Listening To Student Voices: Fifth Graders' Perceptions Of Their Mathematics Learning Within The Context Of A Mathematics Reform

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LISTENING TO STUDENT VOICES: FIFTH GRADERS’ PERCEPTIONS OF THEIR MATHEMATICS LEARNING
WITHIN THE CONTEXT OF A MATHEMATICS REFORM EFFORT

by

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A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Teaching and Learning Principles in the College of Education at the University of Central Florida Orlando, Florida

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2006

Major Professor: Dr. Sherron Killingsworth Roberts
ABSTRACT

This qualitative study explored fifth graders’ perceptions of their mathematics learning within the context of a reform effort. Students’ voices are the focus of this study due to the paucity of literature on student learning from the students’ perspective (Erickson & Shultz, 1992), particularly the elementary student (Gentilucci, 2004). The participants of this study, who in the past have been given a variety of labels including “disadvantaged” or “at-risk,” clearly articulated, even in nonstandard English, their perceptions of their mathematics learning. They passionately explained what helped them learn mathematics as well as what impeded their mathematics learning and were often incredibly insightful in their commentary.

In an effort to hear and present the student voices, the data gathering methods used in this study included the use of focus groups, one-on-one interviews, and classroom observations as well as the use of a student survey. Several ethnographic methods and practices were employed to help ensure the credibility of this study, including triangulation and member checking. Data analysis involved a highly detailed, organic process which culminated in the emergence of a number of significant themes involving students’ perspectives of mathematics, their mathematics experiences prior to fifth grade, and finally their perspectives of their learning during the first year of a mathematics reform effort.

A number of valuable lessons learned as a result of this study are presented and translated into implications for the elementary mathematics classroom. These lessons, based on the students’ own voices, urge teachers to prioritize mathematics instruction, effectively utilize manipulatives, games, and alternative algorithms as well as encourage classroom discourse about
mathematics. If teachers would follow this outline, provided by the students’ voices, students’ mathematical power will be more deeply realized. Additionally, the promise of true reform due to the transformational power of students’ voices is discussed and the possibilities defined.
ACKNOWLEDGMENTS

The journey of my doctoral studies was longer than originally expected due to an unexpected, yet wonderful event. There are a great many people that I must thank for sticking with me and helping to make my dream of a Ph.D. in Education a reality. First of all, I would like to truly thank the participants of my study: the fifth graders of Sunburst Elementary. Your voices made this study come to life. Thank you to their teachers for welcoming me into their classrooms and sharing their time with me. I would also like to thank the principal of Sunburst Elementary for so generously allowing me to conduct my study as well as giving me the opportunity to work with such a wonderful staff.

I have had the great privilege to learn from and be advised by some exceptional professors during my journey. Dr. Michael Hynes, from whom I learned so much during my Master’s coursework and whose guidance was pivotal in my decision to pursue the Elementary Education track of the Ph.D. program. Thank you for sharing your wisdom.

I would also like to thank Dr. Jennifer Deets. You are a masterful teacher and your courses woke the qualitative researcher within me. Thank you for sharing your expertise and for being my trusted advisor on all matters qualitative.

To my dissertation committee: Dr. Patricia Crawford, Dr. Juli Dixon, and Dr. Valerie Sims, all exceptional instructors in their respective fields from whom I learned a wealth of information and knowledge. Thank you for sharing your wisdom as my professors as well as your time in serving on my committee.
This journey would not have been possible without the love and support of my family. To my mother and father, thank you for all you have done over the years to support my educational endeavors. Thank you especially for the untold hours of babysitting services. Without your help this project could not have been realized. To my three beautiful children: Briana, Kellan, and Madelyn, thank you for your love, patience and support during this long journey. Mom’s finally done! And to my husband, Paul, thank you for your love and support through the years. Thank you also for your prodding and encouragement when the end seemed so far away. Thanks for picking up the slack on the home front when I’ve been too busy. My love and deepest thanks goes out to each one of you.

Finally, I must thank the one person, whose unwavering support has truly made this dream possible: Dr. Sherron Killingsworth Roberts, my major advisor and dissertation committee chair. Words cannot express the depth of my gratitude. You have hung in there with me, through thick and thin, ever so gently and sweetly pushing me to be my very best. Thank you for all you have taught me over the years as well as the wisdom and guidance you have shared. Thank you for your endless optimism and encouragement. For all of this, and so much more, I am forever grateful.
# TABLE OF CONTENTS

LIST OF FIGURES ....................................................................................................................... xi

LIST OF TABLES ........................................................................................................................ xii

LIST OF ACRONYMS/ABBREVIATIONS .............................................................................. xiii

CHAPTER ONE: INTRODUCTION ............................................................................................. 1

Looking Back .............................................................................................................................. 2

Listening to the Students ............................................................................................................. 4

The Context for Listening ........................................................................................................... 6

The History Behind the Reform Effort at Sunburst Elementary ............................................... 9

The Need for Reform ................................................................................................................ 12

The Components of Reform ...................................................................................................... 14

