what they said. I thanked the students who remembered and reminded the rest of the class.

For both sets of students, I asked who knew what a survey was to engage their mind and to see if at such a young age any of them had heard of the word. Some of them had. When I asked who could tell me what they thought it was approximately five or six students from each class raised their hand. I asked each one to see what conception they had of a survey, and to let them know that everyone's answer was important. After discussing it quickly, I passed out the surveys to the students. I then asked them to look at the survey, front and back, to make sure they knew there were questions on the front and the back of the survey. I emphasized that there are no right or wrong answers on a survey, and that nobody but me would know. I explained why they might circle strongly disagree, disagree, agree, strongly disagree, and not sure, with clear gestures and facial expressions that may reflect how someone might feel about a statement. I wanted them to be comfortable with whatever feelings they may have while reading the statements and knowing it was okay to circle whatever they felt.

Of Mr. Knight's students, Fadhila raised her hand high and asked me, "Do we have to answer the questions if we don't feel comfortable?" That question made me pause not because of the question itself but that a student so young asked it with such clarity and confidence. I responded to her, "Very good question Fadhila! You asked a very good question. Absolutely not. You are not forced to answer any

questions. If you don't feel comfortable, then skip it. And don't feel bad about not answering it. Okay?" She smiled and said, "Okay." As I walked about, Fadhila raised her hand and asked me another question: "Is it easier to just ask the questions in person like in an interview?" I smiled again big, and responded to her, "Where are you getting all these good questions? Excellent!" I quickly explained when an interview could be used. She smiled after I complimented her on her questions. I told them to write their names on the survey and then to start. I gave them around 12 to 15 minutes to complete it. As I walked around the room during both administrations, I noticed students focused on the questions and reading them silently and circling the response options.

After I collected the surveys from all of the students, I passed out the paper I picked up from the CFEA office. I told them to draw a line down the center of the paper. I told them they could freehand it or fold the paper in half and then draw the line down the crease. A few of them asked me which way should they fold it, and Mrs. Kappas told them which way. I told them to write on the right half of the paper their name, and on the other half write the word, "Math." Most students seemed very intent on finding the middle and drawing a straight line and following my instructions closely. I looked at the clock, and told them we had to hurry. We only had five minutes left, and we had to get through this next part. I told them, "For this next part, we are going to brainstorm. Who knows what a brainstorm is?" Fewer students raised their hands than when asked about a survey. I asked each one whose hand was raised to see what conception they had of a brainstorm, and to let them know that everyone's answer was important.

Originally created as a method for creative problem solving, brainstorming is used to generate as many ideas as participants can, defer judgment or criticism on these ideas, think of the most unusual ideas, and even think of more ideas by association (Osborn, 1963). Although the objective of the brainstorming activity with my students was not to solve a problem, per se, I thought it would be a useful and exciting activity, not only for me, but hopefully for my students, as well, to come to know their top-of-mind thoughts and perceptions of mathematics and mathematicians. Although Osborn (1963) intended its use as a group activity, I originally intended it for both group and individuals as individual brainstorming has been shown to produce high levels of creativity also, and, in some situations, higher than in groups (Diehl & Stroebe, 1991; Furnham & Yazdanpanahi, 1995). Brainstorming individually on a sheet of paper would allow them to think and write as much (or as little) as they knew or could think of without judgment,

criticism, or comparison from anyone. I tried to make the activity like a game of sorts, or individual competition, against the clock; not against other students.

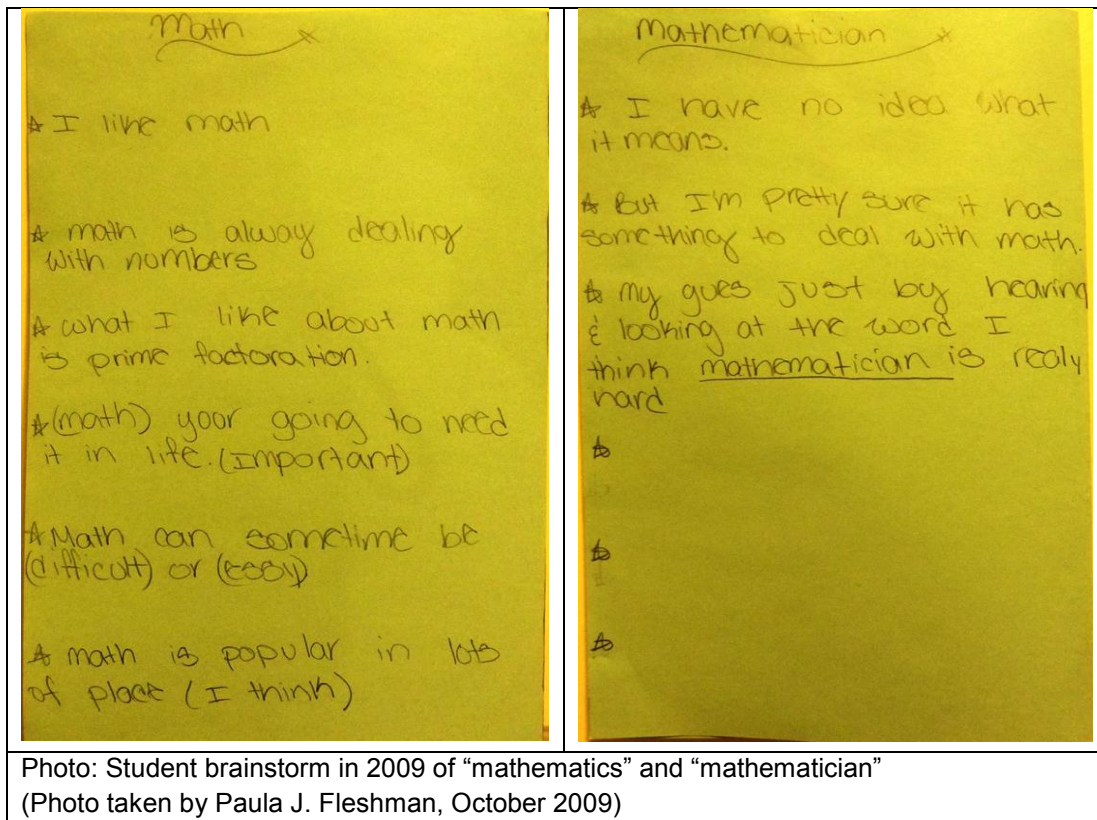
However, I decided against group brainstorming because of limited time and, more importantly, I did not want the collective brainstorming to influence individual thinking and identification with mathematics and mathematicians. Just how much would this research activity influence them? What would they carry with them back to their classrooms from the brainstorming discussions about mathematics and mathematicians? Would I be able to say that I observed them in their natural settings if I or my research has become part of the setting? Could I be able to say at the end of the research that what I observed was their world, so to speak, as they would normally experience it without me and not their world changed because of my research?

In addition to brainstorming, I had originally proposed that students draw a mathematician to gain understanding of the images they held; however, I eliminated that activity due to the length of time it would take and the absence of a scoring protocol. The brainstorms took the form of lists for most of the students. Lists are descriptive structures without any temporally ordered events (Küntay, 2004). Thus, students' brainstorming for approximately two to three minutes each on the words "mathematics" and "mathematician" built descriptive structures regarding their mathematics experiences and knowledge—structures that could give some window to their mathematics identities with respect to how they saw math, felt about math, and possibly used math. The lists generated from the brainstorming would differ from the brief narratives created within their interview transcripts as narratives are discourse structures that express temporally ordered events (Küntay, 2004). Two different genres created by the students will be used to help inform the questions of their mathematics identities inside and outside of the classroom.

I used the stopwatch function on my cellphone to keep time. I told them they had two minutes to write whatever they thought, felt, liked, disliked, knew about math, wanted to know about math. Again, there was no right or wrong answer. I walked around the class as they did the brainstorm on math. I reminded them that they did not have to write in complete sentences because the ideas should bolt out of their brains like lightening. I encouraged them to keep writing although many of them stopped writing after about one minute. Some of them stopped to shake out their writing hand. It seemed that for a few students, their hands grew tired. Most of them seemed like they were really trying to write but there were a few that seemed to give up trying to write the full two minutes.

I called time, and went to the front of the class, and told them to turn over their paper and write the word "mathematician." As soon as I said that, several students in both classes said, "Ooooh! What's that, Ms. Fleshman? What's a mathe-, mathemati..?" I repeated, "Math-e-ma-ti-cian? Well, that's the point. I can't tell you what it is." Ariela, from Mrs. Cruz's class, asked, "But how can we brainstorm about it if we don't know what it is?" I looked at Mrs. Kappas and smiled, and looked at Ariela, and said, "Good point" to which she smiled. I told the class that if they did not know what a mathematician was, then just write that. I encouraged them to think about the word and try to come up with ideas of what it could be since there was no right or wrong answer. Some of the students were still asking what a mathematician was. So I held up my cellphone as a signal that the brainstorm was about to start. Carlos set his watch. I told them, "You have two minutes. Ready, set, go." Carlos started his stopwatch and began writing like everybody else.

Time was moving pretty quickly. Students who had finished were sitting quietly, looking out of the window, or with their heads on the desk. A few students were still writing. At 10 seconds left, I started counting down to one second. I said, "Time's up." I collected the brainstorms from the students as they got up and walked towards the door. They still seemed excited and asked me were they going to do it again the next time I came. I told them no but maybe we'd do something else later on. I walked them back to their classroom along with Mrs. Kappas.



3.7 Classrooms and Archery Observations

In addition to out-of-classroom meetings and activities, I observed each classroom seven times over the year during the double 45-minute mathematics periods. I normally sat in the back of the class to be able to see the full class. I jotted down everything I could as I observed. I also observed archery practice nine times over the year standing either near the shooting line or at the scoring line (during scoring) to jot field notes or videotape. Archery practice normally lasted an hour. I did not follow a timed observation protocol for either classrooms or archery such as jotting every two minutes, or five minutes, or ten minutes as some researchers recommend (Emerson, Fretz, & Shaw, 1995). What if something incredible happened on the off-minute? I would miss it waiting for the prescribed time to write. I fleshed out the jottings and field notes, turning them into thick descriptions (Geertz, 1973). I then coded my field notes using process and descriptive coding.

Process coding is a coding method which uses gerunds to connote action where there is simple observable activity (e.g., reading, talking, raising hands) and more general conceptual action (e.g., struggling, negotiating, adapting) (Saldaña, 2009). Saldaña (2009) further defines processes as "participant actions that have antecedents, causes, consequences, and a sense of temporality" (p. 84).

Keeping this in mind, it was important to understand the before and after of a number of processes, in particular, those that were more evocative than others. Descriptive coding is a coding method that summarizes in a word or short phrase—most often as a noun—the basic topic of a passage of qualitative data, which later can be used to inventory, table, or summarize qualitative data (Saldaña, 2009).

Of the near 100 process codes generated from observing both classes, 60 were more commonly used. Of the near 80 process codes generated from observing archery, approximately 60 were commonly used. Categories were created for the classrooms and archery to give a sense of the actions or processes occurring at large in the classrooms and in archery, including processes of learning mathematics; enacting skills, characteristics, and qualities of mathematicians; and, developing a sense of belonging and community.

3.8 Student Interviews

Towards the end of the school year, I conducted the interview with 25 of the 32 student participants (78.1%) present. The remaining seven were not interviewed due to three reasons: school departure, discipline absence, and time constraints. The 25 who were interviewed constituted half of the general education fifth graders of this elementary community school. The student interview consisted of 16 base questions starting with students telling a little bit about themselves, including their favorite subject, hobbies, and afterschool activities. Midway I asked students if they had heard the word “mathematician” and what they thought a mathematician was.

3.8.1 Researcher Defining Mathematician

After asking students their definitions, I presented the definition I crafted from the literature on mathematicians. I used literature from mathematicians, mathematics education professors, and researchers of mathematicians (who support reformist or constructivist perspectives of mathematics) to gain deeper understanding of what a mathematician is and does, and how mathematicians see themselves beyond their expertise as most people, when they think about what a mathematician is, they first think about expertise or skill. Although some mathematicians believe that one can be called a mathematician only after earning the PhD in mathematics (Murray, 2000), I disagree. As revealed in the literature, being a mathematician is less about professional status and level of practice but more about state and habits of mind.

Such is hidden in definitions of mathematician found in industry. According to the Bureau of Labor Statistics (2009), mathematicians “use mathematical theory, computational techniques, algorithms, and the latest computer technology to solve economic, scientific, engineering, and business problems” where the work of mathematicians falls into two broad classes: theoretical (pure) mathematics and applied mathematics. General dictionary definitions are more accessible: simply a person learned or skilled in mathematics (The American Heritage Dictionary, 2000) or an expert or specialist in mathematics (Collins English Dictionary, 2003). However, the difference in the definitions of mathematician is quite broad—from opaque to simplistic. Psychiatrist Michael Fitzgerald and mathematician Ioan James in *The Mind of the Mathematician* (2007) decried the transcendental, abstract, and disembodied view of mathematics and called for a focus on “what mathematicians actually do rather than attempt a description of the final product” (p. 5).

Therefore, I believe a redefining of the word “mathematician” or, at least, a redefining of the expectations and culture of mathematicians needs to take place as the number of mathematicians overall and, in particular, women mathematicians each year newly entering the workforce with PhD in hand is at a steady low, along with PhDs in mathematics education. I defined mathematician as “someone who likes to learn about math, sees math in almost anything, tries different things in math, is not afraid to try to solve things or figure things out using math, and is not perfect.” The definition included the responses of two African American youth from the pilot—that mathematicians make mistakes, too. See Table 3 below for abbreviated construction of definition and Table A3 in Appendix A for complete construction.

Table 3. Research Definition Construction of Mathematician From Literature	
A mathematician is anyone who ...	Literature Citations
Likes to learn about math	• Fosnot & Dolk (2005), Murray (2000), Smith (2002),
Sees math in almost anything	• Fosnot & Dolk (2005), Kline (1973), Murray (2000), Smith (2002),
Tries different things in math	• Burton (2004), Fosnot & Dolk (2005), Kline (1973), Murray (2000), Smith (2002)
Is not afraid to try to solve problems or figure things out using math	• Burton (2004), Fosnot & Dolk (2005), Lockhart (2009), Piggott (2007), Smith (2002)
Is not perfect	• Burton (2004), Kline (1973), Lakoff & Nuñez (2000), Mathematics Association of America (2007), study pilot test respondents (2009)

Although some of the authors used words such as “numbers” (Smith, 2002) and “patterns” (Fosnot & Dolk, 2005) in their defining mathematicians, I chose not to include these or any words that I thought would direct the thinking of the students to particular aspects of mathematics. Although the definition may seem vague, I wanted them to be able to think as freely about whatever and however they relate to the definition based on what they had learned and experienced with mathematics so far inside and outside of the classroom. For consistency, I used language in the definition that mirrored the language used in the pre- and post-survey, for example, “I try to see math in things around me,” and “Math doesn’t scare me at all.”

The interview questions ended with students telling the world one thing about themselves as it related to math. The last question was not one of the proposed 16 but was thought of during the first interview with Bernardo after I asked him, “If you could use math for one thing in this world, what would you use it for?” Bernardo’s response was immediate and personal, so I wanted to see what else might come out of a similar question where the world was his audience. I asked two more questions: “If there was one thing that you wanted the world to know about you as it pertains to math, what would you want the world to know?” and “Now, if there was one thing that you wanted the world to know about you, what would you want the world to know? It doesn’t have to have anything to do with math. It’s all about you.”

Again, Bernardo's responses were immediate and personal. I added them to the protocol. See Appendix A for student interview question protocol.

For each interview, approximately five to six minutes was needed in total before and after the recording for logistics: confirm the student's desire to participate, confirm their parent's permission for video recording specifically, confirm their desire to be video recorded, set up the audio and video recording equipment, go over ground rules to help make them feel comfortable and empowered (Wescott & Littleton, 2005), wrap up at the end with my giving them five dollars cash as a token of appreciation, their signing for receipt of the five dollars, and to answer any extemporaneous questions they might have. A few students who had permission from their parents to be video recorded refused to be video recorded but consented to audio recording. Although I was slightly disappointed that they did not want to be video recorded, I was pleased to see them exercising their rights and power as research participants, and in particular, as child participants (Christensen, 2004). Recording lengths, on average, were 38 minutes, 24 seconds with the shortest recording lasting 25 minutes, 44 seconds, and the longest lasting 51 minutes, 35 seconds. The total recording time for these 25 students was 15 hours, 59 minutes, 15 seconds, with a total dedicated interviewing time of over 18 hours from May 17, 2010 to June 22, 2010.

After I finished all the individual interviews, I conducted a group interview with just the archery students, except for Antonio who was unavailable due to discipline issues and Javier who was preparing his graduation speech. I conducted the archery interview with Javier separately. The individual interviews did not ask questions about archery so there can be no validating of responses between individual and group interviews with respect to archery. I did not pose archery questions during the individual interviews as time did not permit and not all student participants took archery. I conducted a group interview as it would allow students to initiate, hear, prompt, and even extend or amplify the ideas of their peers (Krueger, 1994; Lewis, 1992), allowing for co-construction of the process (Wescott & Littleton, 2005). I made sure the interview space was a safe space for them to share or not to share, if they chose, and to allow for and respect the contributions of everyone, especially any timid students.

Before I started the group interview, I had them sit at one table so we were all close together—so close that there was almost no room for me. They sat beside whoever they wanted to. I only directed them to sit at that particular table; not which seat as “allowing children the freedom to choose their own seating arrangement can also help to distinguish between the adult-child relationship of the classroom

and the focus group” (Hennessy & Heary, 2005, p. 245). Belen slid over and made room for me. I was glad Belen wanted me to sit beside her because I wanted to make sure she felt heard and included.

We all sat close at one table so we could all have eye contact with each other and to make sure no one felt marginalized by sitting at a distance (Hennessy & Heary, 2005). I also thought the close proximity would enhance the feeling of a small friendship group or club, especially since we all had one obvious thing in common—we were in archery—and another thing which Dayanara assumed was that we all liked math. They inquired about Javier as they knew he belonged in the group. I told them that Javier was busy writing his graduation speech and that I really wanted him to be a part of the group but writing his speech came first, which he acknowledged when I asked him to be in the group interview. I interviewed Javier later on in the afternoon. Unfortunately, time did not permit for a separate interview with Antonio.

I took note of each student’s demeanor, body language, and reactions during the interview (Simons, 2009), particularly, the few students that declined to be video recorded. I transcribed the student interviews verbatim, also noting voice inflections, laughter, facial expressions, and shrugs, for instance, in an attempt to maintain the context of the nonverbal data (Miles & Huberman, 1994). It took approximately 10 to 12 hours to transcribe each interview. I tried to make sure students spoke loudly and clearly enough into the microphone throughout the interview. Nonetheless, transcribing became quite challenging with a few interviews due to students’ mumbling, words running together, or accents. Further, excessive noise in the hallway drowned out their voices at times. For those parts, I replayed the recording and listened to it repeatedly at different speeds and volumes to ascertain what they said.

CHAPTER 4: PRE-ANALYSIS

The corpus of data contained a range from school and classroom artifacts to math assessment scores, which required different data analytic techniques to explore the data broadly and deeply. (See Table 4 for data and corresponding analysis for details.) Before analyzing the corpus of data, I determined the reliability of the data collected through the surveys and interviews. The reliability of a survey indicates the reproducibility or stability of the data gathered by this instrument (Litwin, 2003). For interview transcript data, reliability indicates how reliably or consistently independent coders apply codes to units of data, whether fixed and predetermined, or free-flowing from open-ended interview questions (Kurasaki, 2000).

Analysis / Data	Content	Thematic	Frequency	Graphs, Charts, Matrices	Within-Cross-Case	Case Studies	Descriptive	Inferential	Correlations, Relationships
School and Classroom Artifacts	X								
Brainstorms	X	X	X	X		X			
Field notes	X	X				X	X		
Interview Transcripts	X	X	X	X	X	X	X		X
Survey Data			X	X	X	X	X	X	X
State Math Assessment Scores			X	X	X	X	X	X	X
Demographic Data			X	X	X	X	X		

4.1 Pre-Analysis of Survey Data

For the survey, there are seven independent variables: student participation in CFEA, student participation in archery, and student's teacher, sex, age, ethnicity, and nationality. Student participation in CFEA and archery are active independent variables since it is an intervention, so to speak, given to a group of participants within a specified period of time during the study but not necessarily manipulated by the researcher (Leech, Barrett, & Morgan, 2008). The students are not randomly assigned to CFEA or archery. CFEA students can participate in archery during the year in at least one of four sessions. Students sign up for it at the beginning of the year with the CFEA program director, who assigns students

to sessions. Students' participation in the present research study does not bear on their participation in archery. Each session has no more than 12 to 13 students participating. The archery coach and the CFEA program director try to make sure each interested student participates.

Students' teacher, sex, age, ethnicity, and nationality are attribute independent variables because they are "preexisting attributes of the persons or their ongoing environment that are not systematically changed during the study" (Leech, Barrett, & Morgan, 2008, p. 2). These data were obtained by two different data collection techniques: artifact and third-person inquiry. None of the independent variables were asked as items on the survey. The survey only contained item statements on math beliefs and attitudes with a 5-point agreement/disagreement response scale for each statement. (See Appendix for Students Mathematics Beliefs and Attitudes Survey.) The two teachers participating in the study gave me copies of their student roster, which contained students' sex.

The students' age and ethnicity were retrieved from the city education department upon request of the school's computer lab specialist. Only the demographic information of students whose parents consented to their participation in the study was retrieved. This information was submitted by the parent when the parent first registered the student for admission to Fuentes Elementary Community School. The ethnicity categories were White, African American, Native American, Asian, and Hispanic. There was no indication of nationality or country of origin with this information. I had forgotten to ask the students their nationality during the interviews, and only four students shared anything on their own about their nationality or heritage with me during the interviews.

To find out the Hispanic students' nationality or at least their parents' country of origin, I inquired with Joya, the CFEA program director, who has been part of the CFEA staff for at least a decade and by her accounts (and from what I observed) knew all the families that were registered with the CFEA and many of the children who were not as they, too, lived in neighborhoods around the school. Because of her longstanding history with the CFEA, the school, and the community, she had such intimate knowledge of mostly all the students because she, along with the high majority of the students, lived in the neighborhood. She said she often sees the children and the families out grocery shopping, taking care of business, playing in the park, hanging out, or coming and going on their way to school or work.

The dependent variables in this survey are students' state math assessment scores and ratings, and the survey items. These items measure students' math knowledge, application, beliefs, and

attitudes. The students participating in the study are those whose parents consented to their child’s participation. Only the state math assessment scores of students whose parents consented were retrieved and included in the analysis of the survey data. Third, fourth, and fifth grade math scores were retrieved from the school. The state math assessment is administered every year in the spring.

4.2 Pre-Survey Exploratory Analysis

The Students’ Mathematics Beliefs and Attitudes Survey (SMBAS) contained 26 items, the majority (20) of which I used directly or adapted from the Fennema-Sherman Mathematics Attitude Scales (F-SMAS) (1976). The items came from the following F-SMAS subscales: Math as Male Domain, Mathematics Usefulness, Teacher, Attitude Toward Success in Mathematics, Effectance Motivation in Mathematics, Mathematics Anxiety, and Confidence in Learning Mathematics. The remaining six items were developed to reflect different aspects of mathematics identity from the literature.

The subscales that I developed for the survey were based on the research on mathematics identity and how mathematicians describe themselves and mathematics: Mathematics Usefulness, Classroom Community in Mathematics, Discovery of Mathematics, Mathematics Anxiety, and Confidence in Learning Mathematics. I also included a subscale of Gender Equality to explore the notions of gender mathematics with respect to mathematics identity. These subscales attempted speak to the characteristics of many mathematicians and the understanding that mathematics is an individual, social, cultural, and historical construction. (See Table 5 for subscales with corresponding survey items.)

Subscale	Item	Scoring	Source
Gender Equality	Math is more for boys than for girls.	Reverse	Adapted from (F-SMAS) (1976). Math as Male Domain Subscale
	Boys and girls are equally good at math.	Forward	Adapted from (F-SMAS) (1976). Math as Male Domain Subscale
	Girls are less talented in math than boys by nature.	Reverse	Adapted from (F-SMAS) (1976). Math as Male Domain Subscale

Table 5 (Continued). Subscales with Items, Scoring, and Source			
Subscale	Item	Scoring	Source
Mathematics Usefulness	Knowing math will help me get a good job.	Forward	Adapted from (F-SMAS) (1976). Usefulness Subscale
	Math is not important to my life.	Reverse	Adapted from (F-SMAS) (1976). Usefulness Subscale
	After I graduate from high school, I won't need math.	Reverse	Adapted from (F-SMAS) (1976). Usefulness Subscale
	I do my math because I know how useful it is.	Forward	Adapted from (F-SMAS) (1976). Usefulness Subscale
Classroom Community in Mathematics	I don't like helping other students with math.	Reverse	Constructed
	My teacher makes me feel like I can do well in math.	Forward	Adapted from (F-SMAS) (1976). Teacher Subscale
	I like to help my classmates with math.	Forward	Constructed
	I'm too nervous or scared to share my answers in class.	Reverse	Constructed
	I'd be proud to be the best student in math.	Forward	Adapted from (F-SMAS) (1976). Success Subscale
	If I am the best student in math, I don't want anyone to know.	Reverse	Adapted from (F-SMAS) (1976). Success Subscale
Discovery of Mathematics	I like math puzzles and games.	Forward	Adapted from (F-SMAS) (1976). Effectance Motivation Subscale
	I try to see math in things around me.	Forward	Constructed
	If a math problem is hard, I try to figure it out before asking for help.	Forward	Adapted from (F-SMAS) (1976). Effectance Motivation Subscale
	When I'm outside of school I like to use mental math to figure things out.	Forward	Constructed
	I want to study math when I go to college.	Forward	Constructed
	When I get a math problem wrong, I try hard to understand why.	Forward	Adapted from (F-SMAS) (1976). Effectance Motivation Subscale
Mathematics Anxiety	Math usually makes me feel uncomfortable or nervous.	Reverse	Directly from (F-SMAS) (1976). Anxiety Subscale
	I almost never get nervous during a math test.	Forward	Adapted from (F-SMAS) (1976). Anxiety Subscale
	Math doesn't scare me at all.	Forward	Adapted from (F-SMAS) (1976). Anxiety Subscale
Confidence in Learning Mathematics	I think I could handle more difficult math.	Forward	Directly from (F-SMAS) (1976). Confidence Subscale
	I'm no good at math.	Reverse	Directly from (F-SMAS) (1976). Confidence Subscale
	I can get good grades in math.	Forward	Directly from (F-SMAS) (1976). Confidence Subscale
	It wouldn't bother me at all to learn more math.	Forward	Adapted from (F-SMAS) (1976). Anxiety Subscale

4.2.1 Descriptive Statistics

I conducted exploratory data analyses with descriptive statistics on the pre-survey data to gather demographic and attributional data of the students, check for problems with the data (e.g., outliers, non-normal distribution, data coding or entry errors), check whether statistical test assumptions (e.g., independence of observations, normality, homogeneity of variances) are being met, and examine relationships (correlations) between variables (Fink, 2003b; Leech, Barrett, & Morgan, 2008; Onwuegbuzie & Daniel, 2003). Descriptive statistics (e.g., mean, median, mode, standard deviation, skewness) were computed for all of the variables. Skewness (lack of symmetry in a frequency distribution) between -1 and +1 suggests the data are normally distributed (Leech, Barrett, & Morgan, 2008). Additionally, I visually inspected the distribution in a histogram and boxplots, as although skewness statistics may indicate normality, the data may have multiple modes, extreme scores, or actual skewed distributions (Keppel & Wickens, 2004; Newton & Rudestam, 1999). After reviewing the descriptive statistics, frequency distributions, and graphs, 23 of the 26 survey items indicated non-normal distributions.

Although the mean is a familiar (and sometimes more readily accessible) descriptive statistic, I calculated and used the median for the survey items in addition to the mean for three reasons: (1) to gain understanding of the typical scores of the surveys; (2) the distributions were skewed for most of the items; and, (3) the data were ordinal (Fink, 2003b). The mode was calculated also for the survey items as well as demographic items (sex, ethnicity, teacher, CFEA participation, archery participation) as some of the distributions had more than one peak and I wanted the prevailing characteristic of the scores (Fink, 2003b). However, for remaining numerical scale items such as age, state math assessment scores, summated subscales, computed score differences, and indexes, I calculated the mean as these distributions were normal.

4.2.2 Coding

Each survey item was rated using a five-point Likert-type scale (Agree Strongly = 5, Agree = 4, Not sure = 3, Disagree = 2, Disagree Strongly = 1). To help increase the reliability of the survey, I positively-worded 17 of the 26 survey items with the remaining nine being negatively-worded. Positively-worded items are phrased so that an agreement with the item represents a relatively high level of the attribute being measured. For example, the item "I think I could handle more difficult math" was

positively-worded (Agree strongly = 5, Agree = 4, Not sure = 3, Disagree = 2, Disagree strongly = 1) because an agreement or strong agreement with it indicates a relatively high level of a student's confidence in learning mathematics at least as compared to a disagreement with it. On the other hand, negatively-worded items are items that are phrased so that an agreement with the item represents a relatively low level of the attribute being measured. For example, the item "I'm no good at math" was negatively-worded (Agree strongly = 5, Agree = 4, Not sure = 3, Disagree = 2, Disagree strongly = 1) because an agreement or strong agreement with it indicates a relatively low level of a student's confidence in learning mathematics at least as compared to a disagreement with it.

Before computing each of the students' total scores, I reverse-scored the negatively-worded items so that all of the items were consistent with each other with respect to what agreement and disagreement mean in value. For example, for the subscale Confidence in Learning, the scores for the two items "I think I could handle more difficult math" and "I'm no good at math" cannot be totaled as they originally stand because the values do not mean the same. A value of five (5, Agree Strongly) for "I think I could handle more difficult math" does not mean the same as a value of five (5, Agree Strongly) for "I'm no good at math." Essentially, the values for all of the questions must be in the same direction. I also observed actual score distributions in addition to measures of central tendency to allow for more accurate descriptions of group responses (Marín & Marín, 1991).

4.2.3 Internal Structure and Reliability

I attempted to assess the internal structure of the Students' Mathematics Belief and Attitudes (F-SMAS) pre-survey by conducting a factor analysis for two reasons: (1) I had not used this survey with urban Hispanic fifth graders prior to this study (Litwin, 2003; Marín & Marín, 1991), and (2) the majority of the items came from F-SMAS, which was originally completed by 6th through 12th graders in the 1970s who were ethnically and culturally different from my population of study (Litwin, 2003). The F-SMAS was originally conducted with students in grades 9 to 12, and then a year later with students in grades 6 to 8; however, the high majority (95%) of these students was white, with 2% identifying as African American and 2% identifying as Hispanic. A number of researchers over the decades have adapted or used in whole or in part the F-SMAS with various populations (c.f., Mulhern & Rae, 1998), including African American and Hispanic populations but none with elementary school children.

However, the pre-survey sample size ($n = 32$) was too small to produce reliable results from the factor analysis. Using the FACTOR procedure with principal axis factoring as the extraction method in SPSS, a factor analytic solution could not be obtained as the determinant was less than .0001 (Leech, Barrett, & Morgan, 2008). Research suggests a sample size smaller than 50 is very poor, or more specifically, a sample size with case-to-variable ratio of less than 5:1 is inadequate (Onwuegbuzie & Daniel, 2003). Although research also suggests conducting factor analyses with multiple rotations if there is more than one ethnic group (Marín & Marín, 1991), the number of participants in each subgroup for this pre-survey was too small for such analysis—six African-American/African participants and 26 Hispanic participants. Furthermore, within the Hispanic subgroup there were five Spanish-speaking countries or territories represented—Dominican Republic, Puerto Rico, Mexico, Guatemala, and Honduras—each of which have cultural similarities and differences amongst each other.

I assessed the internal consistency reliability of the pre-survey and its subscales using the RELIABILITY procedure in SPSS (Leech, Barrett, & Morgan, 2008). Although Fennema and Sherman (1976) reported split-half reliability coefficients, I used Cronbach's coefficient alpha (α) to measure reliability as it is typically used when several Likert-type items are summed to make a composite score a summated scale (Leech, Barrett, & Morgan, 2008). The reliability of a survey indicates the reproducibility or stability of the data gathered by this instrument (Litwin, 2003). Positively-worded items were scored positively while negatively-worded items were scored negatively. The standardized alpha for the entire survey of 26 items was .786 with $M = 105.34$ and $SD = 10.30$. However, after computing alpha for each of the subscales and subsequently deleting four items from the survey, the alpha for the new survey of 22 items was .793 with $M = 89.16$ and $SD = 9.41$. Thus, the survey overall has reasonable internal consistency reliability.

To document its performance in my study population, I calculated alternate-form reliability using the BIVARIATE procedure in SPSS (Leech, Barrett, & Morgan, 2008) instead of test-retest reliability as the time between testing was eight months—time enough for items being measured to change (Litwin, 2003). I calculated alternate-form reliability also because I changed the order of the pre-survey questions on the post-survey to minimize practice effect—a phenomenon where individuals may become familiar with the items and thus may answer partly based on their memory of what they answered before (Litwin, 2003). A Pearson's correlation was computed to assess reliability. The following subscales showed

decent reliability: Discovery, $r(30) = .497, p = .006$; Anxiety, $r(30) = .468, p = .011$; and Confidence in Learning, $r(30) = .654, p < .001$.

For many of the students, taking the pre- and post-surveys was a new experience to which they stated that they enjoyed. At different periods throughout the study, students would ask me when they were going to take the survey again. I was hoping the changed order of the questions would help minimize practice effect. In hindsight I should have changed the order of the response set, too, as some students said some of the questions looked familiar even though almost eight months had passed between survey administrations. For each subscale below is the description of the subscale and final reliability. See Table 6 for subscale definitions and reliability.

Subscale	Intended to measure...	α	M	SD
Gender Equality	Students seeing mathematics as a male, neutral, or female domain with respect to relative ability and masculinity/ femininity (Fennema & Sherman, 1976).	.69	7.81	2.04
Mathematics Usefulness	Students' beliefs about the usefulness of mathematics currently, and in relationship to their future education, vocation, or other activities (Fennema & Sherman, 1976)	.64	17.41	2.33
Classroom Community in Mathematics	Students' perceptions of their teacher's attitudes toward them as learners of mathematics and students' anticipation of positive or negative consequences as a result of success in mathematics (Fennema & Sherman, 1976); sense of community by level of helpfulness and sharing of answers (Researcher Constructed)	.72	20.44	3.65
Discovery of Mathematics	Students' effectance as applied to mathematics from lack of involvement in mathematics to active enjoyment and seeking of challenge (Fennema & Sherman, 1976); seeing math around them in everyday experiences and the future (Researcher Constructed)	.59	20.97	2.48
Mathematics Anxiety	Students' feelings of anxiety, dread, and nervousness related to doing mathematics (Fennema & Sherman, 1976).	.62	10.94	2.92
Confidence in Learning Mathematics	Students' confidence in one's ability to learn and to perform well on mathematical tasks (Fennema & Sherman, 1976).	.58	15.72	2.91

Four items were deleted from the quantitative analysis of the survey for decreasing the survey's internal reliability: "Boys and girls are equally good at math," "I don't like helping other students with math," "When I am outside of school I like to use mental math to figure things out," and "It wouldn't bother me at all to learn more math." These four items say something about the students' notions of gender equality in mathematics, the classroom community with respect to mathematics, their curiosity or desire to discover new things mathematically, and their confidence in learning more mathematics. After

considering the information that the deleted items revealed from the students, I decided to leave the items in the post-survey to be able to garner pre-and post-information from the students.

Those items, however, will not be included in the quantitative analyses but will be included qualitatively. As this is an exploratory study of a population of students that has not been studied before, I wanted to keep as much information as possible about the students and their mathematics beliefs, attitudes, and experiences. The challenge would be to incorporate the quantitative data from these four excluded survey items in a qualitative way, or “qualitize” it, by possibly transforming or integrating it to summarize patterns rather than for statistical inference (Onwuegbuzie & Teddlie, 2003), thus not losing valuable information, but adding to the richness of the students’ narratives and the analysis as a whole.

4.3 Survey Analysis Methods

The quantitative analysis included demographic variables, state math assessment scores for 2009 and 2010, and the 22 survey items from both pre and post surveys. Descriptive statistics were computed to understand the distribution and spread of the data in the sample. This allowed for a sketching of students’ beliefs, attitudes, and behaviors as a whole and across categories (i.e., gender, teacher, CFEA participation, age group, and ethnicity) as revealed in the pre-survey conducted in October 2009, suggesting that how students saw themselves at that point was a culmination of their prior experiences in the school. This data, in and of itself, is important because, although schools are aware of their students’ mathematics performance as evidenced on state and school tests, they are not necessarily aware of their students’ beliefs and attitudes with respect to math apart from whether the students like math or not. The post-survey, administered during the last two weeks of school in June 2010, also provided a sketching of students’ math beliefs, attitudes, and behaviors at that time.

4.3.1 Overall Changes From 2009 to 2010

To determine if there were any differences between 2009 and 2010 survey items and subscale responses, I conducted a paired t-test at significance level $\alpha = .05$. To determine the effect size or magnitude of significant differences between the same two variables, I calculated Cohen’s d , a standardized effect size. As SPSS does not calculate Cohen’s d for t-tests, I calculated it using Excel.

For two groups with equal n s, Cohen’s d was calculated by $d = \frac{M_a - M_b}{SD_{pooled}}$, where M_a is the mean of

group A, M_b is the mean of group B, and SD_{pooled} is the average of the standard deviations (SDs) for the two groups with equal ns (Keppel & Wickens, 2004; Leech, Barrett, & Morgan, 2008). Effect sizes for d are interpreted as ranges: small or smaller than typical if $d \approx |.20|$; medium or typical if $d \approx |.50|$; large or larger than typical if $d \approx |.80|$; and, much larger than typical if $d \approx |1.00|$ (Keppel & Wickens, 2004; Leech, Barrett, & Morgan, 2008). It is the absolute magnitude of the coefficient, rather than its sign, that is important when interpreting effect size with closer inquiry suggested for small to medium effect sizes over large effect sizes (Keppel & Wickens, 2004).

4.3.2 Group Changes From 2009 to 2010

To test differences across independent variables such as teacher, gender, CFEA participation, and archery participation, I used a nonparametric test since the size of each subsample was small (less than 30), and many of the survey items were not normally distributed. I conducted the Mann-Whitney U Test which tests whether two unrelated samples have equivalent mean ranks in the population (Leech, Barrett, & Morgan, 2008). It is similar to the independent samples t-test and yields relatively high levels of power (Newton & Rudestam, 1999) although less power than the independent samples t-test. Using Excel, I calculated the effect size r for the Mann-Whitney U Test by converting the z to r , where $r = z/\sqrt{N}$ (Leech, Barrett, & Morgan, 2008). Effect sizes for r are interpreted as ranges: small or smaller than typical if $r \approx |.10|$; medium or typical if $r \approx |.30|$; large or larger than typical if $r \approx |.50|$; and, much larger than typical if $r \approx |.70|$ (Leech, Barrett, & Morgan, 2008). Unlike d that varies from 0 to $-\infty$ or $+\infty$, r varies from 0 to -1.0 or $+1.0$ (Leech, Barrett, & Morgan, 2008). I tested differences of mean ranks at significance level $\alpha = .05$ for 2009 and 2010 survey items, and the change scores for each item, as although the difference may not have been statistically significant at either beginning or end of the year, the amount and direction of change holds important information about that item with respect to the grouping.

To test differences for each subscale, I conducted both parametric and non-parametric tests and tested them at significance level $\alpha = .05$, which gave very similar results of significance across independent variables with only a few exceptions. For the nonparametric tests, I used the Mann-Whitney U Test with r for effect size as mentioned above. For the t-tests, I calculated Cohen's d using Excel;

however, for two groups with unequal n s, Cohen's d was calculated by
$$d = \frac{M_a - M_b}{\sqrt{\frac{(n_a - 1)SD_a^2 + (n_b - 1)SD_b^2}{n_a + n_b - 2}}}$$
,

where M_a is the mean of group A, M_b is the mean of group B (Leech, Barrett, & Morgan, 2008, p. 80). If Leven's Test indicated unequal variances, then the degrees of freedom were adjusted accordingly. Where parametric and non-parametric significance results are the same, the parametric results will be reported. Otherwise, the non-parametric results will be reported.

4.3.3 Correlations and Cross Tabulations

To assess the direction and magnitude of the association (or consistent tendency) between two variables, I calculated a correlation coefficient and tested it at significance level $\alpha = .05$. The correlation coefficient is bounded with values that can range only from -1 to +1, where values that are closer to +1 indicate a strong positive correlation and values that are closer to -1 indicate a strong negative correlation (Furr & Bacharach, 2008). A strong positive correlation indicates a consistent tendency for people who have relatively high scores on one variable to have relatively high scores on the other (Furr & Bacharach, 2008). The same applies to low scores. However, a strong negative correlation indicates a consistent tendency for people who have relatively high scores on one variable to have relatively low scores on the other, and vice versa (Furr & Bacharach, 2008). Correlations close to zero indicate weak or no consistent tendencies between the two variables. For the math assessment variables and the survey subscales, I calculated the Pearson correlation coefficient, r , in SPSS since these two sets of variables were normally distributed or scalar.

For correlation of survey items and scaled math assessment scores, I calculated Kendall's Tau-b, τ , a nonparametric equivalent to Pearson's r , as opposed to the Spearman rank correlation coefficient r_s , another nonparametric equivalent to Pearson's r , because Kendall's Tau-b, τ , handles ordinal data, adjusts for rank ties, and protects against outliers (Wilcox, 2003). Further, the sampling distribution approaches normality fairly quickly when n is small with Kendall's Tau-b, τ , as opposed to Spearman's rho (Sheskin, 2003). As the math performance level and proficiency ratings are derived from the scaled score, the focus of the correlation will be on the scaled scores for each survey item for each corresponding year.

To explore relationships between nominal variables (demographic and quantitized from interview data) and demographic variables, I calculated the Chi-Square statistic. Demographic variables tested were gender, ethnicity, teacher, CFEA participation, and archery participation. Quantitized variables tested were favorite subject, career, hearing the word “mathematician”, “mathematician” videogame or cartoon characters, and “mathematician” identity as analyzed in the mixed analysis.

4.4 Pre-Analysis of Interview Transcript Data

I employed structural and descriptive coding methods on the students' interview responses (Saldaña, 2009). Structural coding is a question-based code that is particularly appropriate for studies with multiple participants, standardized or semi-structured data-gathering protocols, hypothesis testing, or exploratory investigations to gather topics, lists, or indexes of major categories or themes (Saldaña, 2009). Descriptive coding, appropriate for ethnographies and studies with a wide variety of data forms (e.g., interview transcripts, field notes, journals, documents, artifacts, video), summarizes in a word or phrase the basic topic of passage of qualitative data (Saldaña, 2009). Both structural and descriptive codes lend themselves to various types of analyses such as, but not limited to, content analysis, frequency counts, illustrative visuals, thematic analysis, and within-case and cross-case displays (Saldaña, 2009).

The number of codes grew to 74 as responses to the same questions varied in depth and breadth of detail. I then put them aside for a while to gain a fresh perspective and later returned to the codes with the objective of assessing intercoder agreement and reliability—measures of agreement between independent coders about how they apply codes to units of data, whether fixed and predetermined, or free-flowing from open-ended interview questions (Kurasaki, 2000). For nominally categorized data, intercoder agreement is simply the percent of agreement between coders on codes or categories they assign to units of data while intercoder reliability, often measured using Cohen's coefficient κ , is the proportion of agreement between coders after chance agreement is removed from consideration (Cohen, 1960). Researchers have suggested, however, that the distinction between agreement and reliability blurs when dealing with nominal scales as agreement becomes an absolute; coders are either in agreement or disagreement (Tinsley & Weiss, 1975).

To assist me in this validation process, I asked two people from different fields with different levels of research experience. I explained what they would have to do and the time it would take with some flexibility needed. The person I used to help validate my interview codes had a longstanding background in education as a teacher and administrator. To start the training, I gave the coder the code list I had developed and asked her to read through it carefully to familiarize herself with them as she coded. I decided to use a full transcript on which to train the coder as the full code list would most likely be used in a full transcript. I did not randomly select the training text; however, I chose the shortest transcript with 12 pages, which was from Mrs. Cruz's class. The average transcript across the 25 interview transcripts was 18.9 pages and the longest was 30 pages. I explained that we were only coding the student's responses and that a unit of text to code would be anything that represented a single message, a different idea, or change of subject (Kurasaki, 2000). Student responses such as "hmm-hmm," "okay," or "yeah" were not coded. Codes were written to the side of each unit of text. We coded the training sample simultaneously yet independently without consultation (Lombard, Snyder-Duch, & Bracken, 2002). The training sample had 56 units.

I decided to serve as a coder also even though some researchers (as cited in Lombard, Snyder-Duch, & Bracken, 2002, p. 590) have suggested that such a practice weakens the argument that other independent judges can reliably apply the coding scheme. I believe the contrary; independent application of the codes can be established through the independent coders used during the validation process while the researcher is able to strengthen the codes by her or his intimate knowledge of the data and context. It took three hours to complete the training. For this transcript, intercoder agreement was 50.8%.

We discussed discrepancies in our coding for the training text, which actually produced four more codes, bringing the total code list to 78 codes. It is not uncommon that "most qualitative research studies in education will generate 80-100 codes that will be organized into 15-20 categories which eventually synthesize into five to seven major concepts" (Saldaña, 2009, p. 20). We then coded independently yet simultaneously two randomly selected interview transcripts, one from Mrs. Cruz's class and one from Mr. Knight's class. For Mrs. Cruz's class, the transcript was 19 pages, approximately 0.5 pages longer than the average for her class, and took one hour, 40 minutes to code. The transcript from Mr. Knight's class was 21 pages, approximately 1.5 pages longer than the average for his class, and took one hour, 50 minutes to code. These three transcripts represented 10% of the full set of student interview transcripts

with at least 50 units of coded text for each transcript—a good rule of thumb for sample size when assessing intercoder reliability (Lombard, Snyder-Duch, & Bracken, 2002). The second transcript's intercoder agreement was 91.1%, and the third was also 91.1%. I was satisfied with the final set of codes and applied them to the rest of the student interview transcripts. After we finished coding, I asked the coder her thoughts about the transcripts she coded. She said that she found the interview process and the students' responses insightful and comical at some points.

4.5 “Quantitizing” of Interview Transcript Data

As survey and interview data were both available for 22 to 25 of the 30 matched students, I conducted a mixed analysis to not lose potential information and to try to avoid misleading conclusions about the students (Bazeley, 2009). The mixed analysis involved “quantitizing” (Onwuegbuzie & Teddlie, 2003; Sandelowski, Voils, & Knafelz, 2009) qualitative data from student interview questions into dichotomous and categorical variables. Transforming the students' responses to numerical data added to the overall picture, understanding, and analysis of students' mathematics beliefs, attitudes, and performance. Student responses to the following interview questions were quantitized: What is your favorite subject? Have you ever heard the word “mathematician” before? Can you see yourself as a mathematician as I defined it? What do you want to be when you grow up? Have you seen cartoon or videogame characters that you think are mathematicians?

I consolidated both data types into one dataset for analysis which included correlating both types for exploratory and complementarity purposes (Onwuegbuzie & Teddlie, 2003). Regularities and complex relationships in the data were examined using nonparametric statistical techniques, including use of medians rather than means, as these techniques are generally likely to be more appropriate than procedures that assume a large, probabilistic, normally distributed sample (Bazeley, 2003). Although researchers have suggested that logistic regression be conducted with this type of data (Bazeley, 2003), it requires a large sample of at least 60 cases to be accurate (Leech, Barrett, & Morgan, 2008), nearly twice as many cases as my pre-survey ($n = 32$) and post-survey ($n = 31$). Therefore, non-parametric (Mann-Whitney U Test) and parametric (independent samples t -test) tests were conducted also for 2009 and 2010 survey items and subscales at the significance level of $\alpha = .05$.

CHAPTER 5: SCHOOL AND HOME ORGANIZATION AND ENCULTURATION

What follows are results of analyses conducted so far on the quantitative and qualitative data. More in-depth analyses will be conducted at a later time to explore nuanced relationships in the data with respect to the research questions. To address the research questions as fully as possible and paint a fuller picture of this urban elementary community school, I will try to integrate the qualitative and quantitative data as best as possible as the quantitative and qualitative data are rich and broad and telling, even when compartmentalized.

5.1 Culture and Structures of Fuentes: “I Felt At home”

“It’s just something. It’s just something about it. I don’t know. It’s just something about it. I don’t know. I just walked in and I felt real like, I felt at home.” -- Mrs. Stewart, African American Parent Coordinator, Mother of Two

The first guiding question concerned the processes of organization and enculturation that existed inside and outside of the classroom relative to students’ mathematics identities. To explore that question, I observed and inquired about the culture and structures of Fuentes, specifically, how mathematics was a part of the culture of this urban elementary community school and how it bore potential relevance to the development of students’ mathematics identities.

A school’s culture is its set of shared values, attitudes, goals, and practices that characterize that school. For this community school its culture includes the culture of the community residents where the majority of students socializes and lives. Latino, African-American, and African cultures that children and families bring with them to the school meld (and not always easily) with the academic, nurturing, and self-empowerment culture the school strives to create in partnership with the families, the Parent Group Association (PGA), and CFEA. To many children and adults alike, myself included, Fuentes Elementary Community School felt like home, like a family.

In addition to its culture, a school’s structures reflect the beliefs and values of the school (Center for Collaborative Education, n.d.). A school’s structure is the way in which it is organized physically (i.e., classroom size and facilities), temporally (i.e., student and teacher scheduling and grouping, teacher preparation and development), and financially (i.e., allocation of resources) to impact how students acquire, learn, and apply knowledge (Center for Collaborative Education, n.d.). In addition to the size and layout of this urban elementary community school and its classrooms, physical structures include the

teacher resource room, library, computer lab, and CFEA office where further academic resources were stored and used by the youth leaders and students for academic enrichment during extended day and after school. Temporal structures include scheduling of student instruction, lunch/recess, teacher professional development, school leadership meetings, child study meetings, and student enrichment after school.

Over the course of the year including the summer, I observed various aspects of the school's structure and culture via meetings of such committees as the Pupil Personnel Committee (PPC), Senior Leadership Team (SLT), and CFEA to gain understanding of how math is or is not a part of these meetings and their planning. I also attended school events such as school and CFEA orientations and Parent-Teacher Conferences to observe how students and adults alike were enculturated into the school and where math, if at all, played a part. Although the summer academic enrichment was not conducted at this school, its inclusion of students from this school played a part in the continuance of the school's culture. It must be noted that structure and culture are not necessarily independent of one another as various features of a school such as structure, leadership, and ecology reinforce cultural values while the culture may influence a school's structure or process of restructuring (Peterson, 1999). What follows are observations of the school's structure and culture from the outside inward relative to students' mathematics identities.

5.1.1 Outside of the School

Located near Fuenes is a neighborhood park, one that is rife with beautiful foliage that turns colors with the seasons, a small variety of birds, squirrels, lush grass, and areas where children and families enjoy for recreation during the day and early afternoon, especially during the summer. Early childhood centers can be seen taking advantage of the park, bringing younger children to run, play, and breathe fresh air. It stretches beyond what the eye can see at any given point in or near the park. Beyond space to run and relax, it also contains the requisite slides, swings, and climbing apparatus for the children and youth. Sadly, this space of natural beauty also serves as grounds for frequent drug and gang activity, and other criminal acts as theft and sexual assault. As is the case with many urban neighborhood parks, to be around or in this park at night is at one's own peril.



Photo: A view of the park facing the school where students played at times during afterschool program. (Photo taken by Paula J. Fleshman, November 2010.)

However, during the day its potential for mathematics and scientific exploration is enviable with its ample space for experimentation and application of learned topics. For students to see and apply in nature and on human constructions the application of the elementary mathematics they have come to know is not only a treat but a treasure as well. Unfortunately, this exploitation, so to speak, of nature's gifts with respect to the study of mathematics did not happen during the times I observed either classroom over the course of the school year. Neither teacher mentioned during their interviews of using the park as a place to bring relevance, stimulation, motivation, or enlightenment about math to their students. The principal lamented in her interview that she did not see teachers taking their students to the park to help them understand where and how math exists all around them. In the students' interviews, the only times students talked about going outside was for non-math related activities during their afterschool program facilitated by CFEA.

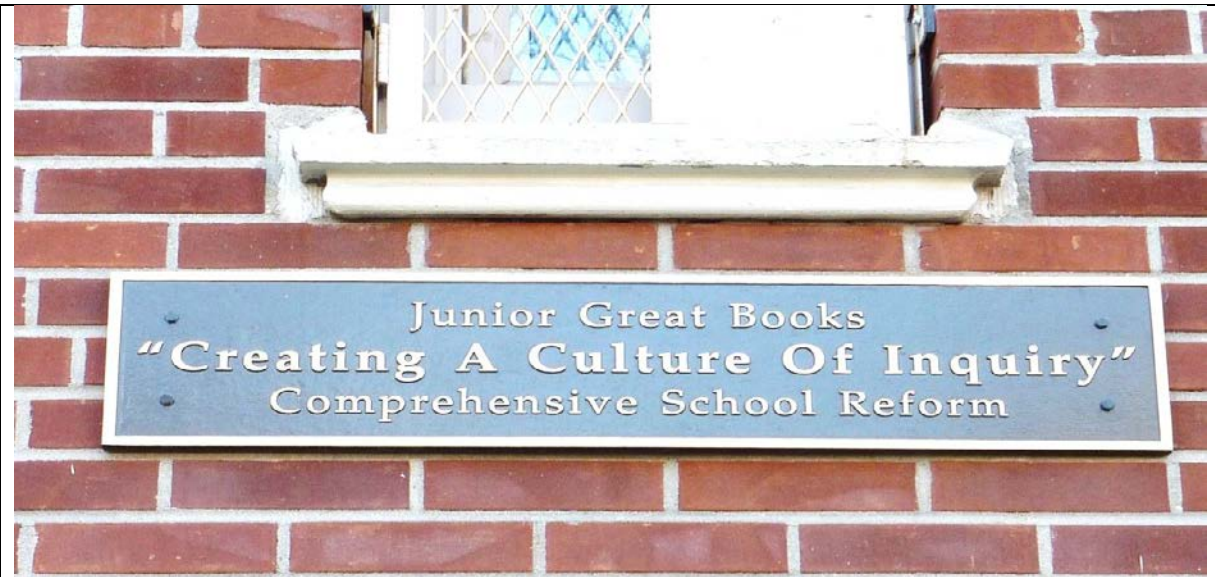


Photo: Plaque of recognition received by the school, located on the side of the school. (Photo taken Paula J. Fleshman, November 2009.)

There is curious irony in the scant use of the school's surroundings. Along the side of the school towards its front entrance is displayed a plaque that recognizes the school as one with a culture of inquiry in literature. This community school received such recognition for its participation in Junior Great Books—a program of reading that employs a research-proven combination of rich texts and active, collaborative problem-solving and Socratic discussion that increases achievement in reading comprehension, critical thinking, and communication skills⁹. In the seven observations I conducted of each classroom over the year, I did not see the use of such inquiry within math lessons. Such application of inquiry would have been helpful in developing aspects of students' math identities over the year, for example, their curiosity, critical thinking, and creativity. An appreciation of mathematics is not exhibited or made clear by signage on the outside of the school.

5.1.2 First Floor, Lobby

However, upon entering the school an appreciation of mathematics is clear. It is an appreciation beyond the school that is supported and celebrated within the school. All who enter this community school are made aware of its goals of students understanding, learning, and performing well in math inside and outside of the classroom—mathematics that is applied today for gains tomorrow. In 2008-

⁹ <http://www.greatbooks.org/programs-for-all-ages/pd/why-learn-shared-inquiry/>

2009, the math staff developer, along with a small group of 5th graders, participated in The Stock Market Game™—an educational program supported by The Securities Industry Financial Markets Association Foundation for Investor Education—that gives students the chance to invest a hypothetical \$100,000 in an on-line portfolio. The objective of the game is for students to learn economic and financial concepts that they will use for the rest of their lives. Research has shown the students who played The Stock Market Game™ scored significantly higher on their math assessments than students who did not play (Learning Point Associates, 2009).



Photo: In the entrance lobby of the school. A banner hung in recognition of school's participation and win of the Stock Market Game™. (Photo taken by Paula J. Fleshman, November 2009.)

The 2008-2009 school year was the first time the school participated in the game. The math developer was happy and nervous about participating because she said she knew very little about the stock market but was excited at the opportunity. She said she and the participating 5th graders met regularly in the computer lab to play and decide how best to invest the hypothetical \$100,000. The game reinforces critical thinking, decision-making, cooperation and communication, independent research, and saving and investing.¹⁰ Even though it was their first year learning and participating in this mathematics game, they won.

¹⁰ The Stock Market Game™ <http://stockmarketgame.com/overview.html>

During the second week of school in 2009 I asked her was she going to facilitate it again this year since they won last year. She told me that the principal wanted her to start a newspaper, and that she was excited to do it and wanted to add a math component to it. I told her I thought that would be a good idea. She said the principal asked a lower grade teacher to facilitate the Stock Market Game™ this year plus an ExCEL program since she was part-time teaching and interning for her administrative license. I asked her how she felt about not doing the Stock Market this year and she said it was fine, and that if the principal wanted the teacher to do it, then she must have a good reason for it. She said doing the newspaper would be good because it was different and her background was really literature. She does math development because at the time she was hired (over a decade or more ago) they did not have a math coach, and the principal asked her to do it. She said she has enjoyed being the math coach. She has learned a lot and been able to help the students and teachers with math in her position.

Unfortunately, although the lower-grade teacher presented as eager to continue The Stock Market Game™, she did not follow through to my chagrin and others'. At the beginning of the year, she held one or two meetings with a select group of students to talk about the game yet quickly thereafter, she let the opportunity die. It was painful for me and others to see the success of a previous year of math engagement of students in real-world application be lost. The potential damage to the math identities of 5th graders without this experience is difficult, if not impossible to determine; however, the potential gain lost is already known from what research has already shown about the positive gains of its 4th grade to 12th grade participants (Learning Points Associates, 2009).

5.1.3 Second Floor, Lobby

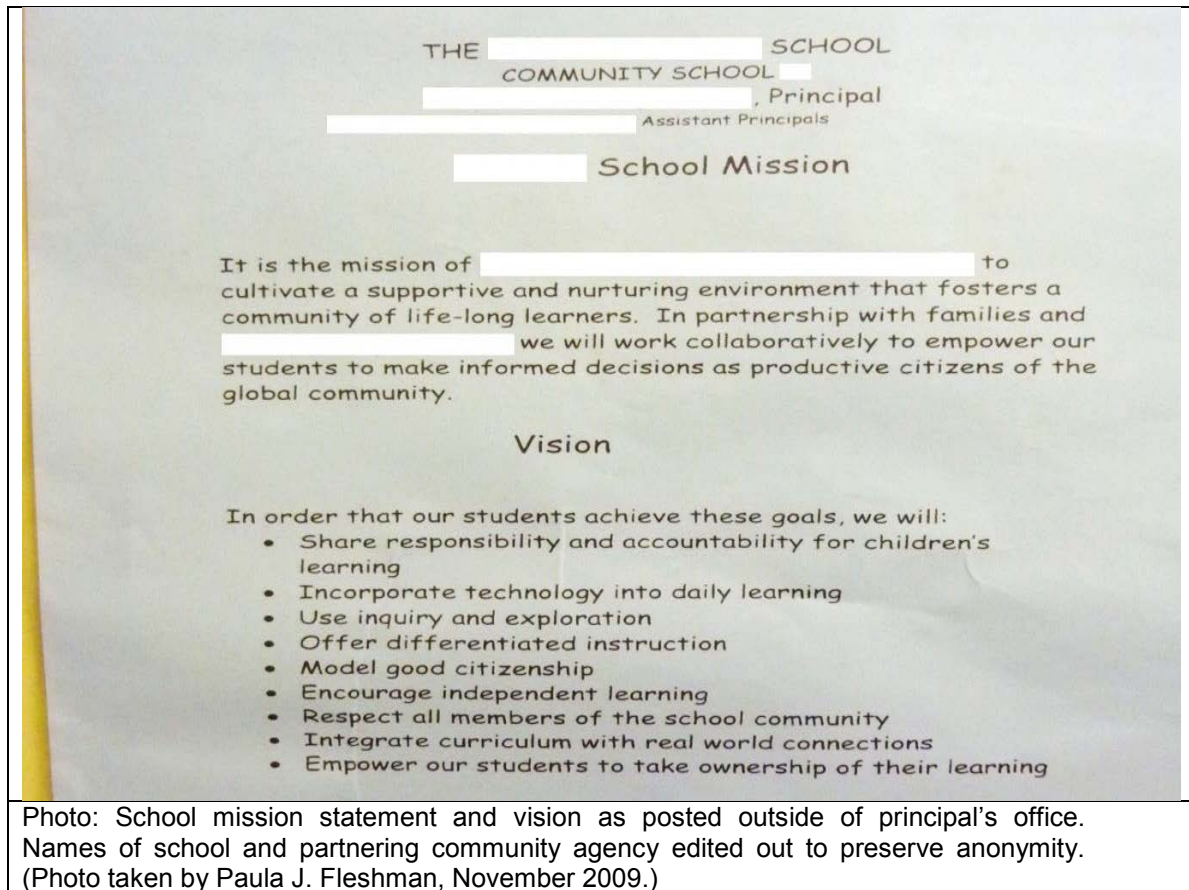
Ascending the spiral-like stairs to the second floor leads one's eyes to a brightly lit lobby with an expansive, colorful, and eye-catching mural on the main wall in front of the auditorium and over the double doors to the auditorium. Painted by older youth who graduated from this school, this mural vibrantly illustrates aspects of the school's culture and its appreciation for the ethnic cultures that comprise the school. The second floor lobby is further decorated with silk trees donated by CFEA to expand the cultural and community motif and partnership in the school. Icons of literature are present in the mural along with the positioning of the school in the community and the innocence and essence of children. On the sides of the walls are framed pictures and images of cultural events that have occurred at the school with the children.