Constructivism ...................................................................................................................... 14

Teaching through Problem Solving ...................................................................................... 15

The Use of Manipulatives ..................................................................................................... 17

Meaningful, Contextualized Instruction ............................................................................... 18

Classroom Discourse ............................................................................................................ 20

CHAPTER TWO: STEPPING THROUGH THE LISTENING PROCESS ........................................ 23

Early Steps ................................................................................................................................ 23

How I Listened ...................................................................................................................... 24

Steps Taken During and After Listening ............................................................................... 29
CHAPTER THREE: FIFTH GRADERS’ PERCEPTIONS OF MATHEMATICS ............... 36

The “Good” ............................................................................................................................... 37

The “Not So Bad” ..................................................................................................................... 38

Unfortunately, the “Ugly” ......................................................................................................... 40

How Could I Be Sure? .............................................................................................................. 40

CHAPTER FOUR: PERCEPTIONS OF THE PAST ................................................................. 46

Teachers’ Efforts to Aid Student Understanding ................................................................. 47

Use of manipulatives ............................................................................................................. 47

Use of pictures ...................................................................................................................... 48

Use of grouping techniques ............................................................................................... 49

The benefits of one-on-one attention .................................................................................. 50

Reliance on Traditional Pedagogy ........................................................................................ 50

Understandings versus Misconceptions with Fractions and Division .............................. 51

CHAPTER FIVE: LEARNING AND THE BEGINNINGS OF REFORM THROUGH THE
STUDENTS’ EYES ...................................................................................................................... 58

Differences Noticed ............................................................................................................... 59

Games They Played ............................................................................................................ 60

Manipulatives They Used .................................................................................................. 63

Alternative Algorithms They Learned ................................................................................ 68

CHAPTER SIX: SHIFTING FROM TRADITIONAL MATHEMATICS INSTRUCTION TO A
REFORM-ORIENTED PEDAGOGY ......................................................................................... 75

Mediating the Cognitive Dissonance .................................................................................... 75

Reform-oriented Pedagogy Observed .................................................................................. 78
Teacher Concerns................................................................................................................................. 83
Reverting Back to Traditional Instruction .............................................................................................. 83
Students’ Frustrations ............................................................................................................................... 85
Positive Aspects of Reform Effort from the Teachers’ Perspective .......................................................... 88
CHAPTER SEVEN: LESSONS LEARNED FROM LISTENING TO STUDENT VOICES .... 93
Lessons Learned and Implications for Elementary Mathematics Instruction....................................... 94
Limitations of the Study........................................................................................................................... 101
Concluding Thoughts............................................................................................................................... 103
APPENDIX A: REFORMED TEACHING OBSERVATION PROTOCOL (RTOP) ........... 107
APPENDIX B: COMPLETED IRB FORM................................................................................................. 113
APPENDIX C: IRB APPROVAL LETTER .............................................................................................. 116
APPENDIX D: SCHOOL DISTRICT RESEARCH REQUEST FORM................................. 118
APPENDIX E: PARENTAL CONSENT FORM......................................................................................... 120
APPENDIX F: EDUCATOR CONSENT FORM....................................................................................... 122
APPENDIX G: FOCUS GROUP QUESTIONS......................................................................................... 124
APPENDIX H: ONE-ON-ONE INTERVIEW QUESTIONS ...................................................................... 126
APPENDIX I: FOLLOW-UP INTERVIEW QUESTIONS........................................................................... 128
APPENDIX J: TEACHER INTERVIEW QUESTIONS ............................................................................ 130
APPENDIX K: STUDENT SURVEY....................................................................................................... 132
APPENDIX L: STUDENT SURVEY RESULTS..................................................................................... 134
APPENDIX M: CHILD ASSENT FORM ................................................................................................. 136
APPENDIX N: TEXT FOR FIGURE 6-FCAT CATEGORIES................................................................. 138
LIST OF FIGURES

Figure 1: Color coded tags................................................................. 32
Figure 2: Example of coded tag......................................................... 32
Figure 3: Tags sorted into themes..................................................... 33
Figure 4: Triangulation illustrated through multiple colored tags........ 34
Figure 5: Pink group working on member checking activity............ 42
Figure 6: Blue group working on member checking activity............. 42
Figure 7: FCAT categories of green and red groups......................... 44
Figure 8: Importance of mathematics and future job opportunities (Part 1) 44
Figure 9: Importance of mathematics and future job opportunities (Part 2) 44
Figure 10: Unit fractions illustrated correctly................................... 52
Figure 11: Fractions drawn with unequal-sized portions.................. 53
Figure 12: Examples of student use of division mnemonic............... 55
LIST OF TABLES