Photo: Cultural motif and school signage at the top of the stairs to the second floor lobby opposite of the auditorium. (Photo taken by Paula J. Fleshman, November 2009.)

Opposite the auditorium on the walls along the stairs are framed black-and-white pictures of students, happy and engaged in their work. Some of the faces I recognized as younger versions of the face I saw regularly during my research study. Beautifully painted and detailed murals also cover the length of this wall, reflective of the ethnic, literary and artistic culture of the school's namesake. The second floor lobby reflects a beauty and appreciation of culture, art, literature, community, and children; however, its appreciation for mathematics is not reflected in this space of the school, except for its progress report, which showed its high grades in student performance and progress in comparison to peer and city averages. The report is displayed as one ascends the stairs to the second floor. Other than progress reports and notices to parents, little to no signage, printed or painted, alludes to the school helping to develop students' mathematics identities—their attitudes, beliefs, and self-perceptions about mathematics and being mathematicians. This, however, may not be appropriate for this community school since its focus is not mathematics as it was named after a cultural literary icon.

5.1.4 Second Floor, Outside of Principal's Office



On the outside wall of the principal's office are the school's mission statement and vision. As a school's mission and purpose are at the heart of its culture (Peterson, 1999), it is imperative to understand it. The mission statement and vision that students, staff, and adults see (or at least pass by each day) speak to student empowerment, community, nurturing, and collaboration. It speaks to fostering students' identity as a life-long learner yet it does not speak to fostering students' identity as a mathematician. Again, such specificity about mathematics may not be appropriate for a school that is not focused on STEM (science, technology, engineering, and math); however, it leaves vague the concept of and subject for life-long learning. Does being a life-long learner include being a life-long learner of mathematics? How does mathematics—the learning, doing, and becoming—live within and support the school's vision? Although the importance of performing well on math assessments (not to be confused with learning and understanding math well) is well known by student, parent, teacher, and administrator alike because of *No Child Left Behind* and its subsequent high-stakes testing and punitive consequences,

the importance of students seeing themselves and performing as mathematicians, or at least developing positive mathematics identities, is not known as it is not written in accessible school literature such as the mission statement.

5.1.5 Third Floor, CFEA Office

In addition to lower grade classrooms with adorned bulletin boards that line the hallway, the third floor holds the CFEA office and the teacher resource room. Outside the CFEA office is a storage area for resource materials and supplies used during afterschool program. Also outside the CFEA is a bulletin board where every month, CFEA staff and youth leaders decorate it with work completed by the students in its afterschool program surrounding a monthly theme such as respect, peer pressure, generosity, diversity, and family. Such themes speak to the children's holistic development, particularly their social and emotional development. This space, outside of the CFEA office, displays students' work surrounding social and emotional development.



Photo: Bulletin board outside of CFEA's office on third floor of the school. It displays work students completed in the afterschool program on the program's monthly theme. (Photo taken by Paula J. Fleshman, March 2010.)

Nonetheless, the display of students' work surrounding academic development, in particular, their mathematics identity development (knowledge, feelings, beliefs, attitudes, self-perception, and power) is just as important and needs an accessible venue beyond the 45 minutes of math and ELA homework help and enrichment students receive in their afterschool classrooms. As a main structure of the urban community school is the partnership between the school and the social service agency, it is most important to give visual space to honor the holistic development of children, which includes their mathematics identities. The negotiation of space on this board and in the glass curio beside it for consistent display of mathematics values, beliefs, and work would help to bring to the open light obvious or budding aspects of students' mathematics identities.

5.1.6 Third Floor, Resource Room

The teacher resource room was a space of support for students, teachers, and staff alike. It was divided into two sections: the mathematics section on the right and the ELA section on the left. Each section had large bookshelves with books and materials for teachers to check out and return when finished. It was a place for teachers to locate and use manipulatives and other materials and resources to supplement and complement the teaching and learning of their students. The resource room housed not only mathematics materials but literary materials as well for ELA, reading, and social studies.



Photo: In Math Section of Teacher Resource Room from rectangular, communal table facing front of room with bookshelves of math manipulatives, tools, and books to the right of the door entrance. (Photo taken by Paula J. Fleshman, November 2009.)

It was also used for small group instruction where the two staff developers (math and ELA) gave specialized attention and support to students in need around a large rectangular table for math and cozy set of half-circle tables for ELA that formed a circle. Finally, it was a place of mutual professional support and conversation for the staff developers and administration (principal and assistant principals) that regularly took place at the half-circle tables often over shared lunches of chicken and rice, plantains, salad, or soup and sandwiches with whole fruit on the side. Often, the staff developers graciously offered me a portion of their lunch, sometimes chiding me for not sitting with them to eat. The chiding was all in good fun as they understood when I had to leave to observe the classrooms during math period, or if I had other meetings to observe.

On the math side, Mrs. Kappas, the math staff developer, and I would often sit and talk at the rectangular, communal table. Mrs. Kappas was an older White woman. Throughout the year, she gladly told me about the on-goings of the school, the students and their families, and her thoughts about their math performance, attitude, and comportant. From the beginning of the research, candor was always a part of the conversations, knowing that the purpose of the research was to explore and understand how students' mathematics identities were developing or at least being affected and enacted in the two fifth grade classrooms. The nature of the conversations ranged from professional to personal, both of us being comfortable with the changes in topic. Such changes seemed natural.

5.1.7 Fourth Floor, Classrooms

Both fifth grade classrooms, situated at the beginning of the hallway on the fourth floors, were well lighted and large, easily accommodating 25 to 27 students. The usage of the walls, windows, and light fixtures for print materials showed a dedication to the requirement of classrooms being print-rich. Interestingly, for the times I was there, I did not see teachers referring to the materials posted around the classroom. Materials were created by student and teacher alike and hung for the initiation and discussion of a newly introduced topic. However, I did not see them acknowledged or referenced even when subsequent topics related directly or indirectly to the work surrounding them. Students' graded assignments were hung on bulletin boards on the closet doors in both rooms.



Photo: Mrs. Cruz's classroom from the doorway facing the rear of the classroom. The SMART Board is to the right of the doorway at the front of the classroom. (Photo taken by Paula J. Fleshman, November 2009.)

In Mrs. Cruz's room were posted pictures of students beaming proudly, holding certificates and toys—symbols of their accomplishments. Purchased with her own money, Mrs. Cruz often rewarded the "Student of the Month" with a game or toy of their choice from her collection bought just for them. Mrs. Cruz's classroom seemed more child-friendly, in particular with the library section and colorful rug. In terms of recognition, Mr. Knight's room held a large chart with stars beside students' names as recognition of good behavior and homework completion.



Photo: Mr. Knight's classroom from inside the door corridor facing the rear of the classroom. The SMART Board is around the left corner of the corridor at the front of the classroom. (Photo taken by Paula J. Fleshman, November 2009.)

Structures and cultures differed inside the classrooms. In both classes, students were asked the following questions at the beginning of the year: “What are three goals that I can set to help me improve my ELA score?” and “What are three goals that I can set to help me improve my math score?” The goals were assessment focused—ways to improve the students’ ELA and math scores—a travesty of the *No Child Left Behind* era. None of the goals were person-focused or identity-focused.

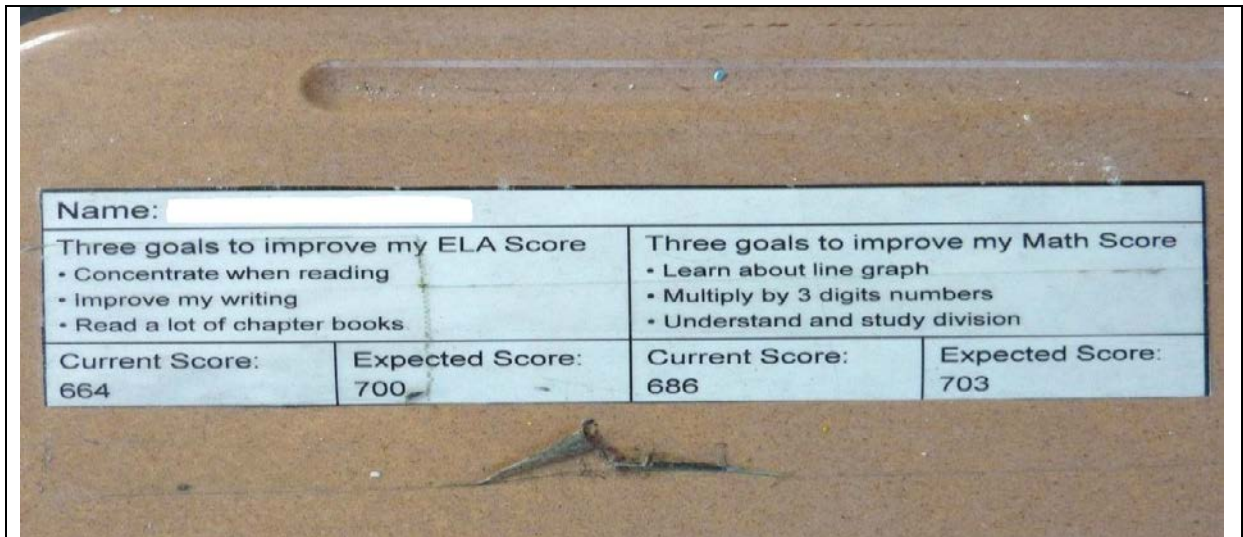


Photo: A student’s goals taped at the top of the desk from beginning of school year to the end. This student was in Mrs. Cruz’s class. (Photo taken by Paula J. Fleshman, June 2010.)

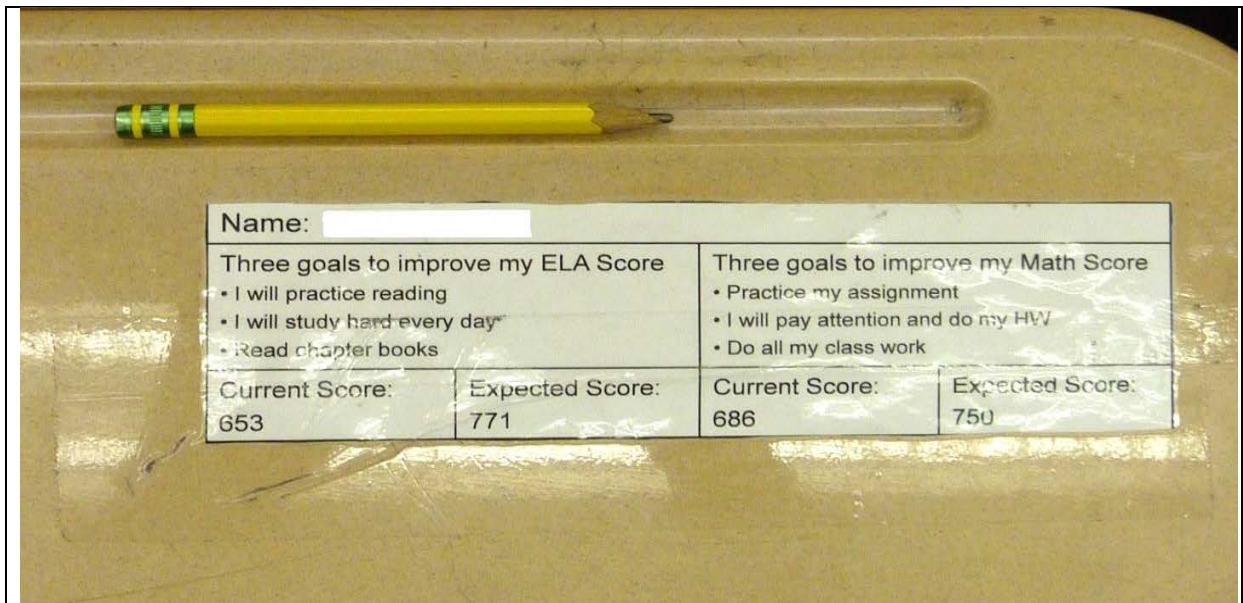


Photo: Another student’s goals taped at the top of the desk from beginning of school year to the end. The student was in Mrs. Cruz’s class. (Photo taken by Paula J. Fleshman, June 2010.)

Mrs. Cruz organized their goals in a graphic and taped them onto the upper part of the students' desks to serve as reminders throughout the year. They were still on the desks on the last day of school. These particular structures—close visual reminders of students' personal goals—were not on the students' desks in Mr. Knight's class; they were hung together in their paper form filling the bulletin boards in the corridor entrance of the class—out of sight of the bearers of these goals. These goals did not stay posted throughout the year. The expected scores were calculated based on past scores.

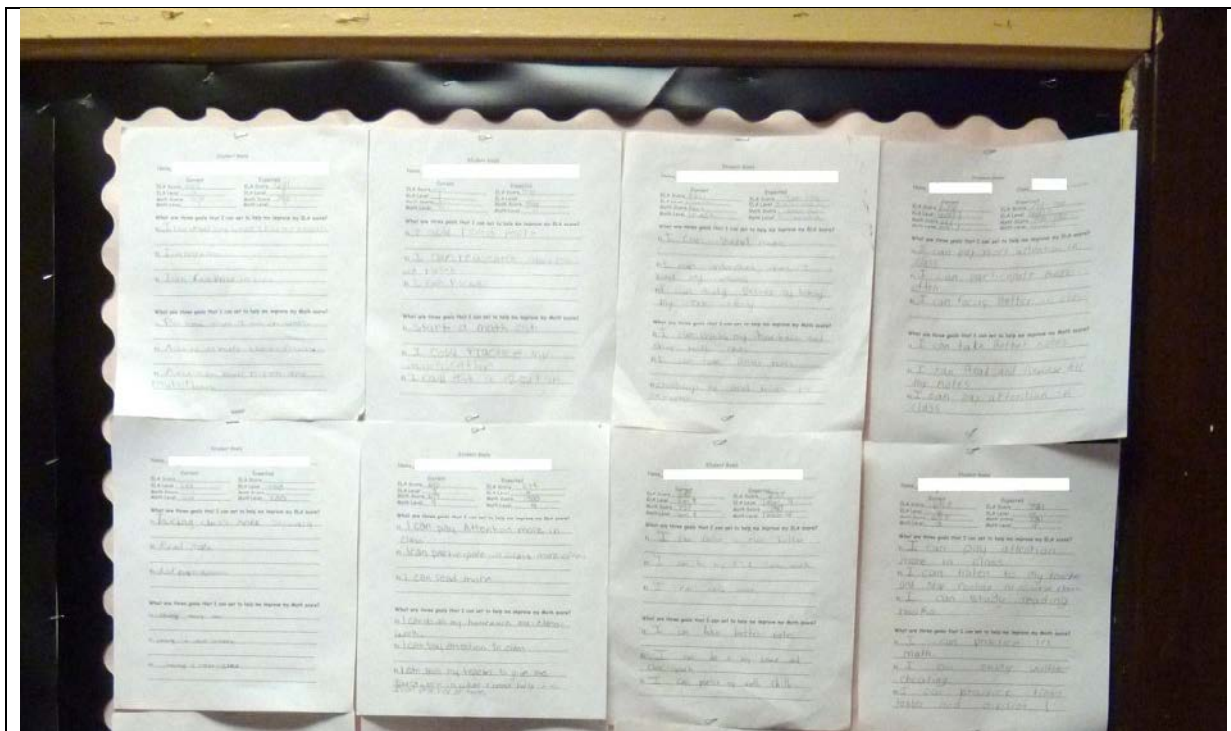


Photo: Top third of one of two bulletin boards of students' goals in Mr. Knight's class from beginning of school year. (Photo taken by Paula J. Fleshman, November 2009.)

5.1.8 Fourth Floor, The Computer Lab

The computer lab provided a structured time and space for students to engage in using computer and Internet-based math games throughout the year. The computer lab and its full-time instructor represent part of the structure of Fuentes that overtly bears potential relevance for the development of mathematics identities in students. Approximately every Tuesday or Thursday after lunch, students as a class went to the computer lab where the computer lab instructor would instruct them on enriching math games and practice assessments to enhance their learning and performance on the current topic.



Photo: School computer lab from corridor opening. SMART Board is on the right-hand wall of the corridor opening. (Photo taken by Paula J. Fleshman, June 2010.)

5.1.9 Back Downstairs to the First Floor, The Gymnasium for Archery

Rounding out the structures for the end of the day is the gymnasium, where students from 3rd to 5th grade participated in archery each Wednesday after school for an hour. Later in the evening, adults practiced for an hour. Once students learned proper safety and form techniques, mathematics was a regular part of archery with Coach emphasizing accuracy in calculation using whatever methods—using mental math, counting on fingers, or using the sides or back of the score sheet to write out the calculations. Just as the importance of archery as a skill is emphasized, so is mathematics. Students sometimes helped each other if they saw their peer's calculations were incorrect or that their peer was struggling. However, Coach often would encourage students to do the calculations on their own, and to let their peers do so also as they had to know it for themselves because in competitions, there is no assistance given, and calculation errors could lead to lost points.



Photo: Gymnasium set up for archery practice for students. Coach handing out arrows to students at beginning of practice. (Photo taken by Paula J. Fleshman, November 2009.)

5.2 Archery—The Gem in the Gym

“I respect myself! I respect my family! I respect my parents! I respect my teachers! I respect my friends!
I’m out!”—end-of-practice mantra

At the end of each practice, Coach calls the archers into a circle. They know what to do next. They extend their arms towards the center of the circle—some of the archers smile and giggle, girls and boys alike, while others dawn serious expressions focused towards the center of the circle. The archers ball their fingers into a fist. One fist of each archer should touch the fist of another. If not, Coach simply says, “Fists tight.” They step in closer, looking at Coach and around the circle. Coach’s fist is in the circle. My fist is in the circle, too. Coach sometimes leads the class’s mantra of respect, and sometimes he’ll ask if someone else wants to lead it. One person will lead while the remaining archers repeat. From the very first practice of the year, Coach has them repeat this mantra. At the last phrase, “I’m out!”, archers shoot their fists in the air as they say it with vigor and then turn their bodies outward from the circle to return their equipment to the proper place and gather their belongings to go home. It is 4:45pm. The hour always goes by so quickly. Sometimes parents are waiting for their child, and if not, the archers wait with remaining friends and students in the cafeteria with CFEA staff.



Photo: Archers' circle at end of practice. Coach and student archers repeating Coach's mantra of respect for self and others (Photo taken by Paula J. Fleshman, December 2009.)

The first time I witnessed this remarkable event was during 2008-2009 school year—a year before I officially began conducting research at the school in 2009-2010. During that time I visited the school to familiarize myself with it and its partnering CFEA. I also wanted my face and presence to become familiar to the school and CFEA staff, and students. In the process I asked Coach if I could observe some of his practices. I had already attended an archery tournament in 2008 and was thrilled by the level of student and staff participation, excitement, and family presence. He happily agreed and even invited me to participate in the adult class if I liked what I saw. I was excited at the very notion. I started learning archery during 2008-2009. I figured I should have some perspective of what students experience as learners of archery if I were to observe them later on with respect to archery and mathematics.

5.2.1 About Archery—From the Students' View

At first blush, the sport may seem dangerous—sharp projectile objects being pointed down the length of the gym and shot approximately 25 to 30 feet towards a round target of colored concentric circles by the arms of children in at least the 3rd grade to those of adults. (To the middle school students' deep chagrin, they could not participate in archery this year because the middle school principal told

CFEA that she only wanted its academic enrichment services and not its archery program.) It may seem dangerous to some students, even students who are not new to the sport.

Dayanara, who has been in Coach's archery program since 3rd grade, expressed concern in our archery group interview about the danger of the sport. Other students chimed in with their perspective.

What follows is that portion of the interview:

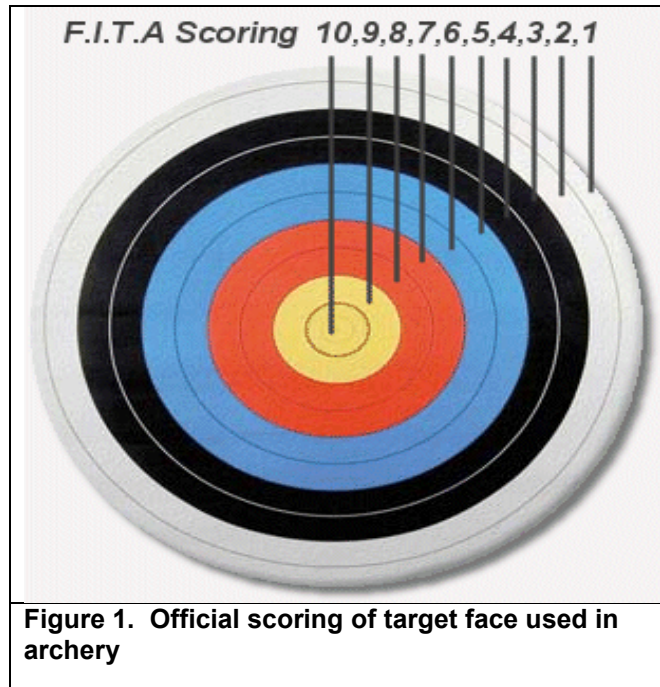
- Dayanara: There's actually one question that concerns me.
Researcher: Yes ma'am.
Dayanara: Why do they let this school do a dangerous sport like archery?
Researcher: Why is it dangerous? That's a good question. Who thinks archery is dangerous?
Hernan: Not me!
Dayanara: It really is dangerous because if the arrows get loose it could kill someone.
Hernan: If they went near the target but nobody would ever do that.
Zulema: Coach wouldn't allow that.
Hernan: And every time when somebody going to the bathroom, Coach blows the whistle and says stop to let them pass.
Dayanara: He blows the whistle and they stop right there.
Researcher: Belen.
Belen: If you see people in front of you, you can't shoot it then cuz you might kill them.
Researcher: Exactly. So, it's not dangerous then because what? Why is it not dangerous? What does Coach emphasize?
Belen: Keep all arrows out of the way so they won't get hurt.



Photo: 5th Grade, Hispanic male archer focusing on target, about to shoot. Coach assisting another student on the shooting line. (Photo taken by Paula J. Fleshman, December 2009.)

Along with Coach's requirement and expectation of respect is that of safety—safety first and foremost. The students know and follow his rules of safety. There is a large green mesh net that hangs behind the target across the full shooting area to catch errant arrows. Further, there is Coach who, seemingly has 360° vision, immediately blows his whistle to stop action if anyone appears near the shooting area. It is possible for people to appear in the area as staff offices, the girls' bathroom, and a stairwell are near the target area. However, before students even touch the bow and arrows, he teaches them proper form and lets them practice on an apparatus he made to simulate the action of using an actual bow. Just as it may seem dangerous, archery may even seem out of place. Archery is normally found in the out-of-doors; not the in-doors of an urban elementary school located in a neighborhood that at one point in recent decades was declared to be the most impoverished area of the United States.

As I have become involved in the sport and the school, I find it a fantastic anomaly that has become a stalwart in the out-of-school time programming at Fuentes Elementary Community School. Archery, as experienced under Coach, finds relevance in the theoretical framework of this research with respect to ecological systems theory, cultural historical activity theory, and culturally responsive pedagogy. It intersects with the community school and traditional cultural values of many Hispanic populations. Fuentes values the academic engagement and holistic enrichment of its children. Academically, archers engage in single- to triple-digit addition and single- to double-digit multiplication during practice with accuracy and individual calculation being encouraged and emphasized. There are five rounds of shooting with three shots per round. Each arrow shot can score from 0 to 10. See Figure 1 below for scoring. An arrow that lands outside of the target face or concentric circle of value 1 is scored as a "miss" with a point value of 0.



In early practice sessions, Coach sometimes helps the students with their calculations, in particular, the younger students. The older students he simply reminds them to check their math because once he takes the score sheets home to input the scores, the scores are final. Just as in the tournament, once scores are submitted, they are final, incorrect or correct. As sessions progress, Coach takes additional measures to help students gain accuracy. Following is a portion of the archery group interview:

- Researcher: Okay. So, he comes looking at you, looking at your paper. Does he tell you the answer or does he...?
- Group: No, he just helps us.
- Hernan: He tells you how to do it.
- Zulema: He tells you how to add it and where to put the numbers. And how to add the biggest numbers and smallest numbers.
- Researcher: Okay. Eduardo.
- Eduardo: Sometimes you might get something wrong so he takes two minus off your score.
- Dayanara: That's if you get it wrong.
- Researcher: Oh, really?
- Group: Yep.
- Researcher: Why does he do that?
- Zulema: Because he taught everybody there and he's always doing it and if you forget to do something on your paper, that he'll take off two points.
- Researcher: Okay, Eduardo, you just said something about ...
- Eduardo: That he's gonna take two minus off it.
- Dayanara: Two minus?
- Zulema: Points.
- Eduardo: Two points off.
- Researcher: Because he wants you to ..?
- Zulema: Remember how to do it.
- Eduardo: To know how to do it right.

Zulema: Cuz he's been teaching you for a long time.
 Dayanara: Say like, if you got a 130 something, 137, right? You shush (at Hernan), and you added it all wrong, so he'll subtract two point from that, and you'll get 135.
 Researcher: Do you think that's fair?
 Group: Yes.
 Dayanara: Yes, it really is cuz like you should already know how to add up all your numbers already.
 Zulema: Yeah, cuz lots of people been there for many years and they still don't know how to do it. It's a lot of work teaching you over, and over, and over, and over.
 Dayanara: It really is.
 Zulema: It's a big waste of time of archery.
 Researcher: Wow. Okay. Domingo? You think it's fair if you add up something wrong and Coach takes away two points?
 Domingo: I think, yes, because the people that go in the archery tournament are very good and they old enough to know how to add up the numbers.
 Researcher: So, how would you feel if Coach took away two points from you?
 Domingo: I would feel bad at myself.
 Researcher: Hmm-hmm. Hernan.
 Hernan: I'd feel bad because I know how to figure out and that sometimes when people don't know how to do it cuz they mostly don't pay attention.

ARCHERY
 In school archery practice
 Date 11/04/09
 My goal for the day 46

End	1	2	3	Score	Running Score
1	X	7	7	24	24
2	8	7	4	19	43
3					
4					
5					
				Total	<u>43</u>

X	Tens	Nines	Score
1	1	0	43

Archer B
 Scorer B
 Target #3

Challenge Archery
 Total _____
 Total _____
 Total _____
 Total _____
 Total _____
 Total _____
 Total _____
 Total _____
 Total _____
 Total _____

Photo: Archery score sheet completed by a student archer after second round of shooting. (Photo taken by Paula J. Fleshman, November 2009.)

The students see the importance of accuracy and mastery of addition as having immediate and future registry. They also see its reciprocal use between archery and mathematics class. I asked them if the math they learned in class helped them to do the math in archery. Everyone in the group said yes, except for Domingo, who said he wasn't sure because maybe he knew it before. Hernan agreed and asserted "because sometimes you need math in your life, like if you wanna work in the store and they buy chips and a 5 cent candy. You're not gonna know how much it is cuz you don't have an education." Domingo chimed in saying, "I use math for everything." For Javier, the math learned in class and practiced in archery had positive effects in both class and archery with respect to speed and accuracy:

Researcher: Okay. Now the math that you learned in, tell me what is the math that you did in archery?
Javier: The only thing I did was addition because when you do multiply because you cannot multiply three numbers at the same time.
Researcher: Okay, so the only math you had to do in archery was math.
Javier: Addition.
Researcher: Thank you. Addition. And so, did you... did that help you with your addition in class?
Javier: Yeah.
Researcher: How so?
Javier: Adding three digits was part of the class umm...(noise in hallway)
Researcher: I'm sorry. All I heard was noise outside. Say that again.
Javier: Adding three digits, umm, adding three numbers with two digits was part of the math class's math.
Researcher: Hmm-hmm. And do you think doing it in archery helped you do it better in math or not so much?
Javier: Better.
Researcher: Better? Okay, how better?
Javier: Because sometimes when I see three numbers with two digits, sometimes I have to do it on paper.
Researcher: Oh. On paper where? In archery or math?
Javier: Math.
Researcher: Okay. So...
Javier: So, archery helps me to make up my mind and to do the math inside my head instead of writing it on paper because if I write it on paper, it's not gonna have too much space.

Students in this group know how their parents feel about their participation. Parents are supportive of their elementary archers in word and deed with parents getting their archers small archery sets for home, taking them to practice on Saturdays that Coach holds at another school, or simply telling their young archers how proud they are of them and to not give up. Students said their parents felt "perfect," "happy," "proud," "happy I'm not expressing my anger at them," "happy because I'm happy," and "good just because I'm happy and I'm always, I'm not nervous and I don't give up."

Within archery at Fuentes, two Latino cultural values are at play: *respeto* (respect of adults and elders) and *personalismo* (importance of interpersonal interactions and relationships). Coach emphasizes and practices *respeto* and *personalismo* although he may not be aware of them specifically as being very traditional Latino values (Clauss-Ehlers & Levi, 2002). It is evident in how he treats the students, the atmosphere he develops in archery practice, and how each practice closes with a lasting statement from school to home about respect for others adults, elders, family, friends, and self. The students know the mantra, even if they get the words out of place. It is simple and true. The feeling of electricity buzzes around the huddle. The huddle, the circle, unbroken is theirs, ours, the archers. In my second interview with Javier, I asked him about the end of practice. He recalled one time in particular:

- Researcher: Hmm. Okay. Okay. So when you guys are in archery and you close out, what is the thing that Coach does? You do something. All of you gather in a circle. What is that?
- Javier: Ohh, we huddle up and then it's a way of saying good-bye.
- Researcher: Okay, so what do you say?
- Javier: We say I respect myself. I respect my family. My teachers. My friends. My parents. I'm out.
- Researcher: I'm out. (Chuckling). Okay. How do you feel about huddling up like that?
- Javier: Excited.
- Researcher: You feel excited.
- Javier: Because one time when we were in practice, I was too excited. I asked him if I could say it. I was too excited, so I messed up.
- Researcher: Okay. Okay. Now does Coach get mad?
- Javier: No.
- Researcher: You've never seen him get angry?
- Javier: No.

Coach's interactions with the students are caring, supportive, and respectful. He doesn't show anger. Not once in my archery experiences with him in practice and tournament have I witnessed him being angry. He demonstrates concern and high expectations for his students, not just as archers but boys and girls. The archers are clear about Coach's lessons of archery, of life. They seem to transcend the walls of the gym where the minds are focused, bows are held straight, and the arrows fly towards the target, some landing on the target near the center, others falling to the floor not even reaching the target. In addition to respect of oneself and others, Coach's other lessons according to the archers are to "never give up," "never doubt yourself," "anyone can do archery, all you gotta do is stay focused," "pay attention," "be careful," "try hard," and "do your best." "Try hard" and "do your best" carries from place to place for Eduardo, whether in the classroom with math, the gym with archery, or the field with baseball as they are also lessons that his father has taught him.

They are also clear about seeing themselves as archers even though they did not appear to know why people use archery. When I asked them if they would call themselves archers, they all said very loudly, “Yes! Of course!”; however, when I asked them when people use archery, the group as a whole did not respond. They did not seem to know when people use archery as much as they knew when people use math. Zulema and Dayanara spoke about archery’s use at a personal level. Zulema used archery as a way to self-manage her anger while Dayanara used archery as entertainment and sport. Javier, on the other hand, spoke in general about archery’s use in hunting.

The identification with being an archer resounded more than their identification with being a mathematician. Everyone saw themselves as archers although everyone did not see themselves fully as mathematicians. Belen and Javier saw themselves as mathematicians a little and Domingo did not see himself as a mathematician. Their identification with being an archer rested on the facility and function of archery: “Because archery is kinda of easy if you stay focused and fun”; “You get to have fun with your friends”; and, “try your best and you can accomplish.”

5.2.2 About Coach—From His View

Coach, an African American, peaceful, happy man, has been an archer for 54 years. Out of four levels of certification, he recently achieved Level 3 Certification which means that he is certified to teach archery to archery teachers around the country. He is also a community archer, one of only eight in the United States. He is certified to set up archery programs in schools across communities all over the city, helping other archery coaches develop and bolster their programs. His love for archery and African American and Hispanic youth is evident as he is currently working to develop a high school archery league in the city.



Photo: Coach preparing to shoot using professional grade equipment. He is modeling proper form and technique to students. (Photo taken by Paula J. Fleshman, March 2010.)

Coach picked up his first bow in the 1950s when he was a “little guy” as he called himself. His father was a bowyer in the 1950s who laminated wood bows at a bow company. Every now and then he would bring bows home from the job and hang them on the wall. Bows back then were made in one piece, totally out of wood, unlike today were they are created and sold in sections (called a take-down design) and not necessarily all wood. Once, his father took him and his two brothers out to shoot when they were young. He took them out to a garbage heap where on one side hard garbage and the other side had a large head of dirt. He took an old cushion, put the cushion in front of the dirt side, moved them back many feet from the target, and let them shoot. Out of his brothers, Coach was the only one to stick with archery. From that one time that his father showed him, he’s has been doing archery ever since.

Technically Coach has been coaching for over 13 years where he first did “small coaching with people locally, helping them with their equipment and helping them to shoot a little better.” In 2002 he started coaching at the university level. He realized that he could affect more students on a larger scale and that he needed to “bring this to [his] community.” In reflecting about his decision to leave the university, Coach said, “the greatest sin for me would be to not use what I know to teach the children from

the Black and Hispanic community.” He continued reflecting on his reach within the Black and Hispanic community, “Instead of reaching fourteen students for four semesters, I now reach almost 800 to 900 students a year.” Coach emphasized “a” when saying “a year” to point to how broad his reach is outside of the university setting and inside his community setting.

I asked Coach what are the values he tries to instill in his program to which he immediately responded “respect for yourself.” He added respect for the practice of archery. Such respect for self, others, and the practice of archery is evidenced by the verse of respect that he and his students (myself included) chant at the end of each practice. It is further evidenced in the way he communicates with people, young and old. Adding to the value of respect, Coach works to instill, is the value of personal development. According to Coach, “It is not about just archery development. It’s about the whole person.” This philosophy about how he carries out his archery program aligns with the philosophy of the CFEA: development of the whole child.

It has only been through the interviews with the students and with Coach that I see just how limited my sight was about mathematics and archery. I would not have thought that students would develop not only mathematically and athletically while learning archery under Coach but holistically as well. For instance, the score sheet for me in the beginning was simply a place for the student archer to add her or his scores, to figure out their progression in archery, to practice accuracy in mathematics. In the interview, I admitted to Coach that I only associated the score sheet with doing math, that I certainly did not associate it with life lessons. However, for Coach and for the students who hear his lesson about the score sheet, it is much more than a narrow, context- and goal-specific mathematical tool, it is a tool for learning skills necessary for real-world engagement—life skills of completing applications for a driver’s license or job, and tasks with accuracy with understanding of consequences.

Other values that Coach tries to instill in his students is working together and listening, neither of which are always easy, regardless of age. For the students who get to class early or stay long enough at the end of practice, Coach assigns particular tasks, depending on the size of the student. Some of the equipment is cumbersome and requires a bit of strength while other pieces of equipment like the armguards and quivers are light. Some of the tasks are easy and can be done quickly if students work together like pulling the masking or electrical tape off the floor. Although Coach may assign tasks,

students usually volunteer to help. The same students that shoot their hands in the air to participate in class in solving math problems are the same students who shoot their hands in the air to help Coach.

Life skills, life lessons, and values of respect, completing the task (completing the score sheet, the application), working together as a team, listening, responding and not reacting are part of Coach's method of developing archers holistically. It is manifested through his words, his carriage, and his demeanor with the students and adults—gentle but steady, uplifting but grounded. I have never heard Coach speak belligerently or rudely to any student, parent, or staff member. He grounds his values in action—his and his students. Learning is doing and doing is learning. Students learn the life skills in the present and carry them with them in the future. Part of that learning and doing is accomplished through another practiced value—goal setting. Each student sets a daily goal of what score they will try to achieve. Each practice is purposeful so students will have a goal to reach. I asked Coach if the values he helps to instill in his students in the archery program are carried with the students, youth and adult. He believed they did:

Coach: I think they do. Learning how to, back to listening, they take time to do that. Learning how to, how should I put it, I've had kids come back to me and say, Coach, you know being in your archery program taught me so many things about dealing with life in general. That's after they've gotten to a bigger size, not the little kids. I don't know. They probably do but I don't know. I've had middle schoolers and high schoolers come back to me later and say the things that you taught me in archery class, I can now use them in my life. And it has helped them, how I talk to people. One was how I talk to people, following through on an idea, setting goals cuz when you come to class, there's always a goal. I'll say, what's your goal today? And they'll say, uhhh, I'm gonna shoot such-and-such. And I'll say, okay, is that your goal? Then that's what we're gonna work on. It makes them concentrate when they have a particular direction they're going in.



Photo: Score sheet with student archer's goal for the day of 85 points. Student is calculating the 4th round score. (Photo taken by Paula J. Fleshman, March 2010.)

Researcher: Right.
 Coach: If you kind of come in haphazardly and say just go shoot, yeah, and I'll sit on the side [mocking disinterest] [research laughing], ahhh what the heck...
 Researcher: Right.
 Coach: Then there's no real drive to become. So when they first come in they fill out their score sheet, they have to set a goal, and usually what I do with the goals is whatever your score was the last week, your goal will be this week, the same score plus one.
 Researcher: Plus one.
 Coach: So as long as you beat your score by one point, you've met your goal.
 Researcher: Right.
 Coach: Cuz it's achievable. I have to give them something they've already done, and they can do a little bit better. Something they can achieve. Some of the kids have told me they have goals now in life. I can move in a particular direction. I can do such and such. I've had adults say the same thing that they've learned so much just by focusing and concentrating and having a purpose and then trying to follow through. It works.

Coach's definition of archer is quite different from my definition. I would define an archer simply as someone who shoots with a bow and arrow. My definition of archer, unlike my definition of mathematician, was based on what an archer does with her or his tools and equipment, and not her or his habits of mind. Coach's definition of archer, like my definition of mathematician, is based on the person's

habits of mind, and not simply what he or she does. For Coach, archery is about the person shooting and not the target. It is mainly about the person trying to hit himself or herself in the middle of the target.

Researcher: ...So an archer. How, this may actually sound simple, but how would you define an archer?
Coach: One who goes within to put their energy in the middle of a target.
Researcher: Wow.
Coach: See, you have to figure out what on the inside makes you put the arrow in the middle because it doesn't go there by anything other than what you do.
Researcher: Okay.
Coach: Does that answer your question? [Smiling]
Researcher: It sure did! [Laughing]
Coach: [Chuckling] All the arrow is, is a catcher's mitt. The target. All it is is a catcher's mitt. So whatever you do puts the arrow down range. So in your case, when you shoot, you figure out what you have to do here [pointing to my head], how you have to come through, how you have to hold your arm, and how it has to feel. [Coach going through the motions of shooting without the equipment]. Then you shoot the shot.
Researcher: Hmm-hmm.
Coach: You already know what that feeling is like.
Researcher: Right.
Coach: So you have to go inside to get it to come outside. Okay.
Researcher: Okay.



Photo: An arrow shot in the target bullseye (center). According to Coach, archers reach inside themselves to put themselves in the center of the target. (Photo taken by Paula J. Fleshman, March 2010.)

Coach lifts and guides his students to becoming archers through culturally responsive ways, using terminology (i.e. "bootlegger") and examples (i.e. skittles) familiar to the students in ways that

connect them to archery and their learning and development. His communication with them is full of high expectation and respect for what they already know and most importantly what they have come to learn and accomplish in archery and school. He never belittles where they are in their learning but pushes them to a higher standard, a higher level of performance and development. I asked Coach what he considered students to be when they first begin in his program, where does the identity of archer begin.

Researcher: Now, so before ummm, before a student is able to do that, then do you call them an archer?

Coach: Naaw, I call them bootleggers. [Smiling]

Researcher: Bootleggers! [Laughing]

Coach: [Laughing] So, and [chuckling] not in a negative term, but they all get it.

Researcher: [Laughing] Right.

Coach: [Chuckling] I say, you're skills-less, you're a bootlegger.

Researcher: [Chuckling] Right.

Coach: Then after they get a few skills, then I say, you're a skittle.

Researcher: [Laughing even louder]

Coach: Right. [Laughing] Then after they start putting them in the middle, then I say, now you have some skills.

Researcher: [Chuckling] Okay.

Coach: And what happens, it's interesting is, all the kids know about bootlegging. If you come in, they say, hey, yo, that's a bootlegger.

Researcher: Right. [Chuckling]

Coach: And so the kid comes in, I say, yo, listen, you're a bootlegger. And he'll say, what's a bootlegger. And I'll say, you haven't learned anything yet. And they'll say, aahh, okay.

Researcher: Right.

Coach: But as long as they know what it means, it's not a bad thing, alright. So everybody comes in, and everybody knows they're a bootlegger. Right, and then after they learn how to shoot the bow, I'll say you've got some skills, but you're still a skittle.

Researcher: I like that. Skittle. [Chuckling]

Coach: [Chuckling] Because they haven't been developed yet. So you're a skittle okay. You know, like the sweet candies. Then after a while they get more proficient for what they need to do, they become skilled. I say, hey, you got skills. Yeah, you got skills. Alright, so you got skills. You got more work to do.

Researcher: [Chuckling]

Coach: Alright, then all of a sudden the kid feels elevated.

Researcher: I like that.

Coach: It's a slow process, when they come in, I'm not going to put you on top but I'm not going to put you down. I'm gonna joke you up. Some when everybody comes in, you're a bootlegger.

Researcher: Okay.

Coach: Like the kids who went to nationals. When they first came to me, they were bootleggers. Now they're shooting national class.

Researcher: Okay. So they're shooting national class. Okay, so, you're an archer.

Coach: Hmm-hmm. You're an archer. You know how to handle your bow. You know how to reference. Alright, you have the strength in which to pull back and aim. You have the concentration. You have the focus. Right, and you have follow-through. So, an archer is a person who shoots an arrow. Okay, but the other definition I gave you is what comes out of you.

Coach is cognizant of his students' identity development as archers they learn and grow personally and athletically in the sport. He is also cognizant of what roll math plays in archery, and how students can become more engaged in math in ways that are practical and important to their real-world engagement. In our interview he suggested ways to lift students' mathematical engagement.

Researcher: Now, I've seen you actually help the kids sometimes when they're doing their score sheet. How do you feel, especially with fifth graders when they're struggling with simple addition?

Coach: Umm, well, one of the things, I actually let them know, I say, you notice how no matter where you go, math follows you? [Said in a lower voice as if talking to a student] And they'll say, yeah. And I say, so you've gotta work on your math. We have this little conversation in a low voice so they're not intimidated. And I say, so you know wherever you go in life, math is gonna be smacking you in the face. [Said in a lower voice as if talking to a student] So you gotta work on this while you're in school, so when you come here, it gets easier. And then they say oh, okay, alright. And then eventually what happens is, when they come down, they get better.

Researcher: Okay.

Coach: That's the conversation to have with a kid who has difficulty with math. I let them know it's a part of life. It's not just part of this game.

Researcher: Hmm-hmm.

Coach: Alright, it's a part of life. So how you choose to deal with it is up to you. So if you need to, get moms to help you with your math during the week or whatever, or have a friend help you with your math.

Researcher: Right.

Coach: But I have a conversation with them. Usually, usually this is with a child who does have difficulty. Most kids that I've worked with, don't. Alright, I will have a couple of kids come in with a whole lot of noise, but then all of a sudden they get quiet because now they're confronted with them, meaning themselves.

Researcher: Right.

Coach: They're now like, whatever my shortcoming is gonna stare me in the face. So I don't make them feel bad about that. I just let them know that we got work on it. We can do this together but mainly you've got to do this when I'm not around. It means schoolwork, homework, and talking to moms and talking to pops. You gotta work on this because it's going to follow you no matter where you go. And then once they get that information instilled in them, how they process it is really up to them. Now, when they're actually doing numbers, I try my best to not do the math for them but help them do the count. I actually help them do the count. And then they'll come up with an answer. I'll say, yeah, you're off by one, and they'll say, oh! I got it now! And they'll write down the right number. So that's basically what I do. I don't actually give them the answer unless we're running out of time. Then I'll yell out the numbers, then we'll add them up together and then they'll write them down. But if we have time, I'll stay right there with that child until that child figures it out. Then go on from there.

Researcher: Hmm-hmm.

Coach: I've noticed that over the years that when you stay right there with the child, they feel safe and they feel like somebody really cares about them, that they've got to finish it. And once they have the numbers right, they

say, oh! I got it Coach, I got it. Okay. Score sheet down and they're ready to go again. So they're not shying away from it. So it's a matter of how I approach them, getting them to feel comfortable with their shortcoming as opposed to being fearful of it. [Clapped once] If that answers your question. So that basically how I handle the math and child who has a problem.

As with the other adults, I asked Coach to define or describe a mathematician. I wanted to explore his conception of mathematician relative to his coaching of his students in archery.

- Researcher: Okay. Umm, okay. So, we're gonna switch gears here just for a little bit. A little bit. Mathematician. Tell me what you think about that word. How would you describe or define a mathematician?
- Coach: One who is super with math. That's what I come to when I think of mathematician. A person who doesn't have to think to do. There's so ingrained with the ability to do math that they can do it without having to think about it.
- Researcher: Okay.
- Coach: Hmm-hmm. Now, you know, it's interesting you ask that because some kids come in, and I yell out some numbers, and they process it almost before I get the last number out of my mouth. So you asked the question in terms of mathematicians, we've got some kids who are mathematicians.
- Researcher: You think so?
- Coach: Yeah! Yeah, yeah.
- Researcher: Okay.
- Coach: Quite a few of them are. Over the last I think two years, I've had less of, I've had less of that.
- Researcher: Hmm-hmm. That being finger counting.
- Coach: Hmm-hmm. I've had less of that. I've had more kids thinking [showing how kids count in their heads, saying numbers under their breath] 5, 9, 3, 85. And then they write down the answer.
- Researcher: Okay.
- Coach: I've had finger counters but I've had less finger counters. See a lot of stuff most people may not think I'm watching, but I watch those things, too. Yeah, I watch all of those things. I watch kids' behavior. I watch kids' progress. I watch your understanding of how things work. And the ability to replicate it. And I watch them when they do their score sheets. I literally, if I have to get on my knees and get down there with them.
- Researcher: Right, I've seen you.
- Coach: I'll stay right there until they get it. But some kids, we'll do the little game where I point [on the target face] and then they have to do the guessing. Some kids have the answer before we put it on paper good. So mathematician for me is a person who can do math without thinking about it.

I asked Coach how he thought students would respond if teachers taught them as if they were mathematicians. He referenced how youth in Africa always understood mathematics as a daily part of their lives, and how parents engaged them in mathematical practices and issues that were pertinent to

their life: from estimating distances to get water to buying, selling, and bartering wares at the market. He continued:

- Coach: ...So I think to answer your question in terms of schools, if they can figure out a way to make it part of their daily habit, more so than just a sit down in the classroom act, if they can figure out a way to make it a daily habit, then I guess it would be much more fun.
- Researcher: Alright.
- Coach: Kids in my class they like it because it becomes, there's a purpose behind it. There's an absolute purpose behind it. You shot your arrows. You have a score. Now you have to figure it out. And the reward is, I shot that like I did the last time. It may not be a monetary reward but it is an internal reward that you got something out of the deal and it gets easier to figure out. So I think in classroom, if they figure out a way to make it more so a personal reward than a monetary reward, they'd get a lot better and become greater mathematicians doing math on a daily basis. [Paused] My brain is being whipped today.
- Researcher: [Laughing]
- Coach: The sister is wearing me out! In a loving way of course, a loving way. [Smiling]

As demonstrated with Coach and his archery program at Fuentes, archery has proven to be a viable conduit to reach under-served, youth of color, some of whom are at-risk. Other organizations like 4-H, the largest youth development organization in the United States, and the National Archery in the Schools Program (NASP) have used archery to reach youth regardless of age, sex, socioeconomic status, background, academic performance, size, and ability. Low-income youth in urban housing projects have participated in archery for mentorships, skill education, self-development, fun and quick success—an especially helpful component for youth who tend to get frustrated quickly (Sabo & Hamilton, 1997). Students who learn archery learn such personal skills as self-responsibility, character building, managing feelings, and self-discipline and social skills as empathy, sharing, accepting differences, and cooperation (Sabo & Hamilton, 1997). Hard-to-reach youth probably have had more experience with successive failures compared to other children in the educational arena. Archery and other shooting sports programs offer youth positive opportunities which bring out life messages of personal pride that come with mastery, personal discipline, responsibility and sportsmanship (Sabo & Hamilton, 1997).

5.2.3 About Archery and Mathematics

Through my own participation in archery and elementary mathematics I have learned a great deal about archery and mathematics, the connection between the areas of expertise, the cultural tools and processes used to learn, to become, to be archers and elementary mathematicians. The identity

development of one is not necessarily disconnected from the identity development of the other. Depending on processes in both classroom and archery setting, the identity of one can help to inform, construct, or complement of the other. Beyond the score sheet, I learned there are numerous aspects of elementary mathematics that can be learned through the study and practice of archery. My learning came through my interactions and conversations with Coach and my interaction with the literature (as sparse as it is on the elementary level) about archery and mathematics.

Teaching archery in the schools was not a new idea as it became part of Ontario, Canada's curriculum in the 1970s (Savoy, 1971). However, NASP is widely regarded as the most successful youth archery program in U.S. history (Grimes, 2007) as it is operating in at least 45 states and 3 countries with more than 1.4 million students having taken NASP lessons from their school's physical education teachers (Grimes, 2007). Although the creators of NASP thought small-scale archery programs or afterschool-only archery programs were doomed to failure (Grimes, 2007), that has not been the case for Coach and his CFEA archery program. Coach's program is fated for success as it continues to grow and involve more students and families, and propel students to national and international competition—experiences they more than likely would not have otherwise.

In its national curriculum, NASP follows national scholastic standards for physical education, social studies, and mathematics where the mathematics standards are those set by the National Council of Teachers of Mathematics (NCTM). For the 4th and 5th grade NASP curriculum, the following NCTM standards are incorporated, and suggests 13 skills and processes that will enable students to learn archery successfully, 11 of which I perceive to be mathematics-related: research, listening, and observation skills; following directions; scoring; effective group participation; communication and cooperation skills; self-evaluation; skill improvement through practice; and, practicing responsibility and respect (NASP, 2006). The remaining two skills speak directly to the physicality of the sport: hand-eye coordination and refinement of motor skills.

In addition to physical skills, the NASP curriculum for 4th and 5th grade students focuses on character development through constructive communication, cooperation, rules, fulfilling commitments, and respect and responsibility to self and others (NASP, 2006). As witnessed in Coach's archery practice with Antonio and as illustrated in the NASP curriculum and by the American Alliance for Health, Physical Education, Recreation, and Dance (Cowart, 1982), archery is for students of all ages and different

abilities including students who may have disabilities. The NASP curriculum includes as an appendix “Teaching Archery to Persons with Disabilities” which details guidelines for disabilities, disability awareness, personal aids and devices and how to work with students with physical, mental, learning, and developmental impairments and disabilities (NASP, 2006).

The mathematics associated with archery ranges from elementary level (addition, multiplication, variables, predictions, representations with tables, charts, and graphs) to graduate and professional level (modeling the flexural rigidity of the arrows, predicting the natural frequency of the arrow, solving equations of motion of the bow, computing geometric functions of the bow, and solving of partial differential equations). Common mathematical concepts such as length, time, and shape, and scientific concepts as weight, mass, distance, and velocity can be learned and experimented with fifth graders through archery. With respect to the mechanics of the bow and arrow, in particular through the process of shooting, mathematical concepts as perpendicularity, length, and diameter can be learned, and scientific concepts as weight, oscillation, and rigidity can be learned.

The visual and material aid of the bow and arrow at rest and in action in students’ hands can readily connect abstract concepts to real-life experiences and make way for deeper understanding of newly acquired information and courageous exploration and discovery of unknown or unfamiliar information but in a tangible way. For detailed treatment of advanced mathematical modeling and archery, see Kooi (1981), Kooi (1991), and Kooi (1998). It is utterly fascinating to see the breadth and depth of mathematics inherent and employed in the mechanics of the bow and arrow. Not only can mathematical modeling be a helpful tool for research on archery, the design of new bow equipment, and the understanding the development of the bow in the past (Kooi, 1991), it can be a helpful tool for students to discover, welcome, and develop the mathematician within by seeing, experiencing, and applying their mathematical knowledge and power to a unique and fun activity in which they have grown to love and become proficient and confident.

5.3 Math Culture and Structures at Home

“My dad told me to, he showed me to shout out what you know. He showed me that if you stay quiet you’ll never learn, and never be successful.”—Zulema, 11 years old, Dominican girl

“In my house, I see math a lot cuz I’m always doing math in my house with my dad. Let’s see, I have a lot of math books so I see math a lot. In my room, there’s a little math thing that I do, flash cards.”—Paolo, 10 years old, Puerto Rican boy

5.3.1 Math Support from Family and Neighbors

Students were not without help and encouragement at home. They did math with their family and by themselves on the computer, whether online or offline. If they needed help with their math homework, they turned to their parents or older siblings if the parents were not available or could not understand the work because of a language barrier. Some of the students' parents spoke Spanish with little understanding of English. All of the students, save two, said they had at least one parent or older sibling to help them with their work. The parents of three students asked or paid neighbors to tutor their child. For two sisters, their mother could not help them because she recently started working and got home too late; however, she still inquired about her daughters' progress in math and what they enjoyed. They turned to each other for help in their math and ELA. See Figure 2 for students' lines of math support at home.

Six students had older siblings in high school or college. Siblings were helpful, even if sometimes under the watchful eye of their parents. Alejandro, whose parents spoke Spanish, turned to his older brother who was in the 10th grade. Alejandro said his brother would explain the math step by step. Even though his mother speaks Spanish, she would make sure his brother helped him and not give him the answer: "He gets a paper and shows me how to do it. My mom is there to make sure he doesn't give me the answer... Sometimes it's funny cuz he just wants to give me the answer so he can go and watch his t.v." Natasha's older brother helped her with the "higher words" (more difficult vocabulary) that she did not know or understand.

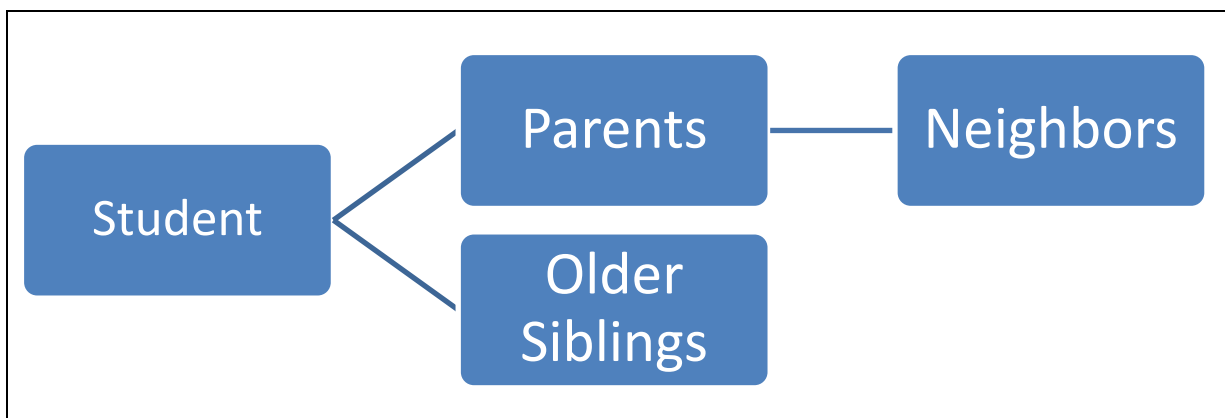


Figure 2. Lines of Math Support for Students at Home

Gerardo considered his older brother a genius and would turn to him for help: "Ask him any question, he gets it. If you ask him a hard question, give him like 30 minutes. Then the next thing, he be like he got the answer." Gerardo said he admired his brother and his entire family except his younger brother, "the little one." He warned never to let "the little one" get close because "he's not fun." At that characterization of his younger brother, I laughed. It was fun, sometimes hilarious, learning of the sibling dynamics of these students, seeing it in their faces and body language, hearing it in their voices. It brought back memories of the dynamics between me and my siblings as children and adults. For Antonio, help was just a phone call away to his older brother who lived in another state: "And I call him, and I say I need help with my homework, and then I tell him what the problem, and I write it down everything that he says."

Three students had parents who were teachers at some point in their home countries before immigrating to the U.S. Maria's and Lourdes's mothers used to be teachers in their countries, teaching math and other topics in Spanish. Fadhila's father used to be a math teacher in Africa. She turned to him first for help. She recalled a time when he tried to help her with adding and subtracting positive and negative numbers. For Fadhila, if her father was unavailable, then she asked her mother and next her two older brothers who were in middle school, one who she believed was very smart in math. Some of the school staff also remembered him being very smart in math. She said she always has somebody at home to help her if she needed.

Parents were helpful to their children often encouraging them beyond the numbers. Carlos said he would turn to his mother if he could not figure out the math. If his mother was busy, he then asked his sister because "she's good at math" and "she's been teaching [him] about algebra." He said his mother helps her sister in algebra and in turn she helps him learn when he asks out of curiosity. Lourdes asked her mother first, then her father. If they were busy or could not help her, then she would ask her older sister who was in college. Even though her older sister had a baby and lived with her boyfriend, she would visit almost every day, helping Lourdes with her math if she needed it. However, Lourdes was resourceful in her learning if no one was around to help: "If nobody's there, I be going on the computer. I be like what is Lattice. Then I went on a website and they had steps to do Lattice. I'm like I don't get this either. (Chuckling)." Leticia was grateful for her mother's attention and help, recognizing the responsibility her mother carries to raise her: "I feel okay [that she helps me with my math] cuz she's my mom. I love

her. And no matter what, even though she gets me mad sometimes and I answer back at her sometimes, and I may think that I hate her, but I don't cuz I really love her, cuz you know, moms are the ones that usually take care of you. Buy you clothing. Pay some of the bills."

Paolo and Zulema were endearing towards their fathers with the help and encouragement they gave. Paolo said that his father taught him how to divide "two digits into three digits and three digits into four digits." Not only did his father teach him different topics in math but he also played and competed with him to improve his skills:

Paolo: Me and my dad sometimes we try to race through the easy questions. (Smiling) We try to go as fast as we can. Usually my dad wins but I win sometimes.

Researcher: And, like your neighborhood and your home. Where do you see math?

Paolo: In my house, I see math a lot cuz I'm always doing math in my house with my dad. Let's see, I have a lot of math books so I see math a lot. In my room, there's a little math thing that I do, flash cards. When I do one, and then you flip it over. You have to try to do it fast as you can.