Table 1 Participants......................................................................................................................... 7
Table 2 Study Timeline.................................................................................................................... 25
# LIST OF ACRONYMS/ABBREVIATIONS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIMS</td>
<td>Activities Integrating Mathematics and Science</td>
</tr>
<tr>
<td>CO (1-9)</td>
<td>Classroom Observation (1-9)</td>
</tr>
<tr>
<td>DSS</td>
<td>Developmental Scale Score</td>
</tr>
<tr>
<td>FCAT</td>
<td>Florida Comprehensive Assessment Test</td>
</tr>
<tr>
<td>FG (1-4)</td>
<td>Focus Group (1-4)</td>
</tr>
<tr>
<td>FI</td>
<td>Follow-up Interview</td>
</tr>
<tr>
<td>IEP</td>
<td>Individual Education Plan</td>
</tr>
<tr>
<td>IM (1-4)</td>
<td>Initial Meeting (1-4)</td>
</tr>
<tr>
<td>IRB</td>
<td>Institutional Review Board</td>
</tr>
<tr>
<td>NAEP</td>
<td>National Assessment of Educational Progress</td>
</tr>
<tr>
<td>NCES</td>
<td>National Center for Education Statistics</td>
</tr>
<tr>
<td>NCTM</td>
<td>National Council of Teacher of Mathematics</td>
</tr>
<tr>
<td>OO</td>
<td>One-on-One Interview</td>
</tr>
<tr>
<td>RTOP</td>
<td>Reformed Teaching Observation Protocol</td>
</tr>
<tr>
<td>SLD</td>
<td>Specific Learning Disabilities</td>
</tr>
<tr>
<td>TI</td>
<td>Teacher Interview</td>
</tr>
<tr>
<td>TIMSS</td>
<td>Trends in International Mathematics and Science Study</td>
</tr>
</tbody>
</table>
CHAPTER ONE: INTRODUCTION

_They have to [teach] it in a way I can understand it, other than just words and that way._

Sandra, OO, lines 60-61

These words, spoken by a fifth grade student, express the frustration felt with regard to her mathematics learning. This quote, and others you will read, are part of a qualitative study I conducted while employed as the mathematics coach at the participant school during the 2004-2005 school year. As a professional educator for more than twenty years, I have learned to listen to students and come to truly value their voices. I realized early on in my career that the way I was teaching, especially mathematics, was not working. I saw and heard firsthand the frustrations that Sandra expressed in the opening quote. I knew there had to be a better way.

In 1993 I was fortunate enough to participate in a Master’s degree program that opened up a whole new world with regard to teaching in general, but more specifically for teaching mathematics and science. The program of study helped us shift our teaching paradigm from a traditional approach towards a reform-based, constructivist approach. I learned how to teach for understanding and present concepts in a way that made sense to students.

Over the years, I have seen again and again how deeply and critically children can think when properly guided and encouraged. This study, born from my earnest belief that we must listen to students, was designed to explore students’ perceptions of their mathematics learning within the context of a reform effort.

Based on research of the past several decades, the frustrations expressed by Sandra have very likely been felt by large numbers of American students for some time. This first chapter will
present some of the reports and research findings that have given all Americans, though educators in particular, cause for concern with regard to the mathematics achievement of our nation’s elementary students. Additionally, I will present information on why I chose to listen to these valued student voices in this study as well as an introduction to the students to whom I listened. Finally, background information on the reform movement in mathematics instruction will be provided for the reader.

Looking Back

Since 1969, the National Assessment of Educational Progress (NAEP), commonly referred to as the Nation’s Report Card, has been assessing what American students at particular grade levels know and can do in a number of academics areas, including mathematics. Although the results of the 2003 and most recent 2005 NAEP assessments continue to show an upward trend in mathematics scores for U.S. students, the actual scores are quite bleak. The results from 2003 show that only 32% of fourth graders and 29% of eighth graders performed at or above the proficient level, with 23% and 32% of fourth and eighth graders respectively performing below the basic level (National Center for Education Statistics, 2003). Very slight improvements for both fourth and eighth grades were reported for 2005. Fourth graders performing at or above the proficient level scored a four percent increase to 36% and eighth graders a single percentage point increase to 30%. The number of fourth graders performing below the basic level was reduced three percentage points to 20% and eighth graders dropped their numbers by a single percentage point to 31% (NCES, 2005).

Unfortunately, in the context of this study the latest results of the largest, most comprehensive international study, the Trends in International Mathematics and Science Study
TIMSS 2003, formerly known as the Third International Mathematics and Science Study, are not terribly encouraging either. TIMSS 2003 is the third comparison in a series of studies given on a four year recurring cycle. TIMSS is designed to track international trends in mathematics and science achievement over time. The first study, conducted in 1995, included over 40 countries and was administered at five grade levels (third, fourth, seventh, and eighth grades, and the final year of secondary school) (International Study Center, n. d.). In 1999, the second assessment in the series was conducted in 38 countries, 26 of which participated in the original assessment in 1995. The mathematics and science achievement of eighth graders was the focus of the 1999 study (International Study Center, n. d.).

Conducted in 46 countries and administered to fourth and eighth graders, the results from TIMSS 2003 show that although fourth graders scored above the international average (U.S. average=518, international average=495), no increase has occurred in scores since the original 1995 study in which fourth graders had an average score of 518 as well. Additionally, American fourth graders were outperformed by eleven countries in 2003, more than the mere seven countries in 1995 (NCES, 2004).