Researcher: Right.

Paolo: With my dad, I do 10 cards every day to see how fast I can do each card. And sometimes I do it faster, and sometimes I do it slower than the other time.

Zulema's mother showed her ways to relate to problems so she could understand them:

And I understand it more when they talk to me and they give me problems and they give me problems that relate to the questions, and they put into stuff that I like. Like you have a hundred candies, like the problem says you have a hundred people and you want to divide them into five. And I be like, mommy I don't know what it is. Cuz this happened when I was in third grade. My mom said alright, imagine you have a hundred candies and you want to divide into five people, and you're one of those five people, how much would you get, and how much would everybody else get. And then after I figured it out, it was 20. She said, okay, if that'll help you, the answer could be 100 divided five. And that would be your answer, too. And it did help me.

Zulema said her father has been encouraging her since she was three. He has been her motivation for participating in class as much as she does: "My dad told me to, he showed me to shout out what you know. He showed me that if you stay quiet you'll never learn, and never be successful."

Three students had neighbors who tutored them with one student, Dayanara, meeting her tutor every day for two hours. Hernan's mother paid the neighbor upstairs to tutor him in math. He also turned to his older brother, a 7th grader, for help. Zulema would go with a neighbor sometimes on Saturday who would give her high school work and sometimes some of her son's college math to do. For Zulema, she believed the high school math had become easy for her.

5.3.2 Home, Digital, Home: Fun and Games...and Learning Still

At home, students also played math games on their computers and went online to the same sites as in school and more. See Figure 3. Although there is always someone to help Fadhila, at times she uses Google [a popular internet search engine] to find websites that give “lessons that explains it to you and it gives you questions to make sure you understand it.” She finds Uptown Education and Math Blasters awesome. Domingo, too, said he goes on Uptown Education where he could pick the subject, the grade level and the subject that “you mostly need help, and it’ll give you problems, and it’ll give you a score.” He thought the site was fun and stayed on it from 20 to 30 minutes a night. Besides learning and having fun on this site, Domingo played other action games. Alejandro said he works on adding decimals using the software his father bought for him and played baseball multiplication on Fun Brain and Cool Math 4 Kids. Hernan said he goes on Fun Brain’s Math Arcade all the time and sometimes he plays at the eighth grade level to learn more things even though he misses a lot of questions. Eduardo also said he played multiplication games online at home so that he could get “more better at multiplying.”



Figure 3. Math Websites Used Most by the Fifth Graders at School and Home

In addition to reading and spelling, Paolo said he would go online at home to do fun things like math. He gave an example of the math he has done on Fun Brain's Math Arcade: "You have to find out the angle and the measurement to wear to put it [the launcher] and so when the guy jumps on it, the thing [the launcher] will go up so it could go to the other side." His favorite thing to do in math is multiplication because of the steps: "Because I like when you have to do one, and then another one, and then once you do that one right, you have to move on to the next one, then you have to add it. So you have a lot of...[steps]."

Natasha played basketball games on Fun Brain's Math Arcade to practice her multiplication and division. Gerardo named Math Munchers as a site he visited often to practice multiplication, in particular, and division, addition, and subtraction. Javier prided himself on completing an entire board game on Fun Brain's Math Arcade. The board game is a pathway of math games to complete at nearly every other step of the way. He detailed his experience with math soccer:

Javier: It tells you what to do. There's these questions on the bottom saying what you need to divide or multiply. Then you put the answer, if you put the answer correctly on there, you get to aim where you're gonna kick...
Researcher: Ahhhh!!
Javier: And then if you answer correctly, you get a score.

Chantelle enjoyed playing a pet survival game online at home where she would have to look around the city for little math clues so she could get money for her pet. It is no wonder why Chantelle enjoyed playing this game. She is a future veterinarian. Finding clues for her online pet was not easy because people can take the clues since it is a competition. She likes competition and admitted losing and winning at times. Zulema, who enjoys a challenge, found Fun Brain's Math Arcade really fun and helpful because it offers strategies on completing the tasks like turning the square:

Well, in Cool Math, when I'm upset I play Cool Math cuz it goes to strategies and then it's trying to find out how you have to turn the square. Like they give you rectangle and they show you different sides and you have to move it to the black hole to go to the next level. And if we don't do the right equation, you'll fall off and you start over. And I've gone to level five and it's unbeatable.

Jesenia found a different Math Munchers online at home than the version they play in the computer lab. She thought the version she found was harder than the one at school. She liked that it was harder, too. She smiled big when she admitted liking the site because it was harder. Although Luis could not remember the math game site he played at home, he recalled that it was really fun and that he

mostly learned about shapes and fractions, and the area and perimeter about the shapes. I really was impressed with Luis's math vocabulary as he was one of the few students, if not the only one, who employed it during our interview with such ease. Antonio, sometimes not one for much talking, shared in detail a few games he liked to play on MathGames.com:

- Antonio: Sometimes pirates throw money out, and then on top it, it says like get \$7.25. I got it. I get like \$5 and then \$2, and then I get 25 cents.
- Researcher: Okay, I have to check that out then. You think it's fun? You think I would think it's fun?
- Antonio: Yeah, cuz sometimes there's a game that there's a lizard. The lizard gotta kick the bag. Like umm it says like 6 plus 2, and then you get equal that number to 8, and then the lizard kicks the bag 8 times.

At home, Dayanara plays Solitaire or a fractions game on the computer. She excitedly shared that her father bought the fractions game for her, and that she plays it three days a week.

5.3.3 Media Influence: Mathematician T.V. and Videogame Characters...Yes and No

To gain understanding of the images of mathematicians that students see in the media, I asked students if they had seen any characters on television or in video games that they thought were mathematicians, or at least used mathematics. With respect to Bronfenbrenner's ecological systems theory, I thought the question might reveal macrosystemic influences of the media in students' own micro- or mesosystems—the system of microsystems, which comprises the interrelations or interactions that the students have with other child and adult members within their microsystems (Bronfenbrenner, 1976). The media whether televised, in print, or digitized is part of the larger culture. I left the question broad as I did not want to steer students' thinking about what they see on television. I did not want them to discount a character they may consider a mathematician or math smart, or at least someone who uses mathematics, because of something I said.

Media mathematicians were by sighted by half (12) of the students. Essentially, on any given day, students would have an equal chance of not seeing such a character on television or in a video game they may consider a mathematician or math smart, or at least someone who uses mathematics, as seeing one. Of the students who said no, most simply shook their head or said "no", except for Zulema, who in addition to saying "no," thought of the videogame *Mario Brothers*, starring two short, pudgy Italian-American plumbers, with the original game *Mario* first appearing in the 1980s. The iconic character and game have evolved over the decades in different versions and gaming systems, thus continuing to grab

the interest of youth and adult alike. Zulema correctly identified it as a game where the player does the math in determining needed points and strategies to win; not the character.

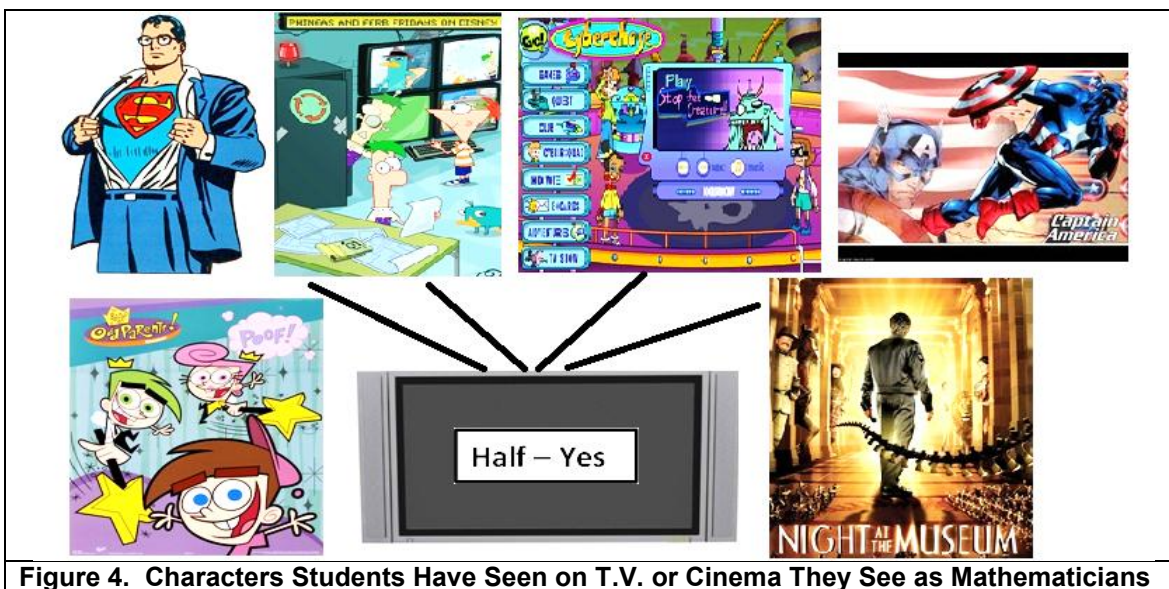


Figure 4. Characters Students Have Seen on T.V. or Cinema They See as Mathematicians

Of the students who said yes, a handful of shows were mentioned. See Figure 4 for images of the characters. Alejandro, along with a few other students, answered Phineas and Ferb, the two primary characters of the cartoon *Phineas and Ferb* created in 2007 that comes on the Disney Channel. In each episode, stepbrothers Phineas and Ferb embark on a grand project which involves interacting with a secret agent platypus to counterspy an evil scientist. Although it is not a “math show”, so to speak, Phineas and Ferb often use mathematics to create their projects and fight the evil scientist. Alejandro named Phineas and Ferb because “they’re smart cuz they know how to build stuff.” Maybe Alejandro was attuned to their use of mathematics and associated their building stuff with intelligence as his own self-perception in math is strongly positive and because his father is in construction and has shown him how he has used mathematics on the job.

Natasha also named Phineas and Ferb because “they had to measure how long the robot is gonna be.” Gerardo also named the two stepbrothers and said they were two little geniuses because “if you ask them to build a chair, they build it like in one minute.” I have watched it and enjoyed it, in particular, the episode where they wrote out mathematical equations to reverse engineer a robot. The equations used symbols familiar to elementary school students. Whether or not the equations or calculations were correct is not the focus for me; it was seeing youthful characters use math to think

through and solve a plot. Dayanara also named Phineas and Ferb, citing the very same episode I watched.

Leticia hesitated at first, said no, and then recalled, *The Fairly Odd Parents*, a cartoon about a boy, Timmy Turner who was granted fairy god parents. Her reason for considering Timmy Turner as a mathematician was one of default: “He’s really bad about at other subjects. So I prefer him as a mathema—I can’t say it...Mathematician.” Carlos excitedly asked could the mathematician be a superhero, to which he named Captain American “cuz he’s very smart.” He proudly called himself “one of those comic geeks, how they read a lot of comics and stuff.” He continued on and named Superman because “he’s very good in math. And when he’s not wearing his costume, he has, he looks like a mathematician because he has a hard job and he wears glasses and everything so and he looks like a strong man, too.” Of all the students, Carlos was the only one who vocalized a physical conception of a mathematician. Interestingly, he was one of the 32.0% who did not see themselves as mathematicians. Maybe his Superman conception of mathematician—does a hard job, wears glasses, and is strong—subconsciously precluded him from seeing himself as one.

To my pleasant surprise, Lourdes named *Tom and Jerry*:

Lourdes: There’s this episode that Tom he goes to school with all these little kids, like real kids and he has to do math and he’s like with math, he don’t really like math so he gets detention as a cat.
Researcher: (Chuckling)
Lourdes: So he puts on a hat and puts on a shirt and some pants and some shoes and he looked like a person. And he painted his face like another color. I mean he looked like a little kid. And he has to do math, and he doesn’t even talk.

(I say “pleasant surprise” simply because of my nostalgia over cartoons I grew up watching.)

Jesenia recalled *Cyberchase*, an educational cartoon series on Public Broadcast Station (PBS) aimed at children eight to 12 years of age that teaches children discrete mathematics and shows them that “math is everywhere and everyone can be good at it!”¹¹ She liked it because “it teaches a lot of math” and “these four, three kids that always use to solve problems with math.” Jesenia was the only student to recall an educational series. Paolo elaborated on a movie instead of a cartoon or videogame—*Night at the Museum*, a 2006 movie based on a 1993 children’s book about how the exhibits at New York City’s American Museum of Natural History come to life. He thought the characters that came to life were

¹¹ *Cyberchase* Educational Philosophy. <http://www.pbs.org/parents/cyberchase/show/philosophy.html>. Retrieved August 16, 2011.

really smart “like with the little Domingo Einstein bobble-head [doll], he was like Pi and something.” Although he said he did not know what they were saying, he knew it had something to do with math because the characters had to “find out the code to a little template so everybody could stop being alive.” Eduardo and Antonio described videogames (but were not able to recall the names) where the player uses mathematical strategies of sorts to win; not the character.

Variable	Item	<i>U</i>	<i>p</i>	<i>r</i>	Mean rank (A)	Mean rank (B)
Math Characters¹	I'd be proud to be the best student in math.	41.0	.025	-.46	15.08	9.92
	I think I could handle more difficult math.	36.5	.027	-.45	15.46	9.54
	Math doesn't scare me at all.	36.0	.028	-.45	15.50	9.50

Note: 1: A=Seen Math Character, B=Not Seen Math Character

Students who said they had seen or knew of math characters showed a significant difference in response to four items in 2010 in particular to their math anxiety, confidence in learning math, and being proud of being the best student in math. The change score from 2009 to 2010 for “If I am the best student in math, I don't want anyone to know” ($U = 32.5, p = .034, r = -.44$) and for “When I get a math problem wrong, I try hard to understand why” ($U = 36.0, p = .049, r = -.41$) were also significant with students who have seen a math character typically showing a positive change while their counterparts did not show a change. Three subscales and the Total Survey for 2010 presented significant differences where students who had seen math characters scored higher than students who had not: Usefulness ($t(14.305) = -2.41, p = .024, d = .49$), Anxiety ($t(22) = -2.35, p = .028, d = .48$), Confidence Learning ($t(22) = -2.21, p = .038, d = .41$), and Survey Total ($t(22) = -2.47, p = .022, d = .72$). For Usefulness, Levene's test indicated unequal variances ($F = 6.76, p = .016$), so degrees of freedom were adjusted from 22 to 14.305. See Table 8 below for means and standard deviations.

Subscale	<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
Usefulness	-2.41	14.31	.024	.49
Confidence in Learning	-2.21	22	.038	.41
Anxiety	-2.35	22	.028	.48
Survey Total	-2.47	22	.022	.72

5.4 Classroom Norms and Ideas: Enactment of Mathematical Norms and Ideas

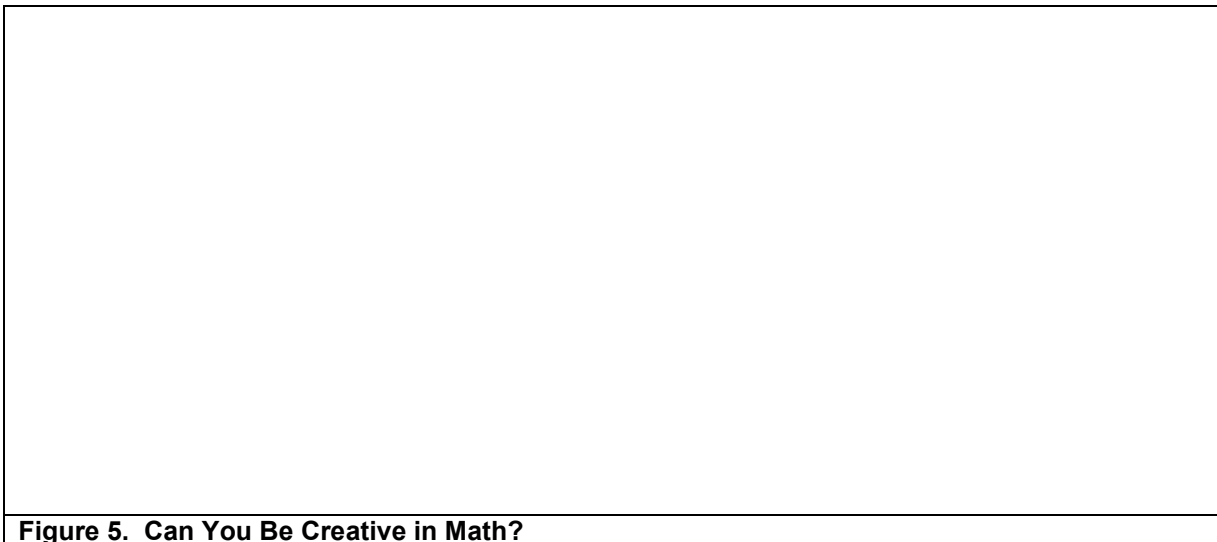
To gain insight into the organization and enculturation inside the classroom, I explored the ways in which mathematical norms, ideas, and ideals were enacted collectively. Mathematical norms are the acceptable standard or ways of being and doing in a classroom with respect to mathematics. Intrinsic to the classroom's mathematical culture, these norms are "constrained by the goals, beliefs, and assumptions of the classroom participants" (Yackel & Cobb, 1996, p. 460). Some mathematical norms and ideas can be seen in processes of contribution and participation such as describing manipulation of numeral or procedures, interpreting explanations in terms of actions on mathematical objects, engaging in mathematical argumentation, justifying strategies, solutions, or ideas, or contributing mathematically different solutions to a problem (Yackel & Cobb, 1996). Students reorganize their mathematical beliefs and values as they participate in and contribute to the establishment of these norms, allowing teachers the opportunity to support students' development of mathematical dispositions (McClain & Cobb, 2001), and in turn, their mathematics identities.

5.4.1 Creativity in Math

"Math is mostly what we learn to create everything...math is what created vehicles, planes."
—Luis, 10 years old, Mexican

"The moving power of mathematical invention is not reasoning but imagination."
—Augustus de Morgan, British mathematician and logician

Creativity, spawned in the imagination, is something that children recognize and employ in different settings and contexts with different tools and processes. Mathematicians see the creative process in using, doing, thinking about, pondering, playing with, investigating, and advancing mathematics. Unfortunately, students are more often than not encouraged to explore, question, interpret, and employ creativity in subjects other than mathematics such as art, ELA, reading, or even social studies (Mann, 2006).



For the majority of the students I interviewed, creativity in mathematics did not seem a foreign or incredulous concept. See Figure 5 for percentages. However, the remaining minority did not think one could be creative using math. The creativity they saw and detailed was grounded in the math they had already experienced and/or learned (e.g., tessellations, figure constructions, the use of shapes like “hexagons, and triangles, and trapezoids”), the math they wanted to learn, the problems they wanted to solve, or the games they wanted to play and best.

Lourdes, even though she did not know if one could be creative in math or use math creatively, asked questions to help her understand if I meant using math to “create stuff” or “create a method to do stuff.” I appreciated the astuteness of Lourdes’s questions, her desire to know, to understand, to participate and contribute in this space, and her understanding of the difference between products and processes in mathematics. This same desire to know and understand mathematics was demonstrated in class in spite of the management struggles that presented in class at times. Eduardo said he did not know while Maria simply said no.

For Fadhila, creativity lived beyond the numbers and the word problems in the Math Journal. She saw how people used math creatively to construct avant-garde structures, materials, projects, and even works of art: “Some people when they make buildings, they make crazy buildings like the Leaning Tower. Some people they just think of squares. And they top it, they put it on top of each other, and they make different kinds of creative buildings, artwork. Anything.” In math class, Fadhila had a chance to be creative when they had to make pictures using shapes and tessellations of shapes. She proudly

exclaimed that she made a duck simply because she liked the sound they make, how they walk, and go “quack, quack, quack. Yeah, quack.” I then asked her if she liked the AFLAC duck, the mascot/icon of the AFLAC insurance company. She exclaimed, “Yeah!” and then proceeded to make the sound of the AFLAC duck. I could not let her have all the fun so I joined in, quacking right along with her. It seemed quite fitting to do so.

Jerome rattled off his idea of creativity with a recent example of him being creative in math outside of school. He used his creativity to challenge friends with math problems:

Jerome: Yeah. Create your own problems. Solve a problem. Yesterday I was in the store and the guy's daughter was doing her homework. She went to the Women's Academy of Excellence.

Researcher: I've heard of that.

Jerome: It's a nice school. It's all girls. She said in her school, they do seventh and eighth is together, and nine and tenth is together, and eleventh and twelve. She doing, she said she doing nine and ten. I was like, cuz one of the boys, she said that you smarter than me in math. I said, no you not. So I gave him a problem. I said 5 times 75 plus y and y equals 5.

Researcher: Okay.

Jerome: And, what was it again? I think it was 130. Yeah, it was 130. Then she gave me a problem with a circle and a triangle in it. It was RPQ and the circle is 180. So she said divided by 90 and then divided by 9, and it came up to 260, I think. Nobody knew it. So then I said, you still think you ready for me. So I gave him another problem. It was like, he was in fourth grade, so I said what's the square root of 81? He said, I don't know. So I said, you still think you smarter than me? He said, no, no, no, no.

Researcher: (Chuckling) Look at you. You showing off?

Jerome: (Smiling)

I smiled and chuckled at the end of his story. For me, it was less about the accuracy of the problem he created or the solutions he derived but more about his self-confidence and competitiveness outside the classroom setting—a manifestation of his math identity away from tests, books, desks, and chairs—that compelled him to use his creativity to showcase his abilities. I love to see students engage in intellectually stimulating communications and challenges in math at whatever level. Those are communications that need to be promoted and honored so students grow to appreciate it and advance it by themselves and for themselves and not shy away from it.

Alejandro, too, saw math being creatively used to construct things like cars with calculations of speed and gas mileage, and to carry on everyday activities like operating cash registers, televisions, cable, and telephones. Zulema believed that she could use creativity to distinguish herself from others: “Everybody likes to draw a pie instead like I could do my own thing. I could just put out cards and put

them into a square or a shape, and I just work it out like that.” In class, he saw creativity using shapes to make figures of all kinds—people, basketballs, and cars. Jorge turned his thinking to his family and home when conceiving examples of creativity:

- Jorge: Umm, like, when I figure it out, like how many people are in my family. And how many electronics are in my house. And umm, how many chairs, and how many umm, plates there to fill the whole family for dinner.
- Researcher: Okay. Wow. Okay. Keep going.
- Jorge: And I try to figure it out since my mom does a pattern of food, I try to figure it out what food she’s gonna make today.

Chantelle thought it was important for people to be creative in math, and not simply to do math just to do math. She immediately recalled the exercise where I asked students in the interview to look around the classroom and tell me all of the math they saw:

- Chantelle: Yeah, a lot. Like I could. I was creative by looking around the room and finding math clues.
- Researcher: Okay.
- Chantelle: That’s creative. But a lot of people don’t think that. A lot of people just, they don’t think that. They don’t do nothing creative about math. They just do math just to do math.
- Researcher: Just to do math. That’s interesting. Now, how do you think you could help somebody realize that math is creative? That you could be creative in math?
- Chantelle: I would show them like I showed you like how to do the little math boxes in the windows and the flag, and a lot of stuff. And I’d just tell them that’s how you could be creative. You could find math clues around the math. You don’t just have to do math. You could be creative and do your own thing. Do your own answers.

Antonio’s examples were physical and experimental, different from the uses of cut-out shapes and figures that his peers often said. Antonio gave example after example each time I asked him if he had any more. The examples were from what he had done somewhere and clearly enjoyed.

- Antonio: Yeah, like how distant, like we could put like a ramp and we could put the ball there, and we could put like how many seconds the ball gonna roll all the way down and go through the hole.
- Researcher: (Smiling) Wow. Okay. You thought about that pretty fast. Did you do that somewhere or you just thought it out?
- Antonio: I did that somewhere.
- Researcher: Okay. What else? How else can you be creative? That was an excellent example.
- Antonio: You could put those things together. Put four together. You could make a box. You could put a ball, and count how many bounces go round and round and round.
- Researcher: Okay, you’re on a roll here. Got any more examples?
- Antonio: You could put that right there and then you put the other one on the floor, and bounce it up and down, and check how many bounces it goes up and down.

Javier, Dayanara, and Carlos, too, thought of challenging friends with made-up problems, which would help friends study and learn math. Carlos said he had never done that but wanted to. I asked him had he told his teacher that he wanted to do that, and he shook his head no.

5.4.2 Classroom Management

Classroom management is crucial in the successful teaching and learning of mathematics in urban elementary schools (Freiberg, Huzinec, & Templeton, 2009; Slavin & Lake (2008). In the interviews, I asked students questions regarding classroom management (i.e., “How do you feel when people don’t listen in class?” “How do you feel when the class is noisy?”). Although not a part of the proposed set of questions, I asked them based on my observations of both classes over the year. I wanted to gain understanding of their feelings, agency, and positioning in class, especially when the teaching and learning was challenged by behavioral problems. I knew how I felt as an adult with respect to classroom management and I knew how I felt as a fifth grader decades ago. I even knew how some of my fifth grade classmates felt then. However, I did not know how Hispanic and African American fifth graders in an urban elementary school feel in 2010.

Students shared that others who do not pay attention in class become distractions for them making them lose concentration and capacity to learn and do their work. Further, some students were often deterred from participating in class and positioning themselves as knowledgeable when their efforts were interrupted by talking, noise, distractions, and misbehavior. Fadhila, when trying to participate and students were talking, sometimes didn’t “feel like answering the question anymore.” To deal with her feelings, she said she just focused and did her own work. Learning was very important to Fadhila to achieve her dreams. She believed she might need the math that she was learning now for her future job. It made her upset if she was not learning. Jorge, a good-spirited student, mature 10-year old, said he just ignores students who keep talking when he is trying to learn. He likened their behavior to his little sister: “It’s like when my sister plays near me and she just shouts, shouts, shouts. I just ignore it. She says I want this right now, I want this right now. So I just dismiss it.”

A handful of students seemed to take a proactive approach when dealing with their disruptive peers, even if their efforts were unsuccessful. Maria said she tells them to shut up: “When you scream at them and tell them to shut up, they will stop talking. They get scared and stop talking.” Maria took a proactive approach when she really wanted to hear what was being said even though she admitted that

sometimes she would be one of the students talking, too. Interestingly, she named herself, Ariela, Chantelle, Jerome, and Carlos as students who the class listened to “cuz we’re loud. We tell them, and they listen.” Ariela, although she said would tell them to be quiet, she said they would “be quiet for a little while and they keep on doing it.” Ariela, at the beginning of the school year was talkative herself; however, as the year progressed, her talking subsided and she began to focus and participate in class more. The part she hated the most about math class was the noise and the disruption as it interfered with her concentration when trying to do math work that she liked:

“...they’re too loud and they mess it up. Like if you’re trying to do something you don’t know and you like it, and you’re trying to work independently, they scream, they shout, they play, they make jokes and you can’t really concentrate.”

Ironically, Carlos over the year was a distraction to others at times, singing, talking, joking around, and making fun of Mrs. Cruz’s accent. According to Bernardo, everyone in the class has told him to stop because he was being annoying and it was not funny. Dayanara also told Carlos to stop playing around and pay attention in class. Dayanara said she felt angry, really angry when students did not pay attention in class, and that she would talk to them in the moment to quiet them. She said she felt good, very good taking responsibility to try to get her classmates in check.

In Mr. Knight’s class, Alejandro, often with a hoarse voice, said that he would tell students to be quiet when they would get really loud; however, he felt like he was wasting his voice on them. The class listened but only temporarily to Fadhila, Javier, and Nilsa when they would tell the class loudly to be quiet. Chantelle bemoaned the constant talking in her class and the negative consequences it bore on the chances to have fun: “Oh, my class is a, my class is a pain cuz they’re always talking. They’re always. You can never do anything in the class. You can’t practice for the graduation. You can’t do anything fun cuz the class is always talking.” Interestingly, Gerardo, who said he could not concentrate with noise around him, refused to tell students to be quiet for fear of repercussions against him: “Nope...Because if I do it, I get in trouble, not them, and then when the teacher comes in, they’re gonna be like why Gerardo’s talking, and everybody’s gonna be quiet...I learned that at the beginning of the year.” Apparently that happened to him at the beginning of the year and affected his way of learning and dealing with distractions in class from then on.

Students felt bad for their teacher when students did not listen to the teacher. Fadhila felt sorry for Mr. Knight when the class did not listen to him. Alejandro felt like teachers were like their parents at

school because they saw them more than their parents. Leticia wanted to help Mrs. George (Mr. Knight's replacement) quiet the class by screaming at them really loud to be quiet: "Because I help Mrs. George out because sometimes her throat hurts and she don't have a voice to yell." When Mr. Knight was teaching, classroom management seemed especially challenging this year. Some students also felt bad for him because of the disrespect he experienced from the students:

Researcher: Okay, okay. So Ms. George's the new teacher. And so when Mr. Knight was here, how was learning math then?

Nicole: Hard.

Researcher: How?

Nicole: Cuz a lot of people was disrespecting him. A lot of people, a lot of people was talking and they wouldn't be quiet. And then he'll say, he'll say, well I'm not teaching no more. Then he'll try again and it don't work because somebody always has to ruin it.

However, the disrespect was reciprocated by Mr. Knight at times. Lourdes shared an instance when Mr. Knight was disrespectful to Reina:

"But Reina, she didn't get a question right and it was about the Lattice, I think. And she got up, she tried it. And Mr. Knight was like, you don't know it. Get outta here. And then she just went to her seat. And I was like, Mr. Knight you can't say that to her. And then he just turned around rolled his eyes at me."

Nicole also expressed her efforts to quiet the class, even though her efforts only worked sometimes:

"Yeah, sometimes but it don't work. They'll either tell me to shut up or they even be like, they just look at me and laugh. Sometimes they listen. Sometimes. But I don't care. I just continue to do my work."

Lourdes expressed her efforts to pay attention and help with classroom management but to little or no avail:

Researcher: Okay, okay. Umm, so when kids would talk and act up, would you tell them to be quiet?

Lourdes: Sometimes.

Researcher: Sometimes. Do they listen to you?

Lourdes: No, they be like shut up, Lourdes, and keep talking.

Sometimes classroom management issues, positive and negative, blocked students who were trying to participate and position themselves as capable and knowledgeable among their peers. With so many students wanting to share their answers either at their seat or at the SMART Board, it became difficult for everyone to be able to participate, causing frustration for not only some students but also for the teacher. (The SMART Board is an interactive whiteboard installed in many classrooms to enhance student learning and increase engagement.) I asked Chantelle if she participated a lot in class and she

replied sometimes: "Sometimes I can't cuz everybody be like me, me, me! And I just be, I don't get picked."

Mrs. Cruz had exercised various strategies to try to manage students' behavior and participation in class. During the October 21st observation, Mrs. Cruz had to reprimand the class for being frustrated for not being called on to share their answers. It was a participation problem of a different nature.

Jerome had his hand raised, and said to me when he didn't get called on to answer, "She don't like us. She always pick somebody up there." [Jerome was referring to him and the other students – Dayanara and Earl - who were sitting at his table group in the back of the class. 'Up there' referred to the students sitting in the front of the class where Mrs. Cruz normally stands.]

Mrs. Cruz put up the next number on the SMART Board and called on a student to answer. Earl sighed because Mrs. Cruz called on Dayanara and he's sitting right next to Dayanara. Earl has raised his hand several times, a few more than Dayanara but he hasn't been called on yet.

Mrs. Cruz had to reprimand the class for complaining loudly about not being called on. Many students had their hands raised throughout the exercise, some waving their hands frantically, others calmly. Some students had looks of frustration on their faces because they weren't called on. Mrs. Cruz said to the class in a loud voice, "Class, I can only call on one person at a time; not all 26 students at once. It is only one of me, and 26 of you. Be patient." [I was glad Mrs. Cruz explained the difficulty in everyone participating at once.]

In addition to strategies to manage student participation, Mrs. Cruz used strategies to manage student engagement. Jerome mentioned a strategy that Cruz used to see if students were paying attention:

Researcher: Okay. Alright. There was one time I was in the class, and I think you and Earl and who else was it? Maybe Chantelle and you guys were really trying to participate and you were raising your hands, and you didn't get called on and you seemed really frustrated. Does that happen a lot?

Jerome: Sometime she'll do that. She'll do that like when she see somebody that's not paying attention and she'll call on them that's not paying attention to see if they're paying attention or not.

Researcher: Okay.

Jerome: She'll do that a lot of times. And then the person that's not paying attention, they get in trouble. And then after that, she pick on somebody that knows it to explain to them that's not paying attention. Then if she see it again, she'll keep doing it. She do it over and over until they finally pay attention. And then sometimes she get tired of it, and so she'll call Mr. Simmonds [the fifth-grade assistant principal] in, and he just talks to the class.

Maria described a strategy that Mrs. Cruz tried to use to manage students' excessive talking, which to Maria's perception was to no avail: "Because before when she moves the tables because the class was too talkative, then she moved it, cuz it was too talkative, then she moved it cuz it was too talkative, then she leaved it like that (trying not to laugh)."

5.4.3 Classroom Tools and Resources

Since the 1800s, the tools of mathematics teaching in the U.S. have been shaped by several powerful factors such as evolving national and local economic infrastructures, growing technical expertise and needs for global and local competition, increasing cultural diversification and resources via immigration and commerce, and changing pedagogical theories and practices (Kidwell, Ackerberg-Hastings, & Roberts, 2008). Slate and slate pencils were replaced by paper and wood pencils which gave way to graph paper and standardized paper-and-pencil tests; brass instruments like protractors and wood instruments like rulers gave way to stainless steel and plastic instruments like geometric templates and slide rules; slide rules gave way to calculators which gave way to computer hardware and software programs; chalkboards gave way to overhead projectors which gave way to SMART Boards (Kidwell, Ackerberg-Hastings, & Roberts, 2008). Such evolution of mathematics teaching tools has made it possible for elementary classrooms today in urban schools to have the basic tools like pencils, paper, rulers, scissors, and calculators to the more advanced tools like desktop and laptop computers and SMART Boards with internet access at the disposal of teacher and student.

Each classroom I observed was evidence of this evolution of such tool development. Matter of fact, almost each classroom in the school across grades had these basic and advanced tools for use, including SMART Boards. Funding received from the federal 21st Century Community Learning Centers grants written in collaboration with CFEA enabled the school to purchase three SMART Boards. The two fifth grade classrooms also had three computers in the rear of each class. Curriculum wise, the school used *Everyday Math* which included standard and supplemental materials and manipulatives (i.e., *Teacher's Lesson Guide*, *Math Masters*, *Student Reference Book*, *Student Math Journals 1 and 2*, and a set of manipulatives). Additional math manipulatives and story books were available in the resource room categorized by grade and subject for teachers to borrow and return when finished. In the context of classroom instruction, manipulatives refer to items that students use to support hands-on learning. Manipulatives are objects such as counters, dice, toothpicks, beans, or coins that students can manipulate to create mathematical models for problem solving. They are different from tools such as pencils, scissors, calculators, rulers, and geometric templates.

The presence of these resources, tools, and manipulatives represents mathematics norms and ideas to be enacted. The question then is the usage of these resources, tools, and manipulatives as it is

the usage where enactment is observed. Across observations, usage of student Math Journals, the main text, was prevalent; less so was the student reference book. Basic tools such as paper and pencils were used in the learning and doing of the mathematics with some usage of scissors, calculators, or geometric templates for lessons that required it. The chalkboard and SMART Board were used also for students to demonstrate their understanding, and the teacher to demonstrate processes and operations.

Unfortunately, teachers used the SMART Board for writing just as they would the chalkboard; for showing videos or online media; or for assessments. The SMART Board has extensive capabilities of which they were not used to the fullest. I inquired with the principal about SMART Board training to which she replied there was training available that teachers could attend on their own. The computers in each classroom were not used on the dates I observed. To my knowledge, they were not used at all since the school has a working, up-to-date computer lab with a highly knowledgeable instructor, various educational grade-and level-appropriate software programs and games, internet access, and DAMS assessment practices that classes could use all year round to prepare students for their state math and ELA assessments. However, on the dates I observed, there was scant usage of manipulatives. See Table 9 for student text, tools, and manipulatives used on observation dates.

Teacher	Date	Text	Tools Used	Manipulatives Used	Pages
Mr. Knight	09/16/09	Student Reference Book; Student Math Journal Vol. 1	Pencil, Notebook, Chalkboard, Overhead Projector, Calculator, Game sheet copies, Colored game chips		p. 306; p. 12
Mrs. Cruz	09/23/09	Student Math Journal Vol. 1	Pencil, Notebook Chalkboard, Calculator		p. 23
Mr. Knight	09/30/09	Student Math Journal Vol. 1	Pencil, Notebook, SMART Board		p. 29 – 31
Mrs. Cruz	10/07/09	Student Math Journal Vol. 1	Pencil, Notebook, SMART Board		p. 40
Mr. Knight	10/14/09	Student Math Journal Vol. 1	Pencil, Notebook, SMART Board		p. 50 – 52
Mrs. Cruz	10/21/09	Student Reference Book	Pencil, Notebook, Chalkboard, SMART Board		p. 271

Table 9 (Continued). Student Text, Tools, and Manipulatives Used on Dates Observed 2009-2010					
Mr. Knight	10/28/09	Student Math Journal Vol. 1	Pencil, Notebook, Plastic geometric template		p. 69 – 72, p. 57
Mrs. Cruz	11/04/09	Student Math Journal Vol. 1	Pencil, Notebook, SMART Board, Marker, Plastic geometric template, Scissors, Glue, Paper		p. 75 – 79
Mr. Knight	12/16/09	Student Reference Book	Pencil, Notebook, Paper, Scissors, Calculator, Game problem cards, Dice		p. 308
Mrs. Cruz	01/06/10	Student Math Journal Vol. 1	Pencil, Notebook, Chalkboard, Plastic geometric template, Calculator		p. 129-133
Mr. Knight	01/13/10	Student Math Journal Vol. 1	Pencil, Notebook, SMART Board		p. 163
Mrs. Cruz	03/10/10	Student Math Journal Vol. 2	Pencil, Notebook, Chalkboard, SMART Board		p.209-211
Mr. Knight	3/17/10	Student Math Journal Vol. 2	Pencil, Notebook, SMART Board, Red crayon, Scissors	+\$1, -\$1 Cash Card Counters; Red counters, Blue counters	p. 230-233

It must be noted, however, that although manipulatives were not used on these dates, Mrs. Cruz, in particular, tried different fun activities with the students as a class to model concepts. On October 7 she had the class move their desks back, stand in front of their desks, form a circle, and hold hands. The objective of this activity was to model reaction time—an upcoming topic in the *Math Journal 1*. Each person would squeeze the next person’s hand as soon as they felt their hand being squeezed by the person beside them. Unfortunately, to the whole class’s chagrin including mine, this activity was not carried out to completion because of the misbehavior and disruption of a few students. Ariela seemed to express the sentiment of the class: “I was mad because like, when we got together it was kinda fun, and then when somebody ruined it, it was boring. And then we had to do something boring.”

Some students felt that manipulatives made learning math fun and helped them learn math better. Chantelle thought learning math would be easier using manipulatives than pencil and paper primarily because she “like[s] to use stuff.” She recounted learning how to divide in fourth grade using pennies. She also recalled lessons in fifth grade when Mrs. Cruz used Skittles candy to help them learn division, fractions, and multiplication. She mentioned that in class they were not supposed to eat the

candy; they were to be used just for the lesson but Antonio ate the candy. I could not help but to laugh when she said Antonio ate the candy. Jesenia also recounted using Skittles candy for learning math but this time for learning probability and percent. Bernardo enjoyed using different shapes like “triangles, hexagons, squares, circles, and that’s it. And polygons” to create figures of monsters.

CHAPTER 6: STUDENTS' MATH PEP: THEIR POSITIONING, ENACTMENT, AND PERSPECTIVES

“Sometimes I talk. I’m not gonna lie to you but not all the time cuz sometimes I really wanna learn it because in sixth grade it’s gonna be harder.”
—Nicole, 10 years old, African American girl

“I like difficult stuff like challenges to help me get smarter.”
—Hernan, 10 years old, Dominican boy

6.1 Students' Math Positioning in Class

“I was kind of nervous like if I get the answer wrong since I got kinda bad kids in my class, they be like oh, Lourdes you’re dumb, you don’t know how to do this question. I be like I don’t care what you say. At least I tried it.”—Lourdes, 10 years old, Dominican girl

How do students position themselves inside and outside of the classroom relative to the mathematical activities and identities? How do they participate in enactment of mathematics identities? More specifically, what are the specifics and characteristics of the following processes inside and outside of the classroom: learning mathematics; enacting skills, characteristics, and qualities of mathematicians; and, developing a sense of belonging? To address these questions, I conducted in-class and out-of-class observations with particular focus on students’ actions and processes, and semi-structured interviews of students with questions about students’ work style, learning needs, and what it takes for someone to become smart in math. I also conducted semi-structured interviews of school and CFEA staff to gain some understanding of how they see students positioning and behaving themselves relative to the learning and doing of mathematics inside the classrooms.

Students are aware of their positioning in class as mathematics and science learners (West-Olatunji et al., 2007). Researchers have suggested that elementary school African American girls’ constructed cultural, gender, and class identities dictate their positionalities in relation to mathematics and science learning, and that their positionalities are also affected by the perceptions, expectations, and support behaviors of teachers, counselors, and parents (West-Olatunji et al., 2007). How students position themselves inside the classroom affects knowledge construction and contribution, power, and relationships. Students manifested there is mathematics positioning in class such as helper, leader, math capable, agent of their own learning, independent, attention seeker, and help seeker. Some students held singular positionalities throughout the year while others held multiple.

6.1.1 Helper and Help Seeker

In the interviews, I asked students, in some variation of the question, if they ever asked others for help in class, and if so, who? I added this question based on students' varied interactions during class observations, and the fact that mathematics is communal, sociocultural, and personal among other things. Students did not always ask each other for help—only when necessary. If needed, most students first asked their classmates, and if their classmates could not help them, they turned to their teacher for help. This turning to students first is telling that some level of the community that exists for some the students. This may seem like an obvious finding—students leaning on each other first for help and then turning to an authority—but somewhere along the pathway to advanced and specialized mathematics, the notion of communal support has become lost in the objectification and stereotyping of mathematics overall. Individual effort has become the torchlight as students' progression from one grade to the next is based on their individual performance on tests.

I then asked students how they felt about asking their classmates for help. There was no shame or embarrassment of these students for drawing from the minds of others, from “learning more and more,” as Eduardo acknowledged. For some, asking and receiving help from their classmates represented some level of belonging and trust. Fadhila, an African female student of tall stature and one of the mathematically highest performing students, said she felt good about asking her classmates for help: “I feel good because I know I can rely on some of my classmates and they could help me whenever I need help...I know I could trust them. That I could trust some people. Yes.”

Students recognized the abilities of others in proximity to them and asked for help. Jesenia, a very quiet and mathematically talented Mexican girl who was one of the student speakers for graduation, was often consulted by the students who sat near her to explain problems and answers to them. She did so willingly. Unfortunately some students skipped the respect and formality of asking and simply copied from her paper. Although in her interview she said she did not mind, her countenance said differently. Hernan, a somewhat talkative yet very competitive and mentally quick student in math, said he calls on Jesenia first to help him out, and “if she doesn't get it then we just ask another one, and if they don't get it, then we just ask Mrs. Cruz. And then she like writes it on the SMART Board and shows everybody.”

Just as many students sought each other for help, they did not mind others seeking them for help. Students felt good when others asked them for help; it made them feel proud of themselves, feel like a

teacher, or feel smart or “like a genius,” according to Gerardo. Interestingly for Gerardo, helping others made him feel like a genius but receiving help from others made him feel like he was not smart and that he was giving up on himself. If he needed help, he said he would not tell anyone at first: “I work it, work it, keep on. And if I don’t get it, I ask my teacher or my genius friend.” I very much appreciated his candor in the interview. Revealing his vulnerability about asking for help was courageous.

Zulema, a Dominican student who seemed to pride herself as on being an oddball, said she helps everyone around her: “When I see somebody upset, I try to help them before they get in trouble. Sometimes they throw fits, and I help them out.” She said she gained her teamwork sensibilities from her mother. However, when she needs help, she said she goes straight to the teacher, then her tight cadre of helpers, Nilsa, Javier, Fadhila, and another student who was not a study participant. Further, she liked receiving compliments from students when she helped them: “It’s really fun hearing how good you are and having your mom be proud of you... Yeah, I like it when my mother’s happy with me. My mom and dad. Sometimes they let me know and sometimes they don’t. But I like it that they’re happy at me.”

For students like Jorge one of the student speakers at graduation, saw the importance of everyone succeeding in math as a communal effort: “...Trying to help them to learn things that they don’t know that I know. And that’s all so they could do better in math.” For others, receiving affirmation from the teacher was appreciated and important as they helped others. Eduardo, who found mutual respect in class and in sports important, said that helping other students “feels good because then Cruz will say thank you for helping the other students, and that feels good.” Jerome and Leticia, two talkative students who seemed to want to participate more in class, did not mind students wanting their help but saw the importance of doing their work first before helping students with theirs.

6.1.2 Dependent

I asked students what they preferred: working together in a group or by themselves. Only three in ten students preferred working by themselves. See Figure 6. The three students who were coded as not having a preference said the choice was “medium” [in the middle] or both working individually and in groups. The majority of students who preferred working together shared the same reasons: they felt they gained better understanding than by themselves and had recourse when needed. For a few, working alone was a deficit because “when you don’t understand the problem, you just stuck.” Being stuck on a problem did not seem to be motivation enough to continue working through the problem without help from

classmates. By working together, students could “help somebody having a difficult time doing the math stuff.” However, the lack of motivation to continue working through a problem by oneself points away from a mathematician’s identity.

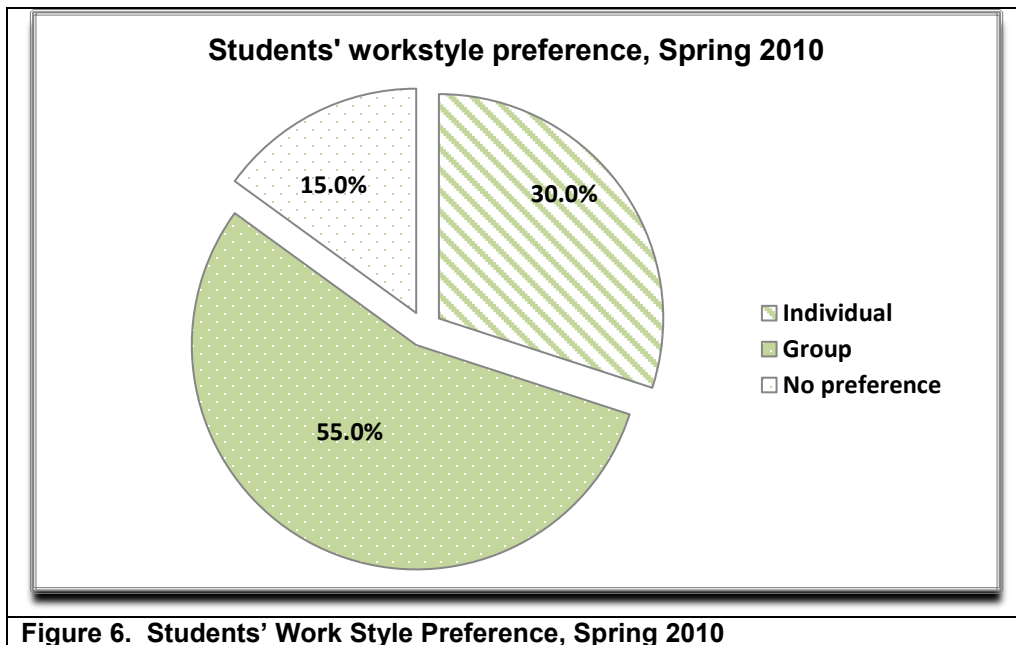


Figure 6. Students' Work Style Preference, Spring 2010

A few students, on the other hand like Alejandro, enjoyed connecting with students who shared their love and ability in math. He liked working with other students like Javier and Fadhila because “they’re great at math, too.” He liked working with Fadhila because “she explains how to do it good and doesn’t give me the answer.” Enjoy the intellectual motivation and challenge from peers is present and this community of mathematicians. I asked him if he ever turned to Gerardo for help because, maybe unbeknown to him, Gerardo considered Alejandro his friend and a math genius. Alejandro said he never turned to Gerardo for help even though Gerardo said he turned to Alejandro for help. It was interesting to see the difference in consideration of the two with respect to their mathematics abilities. A few students also admitted the socially desirable aspect of working together: quite simply, it was fun. Even though Jorge did not like receiving help from students, he liked working in groups because “going independent was kinda boring” and he finished fast. In addition to mutual help and understanding, working in groups meant “catching up” for Antonio with his friends and having fun for Dayanara.

Accountability was a unique response to the question of working in groups. For Paolo, a soft spoken, high-pitched, mathematically agile 10-year old Puerto Rican, working together relieved the pressure of accountability for Paolo. He admitted:

“Because when I’m by myself, it’s like everything is on me. So let’s say I get a question wrong, it’s all on me...Nobody helped me. It’s nobody that could help me to get it right. So it was all on me that I got it wrong. And I don’t like to feel like that.”

However, Paolo did not consider himself a mathematician.

6.1.3 Independent

For Domingo, one of the six students who preferred working independently, accountability was viewed positively: “...because mostly I get all the credit if I do it myself and if I do it good.” I understood Domingo’s reason very well. I also understood Jesenia’s desire to work by herself because sometimes when she worked with other students, she said they usually started to copy her work. Even though she said it was okay that they copied her and that she understood why, the fact that she preferred to not work with students for that reason revealed that it was not okay with her.

In addition to personal accountability, ease of work was a reason given by several students. Javier, very frank about his reasons, explained: “Because going by myself is much easier and simpler and faster. Because when I’m in groups, ummm, when I finish right away, they say, wait, wait, wait, can you at least help me.” I could not help but to smile as he answered because I understood him perfectly. As he enjoyed working by himself, he said he did not often ask for help, and if he did, he asked the teacher first, and next, “one of the smartest people in the class.” He named five people with Fadhila and Nilisa being two of them. The other three were not participants in the study. Nicole was quick to answer that she preferred to work individually for the same reason:

“On my own cuz if I’m in a group, I get distracted. Cuz everybody keeps talking to me and I’m trying to do my work. And then I just go somewhere else and Ms. George be like aren’t you supposed to be in a group? And I just say I wanna work alone.”

Although the stereotype of the mathematician as the loner or oddity persists even in the minds of young people (Picker & Berry, 2000), it is a reality for a few students like Alejandro, Zulema, and Javier who turned to their teacher first for help, and then only to particular classmates for help, seeking only others who they believed were knowledgeable and who they felt could help them best. Jorge, one of the student speakers at graduation, was the only student who sought out the teacher alone for help. He said

he did not turn to his classmates for help because he was “trying to learn the stuff without anybody’s help.” He reminded me of me when I was growing up.

6.1.4 Agent of Own Learning

Students also positioned themselves as agents of their own learning as demonstrated in their various ways of participating in class, including, but not limited to, volunteering answers from one’s seat, solving problems at the SMART Board or chalkboard, or passing out materials to the class. Students who participated in class found it intrinsically rewarding for sundry reasons: the pride in one’s effort or work, the positive affirmation received from the teacher, the simple pleasure of helping others to learn, the importance of learning more themselves by helping others to learn, or the sense of belonging evoked by participating. Lourdes, who often seemed lost or distracted in class, wanted to participate regardless of students’ negative comments. She seemed to be proud of her effort whether it was volunteering answers from her seat or working out problems on the SMART Board:

Researcher: No, I’m saying. No one has said fractions before. And when they look around, when I say look around, what math do you see, you’re the first one that’s said fractions. You’re giving all these good answers. Good grief. So when I’ve been in class, I saw a lot of you participating. I saw you go up to the front sometimes. How’d you feel about participating?

Lourdes: I was kind of nervous like if I get the answer wrong since I got kinda bad kids in my class, they be like oh, Lourdes you’re dumb, you don’t know how to do this question. I be like I don’t care what you say. At least I tried it.

Hernan, an active, competitive 11 year old Dominican boy, liked to “get up in front of everybody and show them how to do it...to show people that don’t know how to get it, then they’re gonna start.” Natasha, a quiet and bright 10 year old Honduran girl, also felt a sense of belonging by participating. She also believed it necessary to graduate: “I feel good cuz I won’t feel like I’m the only person that’s gonna be like by myself cuz I don’t wanna stay back in this school again. I wanna leave.” Bernardo also believed it necessary to graduate: “...Mrs. Cruz said the more you participate, like if you do your work and stuff, she can use our stuff, and if you fail...she’ll bring that up and make us pass if we have a lot of work.” In addition to academic progress, Alejandro, a glasses-wearing, competitive 11-year old Dominican boy, saw participation important to his future career possibilities. He liked to participate “so [he] could get good grades and help [him] have a job when [he] grow[s] up.”

6.1.5 Leader

Students were very clear about the need to pay attention in class. Although paying attention is essentially an individual process, it has communal effects, especially if a large number of individuals are not paying attention in class. If that is the case, then it appears that the class as a collective is not paying attention. A handful of students seemed to take a proactive approach when dealing with their disruptive peers, even if their efforts were unsuccessful. Maria said she tells them to shut up: “When you scream at them and tell them to shut up, they will stop talking. They get scared and stop talking.” Maria took a proactive approach when she really wanted to hear what was being said even though she admitted that sometimes she would be one of the students talking, too.

Interestingly, she named herself, Ariela, Chantelle, and Jerome as students who the class listened to “cuz we’re loud. We tell them, and they listen.” Ariela, although she said would tell them to be quiet, she said they would “be quiet for a little while and they keep on doing it.” Ariela, at the beginning of the school year was talkative herself; however, as the year progressed, her talking subsided and she began to focus and participate in class more. The part she hated the most about math class was the noise and the disruption as it interfered with her concentration when trying to do math work that she liked.

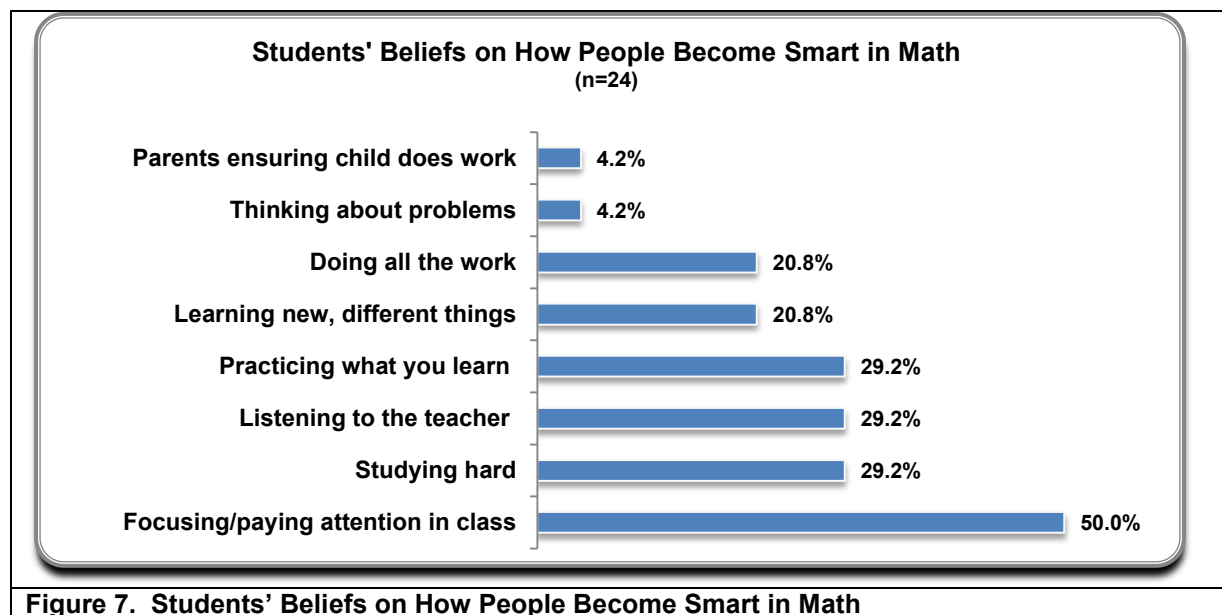
Other students like Dayanara often took responsibility for their learning by trying to get students to pay attention. Dayanara, like others, became annoyed and angry when students did not listen in class. For the most part, the same students were named in each class as trying to quiet others down—Fadhila, Javier, Nilsa, Lourdes, Leticia, and Maritza in Mr. Knight’s class, and Maria, Ariela, Jerome, Chantelle, and Dayanara in Mrs. Cruz’s class. Intentionally or unintentionally, these students positioned themselves as leaders, demonstrating the importance of learning math in an environment where there was focus, quiet, and equitable participation.

6.1.6 Math Smart and Capable

I asked students a variation of the question “How do people become smart in math?” to gain understanding of the processes fifth graders believed were necessary, especially if mathematics is supposed to be accessible to everyone. As with several other questions, this one was not in the proposed set. As semi-structured interviews leave doors open to explore new or unexpected ideas, I took the liberty of asking it among others that connected with the stereotypes and assumptions of how mathematicians come into being. Many people are of the assumptions that mathematicians are born that

way (i.e., born mathematicians); however, many mathematicians themselves speak of their coming into being or awareness sometimes later on in their teens and even early college years, and not in childhood. For many students, becoming smart in math involved more than one process. It was a combination of several processes resting squarely on their shoulders. Only one student, Zulema, included parents in the active development of student's mathematics intellect. See Figure 7. She responded:

"Well, it depends on their parents. If the parents doesn't care what the child does, then they wouldn't, the child wouldn't care at all. Well my mom, she cares. And my mom and dad really care. And she encourages me. She says I told you, you know it. She gives hugs, and everything when I do good. Some parents just don't do that. They just be like I don't care, do whatever you want, get in your room. And the kid just turns on the t.v., and they don't care. They don't do their homework. So, it's up to the parents. My mom says when I'm in trouble for being so talkative. And every time I do that, she's like, oh see, now Zulema you're gonna read a book. Turn off the t.v. She be screaming at us every time we watch the t.v. when we could be reading, and learning more instead of being outside. She be like turn off the t.v. I want you to do work!"



I followed up with "Do you think they [people who are smart in math] were born that way?" See Figure 8 for percentages of responses. Two boys and two girls answered "yes" or "sometimes." Although Ariela said yes, she acknowledged that "some people can be born smart but over the years, you keep going up you're gonna get smarter and smarter, the more you look at it, the more you see it, and the more you, you umm, know how to use it." Luis, who did not see himself as a mathematician, saw heredity as a

possible explanation of people being smart in math: “Well, their parents must have learned a lot of math and they probably got it from their parents.”

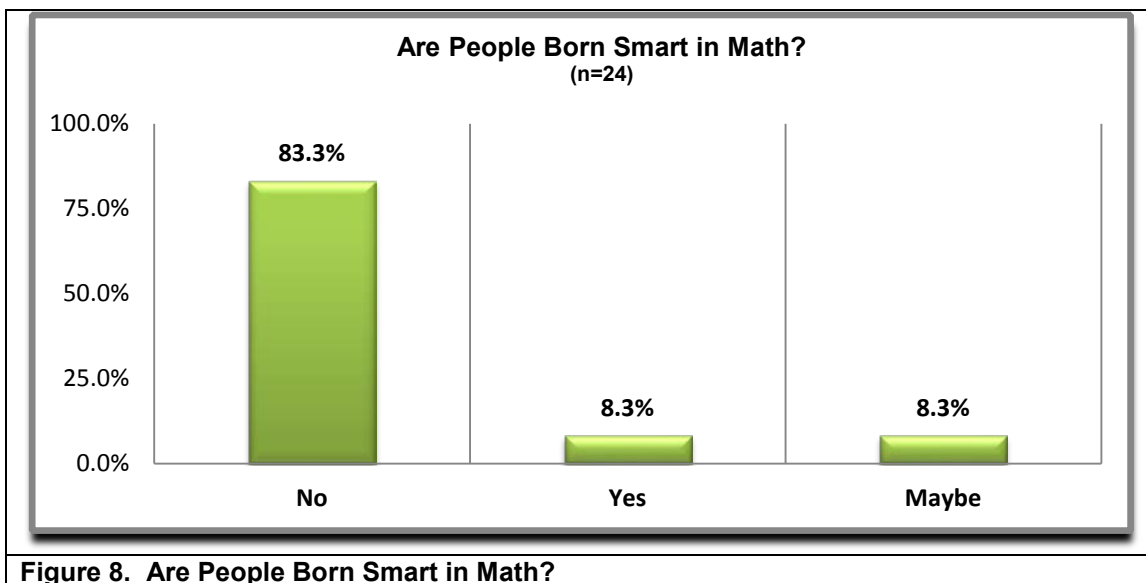


Figure 8. Are People Born Smart in Math?

The remaining twenty students responded emphatically with no. Personal effort in class, specifically paying attention, listening to the teacher, and trying hard, summed up for students how people become smart in math. Some students used themselves or family and friends as examples to support their disagreement with the notion of people being born smart. Alejandro, a self-proclaimed math master, recalled his journey in becoming smart: “No, cuz at first I wasn’t good at math like around in first grade, but then here comes second grade, so I like math.” He is one of the top students in his class. Fadhila used her brother as an example of one becoming smart: “I don’t think it’s true cuz my brother wasn’t always doing good in math but he’s good in math.”

Belen, an incredibly soft-spoken student, inaudible in class, had much to say on the subject: “...that’s not true cuz you could be smart in math even if you’re not born that way. You could learn a lot in math that could make you smart in math and to be a smartmatician, a, a mathematician.” For Paolo who swims and plays baseball, being smart in math was just like being smart or capable in any other subject or skill:

“I don’t think that cuz anybody could be smart in math. Anybody could play baseball. It’s the same thing. That’s what I tell myself. Like cuz when I was in third grade, I needed help with math and my dad told me, how you became a baseball player? Cuz I wasn’t that good. He asked me how I became a swimmer and I couldn’t even swim. So, that make me feel like how do I become a good student. So that’s why I started doing my work and paying attention. So I got everything down pat.”

For Javier, who saw himself as a mathematician more in fourth grade than fifth grade, one could not be born already smart in math but one could be born ready for math, and for someone to think they were perfect in math because they considered themselves born already smart in math was truly upsetting to him: "...nobody's perfect because some day you might get an answer wrong. Because like thinking that you're the best math master of all, saying that you don't care about nobody else trying and trying really hard, I feel really upset when they say that." He associated being born smart in math with perfection in math; an assumption and stereotype that have existed throughout the ages. For two girls, Nicole, the lawyer, and Lourdes, the veterinarian, being smart in math could be delayed or challenged by a mental disability. Nicole quickly defended the possibility of everyone being smart in math, even with a mental disability: "It's not true. Some people that's mentally [that has a mental disability], they could learn it but it's gonna take some time but they could learn it. You shouldn't make fun of them." They were the only two students who considered the possibility of what being born smart in math looked like from a disability standpoint.

For Antonio, when I asked him some what some of the things he liked to do in math class, he responded not with math topics, games, or activities but with responsibilities. He enjoyed being the student who Mrs. Cruz asked to operate the laptop for the SMART Board: "I, love to do, cuz sometimes my teacher, she have to move the computer. She ask me to fix it, and sometimes I fix it and do math at the same time." His feeling needed and capable in math class was what he enjoyed most. He said he felt good when she asked him to help. It appeared that he associated his being needed, his fulfillment of a responsibility shared with no other student, with his ability and intellect. When I told him that I thought he was the only one I had seen at the laptop, he immediately smiled and responded, "Yeah, I'm smart, right?" He proudly recounted his laptop responsibility with different teachers since second grade. Observing Antonio at the laptop, I began to see how focused he could be in class and with his work. Maybe this was a strategy that each teacher used to keep Antonio focused and participating in class, doing his work, and, at the very least, less distracted by his own devices and other students.

6.2 Classroom Processes

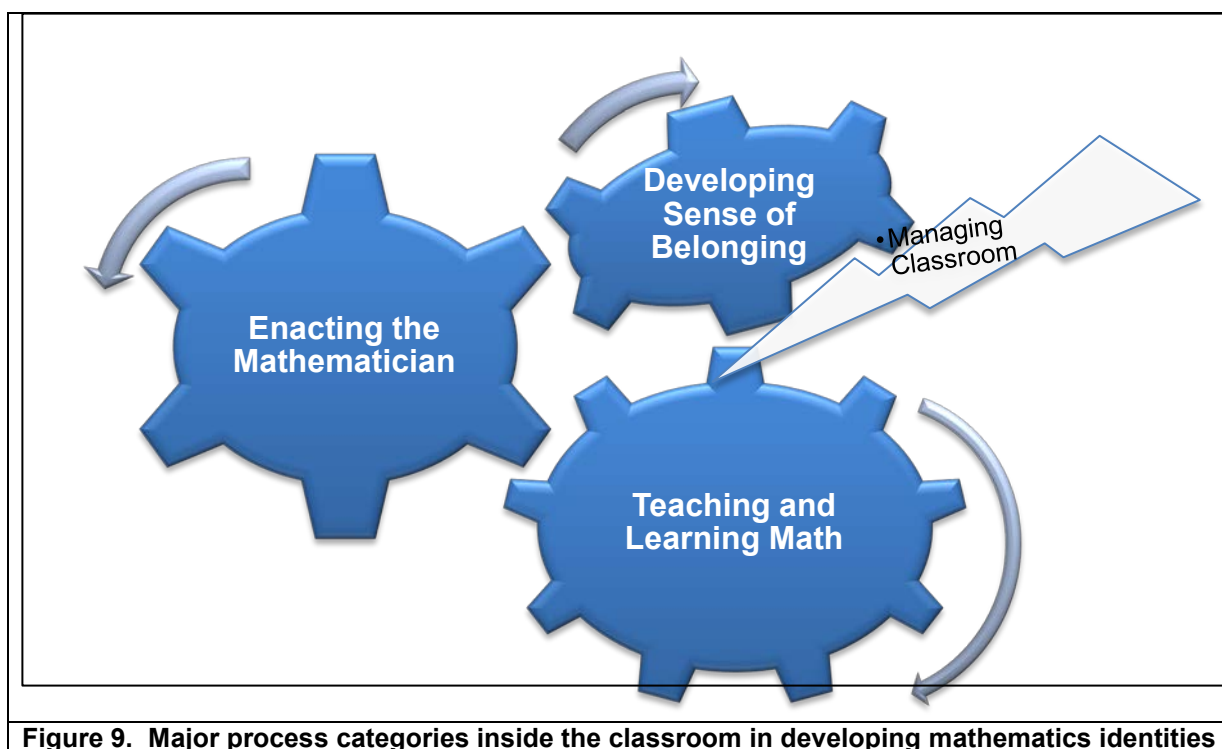
What are the specifics and characteristics of the following processes inside of the classroom: learning mathematics; enacting skills, characteristics, and qualities of mathematicians; and, developing a sense of belonging? To explore these processes and others that may exist in the classroom, I observed both classrooms at various times throughout the year, however, mostly before March 2010. It was not possible to observe both classrooms engaging the same lessons. Therefore, comparisons cannot be made across lessons. What can be explored, however, are processes specific to each classroom over the observation period and processes common to both classrooms.

Research suggests that intervening at the process level may be a successful means of improving both adolescents' engagement in school and their subsequent school performance (Benner, Graham, & Mistry, 2008). For effective and efficient inner-city elementary schools, the following individual student or classroom processes were evident: classmates affiliated strongly with each other, teachers supported students and kept them on task, teachers showed personal regard and interest in students' work, student worked in small or cooperative groups, and students had high aspirations (Waxman et al., 1997). There are generative classroom processes that impact classroom dynamics, also, such as students taking responsibility for making decisions about their learning and production of knowledge and practice, and contributing to the practice of the community (Ares, 2006). Issues of learning and agency are essential to the individual and classroom processes. Identity mediates practice and emerges as a product of repetitive classroom processes of teacher pedagogy, student discourses, and activity (Solomon, 2007).

In observing the classrooms, I took both a wide view and a narrow view. The purpose of the wide view was to see what was the overall feel or atmosphere of the class, the spirit of the teacher and students, while the purpose of the narrow view was to see students in action by themselves and with others. I was always excited to see what the students would learn each day, and how the lesson would be engaged. However, as behavior problems worsened over the year, I became more nervous for the teachers. I could feel my body tensing up when behavior problems started, constantly asking myself, "Who am I? The teacher or the researcher?" in an effort to stay neutral as much as possible. Tension and all, I was still excited to see which students would shoot their hand in the air lightning fast to be called on by the teacher. I wanted the class, the teacher and the students together, to enjoy the math lesson—teaching it, learning it, practicing it, and getting a handle on it. In my spirit, I was rooting for the quiet ones

to raise their voice, hand, or head to give their answers to the questions. I liked seeing the students excited about what was before them, asking questions, helping each other, responding to the teacher, some stumped by it but working through it, and some sailing passed.

The processes of learning mathematics included the teaching of mathematics as it was at times difficult to answer how students learned without mentioning how they were taught. Did they only learn while doing individual or table group work in their Math Journals or did they also learn while attempting to answer mental math questions the teacher posed or while writing what the teacher detailed on the board? The question of the teaching-learning process arises as teaching and learning processes are not independent of one another and both together aid in the cognitive development of the child (Stetsenko & Arievitch, 2002). See Figure 9 for the process categories inside the classrooms.



To gain a sense of the context in which these processes occurred, it is important to have a picture of the classroom settings. Both classrooms were fairly large—large enough for 25 to 27 students comfortably, and twice as large as the middle school classrooms in which I taught on average 35 to 38 steadily growing, erratic tweens and teens. (Tweens are youth between the ages of 10 and 12—too old to be considered a child, per se, and too young to be considered a teenager.)



Photo: Mrs. Cruz's classroom from the doorway facing the rear of the classroom. The SMART Board is to the right of the doorway at the front of the classroom. (Photo taken by Paula J. Fleshman, November 2009.)



Photo: Mr. Knight's classroom from inside the door corridor facing the rear of the classroom. The SMART Board is around the left corner of the corridor at the front of the classroom. (Photo taken by Paula J. Fleshman, November 2009.)

Looking back at my teaching experiences, I have to admit that I was a little envious of the amount of space (floor, walls, and closets) and resources available to the teachers of this school. Each room had staples of teaching, learning, and organization: SMART Boards, chalkboards, bulletin boards, and

bookshelves, small or large, for libraries with reading materials for ELA and social studies, and tools for math. Around their rooms both teachers used the walls, windows, and hanging lights to post signage created for the students by the students and teachers.

What follows are the mathematical processes observed across the classes at various observation points. The processes of student misbehavior and classroom management (i.e., students disrespecting others, students playing around, class talking loudly about non-math topics, teacher ignoring misbehavior, teacher rewarding good behavior) are not included below as the focus is on the mathematical processes. Even still, it appeared that the student misbehavior and classroom management processes did affect the mathematical processes, both teaching and learning, as is common with disruptive behavior (Freiberg, Huzinec, & Templeton, 2009). To what measurable extent such behavior and management processes affected these two classrooms is uncertain; however, qualitatively, the effect was clear in terms of students' and teachers' physical, emotional, and verbal responses and actions in the classroom and the interviews.

6.3 Teaching and Learning of Mathematics

The instructional framework of the math class was guided by the *Everyday Math* curriculum as detailed in the Teacher Resource Manual. The students after their lunch/recess had double periods of math totaling 90 minutes, normally starting at 12:30 p.m. At times, however, teachers needed to teach or review other subjects and either delayed the start of math anywhere from five to 20 minutes, or switched the class entirely to another block period at the beginning or end of the day, if not the next day. I only knew of those changes, if any, upon entering the classroom for the scheduled math period. Those changes happened more often with Mr. Knight, although he and I managed to make up for two missed observations by scheduling different days for me to observe.

Mrs. Cruz regularly opened math class with mental math then followed with the aim, the math message, Math Journal work, review of the Math Journal work, and if time allowed, then ended with the math boxes. The time taken for each aspect or part of the framework varied from lesson to lesson, with mental math, the aim, and math message sometimes overall taking from an half hour to approximately an hour. Mr. Knight also followed for the most part this instructional flow. The teaching of mathematics as a process category included several common processes observed in each classroom at various points over

the school year. See Table 10 below for common teaching processes. What follows are observation excerpts that reflect these teaching processes across the year and across the classrooms.

Table 10. Teaching processes common across both classrooms.	
<ul style="list-style-type: none"> • Teacher acknowledging student's math skills • Teacher affirming student's answer • Teacher allowing students time to process question/assignment • Teacher asking closed-ended question • Teacher asking open-ended question • Teacher calling for volunteers • Teacher calling on student to answer • Teacher drawing on student's prior knowledge • Teacher giving students choice in activity • Teacher helping student • Teacher illustrating math on board • Teacher instructing the class directly • Teacher listening to student • Teacher looking around the room for students to participate 	<ul style="list-style-type: none"> • Teaching making a mistake • Teacher prompting the class to answer • Teacher querying the class/student • Teacher repeating information to class • Teacher repeating student's response to class • Teacher rephrasing question • Teacher responding to student • Teacher self-correcting a mistake • Teacher using teacher resource manual • Teacher walking around room to see about students' work • Teacher writing problems on board to solve • Teacher writing solution on board • Teacher missing opportunity to explain/check for understanding

Mrs. Cruz's Class, Field Notes, 9/23/2009

Aim: How can we identify squared numbers?

Mrs. Cruz, standing at the front of the classroom pointing to the chalkboard, explained to the class: "When an array has the same number of rows and columns, it is shaped like a square and is called square number." Mrs. Cruz drew arrays of dots corresponding with the squared numbers.

1	4	9	16	25
•	• • • •	• • • • • • • • •	• • • • • • • • • • • • • • • •	• •

For each squared number, Mrs. Cruz drew the square root number of columns and rows as dots. For example, for 1, Mrs. Cruz drew 1 dot. For 4, Mrs. Cruz drew 2 rows of 2 dots and 2 columns of 2 dots making 4 dots. And so on for 9, 16, and 25. Students

copied in their notebooks the arrays of dots. Mrs. Cruz looked around the room and called on different students around the room for the arrays.

Mrs. Cruz asked the class, "What did we learn about 49 the other day?" She paused for a few seconds, looking around the room. She looked towards the back of the room, and called on Dayanara, whose hands were raised, first the right one, then the left one. Mrs. Cruz listened to Dayanara's response and then repeated it to the class, "7 rows, 7 columns. It's an array. The same with 6 times 6 equals 36."

Mrs. Cruz turned to Natasha who was sitting towards the back by the closet wall in front of the computers, and said, "Natasha, explain to the class why 36 is a square." Natasha explained in detail.

Mrs. Cruz, still standing by the chalkboard, continued on with her mental math exercise. She turned to Luis, and asked, "Luis, what is 7 times 8?" While she was waiting for Luis's answer, she softly reprimanded a boy for not having moved back to his seat. Luis, sitting towards the closet side of the classroom, answered, "56."

She then called on Carlos, who was sitting towards the front by the closet side. "Carlos, 8 times 7?" Carlos sat still in his seat. He had been talking, and had not answered the question. Mrs. Cruz looked at Carlos, and said, "I'm listening. You tried to trick me twice." Carlos finally answered, "56."

Mrs. Cruz looked at Ariela, sitting at the front of the class, and said: "Ariela, 6 times 7." A few second passed. Mrs. Cruz asked Ariela again. Apparently, Mrs. Cruz didn't hear Ariela. I didn't hear Ariela. A girl sitting near the front said to Mrs. Cruz, "She just said it." I still don't know what Ariela said. Mrs. Cruz did not ask Ariela to repeat it so that she and rest of the class could hear it.

In this brief excerpt of 9/23/2009 occurring a few weeks into the school year, Mrs. Cruz carried out a number of teaching processes mixed with classroom management processes to try to help students to learn and understand arrays, a concept that at this elementary level involves basic multiplication. These processes include Mrs. Cruz graphically illustrating the mathematics concept on the board, looking around the room for students to participate, querying the class, drawing on students' prior knowledge, allowing students time to process the question, listening to students, repeating student's responses to the class, and calling on particular students to respond. Mrs. Cruz's calling on different students across the classroom to answer problems along with acknowledging student's misbehavior also contributed to a sense of belonging and community in the classroom as it gave the impression that the attention, participation, and learning of every student was important. Nonetheless, some of the processes observed did not occur consistently throughout this lesson such as repeating student's responses to the class.

For Mr. Knight, teaching processes that occurred during the second week of school were observed in the field note excerpt below of 9/16/2009. During this lesson, Mr. Knight's aim was to help students understand factors—what are factors, what are not factors. These processes include Mr. Knight

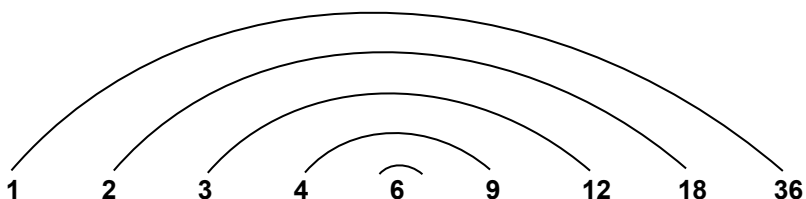
writing the assignment on the board, allowing students time to process the question/assignment, graphically illustrating the mathematics concept on the board, querying the class, calling on particular students to respond, drawing on students' prior knowledge, listening to students, making a mistake, and missing opportunity to explain/check for understanding. Mr. Knight graphically illustrated mathematics on the board twice to aide in his students' understanding and drew on their prior knowledge. However, he did not review the assignment of making multiplication sentences—a task that he could have used to check the students' understanding. Not following through with this assignment brings into question the importance of work assigned in class.

Mr. Knight's Class, Field Notes, 9/16/2009

Aim: What are factors?

Underneath the aim on the chalkboard, Mr. Knight wrote “List all factors of 36. Then make multiplication sentences.” Mr. Knight told the class he was giving them one minute to do the aim. Students copied the aim quickly. The majority of the class was trying to figure out the factors. While the students were working on the aim, Mr. Knight told the students what they were going to work on in class today.

Next, Mr. Knight drew a Factor Rainbow on the chalkboard, first drawing arched lines for the factors of the original number to be filled in. He asked the class what were the factors of 36 since it was the aim. Students called out the factors in no particular order. However, Mr. Knight wrote them in order on the lines. He then drew connecting arrows arching over the factors from the lowest factor to the highest factor, then second lowest to second highest, and so on until the last factor of 6 in the middle with a small arch over itself. The graphic resembled a rainbow with the overarching arrows.



Mr. Knight didn't ask them explicitly what the relationship was between the connected factors. He did not point out this relationship to the students, or the arch that was over one factor only in the middle of the rainbow.

After drawing the factor rainbow, he asked the class, 'How do we know that 5 is not a factor of 36?' He called on a few students. They didn't know how to explain it. Then Mr. Knight wrote on the chalkboard three division problems to illustrate to the class why 5 is not a factor of 36.

$$\begin{array}{r} 7\textcircled{1} \\ 5 \overline{)36} \end{array} \qquad \begin{array}{r} 12 \\ 3 \overline{)36} \end{array} \qquad \begin{array}{r} 5 \\ 7 \overline{)36} \end{array}$$

In the first operation, Mr. Knight circled the 1. He pointed out to the class that because 5 did not go evenly into 36, there was a remainder of 1. However, in the 3rd operation, Mr. Knight circled the 5, and did not put 1 as the remainder.

Mr. Knight then moved off of the Factor Rainbow and onto doing more with factors. He did not have the kids make multiplication sentences, or call out their multiplication sentences if they had made any from following the aim. Mr. Knight told the class to turn to page 306 in their student reference book. Page 306 is Factor Captor. Mr. Knight used the overhead for this exercise.

As I looked at Mr. Knight and looked around the room at the active-ness of the students, I noticed Mr. Knight called on different students to do different chores or responsibilities in the classroom. Students were talking but seemed excited to play Factor Captor.

Mr. Knight tried to quiet the students. He was trying to go over the directions for the game. He said to the class, "The only way this is going to work is if you guys listen." The girls at the table group where I was sitting were quiet.

As the year continued, common teaching processes continued for both teachers. Even after the holiday break in late December of 2009 and early January 2010, teachers returned to the business at hand. In the first week of 2010, Mrs. Cruz covered fractions, with this particular lesson focusing on the ordering and comparing of fractions. Mrs. Cruz continued to employ the same processes since September, the beginning of the school year, as observed in the previous observations such as graphically illustrating math concepts on the board, drawing on students' prior knowledge, looking around the room for students to participate, and calling on students to respond.

In the excerpt of 1/6/2010 below, in addition to the previously observed processes, different ones were observed, those that pointed to teacher-student communication (a back-and-forth, question-answer style) where Mrs. Cruz asked a question and the student answered. Although Mrs. Cruz asked open-ended questions, she mostly asked closed-ended questions requiring a student to offer an answer yet not necessarily with an explanation. Mrs. Cruz rephrased questions if students did not understand or answer, and affirmed students' answers when they were correct. However, she did not check students' understanding, or more importantly, their misunderstanding with ordering and comparing fractions. Mrs. Cruz mostly stood at the front of the class unless circulating around the room to check on students' work.



Photo: Mrs. Cruz's classroom from the rear of the classroom viewing the front. (Photo taken by Paula J. Fleshman, February 2010.)

Mrs. Cruz's Class, Field Notes, 1/6/2010

Aim: How can we order and compare fractions?

Domingo raised his hand and said to Mrs. Cruz that he didn't understand. Mrs. Cruz, at the front of the class, started explaining in terms of a pie. She said, "I want you think of a pie." As she talked, she drew two circles on the chalkboard and drew lines through them to illustrate slices. She continued, "This pie has 12 slices because the denominator is 12. And this pie has 9 slices because the denominator is 9. You see the slices for 9 are bigger than the slices for 12." She shaded in two slices for each pie, and said, "See, it is more. Do you understand now Domingo?" Domingo nodded his head. Seconds later, Domingo raised his hand again, and said, "#8 is confusing."

Mrs. Cruz, standing in front of the chalkboard, said to class: "Let's see who had the answer for problem #8." Mrs. Cruz turned around and wrote problem #8 on the chalkboard: $\frac{2}{3}$, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{3}{4}$. Mrs. Cruz asked the class, "Why was problem 8 hard?" The class was quiet. No one answered her question about why #8 was hard, or offered an answer to the problem, not even the students who I thought would have an answer such as Dayanara, Natasha, Jorge, Jesenia, Paolo, Earl, Luis, Silvestre, or Jerome.

Mrs. Cruz asked the class, "What is $\frac{1}{3}$ of 1?" The class was still quiet. Mrs. Cruz said to the class, in a slight disapproving tone, shaking her head: "Uh-unnn. You don't know what is $\frac{1}{3}$ of 1?" The class was still quiet. Mrs. Cruz looked around the class and repeated it but now put it in terms of dollars and cents: "Uh-unnn. You don't know what is $\frac{1}{3}$ of \$1?" Natasha immediately said, "33 cents." Mrs. Cruz replied, "Good Natasha." Natasha smiled. Mrs. Cruz then asked the class, "Okay. $\frac{1}{4}$ of a \$1?" Jorge said softly, "25 cents." Mrs. Cruz replied, "Yes, good Jorge."

Mrs. Cruz next asked the class, "Now what is $\frac{2}{3}$ of \$1?" There was talking in the class but in low voices. No one answered Mrs. Cruz. Mrs. Cruz asked, "If $\frac{1}{3}$ of \$1 is 33 cents, then how much is $\frac{2}{3}$?" Natasha quickly replied, "2 times that. 66 cents." Mrs. Cruz said, "Good. That is right Natasha. 66 cents." Natasha smiled big. Mrs. Cruz continued along this line of questioning with the class to complete the problem (#8). Mrs.

Cruz was still standing in the front of the classroom between the two table groups closest to the SMART Board.

Mrs. Cruz asked the class, "Now what is $\frac{3}{4}$ of a \$1?" Antonio, sitting at the front table group near the laptop desk, raised his hand and replied, "75 cents." For each cent value students answered, Mrs. Cruz wrote the value underneath the fraction. The class was a bit talkative while Mrs. Cruz wrote on the chalkboard.

$\frac{2}{3}$, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{3}{4}$
66¢ 25¢ 33¢ 75¢

Mrs. Cruz reminded the class, "Class, convert the fraction to decimal first, making it easy to order them. Hernan, can you put them in order please?" Hernan stood up and said the decimals in order. Mrs. Cruz looking towards the back of the room, said to Chantelle: "Chantelle, do you understand why this is the order?" Chantelle nodded her head. Mrs. Cruz didn't probe to see if Chantelle really understood. She continued on.

Mrs. Cruz still standing at the front of the class, said: "Now all we need to do is to convert fractions to decimals. It's going to be easier for you to order fractions if you convert them from fractions to decimals. Let's see what happened to problem 9."

Mr. Knight also continued to employ the same processes since September and include more as observed during the second week after holiday vacation. In this excerpt below of 1/13/2010, Mr. Knight employed additional processes to engage his students in the beginning of class in converting improper fractions to mixed fractions: giving instructions, writing problems on the board, asking closed-ended questions, asking open-ended questions, asking probing questions, allowing students time to process the question/assignment, and affirming students' answers and work. Additionally, his teaching was peppered with direct instruction and emotion management, a skill often employed to help children manage their feelings when they have been hurt by the thoughtless comments of other students. Mr. Knight, too, mostly stood at the front of the class while teaching. When not teaching, he often sat at the SMART Board laptop desk while students worked.



Photo: Mr. Knight's classroom from the center of the classroom facing the front. (Photo taken by Paula J. Fleshman, November 2009.)

Mr. Knight's Class, Field Notes, 1/13/2010

Aim: How do I measure my progress?

Mr. Knight went over improper fractions for about a couple minutes. Mr. Knight put up six improper fractions on the SMART Board for the class to convert to mixed fractions.

$9/3$	$25/4$
$13/6$	$22/8$
$18/4$	$55/25$

Mr. Knight said to the class: "Listen up. That shouldn't take you more than 2 minutes to do these 6 problems." Mr. Knight waited a few minutes and then said to the class: "May I have a volunteer?" Mr. Knight looked around the room for volunteers. Aliyah raised her hand. Mr. Knight called on her.

After Aliyah finished explaining solution steps to the improper fraction $22/8$, Mr. Knight asked Belen, sitting at the first table group by the right wall, "What do I do next?" Belen was silent. She looked confused. Mr. Knight, pointing to the next problem $18/4$, asked Belen, "Why is this an improper fraction?" Belen paused and looked at Mr. Knight. Speaking slowly and barely audibly, she said, "Because the numerator is bigger." Mr. Knight said, "Good. Okay. So divide 4 into 18." Belen sat in silence. Mr. Knight called her up to the SMART Board. Belen got up and went to the SMART Board. There were students who were talking. Mr. Knight didn't reprimand the others for talking even when he was having trouble hearing Belen.

Mr. Knight asked Belen, who was standing in front of him now, "4 times what number is almost 18?" Belen paused and answered: "2?" Mr. Knight stood silently looking at Belen. D paused again, and tried again: "4?" It seemed like Belen was guessing but Mr. Knight went on, "4 times 4 will give you 16. 4 goes into 18 four times with how much left over?" Belen looked upward towards the ceiling and counted on her fingers, "2." Mr. Knight wrote Belen's answer at this point on the SMART Board: $4\ 2/4$. Mr. Knight continued, "Okay. What number goes into 2 and 4?" Belen hesitated. She then counted

silently in her head, and then said, "2." Mr. Knight nodded, and wrote the reduced fraction $4 \frac{2}{4} = 4 \frac{1}{2}$ on the SMART Board. Belen returned to her desk.

Mr. Knight called for volunteers to do the next one. Fadhila raised her hand. She was the only one other than Donny. Fadhila went up to the SMART Board and wrote the problem, $55/22$, at first. Mr. Knight corrected Fadhila and said, "25. 55 over 25." Fadhila seemed a little confused and then realized what she had written. She erased it and wrote $55/25$.

While Fadhila was writing out her answer, Javier started crying and yelled, "No it's not!" Mr. Knight called Javier over to him and talked to him gently. Mr. Knight asked Javier, "Javier, why are you crying?" Javier, with tears running down his face a little red, said, "Because James said I got the answer wrong." Javier was sitting across from James at the same table group.

Mr. Knight to Javier: "Did you get it wrong?"

Javier to Mr. Knight: "No."

Mr. Knight to Javier: "So, why are you crying? You know you didn't get it wrong." Mr. Knight paused, and then continued, "So stop crying." Javier wiped his tears with the backs of his hands. Mr. Knight to K: "Now go back to your seat."

Mr. Knight turned his attention back to Fadhila: "Please explain to us how you did it." Turning partially to the class, and partially to the SMART Board, she pointed to each step as she said it: "25 goes into 55 two times with 5 left over. My denominator is 25. I want to make it into lowest terms. The highest number that goes into 5 and 25 is 5. Then you divide. 5 into 5 goes 1. 5 into 25 goes 5. Then you get $2 \frac{1}{5}$." Fadhila put the marker down when she finished and started to walk back to her seat.

Mr. Knight said to the class, "Ladies and gentlemen, now that's how you do the problem. Nicely explained Fadhila." Fadhila smiled when Mr. Knight said that.

6.3.1 Less Common Teaching Processes

The less common processes were the following: (1) teacher encouraging different solution strategies or techniques from students; (2) teacher referring to the signage around the room; (3) teacher using math manipulatives for lesson; and, (4) teacher doing spontaneous math activity. However, the processes of the teacher showing excitement about the lesson or activity and teacher doing spontaneous math activity were more evident for Mrs. Cruz than Mr. Knight. Spontaneity can evoke excitement in the class and lead to a fun way of learning or reviewing math topics. I observed Mrs. Cruz using spontaneity twice early in the year, once to review a familiar topic and once to introduce a new topic. The review of squaring numbers on 9/23/2009 excerpted below was very exciting and successful.

Mrs. Cruz's Class, Field Notes, 9/23/2009

Aim: How can we identify squared numbers?

On the spur of the moment, Mrs. Cruz told the right side (door side) tables of the class to unsquare 49. The class got excited. The volume level got pretty loud. Some of the students were telling each other how they bet the other students couldn't get the answers right from side to side. Then the others would respond, saying the same thing. Mrs.

Cruz, standing in the middle of the class, said to the class: "If you continue talking, I'll stop."

Mrs. Cruz turned to the left side (window side), pointed, and said, "This side. Square 8." Students called out 64. Mrs. Cruz turned to the right side (door side), pointed, and said, "This side. Tell me the square root of 64." Students called out 8. Both sides got their questions right. The volume level went right back up. The class was excited. Students were bantering with each other, and laughing. A handful of students were standing up on both feet, some were standing on one leg with the other knee in the chair.

Mrs. Cruz was smiling but was waiting for them to quiet down so she could continue. Mrs. Cruz to class: "I'm waiting. You have to be quiet." Mrs. Cruz then asked the unsquare of 100. Natasha said 50 but the right side got it wrong. The next turn went to the left side. She pointed to Hernan. There were 12 students on the left side. 8 students raised their hands. Hernan said, "10".

Mrs. Cruz kept points on the board. The kids cheered or jeered depending on who was winning.

Mrs. Cruz, smiling, said to the class: "I understand you're excited but please, it's so many of us."

Mrs. Cruz pointing to the left side: "This question's not going to be easy. I want you all to tell me all the squares from 1 to 100. In order!" Mrs. Cruz emphasized "in order." The class said in unison "Ooohhhh!!"

Mrs. Cruz had the kids on the left side vote for who they wanted to answer the question, Hernan or Earl. The kids chose Earl. Earl smiled, and then got serious. He stood up, and with his eyes closed, he said the squares almost in a cadence, "1, 2, 4, 9, 16, 25, 36, 49, 64, 81, 100". The left side roared and cheered and gave him high 5s after he finished. Hernan was saying the squares under his breath. I could see his lips moving.

Towards the end of the lesson, Mrs. Cruz tried to introduce a new topic on reaction time. It was exciting at first. Mrs. Cruz excitedly announced to the class they were going to do an experiment, and to stand up, get in a circle, and hold hands. The class got excited. I was excited, too, almost ready to jump in the circle with them. Except for a few initial minutes of a handful of students giggling and saying, "Ewwwee" and "Unn-unnn" (as children do) from not wanting to hold hands, they were ready to begin. To understand reaction time, the objective of the experiment was to squeeze the next person's hand as soon as the person felt their hand being squeeze. It was working beautifully until a somewhat large male student squeezed a much smaller female student's hand too hard. Although he said he did not do it on purpose, many students thought otherwise, partly because he was almost laughing when he apologized.

At that point, the experiment ended abruptly and distressingly with the rest of the students visibly upset at not being able to finish it, so much so, that, after repeated attempts to quiet them, Mrs. Cruz called the assistant principal to the room to control the situation. He came and spoke very sternly to the class, admonishing two students, in particular, who had continued singing and playing around while Mrs.

Cruz was trying to quiet the class. Students were upset at the fact that the whole class was getting in trouble and could not finish the experiment just because of a few students. Both Mrs. Cruz and I were disappointed that it ended so. Adults, too, cherish excitement in the teaching and learning of math.

6.4 Learning Processes

With respect to students' mathematics learning processes, several were more common. See table below. Part of the learning processes also included researcher-student interaction as part of my role as participant researcher, I helped students with their work more so to see their thinking processes than to make sure they had all the answers right. That may seem like a conflict of interest, however, I did not want to show students ways of doing their math different from what Mrs. Cruz had taught them. I had no desire to interject confusion in the classroom. The learning observed stemmed from individual work, group work amongst themselves, and from the teachers.

Table 11. Learning processes common across both classrooms.

- | |
|---|
| <ul style="list-style-type: none"> • Student asking for help • Student concentrating on answer/thinking through problem • Student copying teacher's notes from board • Student doing activity correctly • Student doing activity incorrectly • Student following directions • Student helping another student • Student listening carefully • Student watching how to do something • Student self-correcting mistake • Student trying and not giving up • Student venturing an answer even if unsure • Student working in Math Journal • Student writing what is seen or said |
|---|

Mrs. Cruz's Class, Field Notes, 11/4/2009

Aim: How can we compare triangles?

The class had started in their Math Journals working with triangles. I walked over to Maria to check on her and see how far along she had come. She was sitting in the middle table group by the closets. She asked me for help with p. 78, #3 and #5. With #3, she looked at me and said, "I think it's a triangle." I asked her to read it out loud. She read it with no problem. I asked her, "What is a polygon?" She answered, "A shape with more than three sides." Then after reading the next clue, she said, "Yes, I was right. It was a polygon." She pumped her fist once, and smiled as she wrote the answer.

For #5, she was going to measure the missing angle with a ruler but I told her she didn't need the ruler. I told her, "Look at the triangle. What kind of triangle is this?" She said, "An equilateral." I asked her, "What is an equilateral triangle?" She said, "A triangle with

all equal sides.” I said then, “Well, is that an equilateral?” She shook her head. I pointed to the box drawn for the right angle, and asked her, “What does this little box mean right here?” She shook her head again, and said, “I don’t know.” I said, “Okay, this little box means the triangle is a right triangle. How many degrees is this angle then?” She said, “90.” I said, “Good. Sooo...” I looked at her and waited to see if she could figure out how to get the missing angle as the other angle had 45° written in it. She just looked at me. I said, “Okay, so how many degrees does a triangle have inside of it?” She said, “136.” I made a funny face. She laughed.

Natasha, standing right beside me with her Math Journal on Maria’s desk, said, “140.” I said, “180. Remember?” I asked them again, “How many degrees is a right angle?” Maria said, “90.” I said, “Okay, so if a triangle has 180° and you already have 90 and 45, how do you find what’s left over for angle T?” Maria immediately said, “Subtract” and proceeded to do the calculation in her journal beside the math problem. Natasha, who had been watching closely, wrote it, too.

Mrs. Cruz’s Class, Field Notes, 3/10/2010

Aim: What is exponential notation?

Mrs. Cruz had finished reviewing the nine prime factorization problems she used as a mental math exercise with the class. Mrs. Cruz, standing in front of the SMART Board, asked the class: “Who can solve this? What is 5^4 ?” Two students answered incorrectly with 20. The majority of the class seemed excited to answer. The noise level was somewhat high but the chatter was math chatter with only a few students engaged in non-math talk.

Mrs. Cruz stated to the class: “I want someone to show me their mistake. They said 20.” Silvestre raised his hand fast and high. Mrs. Cruz acknowledged him. Silvestre walked up to the SMART Board...took the SMART Board pen from Mrs. Cruz and underlined the 4 and 5 as he explained in a clear, slow voice: “The 5 you multiply 4 times like this, $5 \times 5 \times 5 \times 5$ and you get 625.”

Mrs. Cruz nodded her head: “Excellent.” Silvestre nodded his head, smiled, and walked back to his desk with a little swagger in his walk. Mrs. Cruz moved onto the definition of exponential notation. She erased what was written before on the SMART Board, and wrote the definition of exponential notation: “Exponential Notation is a shorthand way to write repeated factor expressions.” She wrote an example beside the definition: “Ex: 4^3 is shorthand for $4 \times 4 \times 4$.”

Ariela, pointing to her notebook, turned to Eduardo and asked him, “Why isn’t 5^4 [equal to] 20?” Eduardo turned his body fully to her, and pointed to her work as he explained quietly: “Because of the 4 here, it’s 5 times itself 4 times. It’s 5 times 5 times 5 times 5. Not 5 times 4. You put 20. It’s wrong.” Ariela said, “Ohhhh, okay,” and took her notebook back and wrote it out correctly. Eduardo watched her write it, and nodded and smiled at her when she finished.

In Mrs. Cruz’s class, learning processes emerged differently across the year with students learning from Mrs. Cruz directly and from each other. In both excerpts, student learning processes included asking for help, concentrating on their answers, doing the activity/work correctly, doing the activity/work incorrectly, and not giving up. It may seem odd to include incorrect working of the problems as a learning process but trial-and-error and learning from mistakes are fundamental. An important

difference in the learning processes between the two excerpts is who the students relied on for help. In the former excerpt (11/9/2009), the students relied on each other and me very briefly as Nayajah joined Maria and me in working through the problem. Nayajah had asked others for help before stopping with Maria and me. In the latter excerpt (03/10/2010), students relied on each other as demonstrated when Ariela asked Eduardo for help, and Eduardo helped her directly and patiently, explaining well the steps.

The process is also significant because it shows a different side of Ariela, who did not consider herself a mathematician. It showed a more mature side, a more focused side of her quite possibly because the state math assessment in May was approaching as well as graduation in June, or because simply she wanted to know how to do it. Eduardo, who did consider himself a mathematician, demonstrated a side of himself that came out in archery and the interviews—his belief in helping others, being fair, and trying one’s best. I was proud of both Ariela and Eduardo in that moment—proud of Ariela because of her desire to understand the math and Eduardo for his teaching.

In Mr. Knight’s class, the learning processes for these next two excerpts, one in the early part of the school year, and one in the later part, differ. In the first excerpt, Mr. Knight was trying to teach the class how to measure angles. He was reviewing problem #1 on p. 69 in their Math Journal 1. Students were trying to learn from Mr. Knight’s direct instruction and usage of open- and closed-ended questions. The learning processes observed mostly here were concentrating on the answer, doing activity correctly, doing activity incorrectly, venturing an answer even if unsure, and not giving up. Students were not able to explain how they derived their answers, wrong or right. Unfortunately, Mr. Knight did not guide their learning to help them understand how to use the protractors to measure angles. This part of the lesson dissipated into what seemed to be desperate guesses.

Mr. Knight’s Class, Field Notes, 10/28/2009

Aim: How do we measure angles?

Mr. Knight standing up in front of the SMART Board said to class: “Ladies and Gentlemen, at this point, get our math journals out.” Mr. Knight asked for a volunteer to pass out the math templates (plastic blue template with shapes and ruler). Students were talking a bit. Mr. Knight said to the class: “Right now we’re on p. 69” (p. 69 “Measuring and Drawing Angles With A Protractor” of Math Journal 1). Mr. Knight projected the exercise on the SMART Board.

Mr. Knight said to Javier: “Javier, what did you get for #1?”

Javier to Mr. Knight: “55”

Mr. Knight: “Javier, would you come to the board and show us how you did it?”

(For #1, Use your half-circle protractor. Measure each angle as accurately as you can.)

Javier, who was sitting in the middle table group on the right side of the class, stood up and walked to the SMART Board. He explained in a clear voice and Mr. Knight repeated his explanation: "The vertex is where the 2 lines meet. When he takes the vertex, he's finding the angle. Turn 1 side to 0 degrees. Wherever the other line connects, that's going to be your angle."

Mr. Knight to Javier: "How do we know which numbers to choose?"

Javier: "56 and 24"

Mr. Knight probed: "Yes, but how do we know which numbers to choose? How do we know this?"

Mr. Knight to Reina: "Reina"

Reina: "Acute is more than 90 degrees and up."

Mr. Knight to Reina: "No but you're in the ball park."

Reina to Mr. Knight: "Because the lines come together?"

Mr. Knight: "No."

Shawn: "Acute is 90 and lower, and obtuse is 90 and upper."

Mr. Knight explained how one can tell the angle: "You can tell an acute angle by looking at it. By if it's closing down."

Reina tried again: "65"

Mr. Knight replied: "No, you guys aren't understanding the question."

In the following excerpt of 3/17/2010, Mr. Knight engaged the class in a lesson of subtracting positive and negative numbers using cash counters as manipulatives. This was the first lesson across both classes where I observed manipulatives being used. I was excited to be there to see them being used. Although I only observed seven math periods for each class over the year, interviews with students and school staff confirmed low usage of manipulatives. The learning processes in this lesson were different probably because the manipulatives were being used.

For this lesson, I had all intentions to simply observe because I was excited to see how Mr. Knight would engage them with the cash counters and how the students would use them. However, as soon as Mr. Knight directed the students to begin the exercise in their Math Journal, a handful of students came to the table where I was sitting in the rear of the room for me to help them. The learning processes I observed varied from students doing the activity correctly, explaining their work, helping another student to doing the activity correctly, asking for help, venturing an answer even if unsure, and not giving up.

Mr. Knight's Class, Field Notes, 3/17/2010

Aim: How do I add and subtract positive and negative numbers?

Math Message

Students will shade the cash cards. Negative will be shaded with a red pencil/crayon and positive will be shaded with a regular pencil.

Math Message Follow-Up

Students will take their counters and show +5 counters with 9 counters.

Students will take their counters and show -4 counters with 8 counters.

Students will take their counters and show -3 counters with 9 counters.

(Counters are 1 inch squares of white paper with either a +\$1 or -\$1 on each.)

After Mr. Knight called on a few students to draw the cash counters on the SMART Board to solve the math message follow-up problems, Mr. Knight said to the class, "Turn to p. 232 in your Math Journals." Mr. Knight used the concept of debt and bills to explain negative and positive numbers to the class. Mr. Knight read the definition of account balance on p. 232: "A negative account means you took out more money out of your account than you have. Your account balance is the amount of money you have after you owe." Mr. Knight continued, "'In the black' is the amount you have in your account. Is that positive or negative?" A few students answered, "Positive." Mr. Knight continued, "If you owe money, then your account is in the red." Mr. Knight told the class to do p. 232.

Leticia, Israel, Nilsa, Lourdes, Darren, and Caston were all at my table [at the rear of the class to the right of the computers]. I was trying to prompt them so they would figure out the answers. Leticia seemed to step in and out of confusion, one moment getting it and the next moment not getting it at all.

Darren completed #2 and #4, and showed me happily, "Ms. Fleshman, look." (Problem #2 instructed the students to "Use + and - counters to show an account with a balance of +\$5. Draw a picture of the counters.") He showed me where he had drawn in his Math Journal for problem #2, 6 positive counters and 1 negative counter. I said, "Excellent work, sir." And then asked him, "What other ways can you get positive 5?" He looked at the counters he drew, and then said, "7 positive and 2 negative?" I replied, "Yep." "What else?" He said confidently, "10 positive and 5 negative." I said, "Now you're sailing." Then he showed me #4 where he had drawn two positive counters and two negative counters. I said, "Good work. Now, how else could you get 0?" He replied, "I could do 5 positive counters and 5 negatives counters." He smiled, nodding his head. I said, "Alright, well you left #3 blank. What's going on here?", pointing to #3. (Problem #3 instructed students to "Use + and - counters to show an account with a balance of -\$8. Draw a picture of the counters.") He said, "That's hard. I didn't get it." I said, "You got the others. You can get this one too. It's just a little tricky with the negative. How did you figure out the others?" He showed me again how he figured out #2. I said, "Okay, well instead of a positive number, now you just need to end up with a negative number. How do you think you can do that?"

Darren stood there beside me for a minute looking at his journal. I said, "Well, start drawing something to help you see what you're working with." He started drawing the counters. When he kept drawing past ten I started to stop him but decided to let him keep going. He drew 16 negative cash counters and 8 positive cash counters. He said smiling and nodded, "See, Ms. Fleshman, look. I drew 16 negative and 8 positive and you get 8 positives left! No wait! I meant you get 8 negative left!" I smiled big, and shook his hand, and said, "Well, there you have it! Well done, sir!"

As he walked away, he started to show Israel, and I said, "Uhh-unnh. No sir. Darren, let Israel do it on his own. He can do it. He's done the others. He can do these." Darren laughed and gave Israel a sly look and smiled and walked away. I looked at Israel and

shook my pen at him, and said, “You said you were going to do work at this table. You can do it. You did the others so fast!” And he really had.

Darren, in particular, in this except learned by doing. He learned how to add and subtract negative numbers by using manipulatives of negative and positive unit counters. He learned this abstract concept by doing a very practical activity—counting “money.” He applied what he learned from doing #2 to end with a positive number and #4 to end with zero to then doing #3 to end with a negative number. Darren was eager to show his friend Israel how to do #3—an example of students helping other students, and wanting to teach and learn from each other. He exhibited qualities of a mathematician whether he knew it or not.

6.5 Enacting Mathematicians’ Skills, Characteristics, and Qualities

Observing the enactment of mathematicians’ skills, characteristics, and qualities by the students was a challenging endeavor as the enactment of some may overshadow that of others. Not every mathematician is like Dayanara or Hernan in their enactment—competitive, unafraid to face a math challenge, ready to offer their solutions. Even though Hernan is talkative, he does well in math when he focuses. Some mathematicians are like Jesenia, who sits quietly as she works steadily on the problems, seemingly unconcerned and undeterred that students pass by her seat to copy her answers. Some are like Gerardo and Alejandro, striving to be math geniuses or math masters, besting others in their knowledge and application of math. The processes reflective of such enactment were several. See Table 12 below for the processes.

Table 12. Enactment of mathematicians' skills, characteristics, and qualities	
<ul style="list-style-type: none"> • Student answering correctly • Student answering incorrectly • Student asking for more difficult math • Student asking a math question • Student asking for help • Student calling out the answer • Student defending/justifying answer • Student explaining answer in detail • Student self-correcting mistake • Student showing excitement to learn 	<ul style="list-style-type: none"> • Student showing excitement to participate • Student seeming not sure of answer but persisting • Student using tools to solve math problem • Student competing with other students • Student pointing out teacher's math error • Student raising their hands to answer • Student being upset over not be able to do a math activity • Student being upset over not being called on to give answer • Student venturing an answer even if unsure

In the following excerpt of 11/4/2009, Mrs. Cruz started the lesson with a mental math exercise as usual. This time the exercise was rounding to the nearest whole number. Antonio, who did not consider himself a mathematician, still enacted such qualities during this lesson. It was often difficult for Antonio to stay still and focus because he had Attention Deficit Hyperactivity Disorder (ADHD). This excerpt is particularly important as it illustrates Antonio enacting mathematician qualities and characteristics in spite of his medical diagnosis. One to fluctuate from silence to agitated outbursts when struggling to manage the ADHD, Antonio showed a calmer, more focused side. He answered correctly and showed excitement to learn and participate along with calm in justifying and explaining his answer.

Mrs. Cruz's Classroom, Field notes, 11/4/2009

Aim: How can we compare triangles?

Mrs. Cruz took about five minutes at the beginning of the class to go over cause-and-effect from a reading quiz yesterday. After they finished reviewing, she told the students to take about their notebook and their math journal. Mrs. Cruz walked to the back of the class over to the desk beside me to pick up her *Everyday Math* teacher's manual. She was smiling as she picked up the book and said to me, "This book is my friend. I've used this book so much." The spiral was half out of the book, and she had marked in it heavily.

When she reached up front, she turned and said to the class, "Thanks to those students who are very quiet, and waiting nice, and have written the aim in their notebooks." The class quieted down. She repeated herself, and then continued. After she finished, she said to the class, "We're going to do mental math now. That's very important that we practice our mental math." She smiled when she said that it was important.

Mrs. Cruz, standing in front of the SMART Board, told the class, "I want you to round this number to the nearest whole number." Mrs. Cruz said the number 209.082—"two hundred nine and 82 thousandths." A few students towards the wall side of the room, who had not yet finished writing the aim because they were talking, said, "Wait, wait." She said, "You have to listen."

But this time when Mrs. Cruz read the number, she said the number 209.82—"two hundred nine and 82 hundredths." She repeated it three times because some students were talking. She repeated "209.82" three times but then said 209.082, the number she had originally said.

Antonio, who was still sitting at the desk with the SMART Board laptop, raised his hand to answer. Mrs. Cruz called on him. Antonio stood up and answered, "210." Mrs. Cruz replied to Antonio, "210 is correct." Antonio grinned and sat down. Her accent for this problem is presenting a challenge.

Mrs. Cruz said to the class, "I know some people didn't get it. Antonio, go to the board and please explain how you got 210." Antonio stood up and stepped around his desk to stand at the whiteboard, pointed at his answer, and explained how he got it. As he was explaining, Ariela butted in and tried to correct him. Antonio turned to Ariela and said, gesturing calmly with his hands (pushing both his hands up and down calmly), "Okay, wait, wait, wait. I know." He said this in a calm and patient fashion, not at all like the aggressive way he was acting the other time.

He turned back to the board and continued explaining his answer. "See, you look at the 8 because it's to the right of the 9. So, you round up if it's 5 or above, and round down if it's 4 or below. So since 8 is bigger than 5, you have to round the 9 up to 10. That's how I got 210."

Dayanara, who sits in the back, complained to Mrs. Cruz that she couldn't hear what Antonio said because people were talking. When she said "people", she looked over to the right side/wall side of the room where Carlos, Maria, Natasha, Chantelle, and another boy, Jack, were sitting. Carlos and Jack have been talking the whole time since math started. They have been singing and making noises and playing. Mrs. Cruz has not said anything to them about their behavior.

Mrs. Cruz repeated Antonio's explanation and said it was a very good explanation. Mrs. Cruz repeated how numbers are rounded to the nearest whole number. Mrs. Cruz finally called out Jack for his poor behavior, saying "Don't take advantage thinking that I don't see you what you're doing because I do." Jack mumbled something, shaking his head looking downward. Carlos continued to hum.



Photo: Closer view of the math resource area with tools and signs at left rear of Mrs. Cruz's classroom. (Photo taken by Paula J. Fleshman, November 2009)

Mrs. Cruz's Classroom, Field notes, 1/06/2010

Aim: How can we order and compare fractions?

It was 12:30, the beginning of math period. Mrs. Cruz was now standing in front of the class in front of the SMART Board. Mrs. Cruz told the class: "Find 6 cm in the ruler." Each student had the blue plastic geometric template but not every student was paying attention. A few students at each table group were looking at the template after Mrs. Cruz said to find 6 cm in the ruler. Mrs. Cruz, looking around the class, asked, "How many half centimeters is that?"

Natasha, sitting at her usual location in the room (in the back, right in front of the computers), yelled, "10."

Mrs. Cruz replied looking at Natasha, "10? There are 10 half centimeters in 6 centimeters?"

Natasha, sitting forward towards the edge of her chair, replied, "Noooo but you first said 5, and then you said 6 centimeters." Mrs. Cruz said, "Okay. We're doing 6 centimeters now."

Natasha hesitated, looked quickly down at her template, pointed at the ruler with her index finger, and said quickly and energetically, "12!" Mrs. Cruz, smiling, said to Natasha, "Very good Natasha." Mrs. Cruz looked at me and smiled. I nodded and smiled, too, at Mrs. Cruz, then at Natasha, who was looking at me.

Mrs. Cruz went to the chalkboard and wrote below the aim: "1 ¼ in", and then asked the class, "Who can tell me how you find 1 ¼ inches?" Within a minute, Natasha raised her hand and said excitedly, "I found it, Mrs. Cruz!" Before Mrs. Cruz could ask her what it was or give her instruction, Natasha jumped up and skipped to Mrs. Cruz showing her where on the ruler she had found 1 ¼ inches. Natasha was smiling big. After Natasha showed Mrs. Cruz, she skipped back to her seat still smiling. No one else had raised their hand, called out, or rose out of their chair to answer the question except for Natasha.

The majority of the class was talking. Only a few students at each table group were looking at their templates. Each time I looked around the room, I saw Bernardo, Abel, Jerome, Maria B., Paolo, and Hernan talking, although it seemed like Hernan went in between talking about the math and non-math topics. I couldn't hear his conversations because he was seated at the front left table group. Eduardo was absent today. DeQuan was quiet but seemed disinterested. Maria B seemed unusually talkative.

Mrs. Cruz, looking around the room, next asked the class: "Who can tell me how you find $2\frac{4}{8}$ inches?" Natasha jumped up again quickly and showed Mrs. Cruz on the ruler $2\frac{4}{8}$ inches. Mrs. Cruz nodded as Natasha stood close to her pointing to the ruler. The rest of the class continued talking. Bernardo at this point was spinning the template on his pencil. So was Carlos.

Mrs. Cruz continued with that particular question. Mrs. Cruz asked the class, "How many quarter inches is that?"

Natasha told on Carlos to Mrs. Cruz for breaking the template. Mrs. Cruz asked Carlos if he broke the template. Carlos said, "Nuh-uhhh, I didn't break it. That wasn't me." Natasha retorted, "Yes it was. I heard it break." Carlos said, "It was already cracked a little bit before it broke." Natasha retorted, "Then you broke it."

In this excerpt of 1/6/2010, Natasha's enactment of mathematician qualities and characteristics was evident in her constant participation and focus, and desire for other students to focus. She raised her hand often in each class, always seemed excited to learn more math and participate, and was not afraid to ask the teacher for more difficult math. Not a talkative person, Natasha always seemed happy and ready to learn and participate in math even when others around her were talking and playing, or simply not paying attention. For classroom management, Mrs. Cruz would often rearrange students' seating. Even still, Natasha normally sat in the left middle or rear of the classroom in front of the computers with Carlos, Chantelle, Luis, Jorge and an African American male student sometimes at her table group. Natasha considered herself a mathematician regardless of perceptions and behaviors around her.



Photo: View of the left front of Mr. Knight's classroom facing door corridor and closets. (Taken by Paula J. Fleshman, November 2009.)

Such excitement in participating and learning math spilled over in one very engaging activity in Mr. Knight's class, "First to 100", a game with the object of a player being the first to collect 100 points by solving problems written on problem cards. The entire class seemed very excited to play the game, with students eagerly getting into groups. I was glad to observe this math game in action as involved math students working through math problems individually yet competitively. I stood beside the first table group on the right side of the classroom in front of the chalkboard, watching them play, as excerpted below in 12/16/2009 field notes.

Mr. Knight's Classroom, Field notes, 12/16/2009

Game: First to 100

Zulema drew the next card which started off about a train leaving the station X minutes before 11:05am. X this time was 30 because a 5 and a 6 were rolled with the dice. D, a talkative, energetic male Hispanic student in the group, was gone to the bathroom. Nilsa started solving the problem by subtracting 30 minutes from 11:05. I was pleased to see her method and she would have gotten it right except that she ended up with 10:75 instead of 10:35. She said, "I got it!" And looked at me, and said, "Isn't that right?" I said, "I like how you subtracted. Are you borrowing from 100 minutes or 60 minutes?" She looked at me. It was clear she didn't understand what I meant. Her face was blank. She subtracted it again but doing it the same way, coming up with 10:75. I said, "How does 10:75 sound to you? Can you have 75 minutes like that?" She sat down. I started to try to show her what I meant by her not borrowing from 100 minutes but 60 minutes. She said, "Oh, I know. I'll just count backwards," and started writing the minutes backwards in a column in her notebook from 11:05, 11:04, 11:03, 11:02, 11:01, 11:00, 10:59, 10:58, :57, :56...:25. She kept writing all the way to 10:25 and would have continued had Zulema not solved it. Nilsa was getting close to the answer but hadn't started to count 30 minutes from 11:05 yet to make sure she got it.

Zulema solved it. She was so excited about solving it that she was jumping up and down and fanning herself and laughing. I turned to Zulema and put my hand up, and said, "Good job! High 5!" Zulema laughing, gave me a high-five. Nilsa looked at me and said, "Did she get it?!" I smiled and nodded, "Yep, she sure did. You were close too!" I looked at Zulema and said, "Zulema would you like to explain how you got it?" She nodded and said, "Whew. I'm so excited I can't catch my breath!" Mr. Knight who was sitting at the laptop looked at her and smiled and chuckled. Zulema said, "Mr. Knight, I solved it!" Mr. Knight said, "I'm happy for you Zulema."

Zulema explained how she subtracted 30 minutes from 11:05, the same method Nilsa started using. Zulema, leaning over, pointing to her work, said, "I first started with 11:00 and subtracted 30 minutes like this. I got 10:30. I knew that was right because I looked at the clock [on the classroom wall near the SMART Board]. I then did 11:05 and subtracted 30 minutes and got 10:35." Nilsa looked at me and said, "See I did it right!" I said, "You almost got it. You got 10:75. Not 10:35. See what she subtracted from?" Nilsa looked at Zulema's paper, and said, "Ohhhh! I was so close!" Zulema gave me a double high five.

Lourdes sat quietly the whole time. She had not even tried to solve it. Caston came back from the bathroom. He saw me giving Zulema a hug. She was still jumping up and down, happy. Caston said with a big smile, "What did I miss?" Zulema said to him, "I solved it! It was hard!" Caston saw her writing 30 on the score sheet, and said, "Oh my god! You got 30 points!" Zulema still smiling and laughing said, "Yep!" Caston looked at me, and I said, "Yep! She got it right!"

I looked up and saw Fadhila smiling, and moving her arms and body, and wondered what she was doing. Mr. Knight looked up and saw Fadhila up, too, and asked her what she was doing. She said, "I'm dancing. I got a hard problem right!" I looked at her and smiled big. She looked at me and smiled big and kept on dancing. Mr. Knight starting laughing, and said, "I'm happy for you, Fadhila." Fadhila said, "I'm winning, too!"

It was about 1:55pm. Mr. Knight stood up and looked at me and said, "In about a minute, we're going to debrief about the game and then go on to the next subject." I said, "Good! The class seems to really have enjoyed the game." Mr. Knight said, "I wanted to make sure we did it to make up for when we didn't do math before." I said, "Thank you. I was glad to see it!"

Although the objective of being a mathematician is not winning a game or a prize, recognition of each other's efforts and skill is one aspect of being a part of the community. Feeling and showing excitement for one's mathematical accomplishments is important to the health and growth of the mathematician and community as we are human beings and feelings come with being. Zulema's excitement was the culmination of drawing from her prior knowledge and persisting through the problem. Although Nilsa did not win or answer the problem correctly first, she exhibited the same persistence, the same desire to work it out on her own just as Zulema. It was a treat for me to observe and be a part of another mathematician's excitement—a contagion—as Fadhila also expressed excitement in the form of dancing over solving problems correctly. The exhilaration of doing math well, in particular, challenging

math problems well is something that all students need to and should feel as mathematics is all too often seen and experienced as a lifeless, futile activity, devoid of inspiration and power.

Mr. Knight's Class, Field Notes, 1/13/2010

Aim: How do I measure progress?

Mr. Knight, sitting at the laptop desk at the right of the SMART Board, scrolled down what he displayed on the SMART Board to the mental math part. He asked the class, "At this point, remember what I did?" Donny, seemed eager, and stood up with one foot on the floor and the other knee in the chair, and started to answer, "You took the fractions, and turned it into a decimal, and then a percent."

Mr. Knight set up a 3 column, multi-row table on the SMART Board. He started the table at the upper-left corner with 19/100.