The results for American eighth graders appear a bit brighter with significant improvement in mathematic scores over time as well as scoring above the international average in both the 1999 and 2003 studies. In 2003, eighth graders showed a 12-point increase across the eight year span, scoring a 492 in 1995, a 502 in 1999, and a score of 504 in 2003. Despite the increase, U.S. eighth graders were still outperformed by 14 other countries in 2003 (NCES, 2004). Obviously, based on the results of TIMSS, mathematics achievement in the United States lags behind a host of other countries. Based on results of both national and international data, a
large number of American students still struggle with mathematics and are unable to make sense of, or understand mathematics and as these studies have shown, they perform accordingly.

The data gathered from TIMSS and NAEP are designed to capture a big picture of student achievement; however, most recently, data from these tests feed the high-stakes testing movement. Politicians have used the findings to pass various legislation in order to make states accountable for student learning, the latest being President Bush’s *No Child Left Behind* (U. S. Department of Education, 2002), while those inside and outside the educational community have used the data to call for and work towards educational reform. In response to federal legislation and the pressure for accountability, most states have adopted standards in all content areas, including mathematics. The National Council of Teachers of Mathematics (NCTM) *Curriculum and Evaluation Standards for School Mathematics*, published in 1989, was often used as a framework by professional educators in developing state mathematics standards (NCTM, n. d.) as well as the subsequently published *Principles and Standards for School Mathematics* (2000). In an effort to address the accountability of meeting state standards, the majority of states have now implemented mandatory, high-stakes, standardized tests. Theoretically these tests are supposed to measure student achievement and ensure that students are learning, but is this the case? Many educators have argued it is not and that in fact these tests are detrimental to student learning (see Boaler, 2003; Chambers, 1993; Lomax et al., 1996; Rogosa, 2001 and Garys, 2003 for a discussion of various issues and impacts).

Listening to the Students

Therefore, the following questions remain: What are our students truly learning? And, how do our students learn best? Educators and researchers alike have tried to find the answers in
a variety of ways, often focused on input from adults. However, one powerful route to discerning the truth about student learning that is often overlooked is to examine the discourse of the students as only they provide the most definitive answer. As Gentilucci (2004) explains, “Students are powerful determiners of the learning that occurs in their classrooms. Understanding why they learn well or poorly is predicated upon clearly understanding their perspectives on learning” (p. 133). Student voices must be heard in order to understand what mathematics they have learned and how they learn best; more importantly, we need to hear how they have come to make sense of mathematics. My hope is that the findings from this study will enlighten our understanding as to how children come to feel more confident and secure in their mathematics understandings and abilities. With these thoughts in mind, the following question was the focus of this study: In their own voices, what are fifth graders’ perceptions of their mathematics learning within the context of a mathematics reform effort?

In light of the question addressed in this study, it was vital that the information come from the students themselves since it was their learning about which I was inquiring. Unfortunately, very little research has been conducted about learning from the students’ perspective in any content area. This may be due to the fact that historically children have been marginalized and disempowered. In Eder and Fingerson (2003), a report by Hood, Mayall, and Oliver found that “children are a socially disadvantaged and disempowered group, not only because of their age but because of their position in society as the ‘researched’ and never the ‘researchers’” (p. 34) and although the children were not the actual researchers in the present study, their perspectives and input constituted the major focus of this study. Further, Erickson and Shultz (1992) explain,
“virtually no research has been done that places the student experience at the center of attention…. If the student is visible at all in a research study he is usually viewed from the perspective of adult educators’ interests and ways of seeing, that is, as failing, succeeding, motivated, mastering, unmotivated, responding, or having a misconception. Rarely is the perspective of the student herself explored” (p. 467).

In his study of students’ perspectives on learning, Gentilucci (2004) argues that although the number of studies concerning student perspectives on learning has increased of late, “[w]hat was missing from this line of research, however, was an investigation of elementary students’ perspectives…” (p. 134).

The Context for Listening

As mentioned previously, this study was designed to advance student voices and explore students’ perceptions of their mathematics learning within the context of a reform effort. The participants of this study were 16 fifth grade students who attended Sunburst Elementary School (pseudonym). All of the students were of traditional fifth grade age with the exception of one student who had been retained in fourth grade. See Table 1 below for gender, ethnicity, and teacher assignment. Although to summarize briefly, the participants included six African-American males, eight African-American females, one Hispanic female, and finally one Hispanic male. The students were initially members of two fifth grade classes. In January 2004, a third fifth grade unit was added and five of the study participants were moved into the new classroom.
Table 1