19/100		

Mr. Knight stood up and asked the class, "May I have a volunteer to convert that to a decimal?" 10 kids raised their hand. Caston, rocking back in his chair, raised his hand and said smiling, ".19 (point 19)". Mr. Knight replied, "Now say it like a fifth grader. Caston repeated what he said. Mr. Knight said, "No." Half the class raised their hand. James also raised his hand, and repeated what Caston said. Mr. Knight replied, "Again, you weren't listening. Caston just said that, and I told him no." Donny, who was sitting on the edge of his chair, raised his hand. Mr. Knight called on Donny. Donny said, "19 hundredths." Mr. Knight said, "Very good Donny." Mr. Knight to the class, "Now say it as a percent." Mr. Knight looked around the class and called on Andres, who's hand was not raised. Donny said, "19 percent." Mr. Knight said, "Good Andres. Good."

Mr. Knight typed in to each beginning row cell fractions he wanted them to convert to decimals and percents.

19/100		
9/10		
3/4		
2/5		
43/50		
11/25		

Mr. Knight asked for volunteers to convert the fractions. He paused about a minute looking around the classroom. Then He called on Joshua for 9/10. Joshua stood up and answered, ".9 and 90 percent."

Mr. Knight then called on Leticia for 3/4. Leticia hesitated. A few students said aloud, "We did this yesterday." One student said, "You should know this one." Leticia, sitting at the front of the class, said, ".75" Mr. Knight said to Leticia, "Good."

Mr. Knight moved on to the next one, "2/5". Mr. Knight started working out this one on the SMART Board. $2/5 = \text{?}/100$. Mr. Knight asked the class, "May I have a volunteer to

tell me why I made the denominator to 100.” Mr. Knight looked around the class. 3 students raised their hand. Mr. Knight sounded frustrated, “That’s embarrassing. Only three students in the whole class raised their hand. That’s really embarrassing. We’ve gone over this already.” Mr. Knight looked around the room. The room was silent. Fadhila, Alejandro, and Javier had raised their hand. Mr. Knight called on Fadhila. Fadhila answered, “Because 5 goes into 100 equally.” Mr. Knight replied, “Excellent, Fadhila.”

Mr. Knight to Caston: “5 times what equals a 100, Caston?” Caston responded, “20.” Mr. Knight told Caston to write out the steps on the SMART Board. Caston got up smiling and stepped over to the SMART Board. He wrote out $20 \times 2 = 40$, and then $2/5 = 40/100$. Mr. Knight to Caston, “Thank you Caston.”

Mr. Knight to class, “May I have a volunteer for the next one?”

Donny raised his hand again. Mr. Knight wrote on the SMART Board $43/50 = \quad /100$. Mr. Knight to class, “Why a 100?” Donny said, “50 goes into a 100 equally.” Mr. Knight explained, “Only use a 100 if it’s a multiple of 100.” Mr. Knight asked Alejandro to explain. I couldn’t hear Alejandro’s explanation. Alejandro finished and Mr. Knight told Donny to keep going with answering the problem.

Donny wrote $43/50 = \quad /100$. $50 \times 2 = 100$ below the fraction. Then he wrote and worked out $43 \times 2 = 86$ on the side to get $43/50 = 86/100$. As he was writing he explained, “You multiply the bottom by 2 to get 100, so you multiply the top by 2, too. You get 86 over a 100. Then the decimal is .86, and the percent is 86%.” Donny smiled as he stepped by from the SMART Board. Mr. Knight looked at him and said, “Good job!”

Mr. Knight then turned to the class and said, “The last one?” Mr. Knight wrote out $11/25 = \quad /100$.

Gerardo raised his hand. Mr. Knight called Gerardo up to the SMART Board. Gerardo went up to the SMART Board and wrote out the problem and explained his steps as he wrote them out. Gerardo wrote and explained as he wrote:

(4) $\frac{11}{25} = \frac{44}{100}$. “25 goes into 100 4 times. So you multiply the top and bottom by 4 and you get 100 for the bottom, and 44 for the top.”
As Gerardo handed Mr. Knight back the marker, Mr. Knight said to Gerardo, “Good job, Gerardo. Nice.”

$19/100$	.19	19%
$9/10$	.9	90%
$3/4$	.75	75%
$2/5$	.4	40%
$43/50$	.86	86%
$11/25$	.44	44%

Active participation in the mathematics community is seen in this excerpt of 1/13/2010 with a few students as these student mathematicians, Fadhila, Alejandro, Javier, and Gerardo raised their hands frequently to share their knowledge, with some explaining well their answers. Other mathematicians in the classroom demonstrated their skill as well with explaining their steps and being sure of their answer. Unfortunately, the participation of the same students over and over may point to an atmosphere that does not develop all students as mathematicians. It is difficult to say why only the same students participated.

Disruptive behavior tended to be a problem in Mr. Knight’s class, progressively so over the course of the year, such that an inclusive, supportive atmosphere and community would have been difficult to develop.

6.6 Developing a Sense of Belonging and Community

A sense of belonging and community, in part and whole, was seen primarily in how students responded to each other and to the teacher during the lessons. These notions were expressed also during the interviews. In my participant researcher role, I found myself becoming a part of the classroom mathematics community. Although a few of the processes may seem to reflect teaching processes (i.e. teacher affirming student’s answer, teacher listening to student, teacher repeating student response to class), these same processes help to develop a sense of belonging and community as the contrary of these processes would destroy that sense.

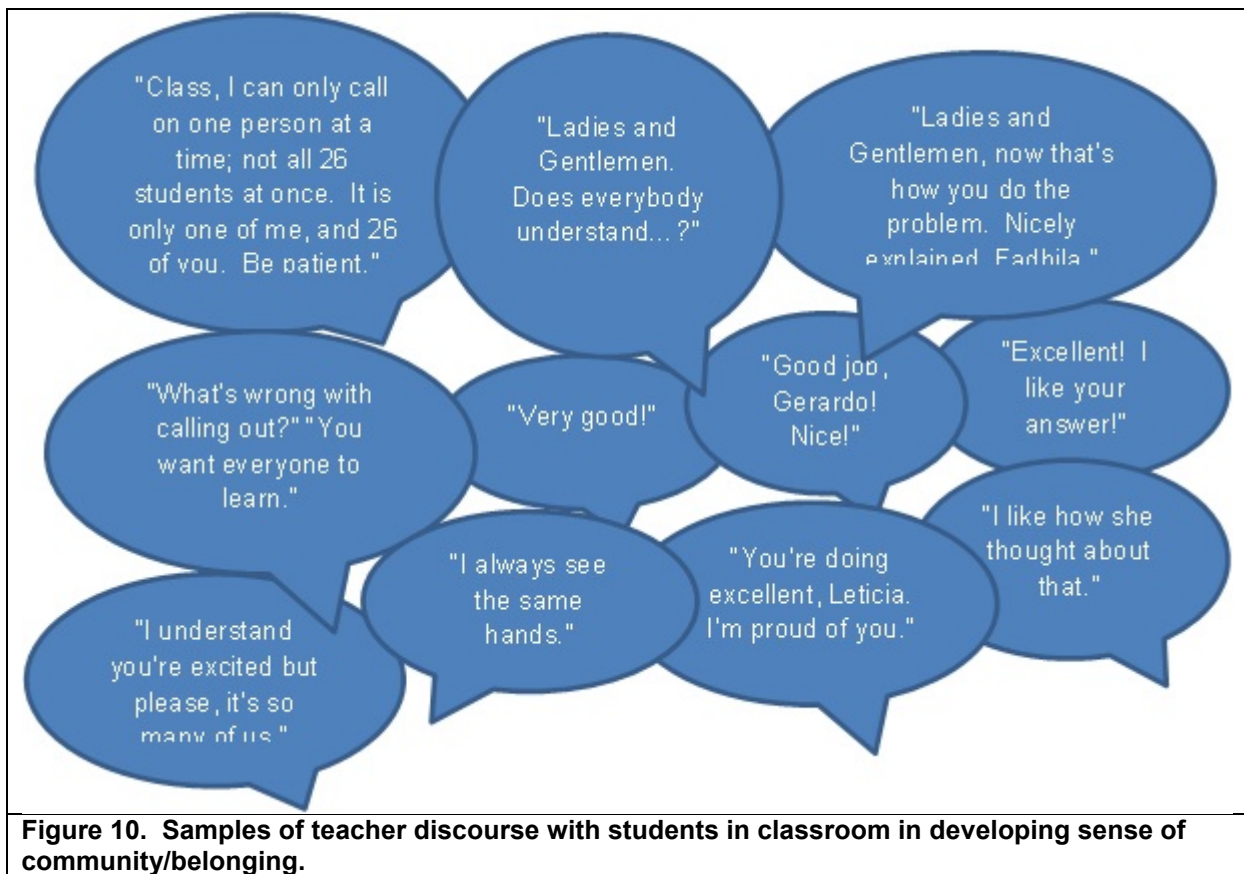
Table 13. Processes common across both classrooms for developing a sense of belonging and community	
<ul style="list-style-type: none"> • Principal engaging students in conversation about their math work • Student affirming other students • Student allowing others to use their tools/pencils • Student admonishing others for misbehavior • Student participating in the math work • Student encouraging others to work on their math • Student acknowledging each other’s math skills 	<ul style="list-style-type: none"> • Student being respectful to other students • Teacher acknowledging student’s math skills • Teacher affirming student’s answer • Teacher giving students a choice • Teacher listening to student • Teacher repeating student response to class

Most of the processes observed, with respect to sense of belonging and community, were communicative—words being expressed from teacher to student, student to student, researcher to student, researcher to teacher, and even principal to student. Whether these words were encouraging, affirming, or admonishing, they contributed to the sense of belonging or community within the classrooms of this school—the sense that everyone was important and so was their learning, participation, and contribution in math in that class. Even though the actions and words of students did not always reflect this sense, Mrs. Cruz, Coach, and stronger students were proactive in trying to keep that sense. The

process of participation in its various forms (answering, asking, volunteering, helping, and trying) is included, particularly, in reflection of one student's notion of sense of belonging. Javier, in his interview, said that participating in math class made him feel like he belonged there, that he was "a part of this place." He went on to say that when he did not raise his hand at all, he just did not feel like he belonged there. Participating in class engendered a sense of belonging in Javier:

"Participating tells me I'm a part of this place...Because sometimes when I don't raise my hand at all, I just feel like ummm I don't belong here...Like I'm new...And I'm supposed to feel that way in first grade because I was new...not in fifth grade."

What follows are words shared between members of the mathematics classroom community that contributed to the sense of belonging/community including words of accountability and responsibility. See Figures 10 and 11 below.



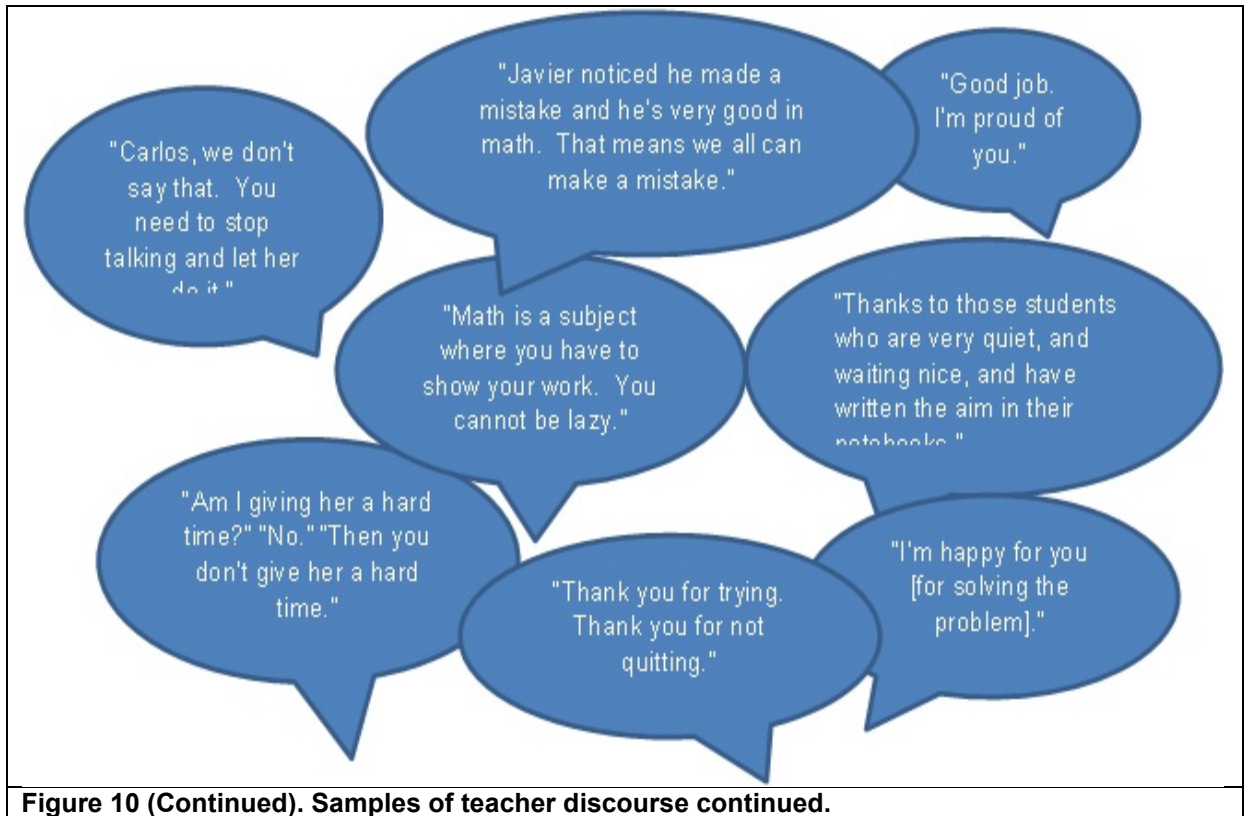


Figure 10 (Continued). Samples of teacher discourse continued.

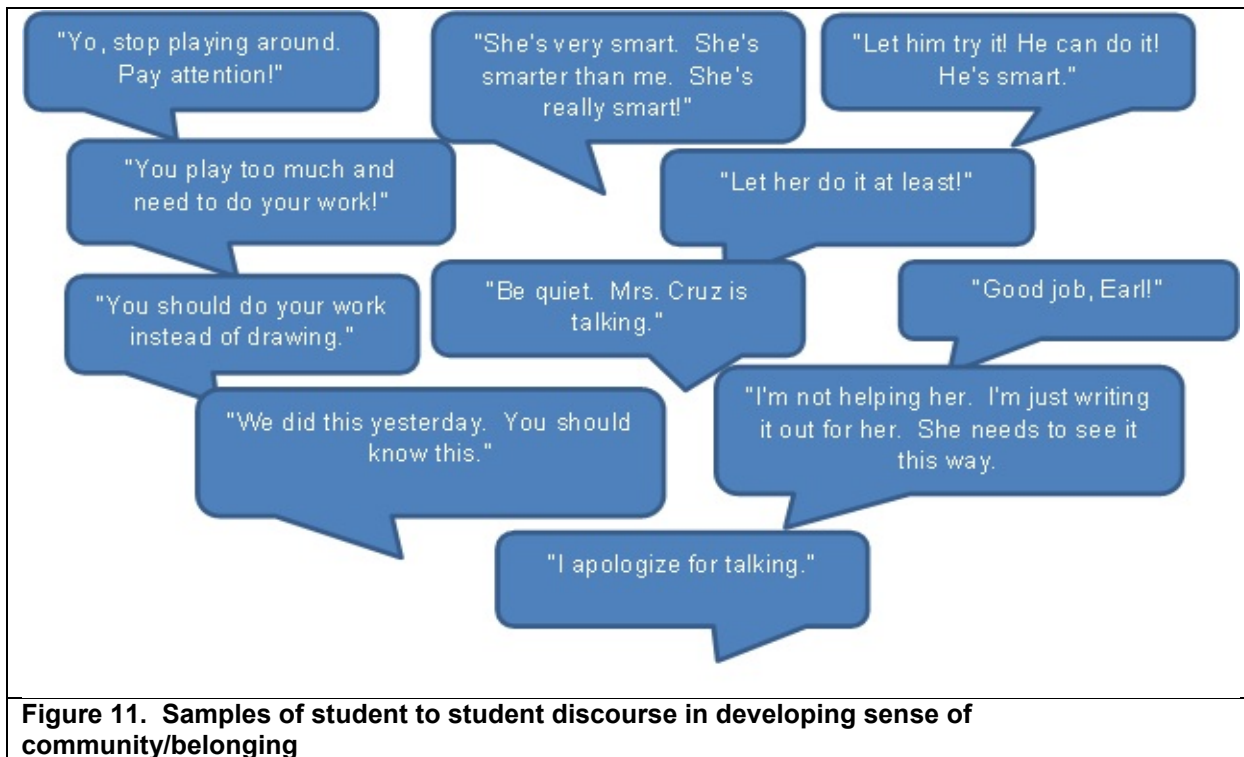


Figure 11. Samples of student to student discourse in developing sense of community/belonging

In sum, these observations attempt to explore how students position themselves inside the classroom relative to the mathematical activities and identities, and how they participate in enactment of mathematics identities. To a large degree, students' mathematics positioning inside the classroom is relative to the classroom processes of teaching, learning, enacting, belonging, and managing behavior. In addition to action, classroom discourse at a surface level shows the importance of language and frequency of such language that helps to develop a sense of belonging or community within the classroom. Even students admonishing each other for misbehavior or lack of attention indicate at some level the desire for community. Teachers more often than students are the initiators and perpetuators of such language and are the model (whether intentionally or unintentionally) for students to also initiate and perpetuate that same language—hopefully an empowering language, a mathematics-identity rich language.

6.6.1 How Students See Others as Mathematicians—Students and Adults

I asked which students they would say were mathematicians other than themselves. I thought it was important to see how students saw each other to get an idea of the community among students within the classroom and possibly across classrooms. All of the students except for Belen named at least one student who they considered mathematicians. See Figures 12 and 13 for numbers of times students were named as mathematicians by their classmates. Belen was not sure about her classmates. The rest of the students consistently mentioned a handful of students. Fadhila named one student who was not a part of the study, who often got in trouble for talking, but was very quick in math and answered correctly in class. I asked Fadhila why she chose this student and she replied: "Because she always knows about math. When I don't understand something, she always helps me...It's cool to have friends who could help you." Maria mentioned Dayanara and Jorge, adding that Jorge actually talks a lot, which was a surprise to me. I told her that I had never heard his voice in class. She could not believe it: "Not at all? It's that he talks. He talks to us about a lot of things. Or when he reads a book he'll show you a lot of things in the book."

Alejandro named Javier and Fadhila in his class because "nobody else likes math that much." He also knew well how much Javier liked science: "Cuz he always reads science books. He reads space books. And he wants to be an astronaut when he grows up." He believed Jesenia in Mrs. Cruz's class

was a mathematician and listed what defined her as one: “Because she’s always quiet. She does her work. She does it right. She pays attention in class.” Paolo named Jesenia because “like she, when it comes to math, everybody tries to walk around the room and look at her paper...She always gets like everything right.” He intimated, “She likes math. I think that’s her favorite subject but she never tells nobody.” He also named Maria because “she does math quick, fast like that. So that’s the only reason she likes it cuz it’s easy to her.”

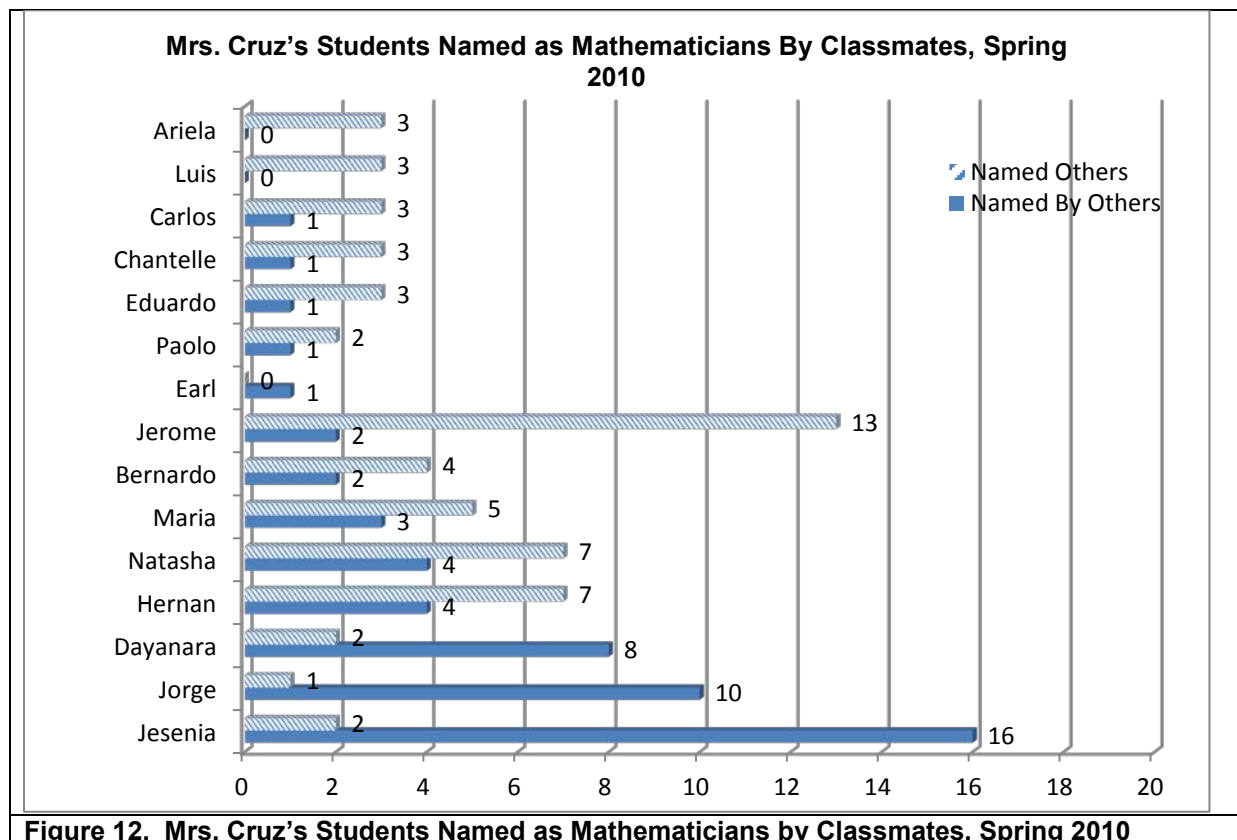
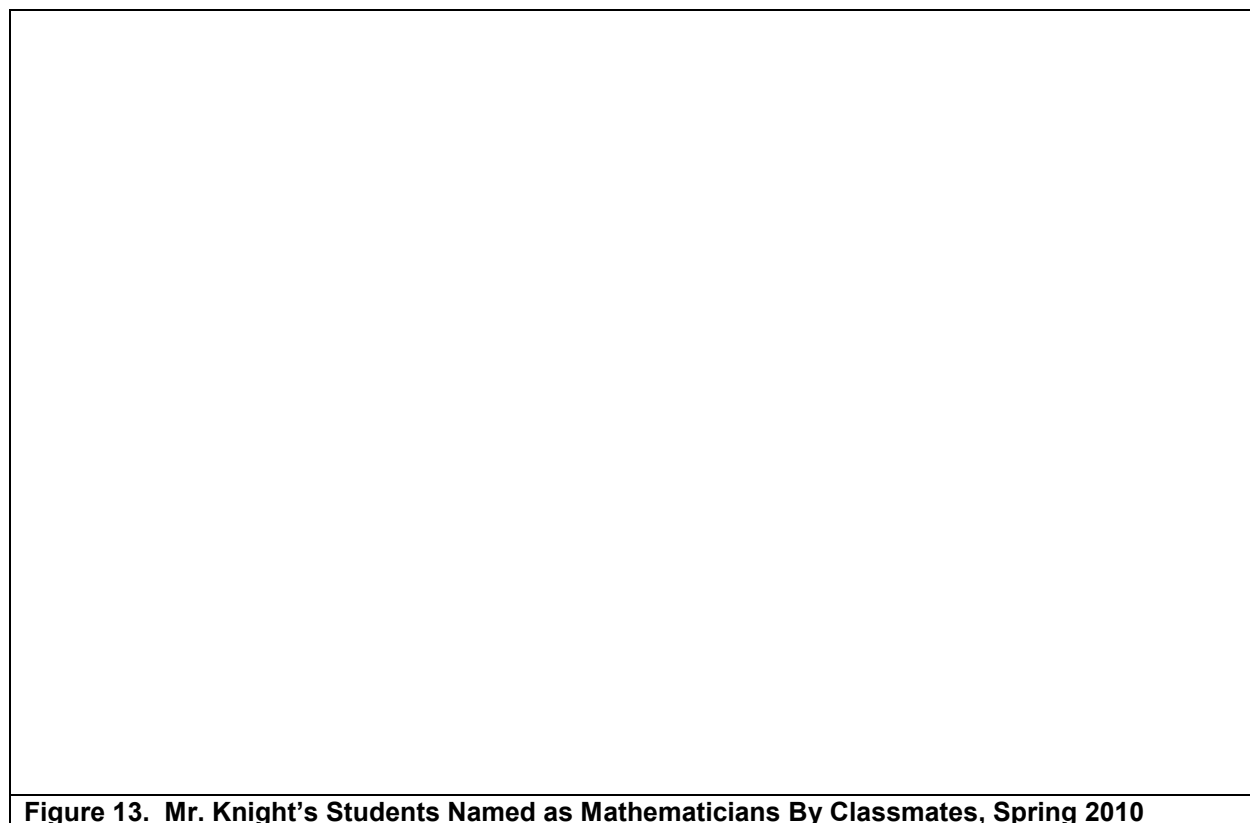


Figure 12. Mrs. Cruz's Students Named as Mathematicians by Classmates, Spring 2010

Jorge, smiling, also said Jesenia. Matter of fact, she was the only student he named: “Sometimes she gets high scores than me. And sometimes I learn from her like a question in the Math Journal that I can’t understand and she told me what to do, and I got the right answer.” Among the seven students Natasha named, Bernardo was one of them. She was the only student who named Bernardo: “Because he, umm, like say somebody need help with their math, he will pay attention to what the teacher was saying so he could help another student, and he could help himself.” Lourdes named Caston, among seven students, commenting on his behavior and ability: “Caston might be bad but he’s good at

math.” Fadhila was one of the seven Lourdes named, whom Lourdes thought she was the smartest one. See Figure 8 below for number of times students were named as mathematicians.



When asked about adults, some students named their family members as mathematicians, in particular, fathers. Domingo named his older sister who was in college because she helps him with his homework a lot and mostly with science. He also named his father because he helps him like his sister but he only helps him with math. Fadhila named her father and older brother who was in middle school. Jerome, too, named his older brother while Belen named her father because “he does math. He helps me with my math. He’s very good at math.” Natasha is the youngest child in her family. She named not only her brother but her sisters, too, as mathematicians because “they could help me when I need help on my homework.”

Carlos named his mother because he believed her to be very good at math, along with his sister and cousin. Gerardo named his older brother and called him a genius: “Ask him any question, he gets it. If you ask him a hard question, give him like 30 minutes. Then the next thing, he be like he got the answer.” Nicole named her mother and sister because “she’s [her mother] like the only one that’s

interested in math. Yeah, and my sister. Yeah, she teaches me math not a lot but she teaches me some things that's hard." Ariela named her cousin because "she loves math. Like sometimes I have trouble and she comes to my house and she helps me." Jesenia named her younger sister and father as mathematicians. Luis named his father and mother, too, as mathematicians.

6.7 Students' Mathematics and Immediate Life Perspectives and Their Identity

Reading through and coding the students' brainstormers shed much light on their top-of-mind thoughts and understanding of mathematics and mathematicians at the beginning and end of the year. Because students could write as much or as little as they wanted, multiple ideas were expressed in the brainstormers. For the brainstorm on "mathematics," I coded the students' responses *in vivo* (using their own words) to attune myself to and maintain participant language (Saldaña, 2009). I counted each separate piece of information a student wrote as an item to be coded. I considered a piece separate if it was written on a different line on their paper, in a different space, or constituted a different idea. Items ranged from mathematics operational symbols and equations their feelings about math and why math is needed. See Table 14 for sample codes and corresponding written items from students' brainstormers.

Code	Example Quote
MathExamples	<ul style="list-style-type: none"> • "I see adding, subtracting, multiplying, and division." • "1*5=5 2*5=10 3*5=15 4*5=20 5*5=25 6*5=30"
LoveMath	<ul style="list-style-type: none"> • "I ♥ math." • "Math makes me feel great."
MathImportant	<ul style="list-style-type: none"> • "I like to study math because it helps you more and helps you in your ELA sometimes." • "It helps you alot like if you want to be a teacher you really have to know a lot of math."
MathOutside	<ul style="list-style-type: none"> • "I see math when I go to the grocery store." • "Math involves alot of stuff in the world like counting money."
MathHard	<ul style="list-style-type: none"> • "I don't like math that much because it is kind of hard to do." • "Math is a hard thing for me to learn."
MathFun	<ul style="list-style-type: none"> • "I think math is fun because you can use it in the store mostly wherever you go." • "And rounding is really fun."
LikeMath	<ul style="list-style-type: none"> • "Everyday I like math because when I was 3 years old I was in a math competition and it was the best one." • "I like to do expanded notation cause [because] I like time table and addition."
MathEasy	<ul style="list-style-type: none"> • "Math is easy." • "Math is simple if you pay attention to it."
HateMath	<ul style="list-style-type: none"> • "I hate math." • "I hate math because there is too much hard questions and you always get a test with lots of hard math questions."
LearnMore	<ul style="list-style-type: none"> • "I want to learn more math for my whole life." • "When I go to collage [college] I want to take 2 class about math and I want to keep learning all the math skills and lessons."
Miscellany	<ul style="list-style-type: none"> • "Math is kinda hard but my teacher helps me and makes sure I understand what is going on." • "Going to have a 4 on math state test."
IDK	<ul style="list-style-type: none"> • "I don't know."

Note: Student quotes are typed exactly as written in the brainstorms with correct spelling in brackets.

For the pre-brainstorm in 2009, 29 of 32 students (90.6%) responded with more than one differently coded idea about mathematics. The number of codes applied across the brainstorms ranged from one to four codes, with a mean of 2.5 codes and median of 2 codes applied. The number of items written ranged from one to 14, with a mean of 5.7 items and median of 5 items written. Since students' responses could include more than one item, the total number of coded items was greater than 33, the total number of students who participated in the brainstorm activities over the year. Encouragingly, only four out of 32 students (12.5%) used the word "hate" when talking about math. See Figure 14 for code percentages of the students' collective 2009 brainstorms.

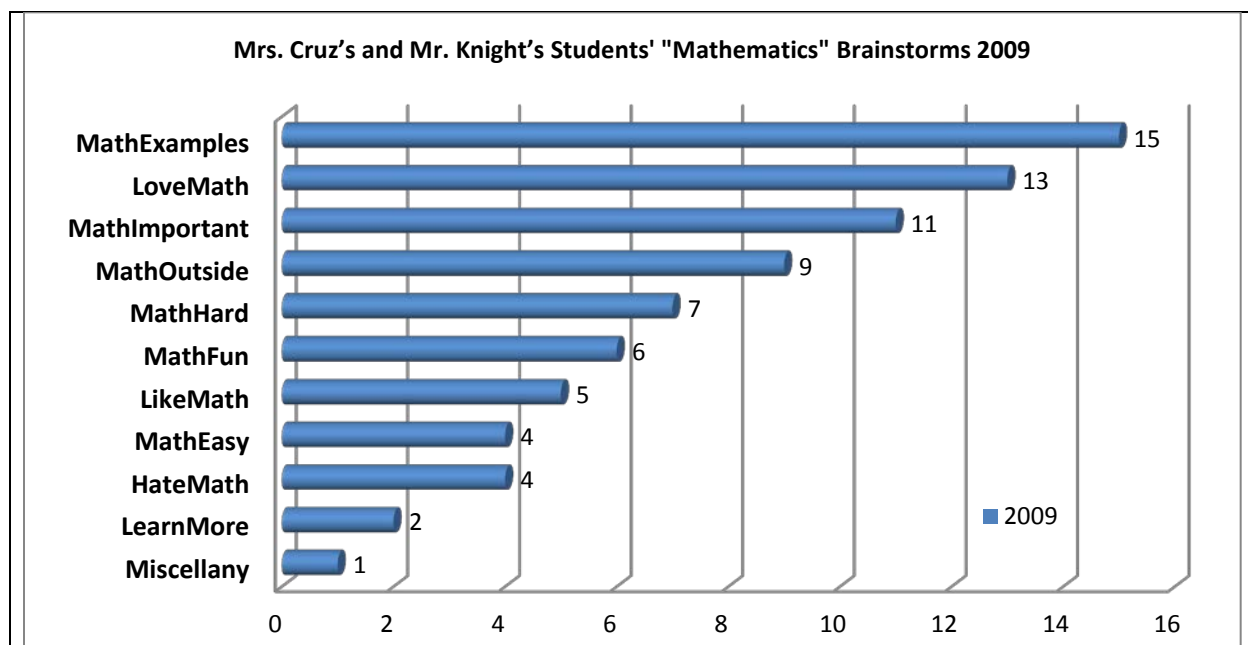


Figure 14. Mrs. Cruz's and Mr. Knight's Students' "Mathematics" Brainstorms 2009

The two students with the highest number of items (14) were girls—Maria in Mrs. Cruz's class and Fadhila in Mr. Knight's class. Interestingly, these two girls expressed different notions about their future in the 2010 interview. Maria is a very bright and somewhat talkative 10 year-old girl whose family is from Guatemala. She likes to have fun and considers herself to be “an outsider person...not an indoor person.” She has no idea of what she wants to be when she grows up. She just knows she wants to be outdoors: “I don't know. All I know, a thought that comes to my mind is to go places, like to visit countries but I don't want to write about it. Just visit. I just wanna go places.” Although she loves math, she does not see herself as a mathematician. Fadhila is also very bright, competitive, and very tall for 11 years old. She is taller than me, and I am 5 feet 7 inches. Her family is from Africa. She is affable, loves math, and sees herself as a mathematician today although the future she is planning does not seem to hold math in the foreground: “Yeah, I have it all planned out. After I be a lawyer, I'm gonna be a judge. And if that doesn't work out, I'm gonna be a musician. And if that doesn't work out, I'm gonna be an artist.”

Regarding the word “mathematician,” in 2009 only three of 32 students (9.4%) in the pre-brainstorm activity at the beginning of the school year indicated that they had ever heard the word. At my showing the word “mathematician” for the initial brainstorm for each class, several students shot their hands into the air enthusiastically asking, “Oooh, what is that?!” Although some struggled to pronounce the word, they asked me, “Ms. Fleshman! What is a math-e, math-e, math-e -ma-ti-cian?!” Although as

an educator I was happy about their excitement to know the unknown or unfamiliar and thrilled as a researcher about their excitement to participate in this particular research activity, I was a little dismayed and perplexed at their not knowing or being familiar with the word, especially since it is grammatically and visually close to “mathematics.” Maybe they just forgot. I was hoping that they had forgotten and simply could not remember. I coded the students’ responses based on whether or not they wrote that they had heard the word “mathematician” and whether or not they wrote anything about it such as a definition or description. See Table 15 for code percentages.

Table 15. “Mathematician” Brainstorm Coding 2009		
Code	Description	Frequency (Percentage)
HeardWroteDD	Have heard the word, wrote close definition or description	3 (9.4%)
NotHeardYesWrote	Have never heard the word mathematician, wrote something	12 (37.5%)
NotHeardNoWrote	Have never heard the word mathematician, did not attempt to write definition or description	11 (34.4%)
IDK	I don’t know (no indication of having heard the word)	6 (18.8%)

Four out of 10 students (37.5%) had not heard of the word but did write something about it, whether it was a definition or description of what they thought mathematicians do:

- “I think it is when you good at math because it is like a magician.”
- “I think a mathematician is a person who knows math really really well.”
- “A person who knows a lot of math.”
- “I think it have to do with numbers like $|x|=1$.”
- “My gues [guess] I just by hearing and looking at the word I think mathematician is realy [really] hard.”
- “Having to do with everything about math.”

The remainder of students (53.2%) did not write anything about it with nearly two in 10 saying simply that they did not know what it meant.

In 2010, the picture looked somewhat different for Mrs. Cruz’s class than in 2009. Regrettably, in 2010 timing and behavioral problems became an issue and I could not conduct the brainstorm for Mr. Knight’s class. By that time Mr. Knight had been removed from the classroom and replaced with a substitute teacher (Mrs. George) for the remaining months of the school year. Mrs. Cruz’s students’ responses changed from 2009 to 2010 but in no particular pattern, except for one: students who wrote items that reflected math used outside of school in 2009 also wrote items that reflected the same in 2010. See Figure 15 for 2009 and 2010 brainstorms of Mrs. Cruz’s students.

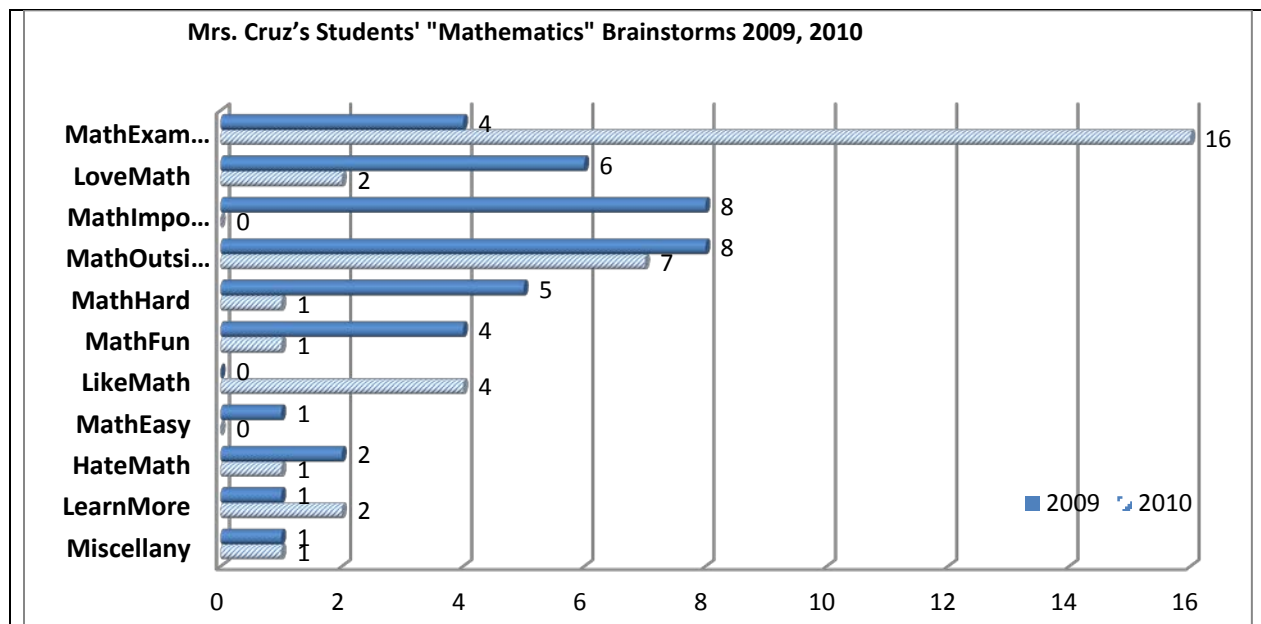


Figure 15. Mrs. Cruz's Students' "Mathematics" Brainstorms 2009, 2010

The rest of the codes varied from 2009 to 2010 for nearly each person. There were many more items that were examples of math (i.e., times table, subtracting, math games, algebra, decimals, protractor, ruler) in 2010 than 2009. Sixteen of 17 students (94.1%) in 2010 wrote items that were math examples. Although no students in 2010 were as explicit as in 2009 about how math was important to them, they were explicit in writing examples of math. See Figure 16 for frequencies.

In 2010, the purpose of the brainstorming on the word "mathematician" was less about whether they had heard the word but more about their thoughts about the word, especially since 25 of the students had heard the word in the interview I conducted with them in May or June. Fourteen of Mrs. Cruz's 18 students in the study wrote a definition or description of mathematician. Their definitions, for the most part, reflected what was discussed in the interview, in particular, the definition of mathematician that I gave them: "A mathematician is a person who sees math in everything." There were a few exceptions, however.

Interestingly, in 2010 Jorge's jottings about "mathematics" and "mathematician" included personal connections to himself. About mathematics, Jorge wrote that he was "going to have a 4 on his math state test." The fifth graders had taken their math state assessment in May, and all of the students were hopeful to pass the test so they could advance to the sixth grade. About mathematicians, he wrote that mathematicians "always gets 4's on report card," "does a good job on tests," "always get respect," and

“always get reward.” His description made me smile. Maybe Jorge should be the youth spokesperson and officer for mathematicians. Jerome, Bernardo, and Dayanara were the only students to write that they could be mathematicians. Further, Jerome said that his family could be mathematicians and Bernardo was the only student who said that his teacher could be a mathematician. (Mrs. Cruz was his teacher.) Although Ariela did not point to herself as a mathematician, she wrote that some people in her class could be mathematicians.

In sum, these 32 fifth grade students’ brainstorms on the words “mathematics” at the beginning of the year showed their feelings about math, in particular, their love of it, and in what ways it is important to them. They also showed how they see math outside of school. The doing of math in the present tense and the positive, strong feelings about math were prominent for these students as they started their last year of elementary school in this community school. What was also prominent, however, in a negative way was their lack of awareness and knowledge of mathematicians—what they do, who they are, and what that means for children beginning to look and have ideas about their academic and career future. By the end of the year, what was prominent about the “mathematics” brainstorm was their focus on the doing of math and less so of the feelings about math. That may be expected as they had just taken their state math assessment the previous month. All of Mrs. Cruz’s students, except for one, indicated on their brainstorms some knowledge or awareness of mathematicians, although that knowledge was based on what they learned through the interview I conducted with them. The remaining students, also engaged in discussion of mathematicians during the interview, were from Mr. Knight’s class and probably would have indicated similarly had the brainstorm been conducted.

6.7.1 Hearing the Word “Mathematician”

In the interviews, I asked each student had they ever heard the word “mathematician” before. Three-quarters of them (19 of 25) replied that they had never heard the word. The remaining six said that they had. One student said he heard the word “mathematician” from his third grade teacher Mr. James (who no longer teaches at this school); another from her third grade teacher, also; the third student heard it from a television program, which she could not remember its name, but seemed excited to share what she remembered; and, the two girls had heard it before but could not recall where. Only one of the six attributed having heard the word during the 2009-2010 school year to his fifth-grade teacher, Mrs. Cruz. These interview responses were similar to the pre-brainstorm results on the word “mathematician” where

only three out of 33 students indicated in their written responses having ever heard the word. This variable was scored as 1 if a student said he or she had heard the word “mathematician” before even if they could not remember where or 0 if they had not.

The analysis of this category brought interesting results. With respect to ethnicity, cross tabulation shows a significant relationship between students’ ethnicity and their having heard the word “mathematician” ($\chi^2(1, 25) = 6.79, p = 0.031, \phi = -.52$) with 75.0% of African American and only 14.3% Hispanic students saying they had heard the word “mathematician.” (The p -value of Fisher’s Exact Test was used since two cells had expected counts less than five.) Contrary to my expectations and hopes even, none of the survey items for 2009 and 2010 presented significant differences. However, significant differences were detected for the state math assessment scores for 2009 and 2010. For the 2009 math assessment, the students in this research were in the fourth grade with different teachers than Mrs. Cruz and Mr. Knight. The math assessment is always administered in the spring, with the 2010 assessment being administered for the first time in May instead of March—a decision rendered by the city chancellor.

For the 2010 math assessment scaled score (as calculated by the state education authority board, the difference was significant ($t(23) = -2.35, p = .027, d = .56$). Students who had heard the word “mathematician” scored significantly higher ($M = 688.17, SD = 18.49$) than students who had not ($M = 666.79, SD = 19.63$). For the 2009 math assessment scaled score, a significant difference also showed ($t(23) = -2.19, p = .039, d = .52$) where students who had heard the word “mathematician” scored significantly higher ($M = 712.67, SD = 28.75$) than students who had not ($M = 681.11, SD = 31.36$). What about the hearing of the word is important, especially when the hearing of the word among the six was experienced differently?

6.7.2 Students Defining Mathematician

Although Kline (1973), Herzig (2004b), Villegas and Lucas (2002), and Bruner (1996) assert that students need to learn to think, feel, and act as mathematicians (or scientists or other topical experts) do, this is not possible when students have never heard of, seen, or met any mathematicians, in general, or even heard the word “mathematician” itself. I asked the students where they had heard the word, and three out of six indicated a teacher—one teacher being Mrs. Cruz, and the other two were the students’ previous third and fourth grade teachers. Two students could not remember, and Chantelle, the sixth student, said from a television program, which she could not remember. Even though the high majority of

the students were not familiar with the word, I asked them what they thought a mathematician was or at least did. Three students answered “I don’t know” and did not contribute more to their answer. They sat in silence with a perplexed look on their face.

I then prompted them with contextual prompts such as “Is there a word in there that sounds familiar to you?” or linguistic prompts such as slowly enunciating each syllable of the word “mathematician” with emphasis on the first syllable “math”. I prompted them for the purpose of eliciting a response. I did not want them to feel anything negative for not knowing an answer or not being able to respond. Further, I did not want them to feel like this was a test of any sort where mistakes or not knowing were penalized. Even after prompting, their answers remained the same: “I don’t know.” However, for three other students prompting drew out generic responses such as “somebody who works with math.” With the exception of a few, students’ definitions about mathematicians overall reflected a focus on skills and expertise rather than habits of mind or feelings. Already in the early stages of their identity development overall, and more specifically, their mathematics identity, being a mathematician is related to how much one knows or can do in mathematics as opposed to how one comes to know mathematics.

All 25 student definitions of mathematician were coded *in vivo* (using their own words) to attune myself to and maintain participant language (Saldaña, 2009). Nearly one-third (8 students) responded with more than one definition for or idea about a mathematician. Therefore, the total number of responses (n=33) exceeds the number of students interviewed. The students’ definitions were put into four categories: expertise, function, desire, and unknown/generic. The expertise category contained responses that stated how good a person is at what they know in math or how much they know or do with math. The function category contained responses that stated specifically what a person did, their function or vocation, with math. The emotion category, the smallest one of them all, contained the single response that stated how a person likes math.

Eight out of ten responses (81.8%) defined a mathematician in terms of expertise (51.5%) or function (30.3%). Thus, nearly half of the responses focused on the *knowing* of mathematics and nearly a third focused on the *doing* of mathematics. Only one response (or 3.0%) focused on the *enjoying* of mathematics. See Table 16 below for student definition codes and sample quotes.

Table 16. Frequency of Coded Student Definitions of Mathematician With Quotes Expressed During Interview

(n=33 responses)

Category	Definition Code/Sample Quotes	Frequency of students	Percentage of students
Expertise (knowing)	A person who is really good at math. "...a person that is very good at math." "That does good in math, does really good. Do excellent in the homework and the test." "...And they're really good at it." "A person who's really good at math." "They're a whiz."	12	36.4%
Function (doing)	A person who helps or teaches people in math. "They teach people about math, and show how what is math and stuff." "Helps people in math." "A math professor."	6	18.2%
Expertise (knowing)	A person who knows a lot of math. "They know a lot of math." "They deal with every math thing like division, multiplication, adding, subtracting, umm, fractions, everything."	5	15.2%
Unknown/Generic	I don't know. "I don't know what a mathematician is."	3	9.1%
Function (doing)	A person who does a lot of math. "They do a lot of math." "A guy that does math every single day and doesn't stop."	3	9.1%
Unknown/Generic	A person who works with math. "...somebody who works with math."	2	6.1%
Desire (liking)	A person who really likes math. "A mathematician is someone who really likes math."	1	3.0%
Function (doing)	A person who figures out new things in math. "...they figure out new math stuff so you can do it."	1	3.0%

6.7.3 Students' Likes and Eases About Math

For the 25 students interviewed, mathematics was a favorite subject for 72.0% of them. This category presented significant differences in mean ranks for numerous items. These items speak partially

to students' math anxiety, confidence in learning math, gender equality, and classroom community. See Table 17 for specific items.

Variable	Item	<i>U</i>	<i>p</i>	<i>r</i>	Mean rank (A)	Mean rank (B)
Favorite Subject¹	Knowing math will help me get a good job.	33.0	.015	-.49	14.67	8.71
	Girls are less talented in math than boys by nature.	24.5	.015	-.49	15.41	6.43
	I like to help my classmates with math.	30.5	.035	-.42	14.81	8.36
	When I get a math problem wrong, I try hard to understand why.	20.0	.003	-.59	15.39	6.86
	I'd be proud to be the best student in math.	27.0	.006	-.55	15.00	7.86

Note: 1: A=Math is their favorite subject, B=Math is not their favorite subject.

In 2010, more significant differences presented for four items: “Knowing math will help me get a good job,” “I’d be proud to be the best student in math,” “When I get a math problem wrong, I try hard to understand why,” “I like to help my classmates with math,” and “Girls are less talented in math than boys by nature.” What makes for the difference? Do students who enjoy math see the enjoyment, and possibly the ability of it, in each other beyond gender more so than those who do not enjoy math? Significant differences also presented in three subscales and the total survey for 2010 with those favoring math scoring higher than those not favoring math: Gender Equality, Discovery, Anxiety, and Survey Total. For Discovery, Levene’s test indicated unequal variances ($F = 5.29, p = .031$), so degrees of freedom were adjusted from 23 to 6.846. See Table 18 below for subscales.

Subscale	<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
Gender Equality	-2.46	23	.022	.56
Discovery	-3.31	6.85	.003	1.03
Anxiety	-2.77	23	.011	.80
Survey Total	-3.25	23	.004	1.25

The effect size for Anxiety is large, $d \geq |.80|$, while the effect sizes for Discovery and the Survey Total are much larger than typical, $d \geq |1.00|$ (Leech, Barrett & Morgan, 2008). The subscale Classroom Community did not present any significant differences even though two of its items, “I’d be proud to be the best student in math” and “I like to help my classmates with math” presented significant differences by themselves. Although it stands to reason that whatever a person favors will be reflected positively in their

beliefs and behaviors, it is quite interesting to see how it plays out between students' responses circled on a sheet of paper in a classroom of their peers and their responses spoken into a recording device in a classroom with me only. To see the interplay of measured responses and researcher expectations is exciting as sometimes my expectations of results are dashed while sometimes they are upheld.

Students favored math for several common reasons. Although Javier favored mathematics and science, he liked math because it was competitive and easy. Domingo, too, favored math and science; science because it was interesting and math because "you'll be able to learn real stuff, how to divide and times things." His favorite thing to do in math was fractions in the Math Journal because they were easy to him. Fadhila favored social studies because she loves to learn about history and read biographies of all people. She favored math because math is very interactive and hands-on: "...You don't just have to use your head. You could use paper, you could use counters, you could use cubes. Anything that will help."

Eduardo enjoyed reading because "you gotta learn different stuff" and math because of the step-by-step nature of learning that he appreciated: "...Like it shows a box that tells me how to do it. And shows me pictures of the same fraction and it shows me how to write it, how to do it." He liked multiplication because it was like adding to him: "That like when it's nine times eight, right? You add, you add the nine, and you add it all up like eight times...nine times eight equals 72." He enjoyed division, also, because Mrs. Cruz showed the class a strategy that helped him to divide better and faster. Belen liked the ease of knowing the facts and answers from reading and the ease of multiplication, especially using the Lattice method—her favorite thing to do in math: "You just have a box, and create it, and just put the numbers that you're multiplying, and you take the small numbers and multiply them. And when you multiply them, you add them all together and that's your answer." I was thrilled to hear Belen explain this method in such detail as I never heard her explain anything in detail in class, much less heard her voice in class.

Some students held math as a singular favorite for the ease or challenge of it. Jerome and Leticia, who had favored math since first grade, found it easy, or at least, easier than other subjects. When I asked Jerome what did he like doing best in math class, he replied that he liked learning improper fractions. Jerome was honest about his assessment of his understanding and performance on improper

fractions, and although it seemed average, the challenge of learning this particular topic and his consideration of it as a game seemed to be the motivation:

Jerome: I like learning improper fractions.
Researcher: Okay. That's interesting. Improper fractions. Okay.
Jerome: It's like it's not hard, it's not easy. It's like right there in the middle. See some people in my class they don't get it, and some people do. Just like that. Fast. (Snapped his fingers.)
Researcher: Okay. And you do it just like that?
Jerome: Nahh, I'm like some of the class. Like they need a little help with.
Researcher: Okay.
Jerome: But it's like a game to me. It's fun.

Leticia found creating shapes or figures easy: "Ahh, shapes. Yeah. Like those block shapes with the hexagon, the triangle, like in the math problem they always say do a shape, find out the length, how many you need to make this shape." For Jorge, math has always been easy for him. He was excited at his excellent performance in math and how proud it makes his mother to see only scores of 4 in math on his report card. He said he liked multiplying fractions and three digit numbers the best and giggled at my asking him if he liked to do the hard stuff.

Gerardo also prided himself on his performance never getting lower than a score of 3 on his state math assessments. He felt his strong suit was multiplication and dared me to test him when I asked him if he thought he was pretty good at it. Even though he got it wrong at first and quickly self-corrected, I was impressed at his agency, competitive spirit, and pride in his own abilities:

Researcher: Multiplication. You think you're pretty good?
Gerardo: Yeah.
Researcher: (Chuckling)
Gerardo: Then test me!
Researcher: Test you right now?
Gerardo: Yes.
Researcher: Alright, let's see. Umm, eight times seven.
Gerardo: Eight times seven (pause) 54.
Researcher: 54?
Gerardo: Wait, hold on. 56.
Researcher: Yeah, there you go.
Gerardo: I forgot to add the 2. I did eight times six is 48, right? So, I added the eight and had 54. But then I made a mistake and then I add a 2, and then the other six is 56.
Researcher: Quick thinking. Do you consider yourself a quick thinker?
Gerardo: Yes.
Researcher: Okay, alright. I've watched you in class. You participate well. Raise your hand, you know the answers. Okay. Umm, nine times nine.
Gerardo: 81.
Researcher: Huh. Umm, 10 times 11.
Gerardo: 10 times 11. 10 times 10 is 100. 110.
Researcher: Last one, I know you're counting the minutes. You set me on a timer. 12 times 12.

Gerardo: 144.
Researcher: Ohh, okay. I'm gonna get you at the end. I'm gonna ask you one [that I think you won't know].
Gerardo: Alright.

For Alejandro, mathematics has been his favorite subject since second grade. He simply enjoyed solving problems, in particular, challenging problems like adding decimals this year. He found adding and subtracting easy as well as “multiply[ing] a lot of numbers and divide” as he “always figure[d] it out.” His favorite topic in math is multiplication using the Lattice Method. Interestingly, he said he did not know how to multiply using the “regular mode.” He used the Lattice Method for multi-digit multiplication, and, for single digits, he multiplied in his head. I asked him to explain the Lattice Method. I told him it was new to me:

Alejandro: Like you just do it. You put a box. And how many numbers you're doing, designs, and then just make it like into two digits.
Researcher: Hmm-hmm.
Alejandro: And then you add the problems and you cross multiply, and when the other numbers are flipping, you add them.
Researcher: Okay.
Alejandro: Then transfer.
Researcher: Okay, so when did you learn this?
Alejandro: In fourth grade from my teacher who taught me, Ms. Z.

In addition to multiplication, Hernan, too, enjoyed “difficult stuff like challenges” as they helped him get smarter. He also enjoyed using the Lattice Method but for turning a mixed number into a proper fraction, which he said he learned just two weeks ago: “It's like when you're trying to multiply the number you put it on the top. And then you do boxes and then you times the number by that, and you put it in, and then you just keep filling it in.” He felt he was good at calculating area, perimeter, and finding the common denominator—topics not mentioned by any other student. Natasha, who enjoyed doing the times tables ever since third grade, also liked adding, using money, and multiplication and division since division was the same thing as multiplication. Zulema, who never found math boring, enjoyed math for how she connected to it and used it as a strategic to focus and get through challenging problems:

“Yeah, I like math cuz to me I have a connection with math. Every time I have a problem, I could just write down a problem, and just anger myself out. Like I'll find the hard problem that I'm not good at, and I'll try to figure out the answer, and it really gets me really frustrated when I get it wrong...So, I get out all my anger just by doing that.”

Jesenia favored math for the practicality of it:

Ummm, like it helps you every day like when you're in the grocery store you see prices, then you don't want like the price to go over like the money you want to spend. Like, for example, you want to spend \$60 on shopping, so you don't want it to pass over the limit.

She found nothing hard in math. When I asked her what things in math she found easy, she rattled off a list: "The perimeter, area, multiplication, division, adding, subtracting. There's more things. There's a long list." Not only did she want to do harder math in class, she wanted harder math in afterschool.

Bernardo and Dayanara, academically at opposite ends of the scale, both favored math for one simple reason: they thought it was easier than all the other subjects. For Dayanara, who prided herself on being good at multiplication, defeating weird-looking aliens in Math Blasters was very easy: "With Math Blasters, it's either adding or multiplying...you have to ummm the way to beat the game is to try to answer all the questions they give you. And to pass them, you have to defeat this alien, a weird-looking alien." Bernardo found subtracting and adding fractions along with multiplication and dividing easy, and thought making bar graphs was sometimes fun. Even though Maria did not favor mathematics as a subject and thought it was boring at times, she found adding, multiplying, and subtracting easy along with number stories. Multiplication was a favorite topic for Carlos and Chantelle even though math was not their favorite, with Chantelle really enjoying the Lattice method for multiplication.

6.7.4 Students' Dislikes and Dis-eases About Math

Although the remaining 28.0% of students did not favor mathematics, only one student hated it. It is important to look at why students favor subjects other than mathematics to understand the connections and processes in learning the non-math topics that engender such interest. Students' dislikes about math centered on their perceptions around the boring or difficult aspects of math. Ariela hated math as a whole because she found it mostly boring and that it seemed like they did math all the time and would never stop. For her, if math was "kinda fun", she would not hate it so much. Oddly, she found dividing fractions easy because "it was almost like multiplication but in a different way." Ariela favored history because "you get to learn about the history and what happens, what happened back in the day." Mathematics has history—a long, culturally-variegated history. Maybe if such history was made accessible to students in ways that piqued their curiosity and connected them to it, mathematics would not take such a backseat for students like Ariela. For Maria math was boring and sometimes difficult. She said she just could not understand fractions, decimals, and percentages. She hated fractions—something that she would tell the world about herself and math.

For Chantelle, reading books for hours to “find out the meaning at the end” grabbed her much more than doing math for hours to find out the meaning at the end. Even though one of Nicole’s favorite lessons in math was learning how to add, subtract, and multiply fractions, her reason for favoring reading and writing as subjects revealed a similar tale of self-expression and challenge: “Cuz it’s fun. You get to express yourself in different kinds of ways and you get to challenge yourself about different kinds of stories.” Paolo’s favorite subjects were spelling and reading as well even though he is very sharp in math and he does math with his father regularly at home in fun and competitive ways. He found some parts of math boring such as subtraction:

- Paolo: Umm, subtraction [is boring], when you have to like subtracting and then you have to borrow. I hate doing that cuz it be like a bigger one and then you have to borrow this, and then you have to cross out, and then I can’t find out which one is which.
- Researcher: Ahhh, okay.
- Paolo: Let’s say you have 10 and then you have like three zeros, and they all have numbers on the bottom. Then you have to find out this becomes 10 and then you cross out that, and then that one has to borrow from that one. Then that one goes 9.
- Researcher: Yeah, it is kinda crazy.
- Paolo: Yeah, it gets on my nerves. (Smiling)

Although Paolo said he found subtraction boring, it seemed that he found it confusing or even irritating as opposed to boring.

Most interestingly, Luis only liked fractions. He was one of three students from all 25 interviewed who mentioned liking fractions. Even for me fractions are a somewhat odd topic to like. I mean, really, who likes fractions? Nonetheless, if Luis could use those fractions in the science he favors so much, he could very well find mathematics not boring, and come alive in answering the questions he posed about doing science:

- Luis: Well, there’s a lot of interested stuff that you could do in it [science]. You could learn about plants, umm, let’s see, how the way life goes, and you could learn a lot of stuff about the world.
- Researcher: Okay. Like what?
- Luis: Like how plants grow? What do many animals eat? What do humans do to survive? What do the trees need to survive? Plants? And how does the world live?

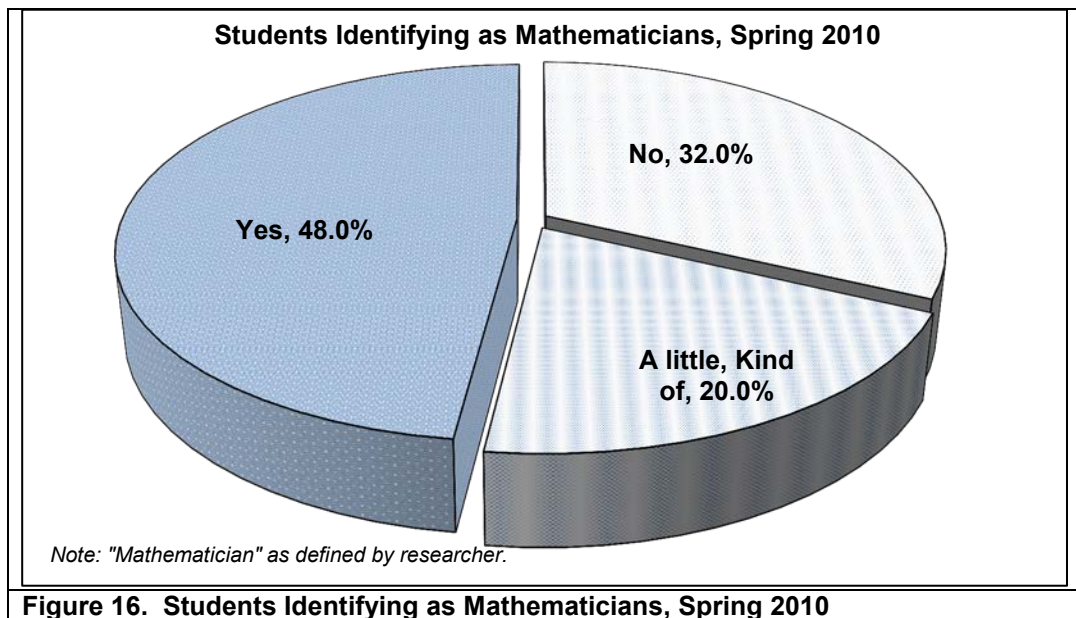
Carlos, too, favored science because “you get to discover things, new things that you haven’t learned and you get to do a lot of projects and stuff, dissect a frog and all that.”

Even though one may not “dissect a frog and all that” in math, there certainly are the elements of discovery and investigation that mathematicians enjoy and readily employ to “do a lot of projects and

stuff.” If these elements were enjoyed and employed more in the classrooms, students may begin to favor mathematics for the same reasons they favor other topics. The goal is not to make mathematics the favorite subject of every fifth grader; however, it should be to help students experience mathematics in such a way that encourages and allows people to express themselves, and bring out the passion of doing, reading, and learning mathematics—processes which have attracted Chantelle to reading. Although students participated often in class, so much to the point where classroom management became an issue at times, somewhere the notion of self-expression was lost on some students during math and not reading or ELA.

6.7.5 How Students See Themselves as Mathematicians

I presented the students with the following definition: “Anyone who likes to learn about math, sees math in almost anything, tries different things in math, is not afraid to try to solve problems or figure things out using math, and is not perfect.” Students responded in different and thoughtful ways. Their responses were coded into three categories: yes/definitely, a little/kind of, and no. Approximately 7 out of 10 students said they were mathematicians definitely or a little. Each student spoke about the parts of the definition they related to or not. I was glad to see them really thinking about the definition and how it applied to them and others, student and adult. See Figure 16 for percentages.



Fadhila was excited at the thought that she could be a mathematician. I read to her my definition of mathematician, and before I could ask if she considered herself one by that definition, she interjected:

Fadhila: I think I'm a mathematician!
 Researcher: That's you?
 Fadhila: Yeah!
 Researcher: Okay! How so?
 Fadhila: Cuz I never give up. I always try. I see math everywhere. And I love to learn about math.
 Researcher: Okay, how do you feel about that?
 Fadhila: I feel good.
 Researcher: Okay. You had this big smile grow on your face. (Chuckling. Fadhila chuckling, too).

Chantelle, too, was excited. Before I could ask her if she considered herself to be the mathematician I defined, she interjected, smiling and giggling:

"Oh, me!...Cuz I always do that. I look around the room a lot. And my teacher don't get it. She be like why you looking around the room. I'm looking for math problems! Cuz sometimes it helps me to think. Like the two times thing, it help me. So I count the windows."

Dayanara was certain that the definition fit her, responding with, "Yes, yes it does...Cuz all the things you said. Like everywhere I look I always see things that include math in everything. And sometimes I solve problems using math. And it's true, I don't get everything right. That's it."

Hernan was clear about his being a mathematician based on what he does outside of school:

Hernan: Because when I go across the street, I see four red cars and like seven black cars. And I just do random, like seven times four is twenty eight cars.
 Researcher: Ahhh, okay. Keep going.
 Hernan: I count the gas stations, and the trees, and stars.
 Researcher: You count the stars.
 Hernan: And how many games I got. Ummm, how many laptops there is. How many pieces of wooden floors are there. That's it.

Zulema also directed her response to what she does outside of school as proof. When she is bored and outside and has nothing to do, so looks around and notices the math that is "around us everywhere. It doesn't matter where we look." For example, she said that if she is outside and sees a cat or dog, she tries to measure how far it runs. Bernardo, on the other hand, directed his response to being a mathematician based on what he does in class on his own:

Bernardo: Cuz I look around the class and I see the closets, and that they rectangles, so I try to figure out what fractions
 Researcher: (Chuckling) Right? What else?
 Bernardo: And then I walk from the closet to the end of the other class to see how many steps it takes to get to the other side.

Eduardo focused on the part of the definition that said mathematicians are not perfect: "Like, like, they don't get everything right?...Like, they just perfect a little bit because they know some of it but not the

whole thing.” He pondered the notion of perfection before I asked him if he considered himself a mathematician. Eduardo seemed to pride himself on trying his best in math, “and though I get it wrong, Mrs. Cruz. just tell me to keep trying and trying, and you get the answer.” Trying his best and never giving up was what identified Eduardo with being a mathematician. Natasha, too, focused on mathematicians’ imperfection, not believing that they made mistakes:

Natasha: (Smiling, surprised look)
Researcher: I can tell the change on your face, you can’t believe that.
Natasha: (Smiling)
Researcher: You can’t believe that mathematicians sometimes get problems wrong?
Natasha: Not really.
Researcher: Not really.
Natasha: Cuz they might get like one question wrong.
Researcher: Okay. Okay. So, just from what I just said about what a mathematician is, can you see yourself as a mathematician?
Natasha: Yeah.
Researcher: Yeah? Tell me why.
Natasha: I may not get everything right on all my tests. I might get like a 98 or a 90.
Researcher: Okay. That’s pretty high up there.

Jerome could see not only himself as a mathematician but “a lot of people.” For him, never giving up was important also as he said he asked questions in class like “how you do this, like what’s the operation and stuff.” In class, for Jerome, math was “like nothing. It’s easy.” Math was easy for Jorge, too, “just too easy” on his tests. Continuous effort and learning from his mistakes was part of his claim as a mathematician:

Researcher: Yes. Okay. You have a big smile on your face. Okay. Tell me why.
Jorge: Because sometimes I miss and make wrong division, and multiplication. Sometimes I miss a number and I keep trying, then the next time I got it right. I be very happy.
Researcher: Okay. Good. What else?
Jorge: Umm, sometimes I do really good on math test. Really good in every test and in my work sometimes I got a couple wrong, but I keep trying and then I got the right answers. It’s just too easy.

Gerardo and Nicole, unlike most students whose perspective was centered in the present, saw themselves as mathematicians in the future. Gerardo saw himself as a mathematician as a fallback to being a baseball player. While Nicole saw herself as a mathematician, she really wanted to be a lawyer but realized that “a lawyer has to do with math. So I gotta understand math before I become a lawyer.” Even though she saw compatibility in both, she did not see co-existence; she did not want to be both, only one.

For the 32.0% of students who did not see themselves as the mathematician I defined for them, most were clear in their reasons why not. Even though Domingo liked science, he did not try to solve things with math a lot. Maria's first thought of a mathematician was not about herself but about another student, Jesenia. She admitted that she did not see math in a lot of things; she just saw it on paper when she did "homework or something." Lourdes said she did not see math everywhere but she liked to try math. Paolo, who was very quick with mental math, had heard the word "mathematician" in his third grade class, and often played math games with his father, said that when he looks around, he does not try to use math except for when he has to. Carlos admitted being a little afraid of some problems but thought when he grew older, he would not be as afraid and he would get better at problem solving. Ariela could not really pinpoint why she disassociated herself from being a mathematician but knew she was not one. Even though the definition spoke about mathematicians trying to solve math problems and not being perfect, Antonio still could not see himself as a mathematician because he believed he was "not good at like every problem in math." Luis's perspective was quite unique on why he did not consider himself a mathematician. Part of it was based on his disliking the subject and also the unfairness of it as he had experienced it:

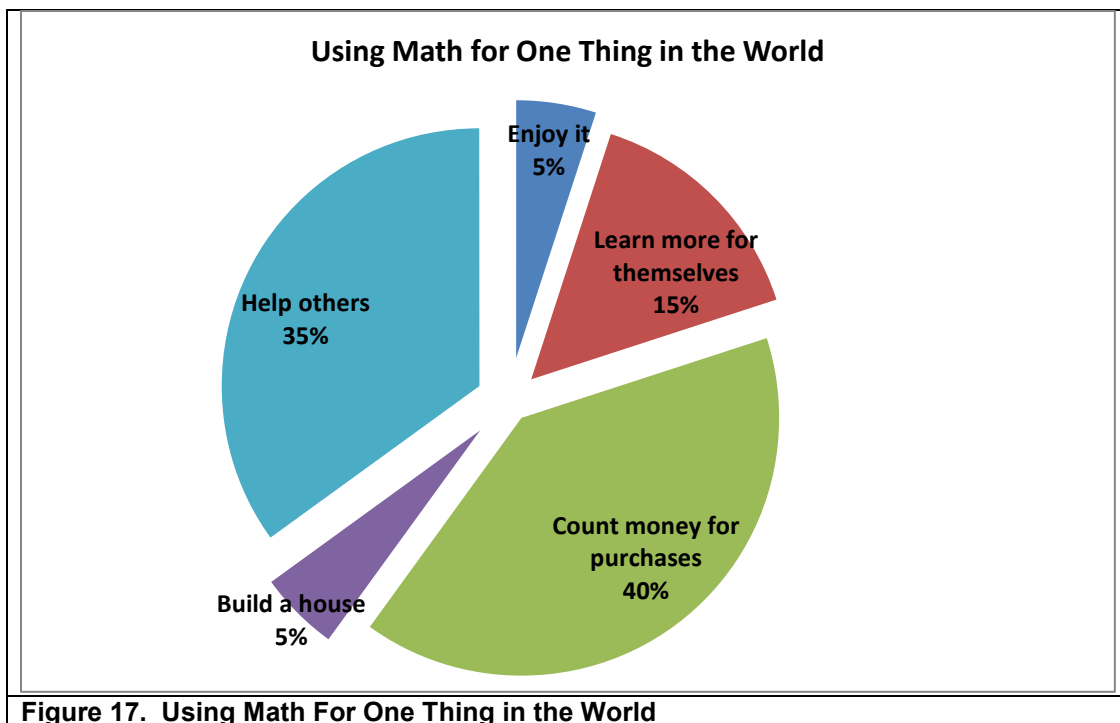
Luis: Well, math I don't really like that much. I only like some parts about it.
And math can sometimes be really hard and unfair.
Researcher: Unfair. That's an interesting word. Why unfair?
Luis: Well, sometimes you get this right and you get a part of it wrong, and you get the whole thing wrong.

6.7.6 Using Math for One Thing in the World

"Counting money...Cuz stores sometimes, just cuz you're a kid, they try to take your money. They think you stupid."—Jerome, 11 years old, African American

Do students' immediate and future life perspectives have any relation to their mathematics identities? If so, in what way? To help explore this question, I inquired how students saw mathematics as important to them. I specifically asked students, "If you could use math for one thing in the world, what would you use it for?" Not every student answered the question. Eduardo, Carlos, and Antonio said they did not know because that was a hard question for them. However, for those that did, math proved important for students in benefitting not only themselves but others, too—for some today and for others in

the future. See Figure 17. Benefits included the simple enjoyment of doing mathematics, helping others, and using it for practical purposes.



One student wanted to use math to continue doing one particular part of it—the part she really enjoyed. Leticia wanted to use math for multiplication because she likes it better. No practical or goal-oriented reason followed it. A few other students, however, found learning math for the sake of knowing more and performing well the one thing in the world for which they would use math. Nicole wanted to use math was passing the state test so she could pass the grade. Domingo wanted to use math to learn more division and other topics he felt he was not that good at doing. Luis wanted to use math to learn more about science, in particular, how planes and vehicles work with respect to the air and wind.

Practicality in everyday life was the one important use for math for nearly half of the students—practicality today and tomorrow. For Bernardo, building a house was most important for using math. He expounded the use of math in building houses: "...if you don't have a house, what are you gonna live in? ... You use math to build. You have to use it to measure, to cut how much wood you need. You're gonna need to use shapes. Use hexes." Bernardo's uncle told him that before anything, you buy a house. Bernardo said he felt happy when his uncle told him that.

Counting money was practical yet basic and significant to their daily lives. Counting money was necessary to Maria so she would know how much she would have to spend. For Jerome, using math to count money was important to children's rights and self-protection. He was the older brother and his family. He had witnessed adult store clerks stealing or attempting to steal from children who were trying to purchase items. Such was a personal experience of his:

Researcher: Okay. Now, if you could use math for one thing in this world, one thing, what would it be?
Jerome: Hmm. Like one thing in this world?
Researcher: One thing.
Jerome: One thing. Counting money.
Researcher: Counting money. Why?
Jerome: Cuz stores sometimes, just cuz you're a kid, they try to take your money. They think you stupid.
Researcher: Has that happened to you before?
Jerome: One time, cuz I put a, I gave him a \$10 bill. And it was, he gave me \$2 back. I was like, hold up. I gave you a \$10 bill. You was supposed to give me a \$5. I was like look. Look. Cuz in this store, he don't put it in the cash register. He just throw it. He put it on the side. He just throw it. I was like, look, you was supposed to give me a \$5. He was like, ooh. I was like, alright. (Said with an air of resoluteness.)
Researcher: (Chuckling) Let him know. Let him know.
Jerome: I was like, I gave you a ten. And he said, no you didn't. I said, Check. He said, Oh, okay, I see it. Yeah, betta know.
Researcher: (Laughing)
Jerome: Cuz he always do that to other people.
Researcher: That's foul.
Jerome: And then when you're older, I think he don't do it.
Researcher: Oh, I see.
Jerome: If you with your mother, your big brother, he don't do it. And that store's like 20 years old. They got rats in there. I don't know if my mom buy stuff from there. Only thing I might buy from there is gum. And like, there's a Subway next to my house.
Researcher: Really?
Jerome: Uhh-huhh. A new store, two new stores. Only thing I go there is for my gum in the morning. That's it.

Parents seemed to be very involved in helping students understand how to count and spend money well with respect to the purchases they made. Zulema credited her mother for helping her understand how to shop:

...like so my mother gave me \$30 for the trip, the senior trip. And they, all they had was like candy and accessories. I notice that the bags looked cheap, because my mom showed me the difference between cheap bags and good bags. And my mom, I remember my mom said if it's hard, really hard and a little bit soft, don't get it. She said if it's little bit rough, but not so soft, it's in the middle, you can get it. It's good for you. And then with t-shirts, it depends on how much it costs and the style. Like if it's a t-shirt and it costs \$30, I'm not gonna get it cuz a t-shirt for \$30 is not worth it. You could go to store and buy like 30 something. 30 of something else instead of one thing. And my mom told me the difference to not get ripped off. She said I'm gonna need it one day. And I said

mommy I don't need it, I don't need it. And for the senior trip, I noticed I really did needed it. The bags were a little bit floppy and it wasn't worth it. And I was like, nope, I can save my money. And now I still have my \$30. And now I don't have to ask my mom for money.

Other students wanted to use math to help others, now or in the future, near or far. Fadhila wanted to go all around the world to learn about other people's lands to help them with their land. Paolo wanted to "divide all the money [he has] to give it to people who need it." His altruism and care for others were based in part on how he perceived his own status. Although Paolo had experienced the recent loss of his mother and was being raised by his father, he still carried in mind and heart the need of others:

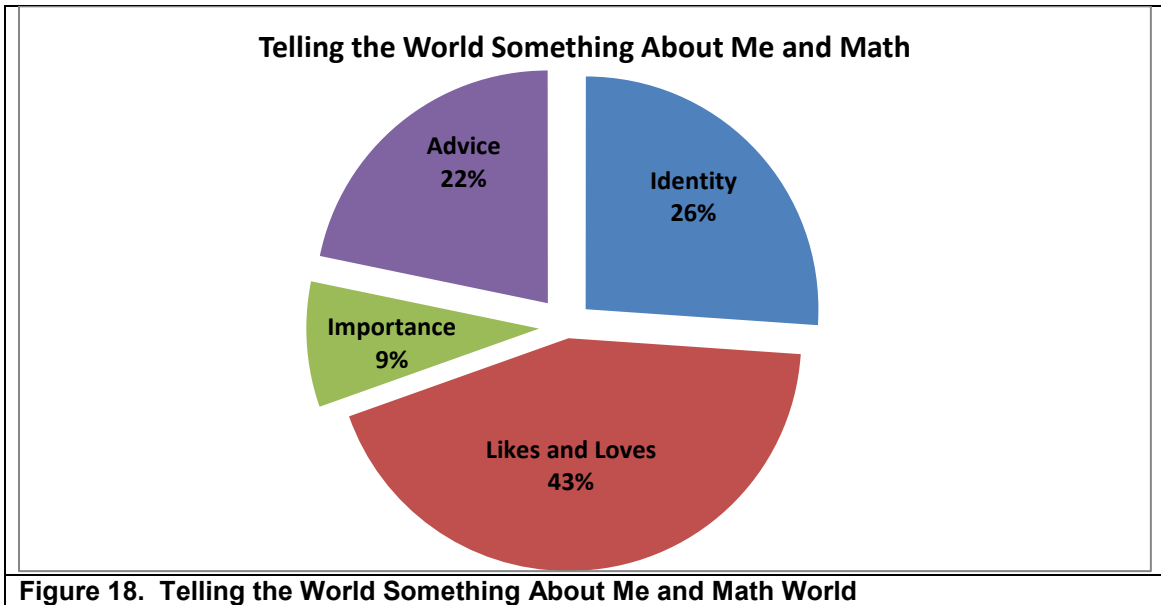
"Because I feel that since I don't need all the money that I have, I can give some of it to people who really need it. Cuz people like me who have a lot of stuff, and people still live on the street without a house. Like in Haiti, they had a earthquake and all the houses burned, burned."

Looking towards the future, Hernan wanted to teach his children "so then when they go to school, they know what they talking about and they could get the question right." Natasha wanted to use math for learning—to spread learning everywhere—in particular, learning times tables and division. Although Lourdes wanted to be a veterinarian as an adult, she wanted to "help kids use math like teach them stuff." Jesenia decided that she would use math to become a doctor: "You have to calculate how much medicine you have to give them because you can't give them that much because they could go into poison, or not that little because it might not work." As a doctor, she did not want a patient to die in her room.

6.7.7 Telling the World Something About Me and Math

"I am the multiplication genius. Never doubt me."—Gerardo, 11 years old, Dominican

I also asked a question that I thought would help to hone in on the relationship between the student and mathematics in their point of view, again exploring their immediate life perspective and their mathematics identity. I asked the following question in some form: "Let's say I gave you a microphone and you could tell the whole world something about you and math. What would you tell them?" Only two students, Domingo and Luis, did not know what they would tell the world. The others, however, would share a range about themselves and mathematics. See Figure 18 below for percentages.



A handful of students responded with statements that spoke to their math identities, how they see themselves in math. Gerardo said that he would tell the world that he was the smart one, to trust the genius, and to never doubt him—he was the multiplication genius. Javier looked forward to becoming “a math master” because everything in the world talks about math as “even ummm math has ELA, too...and sometimes social studies have math because of all the bar graphs they have and line graphs.” Zulema immediately responded that she was good at math and that she knew a lot of equations that lots of people did not know. Jesenia’s response was concise: she’s really good at math and math can help you a lot. Dayanara said simply that she was perfect at it. Then she adjusted her statement: “Not perfect. Good at it.” Maria, on the other hand, was frank: she would tell that she is not much of a math person.

Many students expressed their likes and loves about math. Bernardo said simply that he really enjoyed math. Fadhila said that she would say that she loved math and almost everything she does involves math. She would also say that math is cool and that it is her favorite subject. Hernan would say that he “likes doing multiplication because sometimes it gets complicated but then [he] still go[es] for it and [he gets] it right.” Jerome said he would tell the world that he loves improper fractions, and Paolo and Carlos would tell them that they like multiplication. Leticia, too, said she would tell the world she likes multiplication but also subtraction, addition, and fractions. Leticia would tell them that math is a great subject—her favorite subject—and that “it help you at life...you could use math anywhere you go.” Lourdes said she loved math, she tries her best, and that she does good on her report card.

In trying to answer the question, Chantelle made quite an astute point about her shyness. Nervously, she said she could not tell the whole: "The whole world! I couldn't do it! I'm shy in front of you! How could I, how I'm not gonna be shy in front of all of them?" Although I was quite tickled by her very real response and emotions about over a hypothetical situation, I understood her point. So I changed the focal point so she would not be able to see the audience:

Researcher: Okay. Well, what if I said, okay, you won't see the whole world but you would be able to say something really important about you and math, and then maybe, the whole world would see it on a tape. That's not gonna be that bad.

Chantelle: I'll do it.

Researcher: What would you want the world to know?

Chantelle: How I could see clues around the room, and how I love multiplication, and how I'll do it through money and help my family if I get the money and stuff. That's what I would do.

Researcher: That's what you would tell the world.

Chantelle: Yeah.

Alejandro would tell the world that math is a part of his life as he uses it every day. Luis would tell the world that math can be really important to life. He expounded on just how important:

"I would say, let's see, that math can be really important to life. Math is mostly what we learn to create everything but sometimes math can be really difficult to figure out something. Some things are with math and math is what created vehicles, planes. They used math to carve things. They use a lot of things, how to carve them, where to carve them. Let's see, umm, they use a lot of things for math like creating things when like where is the part to cut them, the pieces and where is the part where you can't cut them cuz everything will be ruined. And math is mostly what we learned from oxygen, plants, where do we get oxygen from and why is there clouds in the sky."

There is beautiful irony with Luis: he does not consider himself a mathematician; math is not his favorite subject; his math state assessment score was below average; and, when he grows up, he wants to be a NASCAR race car driver. With his interests seeming to be so far from math, his ability to see math in the things around him was markedly more pronounced than many of the students who considered themselves to be mathematicians. Maybe such irony speaks to the importance and need of not only bringing out the beautiful script of mathematics but the spaces and places where these scripts function, especially for those who love math and want to do it, so to speak. Maybe such irony speaks to the power and need to know the interconnectedness of mathematics and other disciplines (Kline, 1973; Lockhart, 2009). What was penned on papyrus and paper, and inscribed in dirt and on walls first lived apart from the ink and chisel. So how might Luis's path and his world about him be different if he actually considered himself to be a mathematician, especially since he is able to see math in the world about him

like a mathematician? How might the path and world of the mathematicians in this school be different if they were able to see and articulate the math in the world about them as acutely as Luis?

Eduardo gave advice to other students—the same advice that he proudly gives himself: “I would tell them to try your best even though you’re kids you gotta try your best and do how much you could and just keep going. Keep moving. Keep moving forward.” Jorge said that he is really good and that he could give them advice in math problems. He shared how he used to help other youth in the neighborhood and “after that they get good scores on the report card and test. They, ummm, they umm, I encourage them to do better and they live up to it.” Natasha also offered advice for other students learning math, “that it only could be easy when you’re paying attention and studying.” Nicole, in addition to her saying what she liked, she said that “you gotta use your brain a lot...and it’s sometimes hard to learn but it could be fun, creative...and that’s it cuz I’m shy. (smiling)”. Ariela, who started to pay more attention in class as the year progressed, said that “anybody can do math. It doesn’t matter if you’re smart, if you’re not smart. You just have to keep on trying and never give up.”

6.8 Students’ Future Life Perspective and Their Identities

Students’ future life perspectives were drawn from questions about their college and career aspirations. Although the proposed interview questions did not contain a direct question asking them about their college and career aspirations, I included such a question in the final interview questions set. For their college aspirations I asked some variation of the following questions: Do you want to go to college? What do you want to study when you go to college? For their career aspirations I asked some variation of the following question: What do you want to be when you grow up?

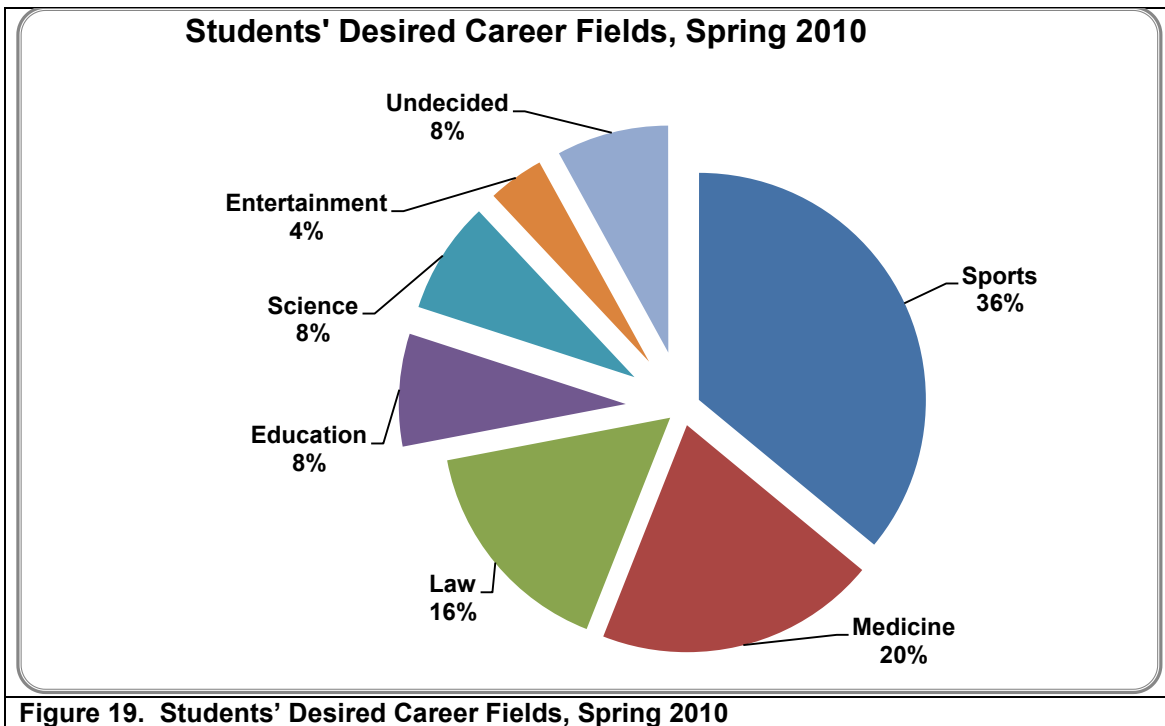
6.8.1 Careers: Looking Towards the Future

Nine students mentioned a career that was coded as math- or science-related career and 14 mentioned careers that were not coded as such. Two students remained undecided even after prompting, with one girl saying, “Ooh! That’s a hard question. They’ve been asking me that since kindergarten and I still don’t know.” This student made it clear that all she wanted to be able to do was to go outside and play. That, I understood. For 2010, no significant differences surfaced for any survey items; only for 2009. All of the students, except for Maria and Ariela, expressed some idea for their career aspirations. Ariela did not know what she wanted to be when she grew up because she had not

really thought about it. For Maria, it was a similar story as she declared, “Ooh! That’s a hard question. They’ve been asking me that since kindergarten and I still don’t know.” The remaining 23 students expressed specific ideas about their career aspirations. Of the 18 students asked about their college aspirations, the majority expressed some awareness of or desire to go to college, even if they did not know what they wanted to study. Regretfully, the remaining seven students were not asked due to time constraints or researcher oversight.

Student college aspirations were coded as “awareness,” “math or science,” or “not math or science.” Students’ responses were coded as “awareness” if they expressed some knowledge of or desire to go to college but did not articulate a particular study. Only two students’ responses were coded as awareness—Maria and Jorge. Although Maria wanted to go to college, she did not know what she wanted to study because she did not know what she wanted to be when she grew up. Jorge, one of three students who wanted to be a NASCAR race driver, did not know what course of study to undertake for his career. Of the three students who did not choose a math or science related courses study, two of them—Nicole and Fadhila—wanted to study law in line with their careers, while Ariela primarily wanted to study Spanish social studies. The remaining 13 students wanted a math- or science-related course of study with three students wanting math, in particular, and the rest wanting some area of science, be it medicine, veterinary science, or a science related to their career.

Twenty-three of 25 students (92.0%) said what they wanted to be when they grew up. I coded the responses as math- or science- related, or not, of which 39.1% wanted a math- or science-related career and 60.9% wanted otherwise. Students indicated careers that were in sports, medicine, law, education, science, and entertainment. Most talked of their future careers with certainty while others expressed possibilities in multiple careers over time. See Figure 19 below for percentages of career fields chosen.



Javier first saw himself as an astronaut with retirement bringing about his second career as a banker. Javier's desire to be an astronaut was not new. He had made it known to his classmates, as indicated by Gerardo and Alejandro, and to adults through the Hopes and Dreams Project—a project that encapsulates students' career aspirations. Domingo and Zulema wanted to be teachers, a science teacher and math teachers, respectively. Jerome, Gerardo, Eduardo, Alejandro, and Paolo saw their future in sports, baseball, in particular, with Jerome playing football. Hernan, Chantelle, Belen, Jesenia, and Lourdes wanted to practice medicine with Hernan and Jesenia as a surgeons first, then veterinarians, and the rest as veterinarians. Chantelle, Belen, and Lourdes wanted to be veterinarians because they liked pets and animals. Hernan was very detailed in his reasons for wanting to study medicine.

Researcher: That's what you wanna be when you grow up? A surgeon. A veterinarian and a surgeon. Why?

Hernan: Because it's weird but I like seeing blood.

Researcher: (Laughing) Oh my god, okay.

Hernan: And you just like, but you gotta go to college to learn the parts so you can know what you're doing. Like if somebody got cancer inside their brain, you gotta take the brain come out and then cut it, and let the thing come out.

Researcher: Hmm.

Hernan: And then put it back.

Researcher: Wow, have you been watching shows, or you just kind of thought of this yourself?

Hernan: I watch shows and movies.

Researcher: Okay, okay. How long have you wanted to be a surgeon?
 Hernan: Like three years.
 Researcher: Okay, okay. Does your family know you want to be a surgeon?
 Hernan: Hmmm-hmmm.
 Researcher: Do you talk to your family about the things you learn in math?
 Hernan: Sometimes...And I like needles. When they give it to me, I just laugh.
 Researcher: What you talking about? You're like the only person who laughs if someone gives you a needle.
 Hernan: It doesn't hurt.

Jesenia was straight forward with why she wanted to be a surgeon and a veterinarian.

Jesenia: I want to be a doctor or a veterinarian.
 Researcher: A doctor or a veterinarian. Wow. Okay. Tell me why. Why a doctor?
 Jesenia: Umm, I really want to help people when they're like sick or something happen to them but what I really don't like about doctors is that you might get their germs, and then you could get sick.
 Researcher: Okay. Okay. So what about a veterinarian?
 Jesenia: Ummm, I wanna help animals when they have a problem (bell sounds off) because I had a cat before and my brother by accident pushed her down the stairs. So I was helping my mom rub her leg because she fell on her leg. I was helping my mom.

There were four future practitioners of law in the group—two as lawyers (Nicole and Leticia) and two as judges (Natasha and Fadhila). Fadhila's desire to be a judge was based on her self-awareness and was revealed when I asked her the one thing she wanted the world to know about herself:

Fadhila: Yes. Fadhila has mouth. I know what to say at certain times. I know when to say some things. I know what to say, when I'm going to say it. Yeah, that's why I'm gonna be lawyer.
 Researcher: Aaah! That was my next question. What are you going to be when you grow up?
 Fadhila: (Chuckling)
 Researcher: It was. Why are you laughing? (chuckling). So, are you going to be a lawyer?
 Fadhila: Yeah, I have it all planned out. After I be a lawyer, I'm gonna be a judge. And if that doesn't work out, I'm gonna be a musician. And if that doesn't work out, I'm gonna be an artist.

Nicole wanted to be a lawyer because she enjoyed the thought of fighting for others:

Researcher: Ahh, a lawyer. Why a lawyer?
 Nicole: Except for staying in the court for seven hours, I think it's fun trying to fight for somebody. Not fight physically. Fight so they could have their rights.
 Researcher: Okay.
 Nicole: And umm I wrote for the newspaper. I wrote that I wanna be a lawyer so I could fight for the people that had accidents if they wanna sue. And the pets, the people that abuse the pets, I'll send them to jail cuz my sister wants to be a veterinarian. So I'll help her.

Of the three NASCAR race car drivers, Jorge and Luis expounded on their desired occupation the most, with Jorge sharing his thoughts on the math involved with driving and Luis sharing his thoughts on

the science with cars in general. Their explanations came about later on in the interview when I asked, “If you could use math for one thing in this world, what would you use it for?” Jorge said he would use it to guess a number of things about racing:

“when to change the tires and to get fuel, or [if] there’s a really big crash waiting in the middle or the end of the race, and I try to figure it out when it’s gonna happen so, so I could go to the back or to the front...I try to figure out what at lap, or at what turn in the back straightaway or front straightaway.”

Luis, who takes boxing lessons after school, said he would use math for science. I asked him to explain.

Luis: Cuz you could learn a lot of stuff with math first, with science. If you put math with science, you could learn a lot of stuff like how does stuff work like planes, vehicles. How are vehicles made? Well, I learned really a lot of stuff like cars aren’t flat cuz it could get in their way, and the air could try to stop them. The air, since it’s so flat, it beat the car. The flat part, on the front could stop them, and that’s why they made cars smooth in the front.

Researcher: Wow! Do your classmates know you’re this smart?

Luis: I’m not that smart. I just learn a lot of stuff from my parents and they show me, too.

Researcher: Okay, okay. Did you learn that part about the air against the car when you were learning about the race cars?

Luis: Umm, I learned it really from my parents cuz they showed me how a car works and in the class, they showed me once, too, and cars work cuz the air goes up and it goes on the top, and it just comes out through the back. And if the cars were flat, the air would just blow and pull them back a little. It would slow them down a little. It would cause drag.

Researcher: Drag. Yes. I like this interview. I’m learning a lot...

6.8.2 Math-related Careers and Mathematics Identity

Quantitatively, how students saw themselves in the future held interesting relationships with their mathematics identities. Contrary to my own expectations and hopes, the Chi-Square test revealed no statistically significant relationships at $\alpha=0.05$ between the students’ career field (e.g., math/science related vs. non-math/science related) and quantitized, nominal variables favorite subject and mathematician identity that spoke to students’ immediate life perspectives in part. See Figure 20 for category percentages.

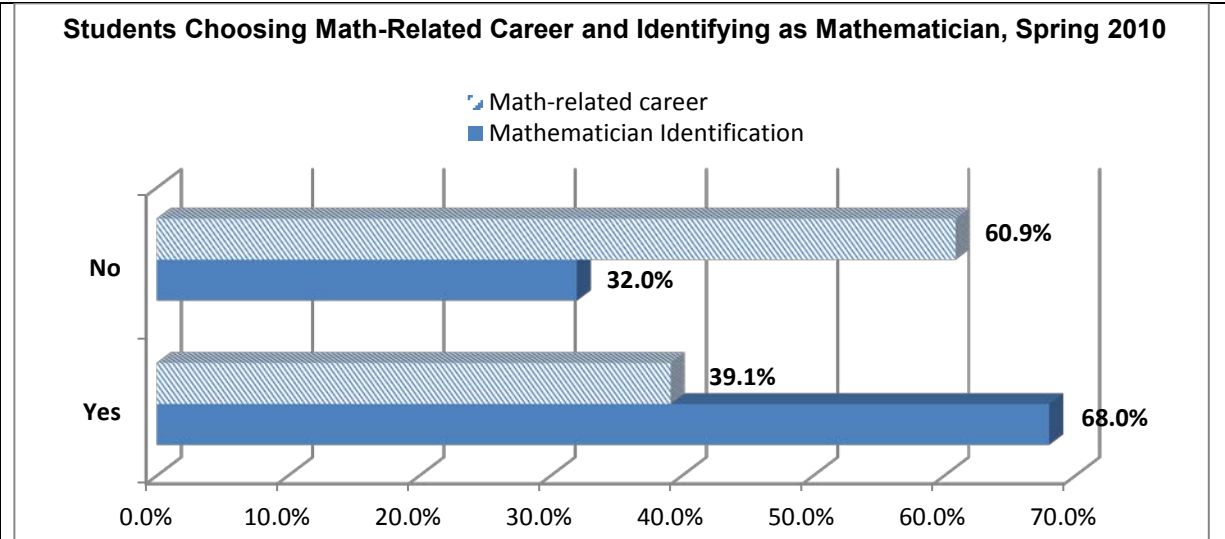


Figure 20. Students Choosing Math-Related Career and Identifying as Mathematician, Spring 2010

Of all 25 interviewed students, the majority saw themselves as mathematicians with much fewer also claiming math as their favorite subjects and choosing a math- or science-related career. See Figure 21 for percentages. Chantelle, the sixth mathematician who chose a math-related career, held reading as her favorite subject because “in reading most people express themselves and it’s passionate to read them. And I like doing that. They’re books. I like them a lot cuz you could read them for hours and you could find out the meaning at the end. And I like it.”

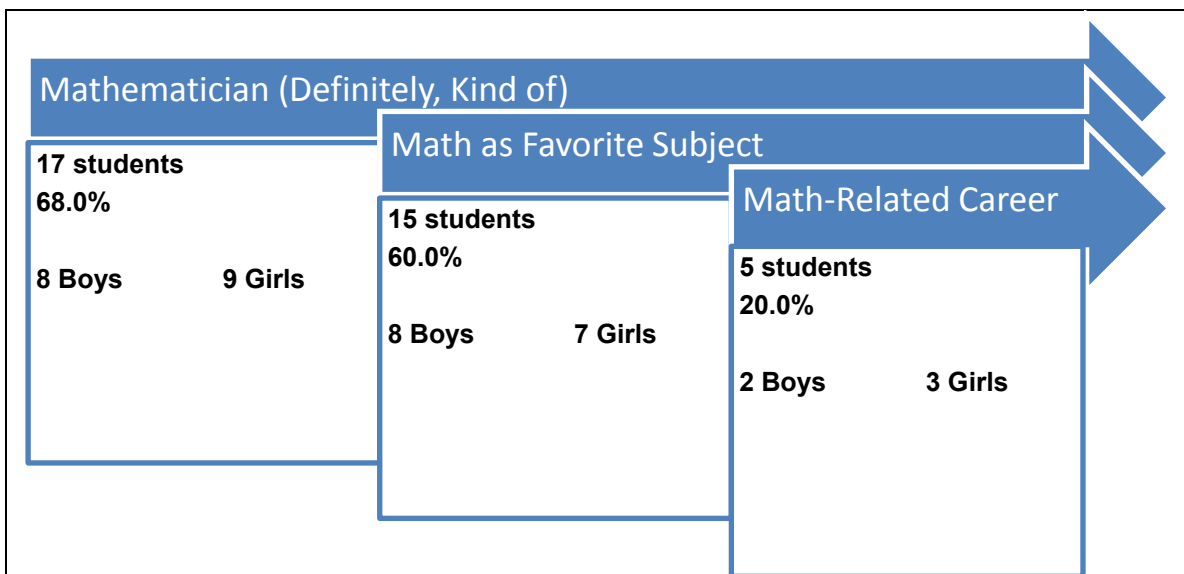


Figure 21. Students' Math Identity, Interests, and Career

The remaining mathematicians chose sports, law, or entertainment as their future career. For example, Dayanara, good-spirited, very bright in mathematics, competitive in archery and math class, saw herself as a mathematician and held mathematics as her favorite subject. What did Dayanara want to be when she grows up? An actress. Natasha, good-spirited, very bright in mathematics, quiet in class, saw herself as a mathematician and held mathematics as her favorite subject, also. However, Natasha wanted to be a judge when she grows up. She, unlike me at my epiphany in the mirror, had definite reasons for wanting to be a judge: "I could be able to like see what is going on in the city and the state...a lot of people are not being a judge these days. They dropping out of school so I don't want to end up being like that. I want to end up being a high class girl. (Smiling)."

Eduardo, somewhat talkative but determined in math class, also saw himself as a mathematician and chose math as a favorite subject. His future plans were rooted in baseball, something he and his family love and encourage him to pursue: "...my family says that when I grow up, umm they want me to be a baseball player, but I want to. I really want to. I really want to." Eduardo said he practices baseball every weekend, Saturday and Sunday, from noon to 6:30 p.m. Quantitatively, two subscales showed significant differences between these two groups of students: Gender Equality ($t(23) = -2.33, p = .029, d = .48$) and Discovery ($t(23) = -2.26, p = .034, d = .66$). Students who considered themselves mathematicians scored higher than those who did not on Gender Equality ($M = 8.41, SD = 1.37; M = 7.00, SD = 1.51$) and Discovery ($M = 21.71, SD = 2.17; M = 19.00, SD = 3.85$).

CHAPTER 7: CASE STUDY—SIDES OF ANTONIO

As I walked up to Mrs. Cruz's classroom around 12:30, I saw Antonio standing outside the room with the door closed. He looked sad and frustrated, but was quiet. I said, "Hi, Antonio. Whatcha doing out here?"

Antonio was quiet and didn't respond. I asked, "What happened?" He said, barely looking at me, "I'm taking a time-out." I said, "Is it voluntary?" He nodded, and said, "Yes." I said, "Okay, see you inside."

He nodded. I opened the door and poked my head in.—Observation field notes, 10/21/2009

"I, I like to draw. I like to play videogames. I love to do karate, and math. And that's it."—Interview with Antonio, 05/26/2010

7.1 Choosing Antonio

As I have done throughout this writing, I have included an epigraph, whether a quote from an interview, a direct comment to me, some characteristic or quality about that person, or a particular of an event. Regardless of its origin, I chose it because of its connection to that person's mathematics identity, whatever it may be. For Antonio, creating an epigraph was challenging, not so much because of the Antonio I encountered and observed across the study, but how he has been constructed inside and outside of the classroom, and constructed in my mind. Epigraphs about a person give the reader a sense of what is important and valued, ultimately by the writer, about that person. What is important about Antonio? Is it that he was diagnosed with Attention Deficit/Hyperactivity Disorder (ADHD)? Or, that mathematics is his one and only favorite subject in school? Is it that he has an Individualized Education Plan (IEP) and receives special services? Or, maybe it is the observation that he tries to self-manage the behavioral symptoms of ADHD, sometimes successfully, sometimes not? Or even the observation that he behaves and positions himself differently with respect to mathematics in different settings at school? I decided to include two epigraphs for Antonio as his identity was larger than his symptoms of ADHD.

Part of my struggle in telling a story about Antonio, as opposed to telling Antonio's story, is that at the beginning of the story it may reveal two things: his behavior – a symptom of ADHD – and my feelings about his behavior, a bias of mine about student behavior in general that I expressed earlier in writing about my role as a researcher. Already, in even beginning the story, the aspect of behavior supersedes his mathematics identity. But what I quickly have come to realize about Antonio, even though it was something that I've known as an educator all along from childhood to adulthood, is that behavior is not indicative of one's ability, interests, or will to learn, especially if the topic to be learned is liked by the learner. What is unfortunate for many students is that their behavioral issues overshadow not only their academic ability and desire to succeed but who they are as a person, a learner. I witnessed such

overshadowing countless times in my elementary, middle, and high school years, in particular with many African-American students, whose comportment was less than what was desired by the teachers but in my eyes they could do the math and should have been in the advanced and AP math courses that I took.

Often students' identities are wrapped up in what people see as opposed to what the students are able to manifest by themselves to those in power—those able to make decisions about their present and their future—be they teachers, school staff and administrators, and, in today's culture of alleged educational accountability vis-à-vis the inundation of achievement tests, the testing administrators as well. I say "by themselves" because, even though identity is an individual and social construction, more often than not, what is seen of the student is not what the teacher sees when they work together as teacher and student in a teaching-learning relationship, but when they work apart from each other, whether the student is working by himself or with other students. Behavior becomes an even greater factor if it is consistently a problem as with students like Antonio who have ADHD.

The case study is not a methodological choice but a choice of what is to be studied (Stake, 2005). They are instrumental as their purpose is to go beyond the cases—the students and settings—to illuminate the main program (Stake, 2006), which in this case is CFEA's archery program. Important in each case study and the research overall is its special contexts or backgrounds which help to illuminate the ecological systems within and beyond the community school which encompass the case studies. Further, case studies also help to illuminate contexts that may be problematic (Stake, 2006).

I chose Antonio as case study because I believed there was a marked difference between the Antonio I observed in class, the Antonio I observed in archery, and maybe even the Antonio constructed by others. Looking at Antonio from these different sides is relevant to exploring the research questions and would provide good opportunities to learn about the complexity and contexts of the archery program and the school (Stake, 2006). The stark difference raised main questions: Why does Antonio function differently in one setting than the other? How is his mathematics identity engaged and manifested in both settings? Cases have power through their particularization (2006) and can offer great potential in demonstrating how and in what ways their findings may be transferable to other contexts or used by others (Simons, 2009). This transferability can be demonstrated through generalizations that are naturalistic or situated (similarities and differences to cases or situations are familiar to readers), concept

(concept generalizes even when the specific instance does not), or process (the process generalizes even when the content and context may not) (Simons, 2009).

What comes to light about Antonio and his ways of being in math class and in archery specific to this community school may be shed light on other school settings that are looking for ways and means to engage students like Antonio. To my knowledge there was no research on the mathematics identities of student archers in an urban elementary community school with or without ADHD. I believe this case study will add to the dialogue on the mathematics beliefs, attitudes, and abilities of students of color within and outside of the classroom setting. It will also add to understanding students of color in archery. Additional case studies will be developed later of student participants with different demographics and mathematics identities.

7.2 Attention Deficit/Hyperactivity Disorder

Antonio is certainly not alone with an ADHD diagnosis and its symptoms, challenges, and construction within the classroom or other learning settings. Approximately 4.4 million children and adolescents—8% of all those ages 4 through 17—have been diagnosed with ADHD, making it this nation's most common childhood behavioral disorder (Scheffler & Hinshaw, 2009). Sadly and painfully, the effects of ADHD go far beyond that of poor behavior in class. Numerous bodily and mental functions are affected: intellectual function, impulse control, sustaining attention, memory, psychomotor function control, emotion regulation, organization, time management, judgment, cognitive flexibility, problem solving, and sequencing complex movements and thinking (Loe & Feldman, 2007).

Academically, children with ADHD show significant underachievement and poor performance, scoring significantly lower on reading and math achievement tests than students without ADHD (Loe & Feldman, 2007). Also, children with ADHD repeat grades, use remedial or tutoring services or special accommodations, attend afterschool programs, and are suspended or expelled more so than students without ADHD (Loe & Feldman, 2007). They are four to five times more likely to use special education services than children without ADHD (Loe & Feldman, 2007). ADHD affects boys roughly twice as much as girls (Scheffler & Hinshaw, 2009), with boys exhibiting higher rates of interference, gross motor activity, and aggression than their female counterparts (Vile Junod, DuPaul, Jitendra, Volpe, & Cleary, 2006). As children with ADHD grow into adolescents, their academic and social performance continues to suffer:

more failing grades, lower subject ratings on report cards, lower class rankings, lower performance on standardized achievement tests, and lower rates of college attendance and graduation (Loe & Feldman, 2007).

Although more researchers are exploring the academic engagement (Vile Junod et al., 2006) and achievement (DuPaul, Volpe, Jitenra, Lutz, Lorah, & Gruber, 2004; Hart, Petrill, Willcutt, Thompson, Schatschneider, Deater-Deckard, & Cutting, 2010; Loe & Feldman, 2007; Scheffler & Hinshaw, 2009) of elementary school students with ADHD, in particular mathematics achievement (Lewandowski, Lovett, Parolin, Gordon, & Coddling, 2007; Zentall, Smith, Ling, & Wieczorek, 1994), a paucity of research exists on the mathematics identity of students with ADHD. A search of major databases of journal publications (i.e., EBSCO Host, SAGE Premier, ScienceDirect, Wilson Web, JSTOR, SpringerLink, and GoogleScholar) using the terms “ADHD,” the Boolean connector “AND”, “mathematics”, the Boolean connector “AND”, and identity” or “mathematics identity” in the abstract field resulted in zero articles located.

7.3 About Antonio

Just as it is important to know how students without ADHD see themselves learning, doing, becoming, and being in mathematics, it is important to know the same of students with ADHD. Antonio, of average height and average build, is a 10 year-old boy whose parents are from the Dominican Republic. He seems quiet and shy, somewhat subdued, even sad at times. He has dark circles around his eyes which make him look sad. Sometimes the darkness is not as pronounced as other times. He is not an only child; he has a younger sister at home, and three older brothers who do not live with him. He takes medication to help manage ADHD. He has an individualized education plan (IEP) where his IEP allows him extra time to complete assessments in an isolated location, and states that he needs counseling to help manage behavioral issues. He participates in CFEA including archery.

Although mathematics is Antonio’s one and only favorite subject, his mathematics performance from 2008-2010 as indicated by the state math assessment showed a steady decline, although from 2009 to 2010 a decline was noted throughout the city due to the drastically changed scoring rubric used by the state’s education governing board. From 2008 to 2010, Antonio’s math assessment score dropped from 671 to 651 to 640. His proficiency ratings dropped from 3.40 to 3.04 to 2.00. His performance level held

steady from 2008 to 2009 at Level 3 (Meets Proficiency Standard) but dropped in 2010 to Level 2 (Meets Basic Standard), where Level 2 signifies a student's partial understanding of the mathematics content at the expected grade level. A decrease in performance of one level for Antonio was similar to the performance of other fifth graders across the city and his classmates.

With respect to the 32 other students who participated in the study, Antonio's 2010 math assessment score was 28 points lower than the mean (668.22), where the lowest score was 620 and the highest score was 707. For 2009, his math assessment score was 33 points lower than the mean (684.59), where the lowest score was 641 and the highest was 751. However, for 2008, Antonio's score was only 4 points lower than the mean (675.37), where the lowest score was 634 and the highest was 728. Comparatively to other boys, students in his age group (10 years), and other Hispanic students participating in the study, Antonio's performance was similar across the years. Although the numbers show a decline in Antonio's mathematics performance—a common trend of students with ADHD (Loe & Feldman, 2007)—they do not speak to his beliefs, attitudes, participation, or positioning in mathematics. In spite of his performance, Antonio still loves math.

In the interview, I asked him to tell me a little bit about himself. He replied clearly and to the point: "I, I like to draw. I like to play videogames. I love to do karate, and math. And that's it." When I asked Antonio why he loves math, he seemed to be stumped at first. It seemed as if he was about to talk about what math does to him, how it makes him feel, but then he recovered with a focus on what he loves to do in math: "Because math it make me like, it makes me. I love math because of times tables, shapes, fractions and umm, division." He credits his liking those topics, even fractions, to his teacher: "Because my teacher teach me how to do fractions, math, umm, division and shapes and multiplication and dividing." For Antonio addition is easy, and it has been easy for him "for like four years" since second grade when he believed that is when he first knew addition. His frustrations about mathematics surface with mixed fractions because "it's hard for [him], because you gotta, sometimes, sometimes you gotta find the equal of the mixed fractions."

At home, besides using the computer at home to communicate with his friends via AIM and MySpace (popular social communication and networking websites), Antonio does math and plays math games on websites such as Coolmath4kids.com and Coolmath-games.com, and plays strategy and adventure games like Mario Brothers on Puffgames.com that use math in various ways. Of the television

he watches and video and computer games he plays, he could not recall any characters that he thought may be mathematicians. Antonio's family supports his scholastic efforts. When he needs help with his math homework, Antonio calls and asks his brother who lives in a nearby state. He calls him, and says he needs help with his homework. He has two other brothers who help him, also. He feels good when they help, partly because he does not see them often as one of them is going to college, and partly because he is receiving the help that he needs: "...I call him, and I say I need help with my homework, and then I tell him what the problem, and I write down everything that he says." His mother, who speaks mostly Spanish, supports them consistently in his treatment and management of ADHD, attended all meetings with the CFEA social worker, school support staff, and referred off-site psychiatrist. She attends the parent- teacher conferences, communicates with his teacher, and comes to the school whenever called.

Although Antonio loves math and heralds math as his favorite subject, his future aspirations do not include math. His other love—karate—comes first. He wants to be like Jackie Chan when he grows up. He claimed to have met Jackie Chan and chopped "many wood tables before" to the point that "they're gonna put [him] at 11 world records." In college, he wants to study "easy stuff, easy stuff...all the stuff in college." Antonio does not seem to be aware of what he could study or do in college besides gym or doing math in gym. His understanding of college is based on what he has experienced with his brother in college ("Bring your brothers or sisters to college" day), what he may desire to experience in college with his brother ("We're gonna have a brother or sister race"), or what he has experienced with his friends ("I'm the fastest in this school and my friends I raced them in the yard...I was the first one at the gate.").

The question of creativity in mathematics drew a quick, positive response from Antonio including an example: "Yeah, like how distant, like we could put like a ramp and we could put the ball in there, and we could put like seconds the ball gonna roll all the way down and go through the hole." Because Antonio had done an exercise like that before, he was able to immediately recall it and expound on it:

- Antonio: You could put those things together. Put four together. You could make a box. You could put a ball, and count how many bounces go round and round and round.
- Researcher: Okay, you're on a roll here. Got any more examples?
- Antonio: You could put that right there and then you put the other one on the floor, and bounce it up and down, and check how many bounces it goes up and down.

The question of how people become smart in math did not draw as quick and detailed a response. For Antonio, people who are smart in math became smart “by thinking whatever problem come in their head...” He paused. He did not continue his answer. It seemed difficult for him to answer. So I continued with my questions along that same vein. I told him that some people say that if you’re smart in math, you got that way because you were born that way. He nodded in agreement but then tried to clarify and said he agreed with that statement “a little bit...cuz sometimes hard. Math is really a little bit hard, and tough, and uhh, something I forgot that word. Uhhh, sometimes hard to divide fractions. That’s it.” Over the interview, I had come to realize that when Antonio says “that’s it” at the end of a response, that’s it—that was the end of his contribution on that topic.

7.4 Antonio in the Classroom

More and more across the observations, Antonio’s mathematics identity came to the fore even as he struggled to manage the behavioral and emotional symptoms of ADHD. On October 21, after I saw Antonio outside the classroom on a self-imposed time-out, I poked my head in and entered the class. A few minutes later, Antonio opened the door, came in, and returned to his seat. He sat quietly in his chair for a brief moment. His struggle, enabled and antagonized by students in the class, quickly continued.

Antonio just called a few students near him “bastard.” He was visibly upset. He kept getting up and going in and out of the classroom, talking loud, sometimes closing the door quietly behind him, sometimes closing it loudly. He stayed outside for 5 to 10 minutes at a time. He seemed better when he came back but he became quickly agitated when he sat back down.

After a while, Mrs. Cruz put Antonio out but she did not put Abel out. He and Abel started arguing and they almost got into a fight. I couldn’t hear what Abel said to Antonio to provoke him. They are not sitting close to each. Antonio is sitting beside the door to the right of the SMART Board, and Abel is sitting a few desks to the left of the SMART Board by the small library in the class. Antonio hasn’t participated at all during math period. He’s gone from being upset to withdrawn and struggling to stay focused. Students such as Abel from across the room and students behind him at Natasha’s table keep antagonizing him. I couldn’t hear what they were saying to him but they were laughing at him.

About 1:50pm, Antonio was brought back into the room by the school psychologist. Even after being brought back in though, he started bothering Abel, or so it seemed. He then quieted down and stayed quiet and paid attention to Mrs. Cruz. For the last 10 minutes that I was there until two o’clock Antonio remained quiet and focused on Mrs. Cruz and the lesson.

There was much energy in the classroom that day. The aim of the lesson was “How can we organize and interpret data?” Although the aim of the lesson was organizing in interpreting data, the

initial part of the lesson was a mental math exercise—a normal routine—on place value. I have never quite understood why the mental math exercise is not related to the aim. Mrs. Cruz called out the number and asked for volunteers to come up to the SMART Board and indicate the place that she called out. Although it wasn't clear what the mental math exercise had to do with the aim, it was clear that the students liked using the SMART Board. With every question that Mrs. Cruz asked or problem that she wrote on the SMART Board for students to answer, at least half the class raised their hands to give an answer, whether to respond at their seat verbally or to come to the SMART Board and write or indicate the answer.

It was exciting to see the level of participation and willingness to participate in the math lesson that day even though it became noisy at different times during the lesson as a class in general and with a handful of particular students who continued to misbehave even after Mrs. Cruz's objections and reprimand (e.g., Carlos talking and humming, Abel laughing and antagonizing Antonio, Eduardo talking and throwing paper across the room at another student, Lyasia talking and singing even while Mrs. Cruz tells her to stop, Ariela and Silvestre making fun of Mrs. Cruz's accent). At several points throughout the lesson students lamented at not being called on to give their answer, which Mrs. Cruz addressed to help them understand the need for patience. Mrs. Cruz said to the class in a loud voice, "Class, I can only call on one person at a time; not all 26 students at once. It is only one of me, and 26 of you. Be patient." The energy in the classroom today was a combination of excitement to learn and to participate from over half the class, distractions from class noise and students antagonizing others, and rude behavior from students towards other students and Mrs. Cruz. In all of this, Antonio struggled to stay focused and learn his one and only favorite subject.

A different Antonio rose to the fore in early November. On the fourth, I entered the class as Mrs. Cruz was reviewing the social studies quiz on the SMART Board. I noticed Antonio sitting at the laptop, with elbows on his knees with his right hand on the laptop. He is controlling the social studies quiz on the SMART Board—scrolling it up or down, depending on what Mrs. Cruz needs. He is doing it well. He hasn't misbehaved while using it yet from what I've seen since I walked in. He seems attentive, focused, quiet, and even mature today. This is different side of Antonio—a side that I had not seen before but glad to see. Mrs. Cruz finishes the social studies review, and begins the math. The aim of today's lesson was "What are congruent triangles?" As usual, Mrs. Cruz started the math period with mental math.

Mrs. Cruz to class: "We're going to do mental math now. That's very important that we practice our mental math." She smiled when she said that doing mental math was important.

Standing in front of the SMART Board, Mrs. Cruz told the class, "I want you to round this number to the nearest whole number." Mrs. Cruz said the number 209.082—"two hundred, nine, and 82 thousandths." A few students towards the wall side of the room by the closets, who had not yet finished writing the aim because they were talking, said, "Wait, wait." She said, "You have to listen."

But this time when Mrs. Cruz read the number, she said the number 209.82—"two hundred, nine, and 82 hundredths." She repeated it three times because some students were talking. She repeated 209.82 three times but then said 209.082, the number she had originally said.

Antonio, who was still sitting at the desk with the laptop, raised his hand, and Mrs. Cruz called on him. Antonio stood up and answered, "210." Mrs. Cruz to Antonio: "210 is correct." Antonio grinned and sat down. Antonio's answer is correct if Mrs. Cruz meant to say hundredths and not thousandths. However, she said "two hundred, nine, and 82 thousandths" at the beginning and at the end. Her accent for this problem seems to be presenting a challenge, or her own confusion of the actual number to be rounded.

Mrs. Cruz to class: "I know some people didn't get it. Antonio, go to the board and please explain how you got 210." Antonio, stood up and stepped around his desk to stand at the SMART Board, point at his answer, and explain how he got it. As he was explaining, Ariela butted in and tried to correct him. Antonio turned to Ariela, and said, gesturing calmly with his hands moving up and down in a patting motion, "Okay, wait, wait, wait. I know." He said this in a calm and patient fashion, not at all like the aggressive way he was acting the other time.