Participants

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>Teacher Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tommy*</td>
<td>M</td>
<td>African-American</td>
<td>Nees</td>
</tr>
<tr>
<td>Azariah*</td>
<td>F</td>
<td>African-American</td>
<td>Nees</td>
</tr>
<tr>
<td>Yami</td>
<td>M</td>
<td>Hispanic</td>
<td>Nees</td>
</tr>
<tr>
<td>Jasmine</td>
<td>F</td>
<td>African-American</td>
<td>Nees</td>
</tr>
<tr>
<td>Shaquille</td>
<td>M</td>
<td>African-American</td>
<td>Nees</td>
</tr>
<tr>
<td>Allen</td>
<td>M</td>
<td>African-American</td>
<td>Nees</td>
</tr>
<tr>
<td>Leah*</td>
<td>F</td>
<td>African-American</td>
<td>Nees</td>
</tr>
<tr>
<td>Rebecca*</td>
<td>F</td>
<td>African-American</td>
<td>Nees</td>
</tr>
<tr>
<td>Shawn</td>
<td>M</td>
<td>African-American</td>
<td>Nees</td>
</tr>
<tr>
<td>Gary*</td>
<td>M</td>
<td>African-American</td>
<td>Nees</td>
</tr>
<tr>
<td>Briangeline</td>
<td>F</td>
<td>African-American</td>
<td>Nees</td>
</tr>
<tr>
<td>Montana</td>
<td>F</td>
<td>African-American</td>
<td>Nees</td>
</tr>
<tr>
<td>Crystal</td>
<td>F</td>
<td>Hispanic</td>
<td>Nees</td>
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<tr>
<td>Sandra</td>
<td>F</td>
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<td>Smith</td>
</tr>
<tr>
<td>Ashley</td>
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<td>Smith</td>
</tr>
<tr>
<td>John</td>
<td>M</td>
<td>African-American</td>
<td>Smith</td>
</tr>
</tbody>
</table>

* Indicates students moved to new fifth grade class in January.
Sunburst is a relatively small, neighborhood elementary school located in an urban area of central Florida. The participant school is a historically low-performing school receiving a grade of D since 1999. In 2004, the school received an F (Florida Department of Education, 2005). Sunburst Elementary enrolls close to 400 students: approximately 85% African-American, 8% white, 5% Hispanic and 2% other. During the 2003-2004 school year, approximately 82% of the students received free or reduced price lunches.

One important consideration to note was the unique situation that occurred as I began this study during the first several weeks of the 2004-2005 school year. Due to the record number of hurricanes to hit central Florida during the first eight weeks of hurricane season in 2004, which coincided with the first eight weeks of the school, students were out of school for eleven days, over three separate and anxiety-ridden occasions. Teachers lamented that it was like starting school three different times. Not until the beginning of October did students and teachers truly get into the rhythm of the school year and establish a daily schedule and routine. Due to these extenuating circumstances, I was unable to officially begin the planned data gathering for this study until early November, though I began maintaining a journal and developing relationships with the students and teachers in August.

Another important consideration of this study was the principal, who was truly the instructional leader of Sunburst Elementary. In January of 2004, this new principal was assigned to Sunburst Elementary in an effort to improve teaching and learning and thereby improving its performance. His exemplary track record in a number of schools in the central Florida area brought hope to the struggling school. In addition, his sensitivity to the issue of socioeconomic status has been apparent on many occasions as I have heard him speak about generational poverty and its subtle and overt effects on student learning at Sunburst Elementary. With the goal
of improved teaching and learning in mind, the principal developed and put into place a school-
wide plan of reform, part of which was the mathematics education reform effort that was central
to this study.

The History Behind the Reform Effort at Sunburst Elementary

The mathematics education reform effort implemented at Sunburst Elementary was part
of a district-wide reform effort to move towards teaching for understanding in mathematics. The
curriculum implemented by Sunburst Elementary, in compliance with the district-wide plan, was
a research-based curriculum, whose development was funded by the National Science
Foundation. A major focus of the program is student engagement in mathematics learning
through the use of problem solving activities, games, and manipulatives, plus ongoing
assessment that guides future instruction.

I spoke with the district level elementary mathematics specialist in order to more fully
understand the district’s involvement in choosing the new curriculum. Ms. Townsend
(pseudonym) described the district’s shift toward mathematics reform as “a gradual change”
(line 1) starting around 1990, following the publication of NCTM’s *Curriculum and Evaluation
Standards for School Mathematics* in 1989. One of the district’s first steps toward reform came
as a result of the district mathematics specialist at the time receiving an Exxon grant. This grant
enabled each school to name an intermediate and a primary teacher as mathematics specialists.
These teachers were introduced to best practice in teaching mathematics and asked to share
information with their colleagues. The district’s most recent efforts culminated with the adoption
of a reform-oriented mathematics curriculum in 2004.
During the intervening years a small percentage, about 25% in Ms. Townsend’s estimate, of the district’s schools began using another popular reform-oriented curriculum, with varying degrees of implementation. Some of the schools chose particular concepts and taught them as replacement units, while a few used it as their primary mathematics curriculum.

The beginnings of reform were also seen at the district level within the professional development department. Two of the people in the professional development department began incorporating reform-oriented practices into their mathematics professional development workshops. Additionally, professional development workshops for Activities Integrating Mathematics and Science (AIMS) were becoming quite popular. The AIMS Educational Foundation creates engaging, hands-on activities that integrate the teaching of mathematics and science and reflect reform-oriented pedagogy. Workshops and professional development continued, though no other major efforts towards mathematics reform were made until the textbook adoption in 2004.

The recent textbook adoption was part of a six-year cycle of adoption for mathematics. As part of Ms. Townsend’s job as elementary mathematics specialist for the district, she supervised and coordinated that effort. As we talked, she explained one of her primary concerns about the process.

*Although my personal feeling was I wanted to move in [the direction toward reform], I did not want to take the district someplace they didn’t want to go, that they would refuse to go.* (lines 26-29)

In light of this concern, Ms. Townsend was “very careful” (line 30) as she put together the textbook adoption committee. She created an application process that covered a broad range of topics regarding mathematics instruction thereby ensuring that a diverse group of teachers
would be selected. She “didn’t want to stack the committee with any one philosophy” (lines 36-37).

Once the committee was selected, they joined the middle and high school mathematics textbook adoption committees and created a rubric to judge the products they would review. Ms. Townsend revealed that she had been “very surprised” (line 56) by the amount of “agreement between Kindergarten teachers and Calculus teachers about how mathematics should be taught” (lines 54-55). The Kindergarten through grade 12 committee agreed that children “should have the opportunity to explore mathematics and use manipulatives” (lines 57-58). They also “valued technology and felt a mathematics curriculum should be engaging” (lines 59-60).

The committees then took the rubric they had created and used it to evaluate all products they reviewed. The elementary committee initially reviewed eight products. The products included both traditional and reform-oriented mathematics curricula. Ms. Townsend explained that the committee wanted to “look at everything. [They were] not going to eliminate anything because somebody had a preconceived notion about it. [They] wanted to look at everything” (lines 46-50).

The committee then applied the rubric, used decision analysis, a formal decision-making process, and cut the choices down to three. The remaining curricula included: one traditional text, one blended text encompassing both traditional elements as well as reform-oriented components, and a reform-oriented text. The committee members were then asked to take the texts to their classrooms and teach from them. Ms. Townsend shared that this aspect was the “most powerful” (line 67) aspect of the entire process. Next the committee members came back together, shared their experiences and feedback with the group, and voted. The reform-oriented curriculum was the overwhelming favorite. The process had begun during the third week of
August 2003 and the committee sent its recommendation to the superintendent on January 31, 2004. Sunburst Elementary, along with the rest of the district, began their implementation of the new curriculum in August 2004.

The remainder of this chapter focuses upon the rationale of constructivist pedagogy that has driven the reform effort in mathematics. The components of reform which will be explored are teaching through problem solving, the use of manipulatives, contextualized instruction, and encouraging classroom discourse. These components were derived from an extensive review of the literature, my years of teaching, my master’s and doctoral coursework, and my role as a change agent at Sunburst Elementary.

The Need for Reform

Student learning and performance has traditionally been viewed through an instructional lens; therefore, concerns have focused on the way teachers teach children rather than the way children learn. The National Council of Teachers of Mathematics (NCTM) expressed concern about mathematics education and issued a vigorous call for reform by way of its 1989 publication of the *Curriculum and Evaluation Standards for School Mathematics*. The “Need for Change” statement of that document explained the significant issue at the center of traditional mathematics teaching: “children begin to lose their belief that learning mathematics is a sense-making experience. They become passive receivers of rules and procedures rather than active participants in creating knowledge” (NCTM, 1989, p. 15). This original *Standards* document expressed NCTM’s view that students need to value mathematics, to feel confident in their ability to do mathematics, to become problem solvers, and to develop the ability to communicate and reason mathematically in order to truly learn and understand mathematics (NCTM, 1989).
This original goal remains a highlight of NCTM’s goals today as evidenced by subsequent publications.

NCTM’s vision for mathematics education reform continued with its publication of *Professional Standards for Teaching Mathematics* in 1991 and *Assessment Standards for School Mathematics* in 1995. Each of these three documents focuses on a distinct aspect of mathematics education: curriculum, teaching and assessment. However, all three espouse NCTM’s strong belief that mathematics education must become student-centered and meaning-based.

Learning should engage students both intellectually and physically. They must become active learners, challenged to apply their prior knowledge and experience in new and increasingly more difficult situations. Instructional approaches should engage students in the process of learning rather than transmit information for them to receive. (NCTM, 1989, p. 67)

NCTM’s most recent effort in furthering the vision of reform in mathematics education was the publication of *Principles and Standards for School Mathematics* in 2000. This document was built upon the foundation and expanded the vision of the previously published *Curriculum and Evaluation Standards for School Mathematics*. Like its predecessors, it also emphasizes the need for mathematics educators to actively involve students in making sense of mathematics. The “Vision for School Mathematics” laid out by NCTM in the *Principles and Standards* (2000) document calls for schools “where all students have access to high-quality, engaging mathematics instruction…. [In these schools] the curriculum is mathematically rich, offering students opportunities to learn important mathematical concepts and procedures with understanding…. [Finally, the students who attend these schools] value mathematics and engage actively in learning it” (p. 3). NCTM acknowledges that although this vision for school
mathematics is highly ambitious and challenging, it is essential that educators work to meet its goal so as to ensure the future success of North American students in a global and ever-changing society (NCTM, 2000). The remainder of this chapter presents the salient components of reform as purported by NCTM over the last two decades.