He turned back to the board and continued explaining his answer. "See, you look at the 8 because it's to the right of the 9. So, you round up if it's 5 or above, and round down if it's 4 or below. So since 8 is bigger than 5, you have to round the 9 up to 10. That's how I got 210." Mrs. Cruz repeated Antonio's explanation and said it was a very good explanation.

Watching Antonio volunteer to participate, answer correctly, and be excited or at least proud or happy about answering correctly was a pleasant difference from the observation before where he seemed very troubled and bothered by a certain handful of students, impeding his focus and attention on math. Mrs. Cruz's affirmation of his participation and answering helps a great deal I think for Antonio. I was definitely surprised but pleasantly so. I saw a different side of Antonio. I was able to see the side of him focused on math and his ability to do it and explain it and enjoy it. The new year came and January of 2010 presented the same Antonio I saw in November, a few months before. The rest of the year for Antonio was met with ups and downs, successful and not-so-successful times in managing his symptoms of ADHD, sometimes having to be removed from school.

Antonio is aware of what he needs to learn math in class, especially when confronted with difficult topics like mixed fractions. He seeks the assistance of his classmates, two friends in particular, Hernan

and Jesenia, and his teacher, Mrs. Cruz. With respect to his work style, Antonio prefers to work in groups. When asked why, he first said he didn't know but then after I rephrased the question to what is so special about working in groups, he responded, "Like we're helping each other, catching up, and.." after which he fell silent and shrugged his shoulders.

In class, assisting his teacher is important to him. He said that one of the things he likes to do is assist Mrs. Cruz with the laptop that is connected to the SMART Board. That seems to be a role that is exclusively or almost entirely his. Never had I seen another student during class operating the laptop for the SMART Board. He loves it when Mrs. Cruz asks him to "fix" the computer. He feels good when she asks him to help. Upon mentioning that I thought he was the only one I had seen at the laptop, he immediately responded, "Yeah, I'm smart, right?" and continued explaining how he has been "at the laptop" since the second grade with each of his different grade level teachers. He seems eager to assist in troubleshooting or problem solving. He tends to the SMART Board laptop and his math work simultaneously at times: "...sometimes we do Math Journal, and on the SMART Board on the computer I put the same page of the Math Journal that we're doing, and I leave it alone, the laptop, and do my work."

7.5 Antonio in Archery

Archery is a sport for students of all ages and different abilities including students who may use personal aids and assistive devices and who may have physical, mental, learning, and developmental impairments and disabilities (Coward, 1982; NASP, 2006). In addition to physical skills, the NASP curriculum for 4th and 5th grade students focuses on character development through constructive communication, cooperation, rules, fulfilling commitments, and respect and responsibility to self and others (NASP, 2006). As Antonio participated in archery, I wanted to gain a sense of his mathematics identity in archery, or at the very least his mathematics participation and enactment in archery. I always wanted to see the type of archer he was becoming.

I observed Antonio towards the latter part of the orientation practice in February. The orientation practice of each session is normally where Coach orients the new students to the rules and equipment but without shooting. However, this time Coach let them shoot but without the target face so students could focus on form first and not scores.

I entered the gym quietly and stood in the back where I normally stood and watched. I saw Antonio, and was pleasantly surprised. I did not know he was interested in archery

or that he had signed up for it. He stood at the left end of the shooting line towards the cafeteria entrance. He had just shot a round. He walked up to the target face quickly and quietly with the rest of the archers, waited his turn to retrieve his arrows, and walked back to the waiting line. His eyes were cast downward a little, seemingly focused on something in front of him. He didn't see me at first when he reached the waiting line but then he turned around and saw me.

I think he was surprised to see me. It was a little difficult to tell. Antonio's visage doesn't seem to change much. But his eyes lit up a little and his eyebrows rose up a little. I waved and said his name. He waved back. I walked up to him and told him I didn't know he was in archery. He said he just started. I looked around the class and noticed a few students who I thought were in the previous session, or at least had participated this year already. That made me wonder about the rotation and how the kids were selected. I asked was this the first session for him. He said yes. I asked him how he liked it so far. He nodded. Antonio doesn't seem to talk much. He seems very quiet even in class. I returned and stood at the back wall observing the students shoot. About eight students were shooting this session, a few at a time. Coach let them continue shooting. Each time Antonio returned to the line, he was quiet and focused, waiting on Coach's instructions. Even with students talking off and on, and noise escalating in the adjacent lobby and cafeteria, Antonio did not say a word.

I looked at the clock and it was about 4:40pm. Coach called the class up to the wheel to get their arrows. I walked up a little halfway towards the wheel. As the kids were walking away with their arrows, Coach told the class to take off their armguards and quivers, and put them in the small black bag on the floor, and to rubber band the arrows and put them in the big black bag on the floor. Coach called the kids over to close out practice properly in the circle. He looked over at me and jokingly said, "Umm, is something wrong with your hand?" I laughed and slid quickly over to the circle to join my fist in with theirs. Antonio looked at me and then quickly looked downward. He was smiling and trying not to laugh. We all repeated Coach's mantra. I saw Antonio's mouth moving and heard his voice only a little. His eyes were focused in the center and he was smiling as he said all the words.

I observed him again in March. The students were shooting at the target face and scoring now.

Coach continued to assist students who needed help. Antonio continued to stay focused on his shooting and on Coach during practice. Even though at times others around were talking and Coach reprimanded them, Antonio stayed quiet.

Each line has shot three times already. A line is finishing up their scoring. With two male students left to finish the scores, Coach blew his whistle once, and said, "B line, let's go." One student, who liked to show me his paper, was on the floor finishing counting on his fingers. Coach walked up to him, and looked at him and asked "Are you okay, young brother?" The student showed Coach his scoresheet, and Coach nodded and responded, "Hmmm, nice score."

Antonio, with the rest of B line stepped to the shooting line, and waited for Coach's instruction. There was some chatter but Antonio was quiet. He checked his foot position and stood with his "bow on toe" like coach had shown them before. There was chatter in the back of the gym with students coming in to go to the cafeteria. There was also chatter from a few of the students in a line who had finished shooting. Although Antonio looked around, like the other students to see what was going on, he turned back around and focused on Coach. Coach said, "You ready guys? Okay, let's go. Make 'em good." Antonio nodded. Coach blew his whistle once said, "Shoot."

Antonio set up quickly and carefully. He had a little trouble with putting the arrow notch on the bowstring but he focused and then easily set it on. Antonio raised his shoulder arm, anchored, focused on the target, held his form for the 3 seconds coach instructed, and released his arrow, held his form, and reset. Antonio looked very good shooting that day. He was focused and listened carefully to and following Coach's quiet one-on-one instructions. When coach gives instruction when archers are shooting, he does it quietly and in their in ear so that instruction is just for them. And if he has to correct their form, he does it in a soft voice, adjusting whatever needs adjusting with their form.



Photo: Antonio set to shoot, ready to release bow. Coach looking watching the archers shooting, with eyes on the target. (Photo taken by Paula J. Fleshman, March 2010.)

While sitting down at the scoring line, each student waited for coach to call up the scores. This was the 4th round. Antonio waited quietly while Coach helped a student with adding up the scores. The student said that he didn't think he was doing good. Coach replied, "No, you're doing fine. You're doing fine. It's a learning process." Coach always gives encouraging words to students who are struggling or think their scores are low. Coach returned to the target, and pulled out Antonio's arrows. Antonio was the last student waiting for scores. Antonio waited patiently, sitting quietly, lightly tapping his pencil eraser on the floor. Coach called out Antonio scores, "8. I'm sorry. 7, 6, 4." Antonio wrote the scores down. Antonio partially counted on his fingers to add up the 7, 6, and 4. While he was adding up the numbers, Coach stood over him slightly, and said, "Take your time. Take your time." Antonio added the round score of 17 to the running score of 50 in his head, and wrote 67 as the final score. Antonio got up quickly and put his scoresheet with the rest of the score sheets on the floor by the target wall. He quickly quietly walked back to the waiting line as A line had one more time to shoot.

Coach called B line one last time to shoot. Antonio and the other two boys took position on the shooting line quickly. Coach blew the whistle once, signaling for them to shoot. As Antonio was setting up to shoot, putting his arrow onto the bowstring, coach quietly told Antonio, "Head up. Lift your head up." Antonio, focused on putting the arrow not onto the bowstring, didn't lift his head up. He was focused on putting the arrow onto the bowstring. Coach put his hand on Antonio's head and gently lifted it and turned it straight in the direction of the target. Coach His hand there until Antonio Santos form properly

and drew back the bow. Then coach let his head go. Antonio held his form, which looked great to me. Coach stood behind Antonio until he completed his shot. After he shot that arrow, Coach said softly, "Nice shot. Nice shot." Antonio continued to shoot his other two arrows. Antonio concentrated as he placed the bow on the arrow string, still having a little trouble. But once he was set, his form for both of those remaining arrows looked great. Antonio quickly stepped off the shooting line to put away his bow.

For this round, the 5th round, Antonio scored 8, 7, and a miss. Coach stood in front of him as Antonio was putting his arrows in his quiver. He had not begun to add up scores. Coach softly said, "15." Apparently Antonio didn't hear him because Coach said it again, "15." Antonio hesitated a few seconds. Coach then said to Antonio, "82" his final score. Coach pointed to where Antonio needed to write 82 in a second box; counted up Antonio's 10's, 9's, and 8's, as part of the scoring; and told him to sign the bottom. Coach helped the students this time with the mat because the class was running out of time. Coach collected the score sheets, making sure that each was filled out properly.

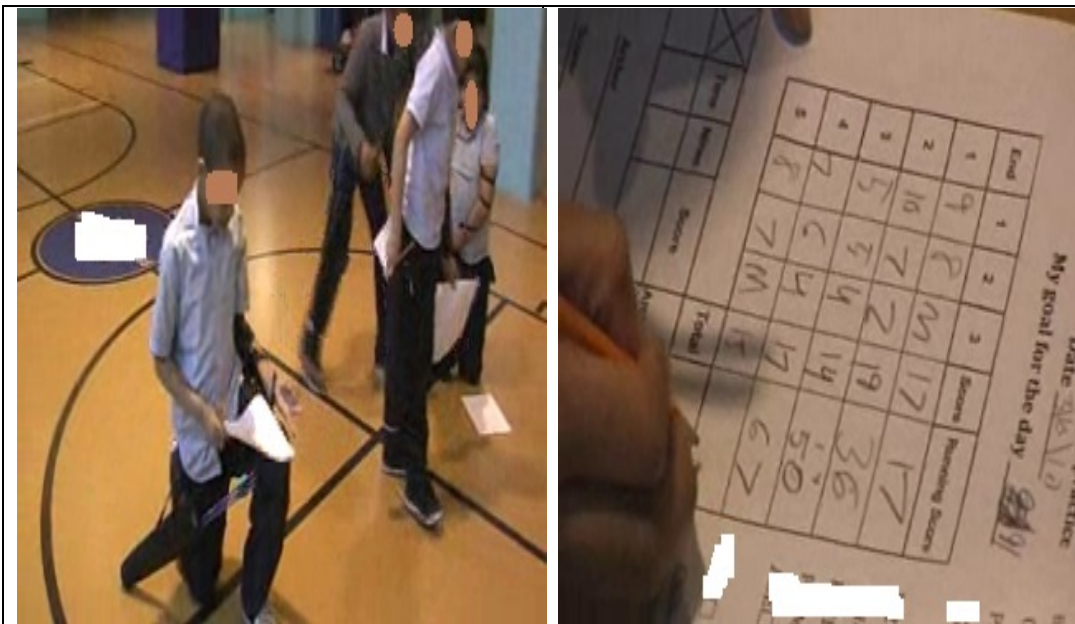



Photo: Antonio kneeling at the scoring line, adding scores with his fingers after shooting. Closeup of scoresheet with Antonio about to add the running score. (Photos taken by Paula J. Fleshman, March 2010.)

For the practice in March, Antonio controlled each movement and setup of his bow and arrow, then focusing on the target at the other end of the gym, holding his form well, and shooting. For some of the calculations, such as the third round of scoring, he quickly added 5, 5, and 4 for the round score in his head and then added the round score to the running score of 36 quickly using his fingers and subtle scratch work on his score sheet to get the total score after three rounds. Although Coach gave him the answers for the last round, Antonio that presented in archery showed mathematical flexibility, agency, and focus. See Figure 22 for a synopsis of Antonio in class and in archery.

In Class	ANTONIO	In Archery
<ul style="list-style-type: none"> ○ Easily distracted by others ○ Struggles to stay focused when ADHD not managed ○ Works hard to use self-management techniques ○ Struggles to control himself when antagonized ○ Loves to feel and show he is capable and smart ○ Loves to help teacher with SMART Board ○ Likes to work in groups ○ Doesn't like being made fun of ○ Works well when ADHD managed ○ Works quietly in Math Journal 		<ul style="list-style-type: none"> ○ Pays attention ○ Quiet ○ Calm ○ Follows instructions and demonstrations ○ Focuses on shooting well ○ Focuses on adding scores correctly ○ Focuses on completing score sheet correctly ○ Shows he is capable and independent ○ Shows confidence when shooting
<p>Figure 22. Synopsis of Antonio in class and in archery</p>		

7.6 Antonio as Constructed by Others

I wanted to get a sense of how other people saw or interacted with Antonio. These were people—his teacher and other staff—who saw or interacted with Antonio in ways that I, as the researcher, could not. As time permitted or occasions arose, I spoke with them and learned more about Antonio, and how they see Antonio mathematically. Mrs. Kappas, the math staff developer, saw maturity, focus, and behavior in addition to mathematical ability as part of their being mathematicians now or becoming mathematicians “down the road,” (a phrase she used several times when talking about the possibility of students becoming mathematicians in the future). She did not see Antonio as a mathematician: “Antonio, I don’t think math is his forte either. He’s got a lot of academic issues and I think math is an issue.”

Antonio’s teacher, Mrs. Cruz, sees him as capable and knows that mathematics is his favorite subject. She sees his desire and agency to learn, and how he participates in class, positioning himself as competent even through his struggles with ADHD and some of the other students. Although he receives resource room services (push-in for reading but not math), she is not aware of how effective these services are for him. She is clear, however, that testing presents a challenge for him. He does not focus on the work at hand, and after the testing period is over, he does not do much work. In preparing him for the assessment tests, Mrs. Cruz believes that Antonio would perform better in a one-on-one or small group setting because by himself, he struggles.

Antonio's resource room teacher, Mr. Smiley, experiences Antonio's struggles more than his successes. He told me one afternoon in early December of an incident with Antonio:

They had to have Antonio leave the school because he had been acting up so bad and his meds weren't working. He had to go to his psychiatrist. The psychiatrist put him on new meds. Yesterday, Antonio told me that the green ones weren't working, and that the white ones work. Or something like that. Antonio arrives to school at eight in the morning, and I take him and immediately give him his medication because it takes an hour for it to start working.

According to Mr. Smiley, Antonio is operating two grade levels below in math, his on-task-attention is three minutes, and his handwriting is totally illegible. He recognizes that Antonio works well one-on-one; however, with two to one, Antonio starts to unravel, and with more than two, he really cannot focus. Mr. Smiley struggles to understand Antonio when he gets excited because he talks so fast and cannot stay on topic. Mr. Smiley confers with Lance, the CFEA social worker, often because Lance says he can understand him. Mr. Smiley says he does not see how.

One of the people who gave me great insight into Antonio specifically with respect to his struggles with ADHD was Lance, the CFEA social worker at the time. I spoke with Lance a few times after October during which he shared his strategies and experiences with Antonio. Lance said Antonio functions well when he has responsibility or tasks to do. Give him something to do and focus on, and he responds well. Lance mostly counsels students who are hypersensitive. They are the classic "What are you looking at?" with attitude. He said Antonio was a hypersensitive child. I retold the story of when I saw Antonio standing outside of Mrs. Cruz's classroom in a voluntary time out. He said Mrs. Cruz letting Antonio time himself out is good because that gives him self-control. He probably gives her a signal so that she'll know he needs to time himself out. The triggers are for him students making fun of him, talking about him. These things set him off. There are similar issues with the group of students he sees. It seems that there were more triggers than Antonio could handle that day.

For students with an IEP that states "needs counseling" and participate in CFEA, Lance goes to the classroom to get the students. He said when he comes to the class to them, sometimes students like it because they get out of class. It reminded me of the several times students from Mrs. Cruz's and Mr. Knight's class have asked me when was I taking them out of the class again. Whenever they ask, they're always excited and hopeful. He said that other times students don't like it when he comes to visit them because it stigmatizes them (his word, their sentiment). He said one time he remembered picking up

Antonio, and on the way out of the classroom, Antonio yelled back at a female student, “I’m not crazy.” Lance said he asked Antonio about it later, and Antonio said some of the students had been picking on him, calling him crazy. Lance said he has to come to the class to pick them up and return them. Students cannot simply walk the hall freely and come to his office.

My conversations with Lance gave me a better understanding of what I observed on that day, allowing me to have a more appropriate perspective about Antonio as opposed to constructing him as a problem child. Lance said he did not like to attribute change in behavior to any one thing in particular that he has done with Antonio or any other students but what the team of staff from CFEA, his teacher, the administration, and his mom have done as a whole. He sees it more of a collaborative approach than just one person.

The CFEA program director’s perspective of Antonio centered less on his academic performance than his behavior. She reminded me that students see the CFEA social worker for behavioral or emotional challenges, not academic. However, all students who are a part of CFEA receive academic support through homework session and academic enrichment. During my interview with her, I inquired as to how CFEA has helped Antonio with his academics. For her, Antonio’s emotional and behavioral growth manifested more in CFEA than his academics. With constant collaboration with the CFEA social worker based at the school in addition to the outside counseling services for Antonio provided by CFEA, consistent support from his mother at his appointments, and alternative activities and behavioral consequences, Antonio changed from a child who could not control his emotional outbursts and behavioral reactions to a child who was employing self-management techniques in fractious situations, at times even taking proactive measures.

These measures reflected what the social worker said about Antonio’s need to feel and be responsible with tasks that he can focus on and do well. Although Joya’s insight about Antonio does not reflect his math identity, it does reflect what is needed to help his math identity flourish—opportunities to develop and demonstrate a positive sense of self, agency, creativity, and competence. It reflects the need and positive impact of the collaborative efforts that the community school provides for Antonio.

Researcher: ...How do you think CFEA has helped Antonio with his academics?
Joya: Well, again, we have homework every day, Monday through Thursday, an hour a day. You know, and well, let’s see. Antonio. Overall.
Researcher: Yes.

Joya: [In the beginning] he was very challenging, and it wasn't academically. It was his behavior. He had a lot of outbursts. He didn't know how to control his temper. And which is why we usually send the kids we do to the social worker. It's, I don't think, it's ever for academic reasons. It's always for behavioral issues. Like we have another one...[name of other student omitted] . He has, he's very temperamental. Loves (emphasizing loves) throwing things. Chairs, books. And Antonio had the same problem. You know, they couldn't keep their hands to themselves. But, ummm, I think the support that the social worker provides or has provided for Antonio in the past couple of years, he's changed a lot.

Researcher: Really?

Joya: Yes. For instance, he would never (emphasizing never) have volunteered to clean the cafeteria in previous years. [Cleaning the cafeteria is an alternative to suspension from the program.] This year he volunteered at least 10 times. "Ms. Joya, can I volunteer to clean the cafeteria?" Yeah, you can!

Researcher: (Laughing)

Joya: Antonio? Yeah, you can! (Smiling)

Researcher: Right. (Chuckling)

Joya: Because that shows something about him. It shows growth. You know he would have never done that. His outbursts are not as, not the way they used to be. Out of 1 to 10 [maturity level] he's probably at around, I would say, an 8 or 9 now. And only two years ago he was at a 2. You know, he would get upset. He would scream. He would cry. He didn't know how to control his temper. He didn't know what to do with all those feelings and emotions.

Researcher: Right.

Joya: And, I think in part it's because he's been seeing the social workers, the different social workers for CFEA. And because now his mother has taken him somewhere else [for additional therapy]. CFEA has, the social worker has provided, outside services for the mother. And she goes to all his appointments, and I know because she comes to pick up a [travel voucher] all the time. She's involved in Antonio's life.

Researcher: Okay.

Joya: You know, academically, like I said I think we continue to provide that academic support by, you know, Monday through Thursday with the homework help. You know, umm, but I do know more about Antonio, like when it does come to his academics, he is one of the students who is a little behind in math and his writing. And I think we provide the best support we could. Again that was the class that had twenty-something students. That was a class that had a lot of students with two group leaders. So how much service could we possibly provide? I think we do the best we can.

7.7 Antonio's Mathematics Identity


Like most students participating in the study, Antonio had never heard the word "mathematician" before. After prompting him further about what is a mathematician and what do they deal with, Antonio responded that a mathematician was someone who dealt with "math...every math thing like division, multiplication, adding, subtracting, umm, fractions, everything." He associated the knowledge of a mathematician with his knowledge. After I read my definition of mathematician to him, I asked him could

he see himself as a mathematician. He said he could not: “No, not really... cuz I’m not good at every problem in math. And sometimes I get problems, things in math like, division sometimes I get it wrong. Shapes I could get but sometimes I get it wrong, and fractions sometimes I get it.” Interestingly, even though the last part of my definition included mathematicians not being perfect, that “they get problems wrong but they keep trying,” Antonio continued to disassociate himself from the notion of being a mathematician unlike a few students in the study who clung to the notion of imperfection, joyfully claiming their mathematician identity. Among his classmates, he only saw two students as mathematicians: Jesenia and Jorge. Ironically, he did not mention Hernan, one of the classmates besides Jesenia who he turns to for help.

Antonio’s mathematics identity seemed to manifest itself more and more as the school year progressed. His medication was changed during the year and he used self-management techniques learned from Lance. The difficulty in seeing Antonio’s full mathematics identity in the classroom in October was because of his self-management struggle coming to the fore, thus overshadowing his desire and ability to position himself as a math-capable student, participate in class, and contribute his knowledge to his math community. However, it is precisely his struggle—struggle to focus, to pay attention, to not be distracted and antagonized by others, to participate in class, to answer questions, to learn, to demonstrate and share his knowledge, to achieve better math scores—that demonstrates his desire and agency in learning and participating in math, his mathematics identity.

Self-management techniques and effective medication seemed to allow Antonio to come out from under his struggle with ADHD and demonstrate his agency, attitude, ability, and desire to do well in math. What also seems to help Antonio’s math identity come to the fore is a safe space for him to learn and work and demonstrate what he has learned and accomplished, and affirmation and validation of his efforts by teachers and adults. All students need a safe space and affirmation to be and become; Antonio may need it much more, and specifically in a smaller setting. It is interesting to see the Antonio that is constructed in the minds of others, children and adults. It is even more interesting to see the Antonio that is constructed in different settings whether it is within a classroom of 25 of his peers, a one-on-one interaction with an adult, or an activity setting where he is with a smaller group of students (no more than 13) and is allowed to show his athletic and mathematics ability and potential without distraction or ridicule. Apart from his seeing boys as more capable than girls in math, Antonio sees for himself the usefulness of

math, seeks to engender a mathematics community in his classroom, loves to discover different things about math, is not terribly anxious about math, and is highly confident in learning math. Although he may not see himself as a mathematician, he still carries a strong mathematics identity. See Figure 23 for different constructions of Antonio by others and himself.

Others' Construction of Him	ANTONIO	His Construction of Him
<ul style="list-style-type: none"> ○ Weak in math but favors it ○ Capable, tries hard, easily distracted ○ Can only focus on one thing ○ Hypersensitive ○ Really struggles with test ○ Hard to understand him ○ Disadvantaged with ADHD ○ Needs to feel capable ○ Works well one-on-one ○ Capable with proper proper medication ○ Self-managing better ○ Helpful, attentive 		<ul style="list-style-type: none"> ○ Loves math ○ Loves karate ○ Likes to draw ○ Wants to study math when he goes to college ○ Sees creativity in math ○ Clear about his interests ○ Seeks help when needed ○ Likes to work in groups ○ Likes to help ○ Likes to feel smart in math ○ Tries hard ○ Does not see himself as a mathematician
<p>Figure 23. Different constructions of Antonio: Others and His</p>		

CHAPTER 8: DISCUSSION

What follows is a discussion of the results of this study, and what I have learned relative to the research questions. Overall, I learned that this community school offered possibilities to students who registered and participated with its services and programs, the direct potential to engage in programs that bore relevance on their mathematical identity development and social emotional development like archery and the computer lab after school. The majority of the fifth graders at this urban elementary community school loved mathematics, and considered themselves mathematicians in a broader sense that reflects habits of mind is post skills. In the classroom, students positioned themselves differently with some positioning themselves as capable and independent, while others positioning themselves as helper or leader. Although the majority of students favored mathematics and saw the relevance of mathematics in their present and future lives, only a small minority saw themselves in careers considered math- or science-related.

Most interestingly, it is the archery program that emerged as an influential structure of the school relative to the students mathematics identities. All the students who participated in archery favored math and many of them felt that how they practiced math in archery made them better at doing math in class and vice versa. Simply, archery was exciting, possibly risky, fun, competitive, inaccessible to many, and engages them in what they love—math. The Coach taught archery in a way that was respectful, responsive, and inclusive to all students, even students with learning disabilities, as observed through case study of Antonio who had ADHD. The students believed that Coach was fair and always expected them to try and do their best. For these archers, the drive to learn and continue in archery was connected to two things—what they loved and who taught them.

With respect to math cultures and structures outside of the school, it is important to know that all of the study participants said they had math support at home, whether the support came from their siblings, their parents, or neighbors that their parents paid to help the students. The support also included technology, whether online web-based games and search sites for math help, or computer games that parents or caregivers purchased for them.

8.1 Research Question 1: Organization and Enculturation

The culture of the school is that of family and community. It is a nurturing and supportive environment that seeks to foster a community of lifelong learners, and in partnership with CFEA, seeks to develop the whole child—academically, emotionally, socially, and physically—during and after school, holidays, and the summer. Academic success is pursued through daytime math curriculum and instruction using *Everyday Math* and afterschool academic enrichment through 45-minutes of homework help every day. Such pursuit attends to students' mathematics performance as assessed by state standards; it does not attend to the development of students to have minds and habits of mathematicians, or goals of math-related careers or courses of study in their future. The macro-level policies and pressures of *No Child Left Behind* particularize students' mathematics development to once-a-year test scores for students (calculated by arbitrary standards and prevailing political agendas) and report cards for schools, consequently translating into increased or decreased school funding.

Looking at the physical structures of the school, there is in terms of its usage little that bears positive influence on the students' images and understanding of mathematicians, and their beliefs, attitudes, and perceptions of mathematics. Although mathematics was a favorite subject for the majority of the students because of its facility, utility, and fun, there was little to no connection between the physical structures of the school (what students see and pass by from day to day) and the learning and doing of mathematics and the awareness and understanding of mathematicians. Although each classroom was equipped with basic and advanced tools such as the SMART Board and manipulatives, SMART Board usage was limited in terms of function, and manipulatives were limited in terms of function and frequency.

Chosen in 2003, the curriculum *Everyday Math* became standard for this city like other cities across the nation even though other major cities across the country had started dropping it as its standard curriculum because its failure to prepare students in basic mathematic operations and for advanced mathematics courses leading to college (Green, 2007). Although the principal stated in the school's comprehensive education plan that teachers use constructivist strategies with *Everyday Math*, there was no evidence of that for the fifth grade teachers. Further, there is limited evidence on the effectiveness of *Everyday Math*, in particular for solving problems, learning concepts, and applications (Slavin & Lake, 2008), aspects that inform students' beliefs, attitudes, and practices in math.

The computer lab, on the other hand, itself a physical and temporal structure, did bear positively on students' mathematics identities. Each class has a structured time to use the computer lab once a week, normally after lunch. During that time, either the full-time computer lab instructor or the teacher engages students in playing digital, computer-based or web based math games, or doing computerized math assessments or lessons. This structure bears positive relevance on students' mathematics identities as students expressed great enjoyment, facility, and increased learning by playing these and more challenging games so much so that they go online at home and continue to play them.

Archery, an afterschool program facilitated by the CFEA, represents a temporal and collaborative structure characteristic of community schools. Within this structure of sports and mathematics practice is a culture of respect and community fostered and protected by the coach that bears relevance to students' identities as archers and as mathematicians. The consistent application and integration of elementary mathematics in the sport and the culturally responsive ways in which the coach demonstrates the importance of learning and doing the practice of mathematics and archery well, not just for achieving temporary goals, but lifetime goals, positively influence the students. All of the archers hold math as their favorite subject and see the connection between doing math well in class and in archery practice and competition outside of the school. Doing math in archery with a focus on accuracy and speed has helped some of them in class.

At home, micro and macro level cultures impact students' learning and doing of mathematics, and their images of mathematicians. Media, although it exists at the macro level along with education policy, is a part of the children's evening, and therefore exists at the micro level, and influences students directly. Part of the intersection of students' images of mathematician and their mathematics identities is the outside influence, or lack thereof, of children's media. What children see in front of the, whether it is on a TV screen, in a magazine, in a book, or a live human being, is what brings together students notions of who they are mathematically and who they can or cannot become mathematically.

The process of watching children cartoons with characters that do math or as one student suggested, that look like they can do math, takes place at home for many students but not all and not regularly. Half the students in the study said they saw characters on TV that they perceived as mathematicians or at least capable of doing math, and half did not. This suggests that on any given day, students at home may not see positive images of characters or people engaging in mathematics, and

certainly not in a way that will encourage students to think, to learn, to feel, and do as mathematicians do, especially since only a handful of shows were mentioned anyway.

Micro levels of culture and structures include the support of their family, foremost, and children's media through digital math games. All the students said that they had someone at home to help them—either their parents, older siblings, or neighbors that their parents paid to tutor them. Even if language was a barrier for the parents (as many of the parents spoke little Spanish), the parents made the older siblings communicate with and help the fifth-grade students in English to do their math homework. Many parents bought math games, digital and non-digital, for the students to play and practice at home, with some of the students saying that their parents played the math games with them and challenged them. In addition to math software is that some parents bought for their children, the students played went online and played the same and other web-based computer games that they played during school in computer lab. Some students used the internet to engage in more challenging math or to help them do math homework on their own.

8.2 Research Question 2: Student's Math PEP: Positioning, Enactment, and Perspectives

Students' math positioning, enactment, and perspectives (math PEP) were explored relative to their mathematics identities. As learning presupposes both what we become and how we act as knowers (Roth & Lee, 2007), what students learn and how students learn is vital to the development of their mathematics identities, especially for those who as of yet do not see themselves as mathematicians and have not pictured themselves as mathematicians, or even math-capable, now or in the future. In this study, most students positioned themselves in class as capable and willing learners of mathematics even in the face of their own and others' behavioral distractions, wanting to participate, answer questions, compete with others, do fun math activities, and do more difficult math. A consistent handful of students positioned themselves as leaders, often telling talkative and disruptive students to be quiet. Students acknowledged who they believed to be mathematicians based on the students' expertise and desire to know and do math.

Students learned mathematics through direct instruction with mental math, answering open- and closed-ended questions, and math message exercises, practicing individually or in groups what they learned. The majority of students enjoyed group work more so than working individually because it

allowed them to give and receive help, if needed. The few students that preferred working individually either enjoyed the sole credit for answering problems correctly or did not want to be distracted or bothered by students talking in the group or asking them for help. Students enjoyed learning through playing challenging and competitive problem-solving type games, expressing great joy when they persisted in solving difficult problems. Students were emphatic that people were not born smart in math and that to become smart in math, focusing and paying attention in class, studying hard, listening to the teacher, and practicing what they learned above were key processes mentioned above others.

A sense of belonging was developed through positive discourse from teacher to student, and student to student. For a few students, participating in class was integral to their sense of belonging. Participating meant contributing to the class and sharing what they knew. That sense was fostered by students taking ownership of the behavioral issues in the class and telling their peers to quiet down and pay attention, understanding that everybody's learning and contributions were important. Students recognizing the strengths and interests of each other was also characteristic of a sense of belonging and community.

Students' immediate life perspectives seemed to be more connected to the facility and utility of mathematics with respect to their daily living. For many of the students, the importance of mathematics was particular to counting money for purchases to make sure they were not cheated or for "doing good on the test." For nearly three-quarters of the students, mathematics was their favorite subject. Future life perspectives on math saw students using mathematics to help others and learn more about mathematics for themselves. All but two students said what they wanted to be when they grew up, with nearly four out of 10 choosing a math-related career even though nearly seven out of 10 saying that they were definitely or kind of a mathematician. Interestingly, students did not shy away from careers in math or science due to perceived lack of ability, insecurity, or disinterest like many students (West-Olatunji et al., 2007); they simply had defined interests in other areas such as sports, law, and entertainment.

One interesting result surrounded the hearing of the word "mathematician." Three-quarters of the students said they had never heard the word mathematician. Even though so many had not heard the word before, I asked them to define or describe a mathematician. Most of the definitions were categorized in terms of expertise (what or how they know) and function (what they do). Interestingly, the students who had heard the word "mathematician" scored significantly higher than their counterparts on

both of their 2009 and 2010 state math assessments. As the hearing of the word bears relevance to their math performance, the context of the hearing—the processes, cultures, and structures—is important to know and understand as half of the students who heard it named one teacher, in particular. This teacher told them the word in connection with a story about a boy their age, and through classroom math competitions. This teacher left the school at the end of 2009 for higher pursuits in education.

8.3 Limitations

There were several limitations to the conduct of this study and the interpretation of results.

1. The year of the study, 2009-2010, is not representative of a “normal” year of operations for this school. For years prior to the study, or at least for 2008-2009, when I started becoming familiar with the school, there were three fifth grade teachers with an average of 16 students in each class plus or minus one student. This year 2009-2010, however, city-wide budget cuts (find a reference for citing budget cuts) forced the elimination of classes for this school, fifth grade being one of them. Thus, for the 2009-2010 academic year, there were only two fifth grade teachers even though student enrollment increased by two students. The two remaining fifth grade teachers had an average class size of 27 students, plus or minus one student. This represents an increase of 11 students in just one year, a difficult change to understand and manage effectively.

The strain of the drastic increase on the teachers was evident throughout the year. This year of observation was not of classrooms of a normal size to which these teachers were accustomed but of an abnormal size to which they were not accustomed. As class size has been shown to be a correlate of achievement (Lubienski, Lubienski, & Crane, 2008; Shin & Chung, 2009) and students’ perceptions of their achievement, in particular mathematics, informs their mathematics identity, one must keep in mind the negative impact of increased class size when considering implications and conclusions of this study.

The principal, in response to the strain of having only two fifth grade classes and the decrease in state math assessment scores for the graduating fifth graders, reinstated the third fifth grade class for 2010-2011, keeping the substitute teacher, Mrs. George, as one of the 2010-2011 fifth grade teachers, and moving two lower grade teachers with strong classroom management skills up to fifth grade. One of the lower grade teachers had a solid reputation from students and teachers alike for classroom management and engaging pedagogical practice. The remaining female fifth grade teacher was moved

to a lower grade. The male fifth grade teacher was removed from the classroom for the last three months of the year. Therefore, the year of the study is not representative of a “normal” year of operations for this school.

2. In 2010, the state assessment program scored the math assessments more stringently than in previous years. Therefore, a substantially lower percentage of students statewide passed the math assessment. For 2009, 86% passed while for 2010, 61% passed. The state assessment program stated that over the years, the tests had become too easy with questions varying little from year to year. So, for 2010, the state made the questions less predictable and raised the number of correct answers needed to pass the tests. Last year, for example, a fourth grader had to get 37 out of 70 possible points on the math test to reach Level 3 (out of 4), or grade level. This year, a fourth grader needed to earn 51 out of 70 points to reach that level. Because the scoring changed this year, students typically scored one level lower with the new scoring. Thus, interpreting performance this year is challenging, in and of itself, and with respect to post survey results.

3. For the last two to two and a half months of the 2009-2010, Mr. Knight was replaced as the teacher of record for his classroom. Mrs. George, a Black Caribbean woman, was the substitute for his class for the remainder of the year. This means that during weeks of preparation for the math assessment, students of Mr. Knight's class were being taught by a substitute teacher, unfamiliar with the students, the curriculum, and the testing procedures as practiced at this school. I decided not to observe Mrs. George and the class since a great deal of her time was spent first on classroom management and preparing for the math test. I did not want my presence to be a stressor for her.

4. The level of behavioral issues and problems for this year was noticeably higher than last year—noticeable to school and CFEA program staff and administration alike. Although most parents of students participating in the study consented to me videotaping their child in the classroom, I decided otherwise because of early and consistent student behavioral issues. Teachers thought that videotaping during class may provoke even more behavioral issues, thus videotaping only occurred during archery practice where behavior management was not an issue.

5. I was the only researcher conducting the study. I attempted to observe each class at least once a month, with efforts to observe both classes every other week. However, with my full-time work schedule,

unexpected observation conflicts, and observations of different aspects of the school, observations at times of the fifth grade classes became difficult to conduct.

6. There were limitations with the study as a few of the questions were double-barreled questions. For example, one of the survey questions asked, "I want to study math when I go to college." This question assumes that the student wants to go to college without directly asking whether or not she or he wants to go. It was in the interviews, however, that I asked the students if they wanted to go to college. All the interviewed students said yes.

7. The study was piloted with African American youth from 4th to 6th grade. It was not piloted with any Hispanic students, however. Although the ELA assessment scores of the fifth grade Hispanic students in the school were comparable for the 2008 and 2009 testing years to those of the fifth grade African American students, it still should have been piloted with this population, too.

8. One glaring omission that I committed during the interviewing process is that I did not ask the students during the interview could they see themselves as mathematicians as they defined or described "mathematician" before I gave them my description of mathematician. Although it was a question written in the proposed interview protocol, I failed to ask it in any of the interviews. I am bothered by that omission as I recognize the loss of something important about the students' mathematical identities in their own voice. Why did I not ask that question? I don't know. To this day, I am still bothered by that omission. Subconsciously, maybe I was too excited to hear their thoughts on a definition/description of mathematician that contrasted with their own definitions/descriptions, thus putting my interests and feelings about the interview over their participation. Maybe I wanted to arrive at an answer I was hoping they would derive, although prematurely, about how we, as adults, define things for children which often times limits their own thinking.

Ironically, I did exactly what I perceive the adult world has done with its constricted definitions and views of mathematicians. In my wanting to open up a world to them, a different way of thinking about this world, that to me they clearly didn't know, I ended up closing a door to their world that I clearly didn't know. Also, maybe I questioned their ability to see themselves as something unfamiliar or unknown to them. Most sadly, this illustrates the problem of researcher power over participant voice, and the struggle that researchers, as human beings, face each time an inquiry is made into the life of another human being, especially a child. Asking them initially would have revealed qualitatively how they see themselves

based on their own definitions/descriptions of mathematician, and not solely on mine. Even though on the survey, their responses reveal to a certain extent how they see themselves mathematically inside and outside of class, it did not directly address the question of whether they thought they were mathematicians themselves—their own conceptions and perceptions of mathematicians from what they have learned from whatever medium.

8.4 Implications

In the year 2030, the fifth grade students of this study will be in the prime working ages of 24-32 where Hispanics will account for about one in five workers in that cohort (Hernandez, Denton, & Macartney, 2007). As the urban community school serves high populations of Hispanic and African American students, it is well poised to impact their holistic development and has been shown to impact positively on their academic achievement. For example, in New York City, students participating in The Children's Aid Society afterschool programs from 2004 to 2007 scored significantly higher on their math tests than students in other city schools, while from 1993 to 1995, the number of third-grade students at a Children's Aid Society community school improved by 25% in reading proficiency 33% in math by the fifth grade (Coalition for Community Schools, 2009). Math achievement is indeed important for students' matriculation from elementary to secondary to higher education; however, it is not enough to develop students' attitudes, beliefs, positioning, and active participation in math.

As the nation continues to change in demographics, especially in urban areas, and continues its pursuit to remain a top global competitor, education and teacher education policies must not forget the children as these policies are often grounded, dare say mired, in political and economic arguments and agendas that have more to do with resources and power than the wellbeing of the child (Michelli, 2005). As community schools are purposed to support the wellbeing of the child, the whole child, education policy should continue to make more room for such community school models of education. As Arne Duncan, the current U.S. Secretary of Education under the Obama Administration is a proponent of community schools, this model of education is supported and funded by Congress with House Resolution 3545, "The Full-Service Community Schools Act of 2009" with its top three out of nine purposes as the following: (1) Providing support for the planning, implementation, and operation of full-service community schools; (2) Improving the coordination, availability, and effectiveness of services for children and

families; and, (3) Enabling principals and teachers to complement and enrich efforts to help all children reach proficiency in reading and math by 2014.

The findings of this study can inform the cultures, structures, and processes of community schools with similar demographics, services, and programs in urban areas. In addition to community schools policy, the results also imply the need for education policy around teacher education programs to implement coursework or practicums involving the theories that frame this study, especially for teachers who will serve in urban settings with populations different from them and schools with strong partnerships with social service and community organizations. Culturally responsive pedagogy has proven impactful for students of color in other research and was shown to bear relevance for the mathematics identities of Hispanic and African American students in one of the classes and, particularly, in archery. In addition to highly qualified teachers having credentialing, academic subject knowledge, and clear, unequivocal statements about beliefs, grounding in pedagogy, foundations, field experiences, and deep content knowledge (Michelli, 2005), they should also learn and use well within their classrooms culturally responsive pedagogy.

The results also imply the need for children's television and gaming media to show mathematicians and mathematically engaging characters that are accessible and relevant to African American and Hispanic children, as these are images they bear in their minds. Such media represent alternative realities that imaginations have created (Greene, 1995), where sometimes it is in these alternative realities that we can see our best selves, or least selves we have never seen before. Centuries ago mathematicians knew the power of imagination, and children know it today. Research has recently suggested that children are less and less creative (Rettner, 2011). Therefore, the results implicate the need for teachers to learn how to engage their own creativity and imagination, and to teach students how to do the same, especially when students know that math can be creative, and they want and need interactive, creative, fun, and challenging math activities and problems to develop their agency and power in math, and in turn, their identities.

And simply, the results implicate the need for schools, teachers, afterschool programs, parents, and neighbors to expose children to the word "mathematician" and let it become an ordinary, un-scary, empowering word in their lexicon, and then expose them to how mathematicians think, feel, and do mathematics using the available advanced tools and resources in the classroom, especially since one of

the tools, the SMART Board, allows internet access to a world of knowledge, experiences, and alternative realities with great potential to bear positively on students' mathematics identities.

In the midst of teachers engaging their students with culturally relevant and responsive pedagogy and students being engaged and challenged by cartoons, videogames, and digital math games, lies the importance of imagination and creativity, the core of mathematics, the essence of what mathematicians do. Somewhere, in the temporally cramped space of teaching, preparing for tests, and managing classroom behavior, students' desires and wishes to learn new and different things or to experiment with the known and unknown must be heard at the very least. I say this not as an indictment of teachers or the profession as a whole, as I once was a middle school teacher and fully understand the madness that ensues within the public school walls and sometimes engulfs the public school classroom teacher, but as a plea to do what may seem impossible, especially in this crippling age of testing the test-takers and the test-givers (not to be confused with the test-makers): find time for the imagination, for creativity, for the mind to peek around and into crevices yet to be discovered and to soar high and far into the open expanse of the known and evolving. To develop mathematics identities and talent, creativity, which takes time to develop and experience to thrive, is essential (Mann, 2006).

8.5 Conclusion

The mathematics identities and their development of African American and Hispanic fifth graders in an urban elementary community school are important to know and understand as their learning and doing of mathematics at this stage in life affects their learning and doing of mathematics in the not-so-distant and distant stages in life. As adult after adult bemoans their childhood experiences learning and doing mathematics, it is easy to see how important positive engagement is in the early years. And, as African Americans and Hispanics continue to be outside of the STEM academic and workforce bubble (for reasons beyond and within their control), development of their mathematics identities early on is critical. Such development holds great potential in community schools—schools in urban communities that work to eliminate non-academic barriers of its students so they can be free to learn and succeed academically and grow holistically.

To engage students from a standpoint of mathematics identity and its development in an urban elementary community school, several theories and concepts come into play: mathematics socialization, cultural-historical activity theory, ecological systems theory, and culturally responsive pedagogy. Each

directly impacts the student, or at the very least, has potential to directly impact the student. More evident in archery than in the classrooms in this study, culturally responsive pedagogy impacted how students see and feel and think about mathematics in general and, more importantly, as it relates to them. Across both of the classrooms and archery practice, the types of activities, discourse, and interactions with each other and with the tools of the class or sport and the different levels of engagement bore out differently and showed somewhat in how students talked about themselves respective to mathematics. For students who are registered with the partnering social service or community-based agency, their interaction with these services and participation with the programs (e.g., social worker, afterschool program) occur at the microlevel, and not at the exolevel as for non-registered students. The community school model brings outer influences inward toward the student for direct interaction, making the potential for positive identity development even greater. Macrolevel influences of media are brought into students' microlevel worlds by their regular engagement of child-friendly mathematics websites in the computer lab at school and even at home. These websites bear relevance to the students' mathematics identity development more so than cartoons and videogames. Such activities and interactions inside and outside inform how students are socialized into or out of mathematics.

In this urban elementary community school, the majority of students still love mathematics, and many of them can see themselves as mathematicians and certainly see the importance of mathematics in their worlds today and tomorrow. But as they matriculate through middle and high school, will they carry the identities they have now with them? Will the change of micro, exo, and macrolevel influences, particularly microlevel, cause those identities to flourish or die? Will the Antonio's of urban schools find such a setting and program as this community school to help them manage their symptoms of ADHD and feel capable—a feeling every human wants, needs, and deserves? Further research is needed to understand how those identities may change throughout their secondary schooling, particularly in middle school, where social, emotional, physical, and environmental changes affect students directly and indirectly and often negatively. Further research is also needed to understand how students with ADHD cope within settings that are culturally responsive and purposeful in activities and interactions with respect to developing positive math identities. This course of research is necessary to help African American and Hispanic students to positively engage with mathematics, to see themselves as capable, even as mathematicians, to pursue it, and to persist in it as their mathematics identities live beyond their scores.

CHAPTER 9: THE YESTERDAY THAT BROUGHT ME TO TODAY

Who I am today is a culmination of my life from before my earliest memories until this very moment as I write these words. My professional identities as mathematician, educator, and education researcher continue to evolve, with the first identity first taking shape in my early childhood. I thank my Mother for that shaping, that molding, as she made my initial everyday experiences with mathematics fun, engaging, challenging, important, and connected to real life objects and activity. Even though some mathematicians believe that the title of mathematician is conferred only after earning the doctorate in mathematics (Murray, 2000), I disagree. Further, I believe the seeds of becoming and being a mathematician, maybe even a newly defined mathematician (as I have tried to do in this research), begin in the early stages of life at home.

I remember me and my Mother sitting on the floor and me watching her play Solitaire and then us playing it together. I was three or four years old. She showed me things, interesting things...curious things with those colored, numbered, cards. Numbers. Counting. Patterns. Sets. Evens. Odds. With that same deck of cards, she would put them in an array, face down, to engage me in a matching game. (That deck got a lot of mileage.) Or, often, we would play a game of Jacks (or Jackrocks as some people might call it), where the player throws the 10 Jacks on the floor and bounces the little red ball. The objective was to pick up the number of Jacks without the ball bouncing twice, starting with one Jack. Counting. Finding groups. Strategizing with considerations of speed, distance, and hand agility. Odds. In addition to the fun and games, she pointed out those real life math-related things and activities in the home or outside when we went on trips. As I grew older, I took advanced math classes in elementary, middle, and high school. I didn't need help often in my advanced classes. I found math very easy then. However, when I did, my Father helped me, either showing me how to do the problem or talking me through it for me to solve it on my own.

In elementary school, my everyday experiences with mathematics were fun, too, yet rudimentary, using math books with pages upon pages of exercises and word problems, reviews, worksheets, speed drills, quizzes, and tests. Even with rudimentary, almost perfunctory exercises, I still enjoyed math. That seed was firmly and deeply planted. I only remember direct instruction from my teachers when learning mathematics; rarely, if at all, were collaborative work, use of manipulatives, constructivist types of activities, or activities that spoke to sociocultural learning theories employed. I cannot say that not having

those learning experiences hindered my learning the mathematics we were supposed to learn in school but I can say that not having those experiences narrowed my understanding, enactment, and appreciation of mathematics as a social, cultural, and humanistic activity. What would my understanding of and positioning in mathematics be today had the pedagogy and curriculum been responsive and inclusive of all students in the class, engaging us in sociocultural and constructivist ways of learning?

I loved learning rules, properties, theorems, and lemmas and how to apply them. To me it was a game, a puzzle. My Mother had prepared me with math puzzles and games already since before starting formal education. So, this was a continuation of the fun. Plus, it was simple. From elementary school to high school the concept was the same—take what you know to find out what you don't know. That was the premise of the instruction that I received from elementary school to graduate school—take what you know and find out what you don't know. It was never about starting with an open problem absent any clues and trying to understand it deeply, making intricate connections with it, drawing hidden relationships from it, looking for new and complex patterns, or creating something, anything, new in mathematics. It was never about deconstructing theorems and proofs and rules and lemmas, or trying to understand how mathematicians from eons ago came up with what to me seemed like beautiful literature or art. It was never about understanding how symbols and notations printed in black-and-white on those pages connected to the reality of the mathematicians eons ago to my reality today and to somebody else's reality tomorrow.

It was never about trying to develop a mathematical mind, as opposed to a rule-following mind, that would encourage and allow us to create beautiful literature or art on our own, and see it as beautiful literature or art of our own. And, from my vantage point, it was never about making sure that every black student had a chance to love mathematics. At least, that is how I saw it then and, frankly, still see it. Should every student have a chance to love mathematics? Absolutely. Will every student love mathematics? Undoubtedly, no. Just like there are some students that do not like social studies or French. But as a black woman, an African American woman, I ask the question with respect to black children because it is black and brown children who are on the edge, the periphery, the outside looking in on what mathematics offers due in large part to the romance and mythology of mathematics (Lakoff & Núñez, 2000) that has been perpetuated and perpetrated on these black and brown children for centuries, at least, in the United States.

I loved mathematics growing up and I still love it. I am fascinated and thrilled by what I see even if I don't quite understand particular topics or concepts. But there is something about my identity which refuses to let me believe that anything is beyond my intellect, my cognitive abilities, my intuition, my emotional resolve to learn, my intestinal fortitude to solve, my innate desire to persist, to do it. My Mother often reminisced of stories about me attempting to do something even as a toddler, where in those stories she said I would often say, "I can do it." Many of the students in this study reminded me of me as a child, determined to do it, to solve it. I am certain that I inherited that "I can do it" mentality from my Mother and my Father, and frankly the mustard seeds of my mathematical abilities and identity from them as my Mother was very practical and adroit in the math she showed me, and my Father was more conceptual, a man quite comfortable with theories and adept at designing and using blueprints for telecommunications systems.

My older sister, Robin, a longtime educator and administrator of educational and holistic program, is now in a doctoral program in science education and administration. Her loves are science, education, and art; mine are mathematics and education. She taught me something most beautiful in mathematics when I was in the first grade. She never remembers that moment. But I do. Clear as day. We were in our room. I was sitting on the floor in front of her as she wrote it on the little green chalkboard Mother had bought us from the thrift store: $3+3+3 = 3 \times 3 = 3^2$. What a "wow" moment indeed for me! I was fascinated by it. So many ways to get to the number 9 using the same little number 3. After that, 3 became my favorite number. And, frankly, I was thrilled at the thought that I could be the only one in my class who knew it. As the older sister, Robin would often teach us (the younger siblings) and help us with our homework.

Even during those early years, Mother saw teachers in all of us including my older and younger brothers whose passions and gifts were in music, all forms. My Mother firmly planted and watered those music seeds, too, in all of us. Bryant, my older brother, was a musical genius, able to sing in perfect pitch; read and write music exceptionally well; sing and play music by sight and by ear; and, play any musical instrument he picked up. Although math was not his strongest or favorite subject, he easily saw the mathematics in music; I didn't. He was the first to point it out to me. Markanthony, my younger brother, also a most gifted musician, has an exceptional ear for rhythms, melodies, and cadences, able to seamlessly combine the sounds of different instruments and voice and genres of music with different

instruments using the latest technologies. Although math was not his strongest or favorite subject, he, too, easily saw the mathematics in music. For me, it simply says there is so much beauty to learn and appreciate in mathematics wherever it exists.

Growing up I was always in the advanced or gifted classes, partially because of my ability but also because my Mother was a very present and perspicacious parent at the school. She understood the benefits and necessity of staying very aware of the goings-on at school as segregation was still on the minds of many and desegregation busing had just started in Virginia. She was never antagonistic; on the contrary, she was fair, participative, and supportive but very clear and undaunted on whatever steps she believed she needed to take on behalf of her children. I never took for granted my Mother's presence at school. She made me feel secure in my academic walk. My Father also supported us in our academic and extracurricular activities, being present and active in our endeavors, near or far. To this day I appreciate parents' and caregivers' informed and diligent support and presence for their child.

School came very easy for me. But it never failed that I was usually, if not, the only black student, then only one of three or four in class with 25 or so white students. That ratio persisted from elementary school to undergraduate school, with graduate school the ratio being even smaller. I am certain that black children and black families and many of the teachers, most of them white, fell prey to the romance and mythology of mathematics that says that mathematics is abstract, disembodied, objective, logical, everywhere in nature and the physical universe, requiring intelligence, and perfect. It wasn't the math that was wrong; the person was wrong (Lakoff & Núñez, 2000).

In elementary school, I really did not understand why even though my school was half black and half white, there was still less than a handful of black children in the advanced or gifted math classes. I thought that if the school was half black and half white then it would only stand to reason that the classes would be half black and half white. That there could always be in every grade in every school the same pattern, the same trend, of more white students excelling in mathematics than black students was troubling to me. There is something to be said of conspiracy theories even if the theory isn't well-founded because something contrary to intuition, to one's gut feeling of what is right and wrong, has transpired for more than one person, over and over again. Such has transpired for many people, noticeably for particular peoples. The way the world is turning today there are so many opportunities to use mathematics in its many-splendored subjects in physical space, outer space, and cyberspace. We

cannot afford for the romance to continue. Just like a bad romance between human beings in a relationship, let it end, and end quickly.

Let me fast forward to high school where my mathematics memories regain footing. I took four years of advanced mathematics with AP Calculus in my senior year with Mr. Pitas, a short, stocky, very hairy, Greek man whose accent I loved but at times couldn't understand. This class was the first class that I ever had to write a mathematical paper. Interestingly enough, that was also the last time I ever had to write a mathematical paper until graduate school. It was a two pager on the function, $f(x)$. I thoroughly enjoyed writing that paper and I earned an A+ on it. Mr. Pitas told me that I did an excellent job on the paper and that he really enjoyed reading it. I have no earthly idea why in college I never had to write a mathematical paper. I was so proud of that paper, one, because I loved writing anyway, and two, mixing different loves and intelligences, mathematical and literary, was beautiful for me. How to bring the beauty of both number, symbols, equations, graphs, correspondence of points, and the natural language that I spoke together to form an aesthetically pleasing piece of work was the question and the challenge that I enjoyed meeting. That excitement in writing that paper I can still feel somewhat. Had an experience like that happened to me in undergraduate school, I am certain that my outlook of mathematics would've been brighter.

It was only when I reached graduate school to study statistics that I experienced somewhat the joy of combining writing and mathematics. I had four professors in the graduate department that taught statistics and explained statistics to us with a clear joy and desire for us to learn statistics. Those professors were Dr. Jerry Mann, Dr. Golde Holtzman, Dr. Keying Ye, and Dr. Klaus Hinklemann. There were no women professors at the time except for one who held a joint position with the statistics department and the agricultural economics department. The obvious absence of women professors in the statistics department was very telling to me. The obvious absence of black professors in the statistics department was even more telling to me. But even with this telling, my identity would not let me quit because I knew I was capable and I wanted to learn the statistics that I had come to know and love. It brought math to life in a much fresher, livelier way; a more picturesque and visually demonstrative way.

With statistics the numbers in mathematics told a more vivid story, a story that connected me to the real world, the physical world, a world where I saw mathematics as being useful. I loved the beauty of the equation although sometimes not being able to understand them. I loved the notion of taking data

points, putting them into the equation, calculating them, and seeing what picture presented itself, what patterns jumped off the page, what stories outliers told about the data itself. It was in linear analysis in graduate school that I finally understood what in the world my advanced calculus professor was talking about in my junior year of undergrad.

But it was also in linear algebra and regression analysis in graduate school where my newfound love of matrix algebra, as learned under Dr. Margaret Murray, reared its beautiful head. Professor Murray was an excellent teacher and purveyor of the beauty and joy found in mathematics—the learning and doing of it. She was one of the few professors which made mathematics accessible and enjoyable. She was one of the few professors who seemed like they really wanted the students to learn the subject. I enjoyed manipulating numbers, variables, rows, and columns and such to find solutions.

Again in this class I was one of three African-American students out of a class of 25 or so white students. I had one of the highest grades in the class overall and I distinctly remember the day Professor Murray handed back the first test. Before she handed it back, she stood at the front of the class and announced that there was one student with a perfect score. Tammy, an African-American woman from West Virginia, sitting to my left that day, looked at me and then directed my attention at a heavysset white man sitting at the left front of the class, who clearly by his smile and his friends patting him on his back, believed he had earned the highest grade. Much to his chagrin, surprise, and maybe even disgust, Professor Murray walked to the back of the classroom and handed me my test paper as she called out my name as having the highest grade on the test—105—a perfect score plus full extra credit. Tammy smiled and started laughing. I smiled and so did Professor Murray.

That experience in my undergraduate mathematics program was one of few that was uplifting and validating of my identity as a mathematician, an African American woman mathematician. Although the women of Professor Murray's (2000) book all agree that one can be called a mathematician after one learns the PhD in mathematics, I disagree. Being a mathematician as revealed not only of this book but other books as well about mathematics and mathematicians is less about professional status and level of practice but more about state and habits of mind. I think a redefining of the word mathematician or, at least, a redefining of the culture of and understanding of mathematicians needs to take place as the number of black and Hispanic students entering mathematics fields and degrees continues to lag behind, and that mathematicians overall and, in particular, women mathematicians each year newly entering the

workforce with PhD in hand is at a steady low. Further, the number of people earning their PhDs in mathematics education is low.

From conducting the literature review of mathematicians (Fitzgerald & James, 2007; Murray, 2000), an important point rang loud and clear: that the educational backgrounds of their parents varied widely and were not the cause, so to speak, of students' mathematical abilities. For many, their parents had little formal education and were largely self-taught. Many families were from humble beginnings with some from quite wealthy families. Some fathers, teaching mathematics or science fields at the university level, in turn, taught their children mathematics. Yet, there rests a "common belief that the mothers of great men are more influential on their development than men" (Fitzgerald & James, 2007, p. 26), some fathers of attributed their child's mathematical gifts to the mother's side of the family.

What was most important, though, to the development of the children in their mathematical abilities and identities was not the education of the parents but the support and encouragement of at least one parent (Fitzgerald & James, 2007; Murray, 2000). Particular supporting factors of early childhood were brought to light in studying the backgrounds of mathematicians: intellectual activities were valued; intense emotional need was satisfied by creative activities; cognitive stimulation at least by the age of five occurred although not necessarily mathematical skills and knowledge; presence of intellectual models was clear; verbal concepts were stressed; and intense self-directed study during the early years was encouraged (Fitzgerald & James, 2007). Some students were late bloomers and some showed mathematical aptitude early on.

I can relate. My parents were highly supportive and encouraging of all of my abilities and academic pursuits as they were with all of my siblings because they held education in the highest regard. Both of my parents were educated although maybe not traditionally for both. My Mother graduated from high school and attended two years of a community college in New York. My Father left school in the seventh grade and entered the military at the age of 14. He was highly intelligent and believed there was something far better for him than what the school system and life offered at the time. He knew he could make a better life for himself. He retired after 25 years of service from the Air Force as an expert in telecommunications systems. I think all I needed was to know that my parents supported me. They were the strongest platform of academic liftoff that I could have asked for.