The Components of Reform

*Constructivism*

Active participation in creating knowledge is the cornerstone of constructivism. During the past two decades, various constructivist perspectives have been the focus of much of the mathematics education research and constructivism played a significant role in the mathematics education reform movement spearheaded by NCTM (Simon, 1995). Constructivism holds that all knowledge is constructed (Noddings, 1990); that is, new ideas are built upon pre-existing ideas. New knowledge is linked to previous knowledge creating interconnecting networks. Constructing knowledge is an active process and requires active participation on the learner’s part. Children’s minds are not “blank slates” as was once believed, nor are they empty vessels in which knowledge can be poured. Further, Cobb (1988) explains, “teachers and students are viewed as active meaning-makers who continually give contextually-based meanings to each others’ words and actions as they interact” (p. 88). This shift in the way educators view student learning has required pedagogical reforms as well.

Although there is not an absolute definition or single set of characteristics that define the reform movement in mathematics education, a number of very effective strategies and practices,
such as the use of manipulatives have evolved that enable children to construct meaning in mathematics. Through my experiences and a thorough literature review, I have found that some of the strategies and practices commonly seen in reformed-oriented lessons and classrooms include teaching through problem solving (Hiebert, et al., 1996; Lubienski, 1999, 2000; Van de Walle, 2004; Wood & Seller, 1996), using manipulatives during instruction (Cain-Caston, 1996; Capps & Pickreign, 1993; Cotter, 2000; Heibert & Wearne, 1992; Heuser, 2000; Moch, 2001; Phillips, Phillips, Melton & Moore, 1994; Ross & Kurtz, 1993; Stein & Bovalino, 2001; Sowell, 1989; Suydam & Higgins, 1977; Thompson, 1994), presenting lessons that are meaningful and contextualized (Heckman & Weisglass, 1994), and promoting classroom discourse (Knuth & Peressini, 2001; Piburn & Sawada, 2000; White, 2003).

*Teaching through Problem Solving*

Attention was first called to the importance of teaching through problem solving in the 70s as dissatisfaction with the back-to-basics movement grew within the mathematics education community (Herrera & Owens, 2001). NCTM first offered problem solving as an instructional focus in its 1980 publication of *An Agenda for Action*. NCTM continued its support of teaching and learning through problem solving in 1989 with the publication of *Curriculum and Evaluation Standards*. It stated that problem solving should be “a primary goal of all mathematics instruction and an integral part of all mathematical activity” (NCTM, 1989, p. 23) and that students should “use problem-solving approaches to investigate and understand mathematical content” (NCTM, 1989, p. 75). Further, in its latest publication, *Principles and Standards for School Mathematics* (2000), NCTM offers five process standards for mathematics;
Problem Solving being the first. The Problem Solving Standard states students should “build new mathematical knowledge through problem solving” (NCTM, 2000, p. 52).

The literature suggests a number of convincing reasons that the teaching and learning of mathematics through problem solving has been supported and encouraged since the mid-70s. Hiebert et al. (1996) explain the practice of teaching through problem solving as “allowing the subject [mathematics] to be problematic” (p. 12). In other words, “allowing students to wonder why things are, to inquire, to search for solutions, and to resolve incongruities” (p. 12). In doing so, students are able to connect new ideas to prior knowledge and to construct concepts and deeper understandings of mathematical ideas. In his text for preservice teachers, Van de Walle (2004) shares several additional reasons to value teaching mathematics through problem solving. His reasons include problem solving enabling students to focus on ideas and sense making in mathematics, developing “mathematical power” and the belief that they can do mathematics and that mathematics makes sense. Further, he states that teaching through problem solving can provide valuable ongoing assessment data, and last, he offers it can be fun for both teachers and students. Finally, research evidence suggests that teaching through problem solving may improve students’ mathematics achievement. Wood and Sellers (1996) found that second and third grade students receiving problem-centered mathematics instruction for two years performed significantly better in both computational proficiency and conceptual understanding than children receiving traditional textbook instruction.
The Use of Manipulatives

The use of concrete materials or manipulatives (i.e., base-ten blocks, beans, fraction circles, tangrams, Cuisenaire rods, pattern blocks) affords students the opportunity to discover and construct mathematical concepts through active engagement. The first use of manipulative materials can be traced back to the nineteenth century and evidence of their use in schools can be found as early as the 1930s (Sowell, 1989), though focus on their use as tools for mathematics instruction began in the 1960s. Reviews of early studies from the late 60s and 70s as to their effectiveness offered mixed results, but later, more comprehensive reviews of research clearly indicated benefits (Sowell, 1989; Suydam & Higgins, 1977).