In addition to my parents, my teachers and guidance counselors also supported me. The teachers really wanted to make sure I understood the material. They expressed an interest in my future plans. They always gave me informed input into my next steps. My guidance counselor made sure to put me in programs and recommend me for awards that reflected my high academic standing and pursuits. Much of this I missed when I went to Virginia Tech. Maybe Professor Murray took her experiences in mathematics to heart and wanted to make sure that her students, in particular, her female students, understood matrix algebra and were successful. Maybe she saw my love of math and wanted to nurture it.

The inspiration of teachers whether at the elementary school, middle school, high school, or college level can never be understated and must never be taken for granted. For some mathematicians, it was the intellectual exchange with peers and teachers that helped them to blossom (Fitzgerald & James, 2007). Such inspiration is especially key during the transition from elementary school to middle school, as students begin to form their own identities. In elementary school students normally want to please adults and each other so they have not quite formed an identity of their own. Although it may seem with some students they have formed a clear identity, most students at that age have not. And it is from elementary school to middle school, most often fifth grade to sixth grade, that students' mathematical interests and performance starts to decline, particularly for girls. It is altogether not certain why this decline happens for girls but what is certain is that if that decline is not met and addressed with essentially an equal or more powerful force that engages them mathematically, then the decline will continue even in high school and college.

My Father, when I was growing up, would often tell me that learning is 80% the responsibility of the student, and 20% the responsibility of the teacher. The current politics of the day would suggest that learning is 100% the responsibility of the teacher and 0% the responsibility of the student. I agree with my father, to a certain extent. As I have dawned and developed through the years of professional and academic experiences the identities of educator and education researcher, especially at this moment in my professional career, I understand the influences that are sometimes within our grasp and others that are beyond.

Bronfenbrenner's ecological systems theory (Bronfenbrenner, 2000; Bronfenbrenner & Ceci, 1994) seems so logical, so relevant, so crucial to understand and navigate the systems that surround and

impact the students and their families, positively or negatively, and the bidirectional influential interactions that students and families have between and within these systems—classrooms, schools, afterschool programs, educational policies, social policies, media, and the like. Encouragingly, within the microsystem is the potential for there to be not just one teacher out of a classroom of 15 or 25 or even 35 students but that there would be that same number of teacher-learners, where lives the understanding that teaching and learning are inseparable and sometimes indistinguishable. I think Lev Vygotsky hit the nail on the head with his sociocultural learning theory.

Just as many of the women mathematicians before me (Murray, 2000), I also wanted to be a teacher. Education was my second love. My Mother was the consummate educator. In middle school and high school, I tutored my friends, and even, the neighborhood bully. Helping students with math came easy for me all throughout elementary, middle, high school, and college. And when it became challenging, when I started teaching adults in a GED math program in New York City, I loved it even more because it made me really think about my ways of teaching. Were they uplifting and empowering to my students—adults who held fears and insecurities but promise, too? Or were they just like the ways they were taught in middle and possibly high school before they left school?

Today my identity of education researcher is grounded in my research experiences from the Girl Scout Research Institute, in my doctoral MetroMath fellowship, and in my dissertation research. The particular topics of my doctoral research are because of my educator and mathematician identities. In some ways, these identities are separate while in other ways, they have become intertwined. How have these identities moved in and out of each other along my life course? How have they evolved?

These questions of identity, especially my research identity, grew beyond the research I was conducting but I could see that growth only partially. My advisor, Dr. Anna Stetsenko, who clearly loves her work, sharing her work, and nurturing the work of her students as their own, gave me insightful and judicious advice, comment, and encouragement throughout the research, and opened windows of understanding for me into my own researcher identity development. She saw what I was becoming beyond an education researcher even though I didn't. But that is my journey of identity to continue. That is my evolving to understand. As a participant observer in my life course, I want to understand not only how I came to be what I am but also to try to discover how I can become what I am not yet (Bronfenbrenner, 1995), or discover what I have not yet seen but may already be there. So I look back to

see today. I hold tight to the lessons I learned along the way. I look at the yesterday that brought me to today and am inspired about the tomorrow to come.

APPENDICES

- A. Student Survey and Statistics
- B. Interview Protocols

APPENDIX A: STUDENTS' MATHEMATICS BELIEFS AND ATTITUDES SURVEY

Read each of the statements below carefully. Under each statement, circle if you agree strongly, agree, disagree, disagree strongly or are not sure with the statement. This is not a test so there is no right or wrong answer. It's all about your opinion so be honest. Your answers are confidential so they will not be shared with anyone at all.

- | | | | | | | |
|------------|---|----------------|-------|----------|-------------------|----------|
| 1. | Math usually makes me feel uncomfortable or nervous. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 2. | I can get good grades in math. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 3. | It wouldn't bother me at all to learn more math. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 4. | I do my math because I know how useful it is. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 5. | Girls are less talented in math than boys by nature. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 6. | After I graduate from high school, I won't need math. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 7. | I'd be proud to be the best student in math. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 8. | If a math problem is hard, I try to figure it out before asking for help. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 9. | I don't like helping other students with math. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 10. | When I'm outside of school I like to use mental math to figure things out. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 11. | I'm too nervous or scared to share my answers in class. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 12. | I try to see math in things around me. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |

- | | | | | | | |
|------------|---|----------------|-------|----------|-------------------|----------|
| 13. | Math is more for boys than for girls. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 14. | Math doesn't scare me at all. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 15. | If I am the best student in math, I don't want anyone to know. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 16. | I think I could handle more difficult math. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 17. | I like math puzzles and games. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 18. | I almost never get nervous during a math test. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 19. | I'm no good at math. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 20. | I want to study math when I go to college. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 21. | Math is not important to my life. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 22. | I like to help my classmates with math. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 23. | Knowing math will help me get a good job. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 24. | When I get a math problem wrong, I try hard to understand why. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 25. | Boys and girls are equally good at math. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |
| 26. | My teacher makes me feel like I can do well in math. | Agree strongly | Agree | Disagree | Disagree strongly | Not sure |

Yaaaaay!! You're finished! Thank you very much for completing this survey!

APPENDIX A: SURVEY ITEM STATISTICS FOR 2009 AND 2010

Table A1. Students' Mathematics Beliefs and Attitudes Survey (2009 and 2010)						
(For 2009, n=32, and for 2010, n=31)						
Subscale/Item	Median		Mean		Sum	
	2009 (1 to 5)	2010 (1 to 5)	2009 (1 to 5)	2010 (1 to 5)	2009 (32 to 160)	2010 (31 to 155)
Gender Equality						
Math is more for boys than for girls.	5.00	4.00	4.22	4.23	135	131
Girls are less talented in math than boys by nature.	3.00	4.00	3.59	3.71	115	115
Mathematics Usefulness						
Knowing math will help me get a good job.	5.00	5.00	4.56	4.61	146	143
Math is not important to my life.	5.00	5.00	4.56	4.48	146	139
After I graduate from high school, I won't need math.	4.00	5.00	4.34	4.35	139	135
I do my math because I know how useful it is.	4.00	5.00	3.94	4.45	126	138
Classroom Community in Mathematics						
My teacher makes me feel like I can do well in math.	5.00	5.00	4.66	4.26	149	132
I like to help my classmates with math.	4.00	4.00	4.13	4.00	132	124
I'm too nervous or scared to share my answers in class.	4.00	2.00	3.59	3.06	115	95
I'd be proud to be the best student in math.	5.00	5.00	4.38	4.58	140	142
If I am the best student in math, I don't want anyone to know.	4.00	4.00	3.69	3.94	118	122
Discovery of Mathematics						
I like math puzzles and games.	5.00	4.00	4.53	4.06	145	126
I try to see math in things around me.	4.00	4.00	3.66	3.58	117	111
If a math problem is hard, I try to figure it out before asking for help.	4.00	4.00	4.28	4.32	137	134
I want to study math when I go to college.	4.00	4.00	4.28	4.10	137	127
When I get a math problem wrong, I try hard to understand why.	4.00	4.00	4.22	4.10	135	127
Mathematics Anxiety						
Math usually makes me feel uncomfortable or nervous.	4.00	4.00	3.63	3.87	116	120
I almost never get nervous during a math test.	3.00	2.00	3.13	2.71	100	84
Math doesn't scare me at all.	4.50	4.00	4.19	3.68	134	114
Confidence in Learning Mathematics						
I think I could handle more difficult math.	4.00	4.00	3.22	3.52	103	109
I'm no good at math.	4.00	5.00	4.12	4.39	132	136
I can get good grades in math.	4.00	5.00	4.25	4.19	136	130
Total Scores	89.5	89.0	89.16	88.19	2853	2734
Total Possible Scores	110	110	110	100	3520	3410
Total Percentages					.81	.80

APPENDIX A: SURVEY SUB-SCALE STATISTICS FOR 2009 AND 2010

Table A2. Students' Mathematics Beliefs and Attitudes Survey (2009 and 2010)			
(n=30 matched students)			
Subscale/Item	Mean		Significant Difference?
	2009 (1 to 5)	2010 (1 to 5)	Yes/No
Gender Equality	3.95	3.88	No
Mathematics Usefulness	4.33	4.48	No
Classroom Community in Mathematics	4.10	3.93	No
Discovery of Mathematics	4.23	4.03	No
Mathematics Anxiety	3.64	3.44	No
Confidence in Learning Mathematics	3.82	4.01	No

Note: Paired t-test conducted at $\alpha = .05$.

Table A3. Researcher Definition Construction of Mathematician From Literature	
A mathematician is anyone who ...	Citations and supporting quotes/statements
Likes to learn about math	<ul style="list-style-type: none"> • Smith (2002), p. 124: "Mathematicians can be distinguished by their constant readiness to learn more about mathematics; they are open to mathematical experiences, are unafraid of mathematical environments, and have a continual feeling and fascination for relationships among numbers." • Murray (2000), p. 201: One of the women mathematicians that the author interviewed said that, "A mathematician is someone who is drawn, again and again, to the process of creating something new in mathematics, someone who enjoys 'the crystal moment of great discovery' when a new idea first takes hold." • Fosnot & Dolk (2005), p. 187: Youth should learn from an early age "to recognize, be intrigued by, and explore patterns, and as they begin to overlay and interpret experiences, contexts, and phenomena with mathematical questions, tools, and models, they are constructing what it really means to be a mathematician."
Sees math in almost anything	<ul style="list-style-type: none"> • Smith (2002), p. 124: "Mathematicians can be distinguished by their constant readiness to learn more about mathematics; they are open to mathematical experiences, are unafraid of mathematical environments, and have a continual feeling and fascination for relationships among numbers." • Murray (2000), p. 201: "A mathematician is someone who is drawn, again and again, to the process of creating something new in mathematics, someone who enjoys 'the crystal moment of great discovery' when a new idea first takes hold." • Fosnot & Dolk (2005), p. 181: "...creativity is at the core of what mathematicians do." • Fosnot & Dolk (2005), p. 187: The author suggested that youth should learn from an early age "to recognize, be intrigued by, and explore patterns, and as they begin to overlay and interpret experiences, contexts, and phenomena with mathematical questions, tools, and models, they are constructing what it really means to be a mathematician." • Kline (1973), p. 58: "Mathematicians are creative and create through "imagination, intuition, experimentation, judicious guessing, trial and error, the use of analogies even of the vaguest sort, blundering and fumbling enter."
Tries different things in math	<ul style="list-style-type: none"> • Smith (2002), p. 124: "Mathematicians can be distinguished by their constant readiness to learn more about mathematics; they are open to mathematical experiences, are unafraid of mathematical environments, and have a continual feeling and fascination for relationships among numbers." • Murray (2000), p. 201: "A mathematician is someone who is drawn, again and again, to the process of creating something new in mathematics, someone who enjoys 'the crystal moment of great discovery' when a new idea first takes hold." • Fosnot & Dolk (2005), p. 181: "...creativity is at the core of what mathematicians do."

Table A3 (Continued). Researcher Definition Construction of Mathematician From Literature	
Tries different things in math	<ul style="list-style-type: none"> • Fosnot & Dolk (2005), p. 187: Youth should learn from an early age “to recognize, be intrigued by, and explore patterns, and as they begin to overlay and interpret experiences, contexts, and phenomena with mathematical questions, tools, and models, they are constructing what it really means to be a mathematician.” • Burton (2004), p. 187: “A crucial difference between mathematicians and most learners is that mathematicians see themselves as the agents of their own learning.” • Kline (1973), p. 58: “Mathematicians are creative and create through “imagination, intuition, experimentation, judicious guessing, trial and error, the use of analogies even of the vaguest sort, blundering and fumbling enter.”
Is not afraid to try to solve problems or figure things out using math	<ul style="list-style-type: none"> • Smith (2002), p. 124: “Mathematicians can be distinguished by their constant readiness to learn more about mathematics; they are open to mathematical experiences, are unafraid of mathematical environments, and have a continual feeling and fascination for relationships among numbers.” • Fosnot & Dolk (2005), p. 187: The author suggested that youth should learn from an early age “to recognize, be intrigued by, and explore patterns, and as they begin to overlay and interpret experiences, contexts, and phenomena with mathematical questions, tools, and models, they are constructing what it really means to be a mathematician.” • Burton (2004), p. 187: “A crucial difference between mathematicians and most learners is that mathematicians see themselves as the agents of their own learning.” • Piggott (2007), p. 4: “Mathematics is as much about posing problems as problem solving, noticing within a situation that there is a question waiting to be asked. At this point, the creativity is in noticing there is something to be investigated.” • Lockhart (2009), p. 61: “Painful and creatively frustrating as it may be, students and their teachers should at all times be engaged in the process [of problem solving]—having ideas, not having ideas, discovering patterns, making conjectures, constructing examples and counterexamples, devising arguments, and critiquing each other’s work.”
Is not perfect	<ul style="list-style-type: none"> • Lakoff and Núñez (2000) explicated and refuted the mythology of mathematics that has persisted for ages, bringing it to the level of collective and cultural human imagination and effort; that which is not perfect. • Burton (2004) refuted the arrogance and exclusivity perpetrated and perpetuated by the mathematics community. • Pilot test (2009), responses from two African American youth. • Kline (1973), p. 58: “Mathematicians are creative and create through “imagination, intuition, experimentation, judicious guessing, trial and error, the use of analogies even of the vaguest sort, blundering and fumbling enter.” • Mathematics Association of America (2007), p. 45: “The historical difficulties mathematicians had at critical junctures in the development of their subject are frequently mirrored in the learning difficulties that students have at the same critical junctures.”

APPENDIX B: INTERVIEW PROTOCOLS

STUDENT INTERVIEW QUESTIONS

1. Can you tell me a little bit about yourself? What is your favorite subject? Why? What do you like to do after school?
2. What do you like most about this school? What do you like least? What did you like most about learning math last year? What did you like the least?
3. Tell me about the math that you're learning this year and the books that you're using. Tell me about the most exciting or interesting thing you did in math this year. What made it so exciting or interesting?
4. Tell me about the most boring or difficult thing you did in math this year. What made it so boring or difficult?
5. Think of as many places in this school where you see math. What are those places? How do you see math in those places? Where do you see math outside of school? Is the math that you learn in class something that you can use in real life? Why do you say that?
6. Do you talk to your parents and family about what you learned in math class? What do you tell them?
7. Do you go to any after-school activities? Which ones? What do you like about those activities? What don't you like? Do you do any math in those activities? What kind of math do you do? How do you feel about that?
8. How often do you get to use the computer lab or the computers in your classroom? What types of things do you do using the computer?
9. What math activities do you do on the computer? Do you work on your math assessment problems on the computer? By yourself or with someone's help? How do you feel about being able to work on the problems by yourself? How do you feel about the math activities you do?
10. Have you ever heard the word "mathematician" before? Tell me what you think a mathematician is, or describe for me what you think a mathematician does. Who do you think could be a mathematician? Why/why not?
11. Do you see yourself as a mathematician? Why/Why not? Can you see yourself as a mathematician when you get older? Why/Why not?
12. What if someone told you that a mathematician was anyone who likes to learn about math, sees math in almost anything, tries different things in math, is not afraid to try to solve problems or figure things out using math, and is not perfect? Now what do you think about mathematicians? Could you see yourself as one now? Maybe in the future?
13. Can you think of anyone you know that could be mathematicians? What about cartoon characters, or video games, or video game characters?
14. If you could use math for one thing in this world, what would you use it for?
15. If you could learn anything in math, what would you like to learn?
16. If there was one thing that you wanted the world to know about you as it pertains to math, what would you want the world to know?

17. If there was one thing that you wanted the world to know about you (not having to pertain to math), what would you want the world to know?
18. Is there anything else you'd like to tell me about math?

SCHOOL ADMINISTRATION/FACULTY INTERVIEW QUESTIONS

1. How many years have you taught in an elementary school? How many years have you taught here? If you have taught at other schools, how would this school compare to the others, in general, and in terms of mathematics teaching and learning?
2. How would you describe the overall culture of this school? Its environment? The teaching staff? The school administration? The CFEA administration and staff?
3. How do you see mathematics as being a part of the culture or environment of this school?
4. What curriculum do you use to teach math in your class? (What curriculum is used in this elementary?) What are your feelings about the curriculum, in general, and with respect to the students' learning and performance?
5. I'd like to switch gears a bit and talk about students' mathematics' identities. What comes to mind when you hear the phrase "mathematics identities"? What mathematics identities, as you describe them, do you see most prevalent in your students?
6. In what ways do you think that the curriculum helps develop students' mathematics identities (how they see themselves learning and doing math)? In what ways do you think that the curriculum does not help develop students' mathematics identities (how they see themselves learning and doing math)?
7. How would you define or describe a "mathematician"? Describe how you see yourself mathematically. Describe how you learned mathematics growing up.
8. Describe how you see your students mathematically. What characteristics or behaviors do you see them enacting normally in class? Do you see these characteristics or behaviors as depending on the lesson they're learning?
9. Some research says that students who are engaged in their learning as if they were young mathematicians have a better chance of improving in their math performance and outlook. What do you think about that? Is that a reasonable or unreasonable assertion? Why?
10. What would be your ideal setting, ways, or structures to engage students in math as mathematicians, as you define the term?
11. What if someone told you that a mathematician was anyone who likes to learn about math, sees math in almost anything, tries different things in math, is not afraid to try to solve problems or figure things out using math, and is not perfect? Now what do you think about mathematicians?
12. How do you think students would respond if they considered themselves mathematicians as just defined? How do you think they would be in class and outside of class?
13. What about this school allows or encourages students to see themselves and operate as mathematicians? What about this school allows or encourages teachers to see themselves and operate as mathematicians?
14. How do you see parents affecting their child's mathematics attitudes, behaviors, performance, identities? How are parents involved in their child's participation and engagement in class and in CFEA activities?
15. If anything, what would you change about this school to help develop students' mathematics identities?

16. What do you think about the services that CFEA provides to the students? How do you see the services as impacting students' mathematical engagement and performance?
17. How do you see the community school structure and programs in developing children holistically?
How do you see the community school structure and programs in developing children's mathematics identities?
18. Is there anything else you'd like to add?

COMMUNITY SCHOOL ADMINISTRATOR/STAFF INTERVIEW QUESTIONS

1. How many years have you worked for CFEA? How many years have you been based with this school? What is your current position here? What are your main responsibilities here at this school?
2. How would you describe the overall culture of this school? Its environment? The teaching staff? The school administration? The CFEA administration and staff?
3. How do you see mathematics as being a part of the culture or environment of this school?
4. How do the programs of CFEA intersect with the math curriculum taught at this school? How do you see the children responding to the programs?
5. I'd like to switch gears a bit and talk about students' mathematics identities. What comes to mind when you hear the phrase "mathematics identities"? What mathematics identities, as you describe them, do you see most prevalent in the fifth grade students overall, and in particular, the fifth grade students who may receive special services from CFEA?
6. In what ways do you think the CFEA programs help develop students' mathematics identities (how they see themselves learning and doing math)? In what ways do they not help?
7. How would you define or describe a "mathematician"? Describe how you see yourself mathematically. Describe how you learned mathematics growing up.
8. Describe how you see the students mathematically in CFEA programs. What characteristics or behaviors do you see them enacting normally in CFEA programs?
9. Some research says that students who are engaged in their learning as if they were young mathematicians have a better chance of improving in their math performance and outlook. What do you think about that? Is that a reasonable or unreasonable assertion? Why?
10. What would be your ideal setting, ways, or structures within a community school system to engage students in math as mathematicians, as you define the term?
11. What if someone told you that a mathematician was anyone who likes to learn about math, sees math in almost anything, tries different things in math, is not afraid to try to solve problems or figure things out using math, and is not perfect? Now what do you think about mathematicians?
12. How do you think students would respond if they considered themselves mathematicians as just defined? How do you think they would be in class and outside of class?
13. What about this school allows or encourages students to see themselves and operate as mathematicians? What about the CFEA programs allows or encourages students to see themselves and operate as mathematicians? How do you see the school and CFEA working together to develop students mathematically and holistically?
14. If anything, what would you change about this school and the CFEA programs to help develop students' mathematics identities?
15. How do you see parents affecting their child's mathematics attitudes, behaviors, performance, identities? How does CFEA involve parents in their child's participation and engagement in CFEA and school?
16. What do you think about the services that CFEA provides to the students? How effective do you feel are the services with regard to developing students' mathematical engagement and performance?

17. How effective is the community school structure in developing children holistically, including their mathematics identities?

18. Is there anything you'd like to add?

PARENT COORDINATOR/VOLUNTEER INTERVIEW QUESTIONS

1. Please tell me about yourself. How long have you been with volunteering here at this school? What responsibilities do you have here? How much do you interact with the students at this school? In what ways?
2. Do you have children or nieces or nephews of your own that attend this school? If so, what grade are they in? What activities do they participate in with CFEA?
3. How would you describe the overall culture of this school? Its environment? The teaching staff? The school administration? The CFEA administration and staff?
4. How do you see mathematics as being a part of the culture or environment of this school?
5. How do you see the programs of CFEA intersecting with the math curriculum taught at this school? How do you see the children responding to the programs?
6. I'd like to switch gears a bit and talk about students' mathematics identities. What comes to mind when you hear the phrase "mathematics identities"? What mathematics identities, as you describe them, do you see most in the fifth grade students overall?
7. In what ways do you think the CFEA programs help develop students' mathematics identities (how they see themselves learning and doing math)? In what ways do they not help?
8. How would you define or describe a "mathematician"? Describe how you see yourself mathematically. Describe how you learned mathematics growing up.
9. Describe how you see the students mathematically in CFEA programs. What characteristics or behaviors do you see them enacting normally in CFEA programs?
10. Some research says that students who are engaged in their learning as if they were young mathematicians have a better chance of improving in their math performance and outlook. What do you think about that? Is that a reasonable or unreasonable assertion? Why?
10. What would be your ideal setting, ways, or structures within a community school system to engage students in math as mathematicians, as you define the term?
11. What if someone told you that a mathematician was anyone who likes to learn about math, sees math in almost anything, tries different things in math, is not afraid to try to solve problems or figure things out using math, and is not perfect? Now what do you think about mathematicians?
12. How do you think students would respond if they considered themselves mathematicians as just defined? How do you think they would be in class and outside of class?
13. What about this school allows or encourages students to see themselves and operate as mathematicians? What about the CFEA programs allows or encourages students to see themselves and operate as mathematicians? How do you see the school and CFEA working together to develop students mathematically and holistically?
14. If anything, what would you change about this school and the CFEA programs to help develop students' mathematics identities?
15. How do you see parents affecting their child's mathematics attitudes, behaviors, performance, identities? How does CFEA involve parents in their child's participation and engagement in CFEA and school? What role do you have with parents?

16. What do you think about the services that CFEA provides to the students? How effective do you feel are the services with regard to developing students' mathematical engagement and performance? What do you think about the services that the school provides to the students?
17. How effective is the community school structure in developing children holistically, including their mathematics identities?
18. Is there anything you'd like to add?

ARCHERY COACH INTERVIEW QUESTIONS

1. How many years have you been an archer? What made you interested in archery? How long have you been coaching? Describe the students, youth and adult, you've coached over the years. How did archery become part of the CFEA activities here?
2. How would you describe the overall culture of this school? Its environment? The teaching staff? The school administration? The CFEA administration and staff? The parents?
3. How do you see mathematics as being a part of the culture or environment of this school?
4. How do you see math as a part of archery? What math do you see students using or learning in archery? What about the math do you see students doing easily in archery? What about the math do you see students having trouble doing in archery?
5. Do you know if CFEA and the school work together to incorporate archery in the math curriculum?
6. What values do you try to instill in the students as they learn archery? Why do you think these values are important? Do you know if these same values are carried into other aspects of the students' lives like their classes, other CFEA activities, home?
7. How do students feel about being in archery? What behaviors or characteristics do they normally exhibit in practice? What do you want most for students to learn from being in your archery program?
8. Let's switch gears a bit. How would you define or describe a "mathematician"? Describe how you see yourself mathematically. Describe how you learned math growing up.
9. Describe how you see your students mathematically. What characteristics or behaviors do you see them enacting normally in archery?
10. Some research says that students who are engaged in their learning as if they were young mathematicians have a better chance of improving in their math performance and outlook. What do you think about that? Is that a reasonable or unreasonable assertion? Why? Could the same be said for engaging students as if they were already archers?
11. What would be your ideal setting, ways, or structures within a community school system to engage students in math as mathematicians?
12. What if someone told you that a mathematician was anyone who likes to learn about math, sees math in almost anything, tries different things in math, is not afraid to try to solve problems or figure things out using math, and is not perfect? Now what do you think about mathematicians?
13. How do you think students would respond if they considered themselves mathematicians as just defined? How do you think they would be in class and outside of class?
14. How would you define an archer? How do you think students would respond if they considered themselves archers already? How do you think they would be in class and outside of class?
15. What about this school allows or encourages students to see themselves and operate as mathematicians? What about the CFEA programs allows or encourages students to see themselves and operate as mathematicians? How do you see the school and CFEA working together to develop students mathematically and holistically?
16. If anything, what would you change about this school and the CFEA programs, including archery, to help develop students' mathematics identities?

17. At how many other schools do you teach archery? What are these schools like? How do the students and administrators (principal, program directors) feel about the archery program? How do you see the students growing because of archery? In what ways do you see yourself growing/having grown because of archery?

18. Is there anything you'd like to add?

ARCHERY STUDENTS INTERVIEW QUESTIONS

1. Can you tell me a little about yourself? What is your favorite subject? Why? What do you like to do after school? How did you find out about archery? What made you want to join?
2. What do you like most about archery? What do you like least about archery?
3. Can you tell me when people would use archery?
4. Can you see yourself as an archer? Would you like to continue practicing and competing in archery would you get older?
5. Let's switch gears a bit. Do you do any math in archery practice? What math do you do? Is it like the math you do in class?
6. What math are you doing now in class? How do you feel about that math? Is it easy? Hard? Tricky? Can you see how you would use it in real life?
7. How do you feel about the math you do in archery practice? Is it easy? Hard? Tricky? Can you see how you would use it in real life?
8. Does the math you learn in class help you in doing the math in archery? How so?
9. Tell me about archery practice. What do you do when you first come in? What next? Does everyone get a chance to shoot? How does archery practice end?
10. What lessons does the coach try to teach you?
11. How do you feel about coming to archery? How do you feel about yourself when you're at the line shooting? When you're calculating your scores? At the end of practice?
12. What are the most important things you've learned in archery so far?
13. Do you talk to your parents and family about what you learned in archery? What do you tell them? How do you think your parents and family feel about you learning archery?
14. Do you think anybody can learn archery? Why? Do you think anybody can learn math? Why? What does it take to learn archery? What does it take to learn math?
15. Is there anything you'd like to tell me about you learning archery?

REFERENCES

- Agosto, R. (1999, December). Community schools in New York City: The Board of Education and The Children's Aid Society, *NAASP Bulletin*, 83, 57-63.
- Alfaro, E. C., Umaña-Taylor, A. J., & Bámaca, M. Y. (2006, July). The influence of academic support on Latino adolescents' academic motivation. *Family Relations*, 55, 279-291.
- Ares, N. (2006). Political aims and classroom dynamics: Generative processes in classroom communities. *Radical Pedagogy*. Retrieved from http://radicalpedagogy.icaap.org/content/issue8_2/ares.
- Ashcroft, M. H., & Kirk, E. P. (2001). The relationships among working memory, math anxiety, and performance. *Journal of Experimental Psychology: General*, 130(2), 224-237.
- Azmitia, M., Cooper, C. R., & Brown, J. R. (2009, February). Support and guidance from families, friends, and teachers in Latino early adolescents' math pathways. *Journal of Early Adolescence*, 29(1), 142-169.
- Baker, J. A. (1999). Teacher-student interaction in urban at-risk classrooms: Differential behavior, relationship quality, and student satisfaction with school. *The Elementary School Journal*, 100(1), 57-70.
- Banks, J., Cochran-Smith, M., Moll, L., Richert, A., Zeichner, K., LePage, P., Darling-Hammond, L., & Duffy, H. (2005). Teaching diverse learners. In L. Darling-Hammond & J. Bransford (Eds.), *Preparing teachers for a changing world: What teachers should learn and be able to do* (pp. 232-274). San Francisco, CA: Jossey-Bass.
- Bartholomew, K., Henderson, A. J. Z., & Marcia, J. E. (2000). Coded semistructured interviews in social psychological research. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology* (pp. 286-312). New York: Cambridge University Press.
- Bazeley, P. (2003). Computerized data analysis for mixed methods research. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research* (pp. 351-384). Thousand Oaks, CA: SAGE Publications.
- Bazeley, P. (2009, July). Editorial: Integrating data analyses in mixed methods research. *Journal of Mixed Methods Research*, 3(3), 203-207.
- Benner, A. D., Graham, S., & Mistry, R. S. (2008). Discerning direct and mediated effects of ecological structures and processes on adolescents' educational outcomes. *Developmental Psychology*, 44(3), 840-954.
- Blank, M. J. (2011). Engaging the entire community: The community school's way. In S. Redding, M. Murphy, & P. Sheley (Eds.), *Handbook of family and community engagement* (pp. 45-54). Lincoln, IL: Academic Development Institute. Retrieved from www.families-schools.org
- Blank, M. J., Melaville, A., & Shah, B. P. (2003, May). *Making the difference: Research and practice in community schools*. Washington, DC: Coalition for Community Schools and Institute of Educational Leadership.
- Boaler, J., & Greeno, J. G. (2000). Identity, agency, and knowing in mathematics worlds. In J. Boaler (Ed.), *Multiple perspectives on mathematics teaching and learning* (pp. 171-200). Ablex Publishing: Westport, CT.

- Bronfenbrenner, U. (1976, October). The experimental ecology of education. *Educational Researcher*, 5(9), 5-15.
- Bronfenbrenner, U. (1995). The bioecological model from a life course perspective: Reflections of a participant observer. In P. Moen, G. H. Elder, & K. Lüscher (Eds.), *Examining lives in context: Perspectives on the ecology of human development*. (pp. 599-618). Washington, DC: American Psychological Association.
- Bronfenbrenner, U. (2000). Ecological systems theory. In A. E. Kazdin (Ed.), *Encyclopedia of Psychology*, 3 (pp.129-133). Washington, DC: American Psychological Association.
- Bronfenbrenner, U., & Ceci, S. J. (1994). Nature-nurture reconceptualized in developmental perspective: A bioecological model. *Psychological Review*, 101(4), 568-586.
- Bruner, J. (1996). *The culture of education*. Cambridge, MA: Harvard University Press.
- Buck, G. A., Leslie-Pelecky, D., & Kirby, S. K. (2002, Fall). Bringing female scientists into the elementary classroom: Confronting the strength of elementary students' stereotypical images of scientists. *Journal of Elementary Science Education*, 14(2), 1-10.
- Burton, L. (1999). The practices of mathematicians: What do they tell us about coming to know mathematics? *Educational Studies in Mathematics*, 37, 121-143.
- Burton, L. (2004). Mathematicians as enquirers: Learning about learning mathematics. In A. J. Bishop (Ed.), *Mathematics education library*, 34. London: Kluwer Academic Publishers.
- Center for Collaborative Education (n.d.). *School structures that support learning and collaboration*. Boston, MA: Author. Retrieved from <http://www.turningpts.org/pdf/Structures.pdf>
- Chambers, D. (1983). Stereotypic images of the scientist: The Draw-A-Scientist test. *Science Education*, 67, 255-265.
- Child Trends. (2004). *Educational attainment (youth)*. Retrieved from www.childtrendsdatabank.org/?q=node/163
- Christensen, P. H. (2004). Children's participation in ethnographic research: Issues of power and representation. *Children & Society*, 18, 165-176.
- Civil, M. (2002). Everyday mathematics, mathematicians' mathematics, and school mathematics: Can we bring them together? In Brenner, M. E., & Moschkovich, J. N. (Eds.), *Every day and academics mathematics in the classroom* (pp. 40-62). Reston, VA: National Council of Teachers of Mathematics.
- Clauss-Ehlers, C. S., & Levi, L. L. (2002, October). Violence and community, terms in conflict: An ecological approach to resilience. *Journal of Social Distress and the Homeless*, 11(4), 265-278.
- Coalition for Community Schools and Institute for Educational Leadership. (n.d.). *Community School: Partnerships for Excellence*. CCS Report #3356. Retrieved from <http://www.communityschools.org/assets/1/Page/partnershipsforexcellence.pdf>

- Coalition for Community Schools. (2009). *Community schools research brief '09*. Washington, DC: Author. Retrieved from <http://www.communityschools.org/assets/1/AssetManager/CCSResearchReport2009.pdf>
- Cobb, P. (2004, July - September). Mathematics, literacies, and identity. *Reading Research Quarterly*, 39(3), 333-337.
- Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement*, 20(1), 37-46.
- Collins Gem English Dictionary. (2009). *Collins English dictionary, 15th Ed*. United Kingdom: Author.
- Conference Board of the Mathematical Sciences. (2001). *The mathematical education of teachers*. Providence, RI and Washington, DC: American Mathematical Society and Mathematical Association of America.
- Cowart, J. (1982, May). Program adaptations for students in four selected sports: Badminton, golf, archery, and tennis. *Practical Pointers*, 5(10), 3-10. ERIC Document Reproduction Service No. ED242129. Retrieved from EBSCOHost ERIC database.
- Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches* (2nd ed.). Thousand Oaks, CA: SAGE Publications.
- Diehl, M., & Stroebe, W. (1991). Productivity loss in idea-generating groups: Tracking down the blocking effect. *Journal of Personality and Social Psychology*, 61(3), 392-403.
- Dryfoos, J. G. (1995). Full service schools: Revolution or fad? *Journal of Research on Adolescence*, 5(2), 147-172.
- DuPaul, G. J., Volpe, R. J., Jitenra, A. K., Lutz, J. G., Lorah, K. S., & Gruber, R. (2004). Elementary school students with AD/HD: Predictors of academic achievement. *Journal of School Psychology*, 42, 285-301.
- Eccles, J. S. (1999, Fall). The development of children age 6 to 14. *The Future of Children*, 9(2), 30-44.
- Edmond, R. (2005). Ethnographic research methods with children and young people. In S. Greene & D. Hogan (Eds.), *Researching children's experience: Approaches and methods* (pp. 123-139). London: SAGE Publications.
- Eisenhart, M. A. (1988). The ethnographic research tradition and mathematics education research. *Journal for Research in Mathematics Education*, 19(2), 99-114.
- Eisenhart, M. A. (2001, November). Educational ethnography past, present, and future: Ideas to think with. *Educational Researcher*, 30(8), 16-27.
- Emerson, R. M., Fretz, R. I., & Shaw, L. L. (1995). *Writing ethnographic fieldnotes*. Chicago, IL: The University of Chicago Press.
- Erickson, F. (1984, Spring). What makes school ethnography 'ethnographic'? *Anthropology & Education Quarterly*, 15(1), 51-66.
- Fadigan, K. A., & Hammrich, P. L. (2004). A longitudinal study of the educational and career trajectories of female participants of an urban informal science education program. *Journal of Research in Science Teaching*, 41(8), 835-860.

- Feilzer, M. Y. (2010). Doing mixed methods research pragmatically: Implications for the rediscovery of pragmatism as a research paradigm. *Journal of Mixed Methods Research*, 4(1), 6-16.
- Fennema, E. & Sherman, J. A. (1976). Fennema-Sherman Mathematics Attitudes Scales: Instruments designed to measure attitudes towards the learning of mathematics by males and females. *JSAS Catalog of Selected Documents in Psychology*, 6(1), 3b.
- Fine, G. A., & Sandstrom, K. L. (1988). *Knowing children: Participant observation with minors*. In J. Van Maanen (Ed.), *Qualitative research methods series*, 15. Newbury Park, CA: SAGE Publications.
- Fink, A. (2003a). *How to design survey studies* (2nd ed.). Thousand Oaks, CA: SAGE Publications.
- Fink, A. (2003b). *How to manage, analyze, and interpret survey data* (2nd ed.). Thousand Oaks, CA: SAGE Publications.
- Fitzgerald, M., & James, I. (2007). *The mind of the mathematician*. Baltimore, MD: The Johns Hopkins University Press.
- Fort, D. C., & Varney, H. L. (1989, May). How students see scientists: Mostly male, mostly white, and mostly benevolent. *Science and Children*, 26(8), 8-13.
- Fosnot, C. T., & Dolk, M. (2005). "Mathematics" or "mathematizing"? In C. T. Fosnot (Ed.), *Constructivism: Theories, perspectives and practice* (2nd ed.) (pp. 175-192). New York, NY: Teachers College Press.
- Freiberg, H. J., Huzinec, C. A., & Templeton, S. M. (2009). Classroom management—a pathway to student achievement: A study of fourteen inner-city elementary Schools. *The Elementary School Journal*, 110(1), 63-80.
- Freeman, M., & Mathison, S. (2009). *Researching children's experiences*. New York, NY: The Guilford Press.
- Furnham, A., & Yazdanpanahi, T. (1995). Personality differences and group versus individual brainstorming. *Personality and Individual Differences*, 19, 73-80.
- Furr, R. M., & Bacharach, V. R. (2008). *Psychometrics: An introduction*. Los Angeles, CA: SAGE Publications.
- Gee, J. P. (2001). Identity as an analytic lens for research in education. In W. Secada (Ed.), *Review of research in education*, 25 (pp. 99-125). Washington, DC: American Educational Research Association.
- Geertz, C. (1973). *The interpretation of cultures: Selected essays*. New York, NY: Basic Books.
- Green, E. (2007, November 20). Texas challenges city on math curriculum. *The New York Sun*. Retrieved October 13, 2010 from <http://www.nysun.com/new-york/texas-challenges-city-on-math-curriculum/66711/>.
- Greene, M. (1995). *Releasing the imagination: Essays on education, the arts, and social change*. San Francisco, CA: Jossey-Bass.
- Grimes, R. (2007, August/September). NASP fives years old and growing stronger. *Bowhunter*, 36(8), 34-38.

- Grossman, J. B., & Vang, Z. M. (2009, January). *The case for school-based integration of services: Changing the ways students, families, and communities engage with their schools*. Philadelphia, PA: Public/Private Ventures.
- Gutstein, E. (2003). Teaching and learning mathematics for social justice in an urban, Latino school. *Journal for Research in Mathematics Education*, 34(1), 37-73.
- Hammrich, P. L., Richardson, & Livingston, B. (2000, Fall). Teachers' reflective dialogue in confronting the gender gap. *Journal of Elementary Science Education*, 12(2), 39-52.
- Hammrich, P. L., Richardson, G. M., Green, T. S., & Livingston, B. (2001, April). Sisters in Science: Using sports as a vehicle for science learning. (Retrieved from ERIC Document Reproduction Service. ERIC No. ED 452 094).
- Hart, S. A., Petrill, S. A., Willcutt, E., Thompson, L. A., Schatschneider, C., Deater-Deckard, K., & Cutting, L. E. (2010). Exploring how symptoms of Attention-Deficit/Hyperactivity Disorder are related to reading and mathematics performance: General genes, general environments. *Psychological Science*, 21(11), 1708-1715.
- Hemphill, F.C., & Vanneman, A. (2011, June). *Achievement Gaps: How Hispanic and White Students in public schools perform in mathematics and reading on the National Assessment of Educational Progress* (NCES 2011-459). Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Retrieved from <http://nces.ed.gov/nationsreportcard/pdf/studies/2011459.pdf>
- Hennessy, E., & Heary, C. (2005). Exploring children's views through focus groups. In S. Greene & D. Hogan (Eds.), *Researching children's experience: Approaches and methods* (pp. 236-252). London: SAGE Publications.
- Hernandez, D. J., Denton, N. A., & Macartney, S. E. (2007). Young Hispanic children in the 21st century. *Journal of Latinos and Education*, 6(3), 209-228.
- Herzig, A. H. (2002). Where have all the students gone? Participation of doctoral students in authentic mathematical activity as a necessary condition for persistence toward the Ph.D. *Educational Studies in Mathematics*, 50(2), 177-212.
- Herzig, A. H. (2004a, Summer). Becoming mathematicians: Women and students of color choosing and leaving doctoral mathematics. *Review of Educational Research*, 74(2), 171-214.
- Herzig, A. H. (2004b, September). 'Slaughtering this beautiful math': Graduate women choosing and leaving mathematics. *Gender and Education*, 16(3), 379-395.
- Hill, M. (2005). Ethical considerations in researching children's experiences. In S. Greene & D. Hogan (Eds.), *Researching children's experience: Approaches and methods* (pp. 61-86). London: SAGE Publications.
- Holland, D., Lachicotte Jr., W., Skinner, D., & Cain, C. (1998). *Identity and agency in cultured worlds*. Cambridge, MA: Harvard University Press.
- Keppel, G., & Wickens, T. D. (2004). *Design and analysis: A researcher's handbook* (4th ed.). Upper Saddle River, NJ: Pearson Prentice Hall.

- Keith, N. Z. (1996). Can urban school reform and community development be joined? The potential of community schools. *Education and Urban Society*, 28, 237-268.
- Kidwell, P. A., Ackerberg-Hastings, A., & Roberts, D. L. (2008). *Tools of American Mathematics Teaching, 1800-2000*. Baltimore, MD: The Johns Hopkins University Press.
- Kline, M. (1973). *Why Johnny can't add: The failure of the new math*. New York, NY: Random House.
- Kooi, B. W. (1981). On the mechanics of the bow and arrow. *Journal of Engineering Mathematics*, 15(2), 119-145.
- Kooi, B. W. (1991). Archery and mathematical modeling. *Journal of the Society of Archer-Antiquaries*, 34, 21-29.
- Kooi, B. W. (1998). The Archer's Paradox and modeling, a review. *History of Technology*, 20, 125-137.
- Kozulin, A. (2004). Vygotsky's theory in the classroom: Introduction. *European Journal of Psychology of Education*, 19(1), 3-7.
- Krueger, R. A. (1994). *Focus groups: A practice guide for applied research* (2nd ed.). Thousand Oaks, CA: SAGE Publications.
- Küntay, A. C. (2004). Lists as alternative discourse structures to narratives in preschool children's conversations. *Discourse Processes*, 38(1), 95-118.
- Kurasaki, K. S. (2000, August). Intercoder reliability for validating conclusions drawn from open-ended interview data. *Field Methods*, 12(3), 179-194.
- Ladson-Billings, G. (1994). *The dreamkeepers: Successful teachers of African American children*. San Francisco, CA: Jossey-Bass.
- Ladson-Billings, G. (1997). It doesn't add up: African-American students' mathematics achievement. *Journal for Research in Mathematics Education*, 29(6), 697-708.
- Lakoff, G., & Núñez, R. E. (2000). *Where mathematics comes from: How the embodied mind brings mathematics into being*. New York, NY: Basic Books.
- Learning Point Associates. (2009). *The study of The Stock Market Game*. Washington, DC: FINRA Investor Education Foundation. Retrieved from http://www.learningpt.org/smg/SMG_Study.pdf
- Leech, N. L., Barrett, K. C., & Morgan, G. A. (2008). *SPSS for intermediate statistics: Use and interpretation* (3rd ed.). New York, NY: Routledge Academic Press.
- Legg, A. M., & Locker, Jr., L. (2009). Math performance and its relationship to math anxiety and metacognition. *North American Journal of Psychology*, 11(3), 471-486.
- Lewandowski, L. J., Lovett, B. J., Parolin, R., Gordon, M., & Coddling, R. S. (2007, March). Extended time accommodations and the mathematics performance of students with and without ADHD. *Journal of Psychoeducational Assessment*, 25(1), 17-28.
- Lewis, A. (1992). Group child interviews as a research tool. *British Educational Research Journal*, 18(4), 413-421.

- Litwin, M. S. (2003). *How to assess and interpret survey psychometrics* (2nd ed.). Thousand Oaks, CA: SAGE Publications.
- Lockhart, P. (2009). *Mathematician's lament: How school cheats us out of our most fascinating and imaginative art form*. New York, NY: Bellevue Literary Press.
- Loe, I. M., & Feldman, H. M. (2007). Academic and educational outcomes of children with ADHD. *Journal of Pediatric Psychology, 32*(6), 643-654.
- Lombard, M., Snyder-Duch, J., & Bracken, C. C. (2002, October). Content analysis in mass communication: Assessment and reporting of intercoder reliability. *Human Communication Research, 28*(4), 587-604.
- Lubienski, S. T., Lubienski, C., & Crane, C. C. (2008, November). Achievement differences and school type: The role of school climate, teacher certification, and instruction. *American Journal of Education, 225*, 97-138.
- Ma, L. (1999). *Knowing and teaching elementary mathematics: Teachers' understanding of fundamental mathematics in China and the United States*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Mann, E. L. (2006). Creativity: The essence of mathematics. *Journal for the Education of the Gifted, 30*(2), 236-260.
- Marín, G., & Marín, B. V. (1991). *Research with Hispanic populations*. In L. Bickman & D. J. Rog (Eds.), *Applied social research methods series, Vol 23*. Newbury Park, CA: SAGE Publications.
- Martin, D. B. (2000). *Mathematics success and failure among Africa-American youth: The roles of sociohistorical context, community forces, school influence, and individual agency*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Mathematics Association of America. (2007). *Algebra: Gateway to a technological future*. Washington, D.C.: Author.
- Matthews, M. S., & Farmer, J. L. (2008, Spring). Factors affecting the Algebra I achievement of academically talented learners. *Journal of Advanced Academics, 19*(3), 472-501.
- Mauthner, M. (1997). Methodological aspects of collecting data from children: Lessons from three research projects. *Children & Society, 11*, 16-28.
- McClain, K., & Cobb, P. (2001, May). An analysis of development of sociomathematical norms in one first-grade classroom. *Journal for Research in Mathematics Education, 32*(3), 236-266.
- Mead, M., & Metraux, R. (1957). Image of the scientist among high-school students. *Science, 126*, 384-390.
- Michelli, N. (2005, May/June). The politics of teacher education: Lessons from New York City. *Journal of Teacher Education, 56*(3), 235-241.
- Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd Ed.). Thousand Oaks, CA: SAGE Publications.
- Mulhern, F., & Rae, G. (1998, April). Development of a shortened form of the Fennema-Sherman mathematics attitudes scales. *Educational and Psychological Measurement, 58*(2), 295-306.

- Murray, M. A. (2000). *Women becoming mathematicians: Creating a professional identity in Post-World War II America*. Cambridge, MA: The MIT Press.
- Nasir, N. S. (2002). Identity, goals, and learning: Mathematics in cultural practice. *Mathematical Thinking and Learning*, 4(2&3), 231-247.
- Nasir, N. S., & Saxe, G. B. (2003, June/July). Ethnic and academic identities: A cultural practice perspective on emerging tensions and their management in the lives of minority students. *Educational Researcher*, 32(5), 14-18.
- National Archery in the Schools Program (2006). *National Curriculum: Grades 4-5*. Sparta, WI: Author. Retrieved from http://nasparchery.com/data/nasparchery/file/321_5341_4-5%20National%20Curriculum%20FINAL.pdf
- National Science Teachers Association. (2004, December 14). TIMSS 2003: Eighth-grade performance up, fourth-grade scores flat. *NSTA Reports*. NSTA WebNews Digest. Retrieved from http://www.nsta.org/main/news/stories/nsta_story.php?news_story_ID=50039
- Newton, R. R., & Rudestam, K. E. (1999). *Your statistical consultant: Answers to your data analysis questions*. Thousand Oaks, CA: SAGE Publications.
- Ogbu, J. U. (1981, Spring). School ethnography: A multilevel approach. *Anthropology & Education Quarterly*, 12(1), 3-29.
- Onwuegbuzie, A. J., & Daniel, L. G. (2003, February 19). Typology of analytical and interpretational errors in quantitative and qualitative educational research. *Current Issues in Education* [On-line], 6(2). Retrieved from <http://cie.ed.asu.edu/volume6/number2/>
- Onwuegbuzie, A. J., & Leech, N. L. (2005a, December). On becoming a pragmatic researcher: The importance of combining quantitative and qualitative research methodologies. *International Journal of Social Research Methodology*, 8(5), 375-387.
- Onwuegbuzie, A. J., & Teddlie, C. (2003). A framework for analyzing data in mixed methods research. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of Mixed Methods in Social and Behavioral Research* (pp. 351-384). Thousand Oaks, CA: SAGE Publications.
- Osborn, A. F. (1963). *Applied imagination: Principles and procedures of creative problem solving* (3rded.). New York, NY: Charles Scribner's Sons.
- Packer, M. J., & Goicoechea, J. (2000). Sociocultural and constructivist theories of learning: Ontology, not just epistemology. *Educational Psychologist*, 35(4), 227-241.
- Parsons, E. C. (1997). Black high school females' images of the scientist: Expression of culture. *Journal of Research in Science Teaching*, 34(7), 745-768.
- Penuel, W. R., & Wertsch, J. V. (1995). Vygotsky and identity formation: A sociocultural approach. *Educational Psychologist*, 30(2), 83-92.
- Peterson, K. D. (1999). *Shaping school culture: The heart of leadership*. San Francisco, CA: Jossey-Bass.
- Picker, S. H., & Berry, J. S. (2000). Investigating pupil's images of mathematicians. *Educational Studies in Mathematics*, 43(1), 65-94.

- Picker, S. H., & Berry, J. S. (2002). The human face of mathematics: Challenging misconceptions. In D. Worsley (Ed.), *Teaching for depth: Where math meets the humanities* (pp. 50–61). Portsmouth, NH: Heinemann.
- Piggott, J. (2007, May). Cultivating creativity. *Mathematics Teaching: Incorporating Micromath*, 202, 3-6.
- Quinn, J. (2005, Fall). The Children's Aid Society community schools: A full-service partnership model. *New Directions for Youth Development*, 107, 15-26.
- Reardon, S. F., & Galindo, C. (2007). Patterns of Hispanic students' math skill proficiency in the early elementary grades. *Journal of Latinos and Education*, 6(3), 229-251.
- Reese, L., Balzano, S., Gallimore, R., & Goldenberg, C. (1995). The concept of educación: Latino family values and American schooling. *International Journal of Educational Research*, 23(1), 57-81.
- Rettner, R. (2011, August 12). Not your imagination: Kids today really are less creative, study says. *Today Parenting*. Retrieved from <http://today.msnbc.msn.com/id/44122383#.TlIlmqiyWwA>
- Reys, R. E. (2000, November). Doctorates in mathematics education—An acute shortage. *Notices of the AMS*, 47(10), 1267-1270.
- Reys, R. E., Glasgow, R., Teuscher, D., & Nevels, N. (2007, November). Doctoral programs in mathematics education in the United States: 2007 status report. *Notices of the AMS*, 54(10), 1283-1293.
- Rock, D., & Shaw, J. M. (2000, May). Exploring children's thinking about mathematicians and their work. *Teaching Children Mathematics*, 6(9), 550-555.
- Roth, W-M., & Lee, Y-J. (2007, June). "Vygotsky's Neglected Legacy": Cultural-Historical Activity Theory. *Review of Educational Research*, 77(2), 186-232.
- Roth, W-M., Tobin, K., Elmesky, R., Carambo, C., McKnight, Y-M., & Beers, J. (2004). Re/Making identities in the praxis of urban schooling: A cultural historical perspective. *Mind, Culture, and Activity*, 11(1), 48-69.
- Sabo, K. E., & Hamilton, W. V. (1997, October). 4-H shooting sports hits the mark with youth-at-risk. *Journal of Extension*, 35(5). Retrieved from <http://www.joe.org/joe/1997october/a3.html>
- Saldaña, J. (2009). *The coding manual for qualitative researchers*. Los Angeles, CA: SAGE Publications.
- Sandelowski, M., Voils, C. I., & Knafl, G. (2009, July). On quantizing. *Journal of Mixed Methods Research*, 3(3), 208-222.
- Savoy, G. H. (1971, October). Archery: A catalyst for subject integration. 1-11. ERIC Document Reproduction Service No. ED085149. Retrieved from EBSCOHost ERIC database.
- Scales, P. C., & Leffert, N. (2004). *Developmental assets: A synthesis of the scientific research on adolescent development* (2nd ed.). Minneapolis, MN: Search Institute.
- Scheffler, R. M., & Hinshaw, S. P. (2009, July 23). ADHD, medication, and academic achievement among elementary school students: An important component of long-term success in school and in life. *Teachers College Record*. ID Number: 15726. Retrieved from <http://www.tcrecord.org>

- Sheskin, D. J. (2003). *Handbook of parametric and nonparametric statistical procedures* (3th ed.). Boca Raton, FL: Chapman and Hall/CRC.
- Shin, I., & Chung, J. Y. (2009). Class size and student achievement in the United States: A meta-analysis. *KEDI Journal of Educational Policy*, 6(2), 3-19.
- Simons, H. (2009). *Case study research in practice*. London: SAGE Publications.
- Slavin, R. E., & Lake, C. (2008, September). Effective programs in elementary mathematics: A best-evidence synthesis. *Review of Educational Research*, 78(3), 427-515.
- Smith, F. (2002). *The glass wall: Why mathematics can seem so difficult*. New York, NY: Teachers College Press, Columbia University.
- Solomon, Y. (2007). Experiencing mathematics classes: Ability grouping, gender and the selective development of participative identities. *International Journal of Educational Research*, 46, 8-19.
- Sorge, C., Newsom, H. E., & Hagerty, J. J. (2000, August). Fun is not enough: Attitudes of Hispanic middle school students toward science and scientists. *Hispanic Journal of Behavioral Sciences*, 22(3), 332-345.
- Stake, R. E. (2005). Qualitative case studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *The SAGE handbook of qualitative research* (3rd Ed.) (pp. 443-466). Thousand Oaks, CA: SAGE Publications.
- Stake, R. E. (2006). *Multiple case study analysis*. New York, NY: The Guilford Press.
- Steinke, J., Lapinski, M. K., Crocker, N., Zietsman-Thomas, A., Williams, Y., Evergreen, S. H., & Kuchibhotla, S. (2007, September). Assessing media influences on middle school-aged children's perceptions of women in science using the Draw-A-Scientist Test (DAST). *Science Communication*, 29(1), 35-64.
- Stetsenko, A. (2005). Activity as object-related: Resolving the dichotomy of individual and collective planes of activity. *Mind, Culture, and Activity*, 12(1), 70-88.
- Stetsenko, A., & Arieivitch, I. M. (2002). Teaching, learning, and development: A post-Vygotskian perspective. In G. Wells & G. Claxton (Eds.), *Learning for life in the 21st century*. (pp. 84-96). United Kingdom: Blackwell Publishers.
- Stetsenko, A., & Arieivitch, I. M. (2004). The self in Cultural-Historical Activity Theory: Reclaiming the unity of social and individual dimensions of human development. *Theory & Psychology*, 14(4), 475-503.
- Stetsenko, A., & Vianna, E. (2009). Bridging developmental theory and educational practice: Lessons from the Vygotskian project. In O. A. Barbarin & B. H. Wasik (Eds.), *Handbook of child development and early education* (pp. 38-54). New York, NY: The Guilford Press.
- Stillwell, R. (2010, June). *Public school graduates and dropouts from the common core of data: School year 2007-08* (NCES 2010-341). Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Retrieved from <http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2010341>
- The American Heritage Dictionaries, Editors. (2000). *The American heritage dictionary of the English language* (4th ed.). New York, NY: Houghton Mifflin Company.

- The Children's Aid Society. (2001). *Building a community school* (3rd ed.). New York, NY: Author.
- The Princeton Review. (n.d.). Mathematician: A day in the life of a mathematician. Retrieved from <http://www.princetonreview.com/Careers.aspx?cid=94>
- Tinsley, H. E. A., & Weiss, D. J. (1975). Interrater reliability and agreement of subjective judgments. *Journal of Counseling Psychology*, 22(4), 358-375.
- Tsui, J. M., & Mazzocco, M. M. (2007, Winter). Effects of math anxiety and perfectionism on timed versus untimed math testing in mathematically gifted sixth graders. *Roeper Review*, 29(2), 132-139.
- Tudge, J., & Hogan, D. (2005). An ecological approach to observations of children's everyday lives. In S. Greene & D. Hogan (Eds.), *Researching children's experience: Approaches and methods* (pp. 102-122). London: SAGE Publications.
- U.S. Census Bureau. (2008, August 14). An older and more diverse nation by midcentury. Retrieved from <http://www.census.gov/newsroom/releases/archives/population/cb08-123.html>
- U.S. Department of Education, National Center for Education Statistics. (2008, Fall). *Digest of Education Statistics: 2009*. 2007-08 Integrated Postsecondary Education Data System (IPEDS). Retrieved from <http://nces.ed.gov/programs/digest/d09/>
- U.S. Department of Labor, Bureau of Labor Statistics. (2009). Mathematicians. *Occupational Outlook Handbook, 2010-2011 Edition*. Retrieved from <http://www.bls.gov/oco/ocos043.htm>
- Vanneman, A., Hamilton, L., Baldwin Anderson, J., and Rahman, T. (2009, July). *Achievement Gaps: How Black and White students in public schools perform in mathematics and reading on the National Assessment of Educational Progress*, (NCES 2009-455). Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Retrieved from <http://nces.ed.gov/nationsreportcard/pdf/studies/2009455.pdf>
- Vile Junod, R. E., DuPaul, G. J., Jitendra, A. K., Volpe, R. J., & Cleary, K. S. (2006). Classroom observations of students with and without ADHD: Differences across types of engagement. *Journal of School Psychology*, 44, 87-104.
- Villegas, A. M., & Lucas, T. (2002). *Educating culturally responsive teachers: A coherent approach*. Albany, NY: State University of New York Press.
- Waxman, H. C., Huang, S-Y, L., Anderson, L., & Weinstein, T. (1997, September/October). Classroom process differences in inner-city elementary schools. *The Journal of Educational Research*, 91(1), 49-59.
- Wells, G. (2007). Who we become depends on the company we keep and on what we do and say together. *International Journal of Educational Research*, 46, 100-103.
- West-Olatunji, C., Pringle, R., Adams, T., Baratelli, A., Goodman, R., & Maxis, S. (2007). How African American middle school girls position themselves as mathematics and science learners. *The International Journal of Learning*, 14(9), 219-227.
- Westcott, H. L., & Littleton, K. S. (2005). Exploring meaning in interviews with children. In S. Greene & D. Hogan (Eds.), *Researching children's experience: Approaches and methods* (pp. 141-157). London: SAGE Publications.

- Wilcox, R. R. (2003). *Applying contemporary statistical techniques*. San Diego, CA: Academic Press.
- Williams, J., Davis, P., & Black, L. (2007a). An agenda for CHAT in educational research: An editorial response. *International Journal of Educational Research*, 46, 104-107.
- Williams, J., Davis, P., & Black, L. (2007b). Sociocultural and Cultural-Historical Activity Theory perspectives on subjectivities and learning in schools and other educational contexts. *International Journal of Educational Research*, 46, 1-7.
- Woodhead, M., & Faulkner, D. (2000). Subjects, objects, or participants? Dilemmas of psychological research with children. In P. Christensen & A. James (Eds.), *Research with children: Perspectives and practices* (pp. 9-35). London: Falmer Press.
- Woolley, M. E., Kol, K. L., & Bowen, G. L. (2009, February). The social context for school success for Latino middle school students: Direct and indirect influences of teachers, family, and friends. *Journal of Early Adolescence*, 20(1), 43-70.
- Yackel, E., & Cobb, P. (1996, July). Sociomathematical norms, argumentation, and autonomy in mathematics. *Journal for Research in Mathematics Education*, 27(4), 458-477.
- Zentall, S. S., Smith, Y. N., Ling, Y. B., & Wieczorek, C. (1994, October). Mathematical outcomes of attention-deficit hyperactivity disorder. *Journal of Learning Disabilities*, 27(8), 510-519.