Research has shown the benefits of using manipulatives as a way to actively involve students in learning mathematics and that the appropriate use of manipulatives in mathematics instruction can enhance students’ conceptual understanding (Cain-Caston, 1996; Capps & Pickreign, 1993; Cotter, 2000; Heibert & Wearne, 1992; Heuser, 2000; Moch, 2001; Phillips, Phillips, Melton & Moore, 1994; Ross & Kurtz, 1993; Sowell, 1989; Stein & Bovalino, 2001; Suydam & Higgins, 1977; Thompson, 1994). Stein and Bovalino (2001) assert, “Manipulatives can be important tools in helping students to think and reason in more meaningful ways” (p. 356). Further, Capps and Pickreign (1993) point out, “Manipulative experiences are a critical part of the process of linking the concrete representations of the mathematical idea to its more abstract symbolic representation” (p. 9).
Meaningful, Contextualized Instruction

Educators, though armed with the understanding that children must construct their own knowledge, must also make certain that mathematics instruction is meaningful by employing effective strategies to guide students toward mathematical understanding. Heckman and Weissglass (1994) noted that the traditional teaching methods used in mathematics cause problems for students, particularly students of lower socio-economic status, because they fail to interest and engage the students in the learning of mathematics. Students often do not see the need for mathematics.

In my years of experience as a classroom teacher, I found my students consistently more engaged and involved in their mathematics learning when presented with authentic, contextualized tasks, such as writing a letter to the principal of an elementary school sharing their solution to a problem that revolved around stocking a fish aquarium for their classroom. Similarly, when teaching an integrated unit on colonial America, my students worked diligently to find the solution to a mathematical problem that early sea merchants may have faced.

It is imperative that changes in teaching practices continue to focus on meaningful, authentic activities; that is, activities that are grounded in a real-life context. As evidence, Heckman and Weissglass (1994) “contend that acquiring knowledge in a real-life situation…enhances a student’s self-confidence and stimulates initiative in acquiring knowledge in other [areas], especially those that are meaningful to his/her environment and lifestyle” (p. 30). As the next section of the literature review indicates, a substantial area of recent research that supports contextualized instruction is brain-based learning which can be applied to all content areas.
Brain-based learning

Research on brain-based learning supports the need for meaningful learning which coincides with the primary goal of the mathematics reform movement; meaningful learning in mathematics. The brain resists learning isolated bits of information (Green, 1999) or surface knowledge that has little meaning or connectedness with other knowledge (Caine & Caine, 1991). Therefore, when mathematics is taught in disconnected, isolated algorithms students are confused and have difficulty retaining information. Caine and Caine’s research confirms that for meaningful learning to occur, physiological and contextual connections must be made, such as in teaching through problem solving and when using manipulatives to teach mathematics. When appropriate connections are made, students are better able to remember the information presented (Caufield, Kidd, & Kocher, 2000).

An added key to meaningful learning, according to Caine and Caine (1991), is that of redundancy. This concept involves presenting students with information a number of times and in a variety of ways so that the brain is able to pick up on the patterns and connections it searches for when learning. Clearly, the appropriate use of manipulatives in mathematics instruction and teaching through problem solving address the need for both physiological and contextual connections as well as the notion of redundancy. Their use also ensures active student engagement which is essential for meaningful mathematics learning.
Classroom Discourse

Traditionally, the discourse, or conversation, that has gone on in classrooms has been quite one-sided with the teacher leading and doing most of the talking (NCTM, 1991). In reform-minded classrooms or lessons, the students participate and initiate to a much greater extent. The emphasis on promoting meaningful discourse in mathematics to improve mathematics learning is one of the components for reform offered in NCTM’s 1989 *Curriculum and Evaluation Standards* document: “Interacting with classmates helps children construct knowledge, learn other ways to think about ideas, and clarify their own thinking” (p. 26) about mathematics. Further, the significance of promoting classroom discourse was illustrated with three of the six teaching standards in NCTM’s 1991 publication of *Professional Standards for Teaching Mathematics*, including the teachers’ role in discourse, the students’ role in discourse, and tools for enhancing discourse.

This emphasis persists and is further illuminated in the *Principles and Standards for School Mathematics* (2000) document: “Listening to others’ explanations gives students opportunities to develop their own understandings. Conversations in which mathematical ideas are explored from multiple perspectives help the participants sharpen their thinking and make connections” (p. 60).

Educators are just starting to tap into the power of social learning formats, such as inquiry groups or literature circles. Truly, learning is a social endeavor, a concept first explored by Vygotsky (1978), and learning mathematics is no exception. The social aspect of learning mathematics cannot be ignored if students are to be successful in communicating and retaining their knowledge of mathematics. This continued need to address the social nature of mathematics
learning as part of the mathematics reform effort is evident in the literature. Piburn and Sawada (2000) employ Vygotsky’s view of learning as “primarily a socio-linguistic phenomenon” (p. 3) as part of the theoretical rationale for the significant focus on classroom discourse in their Reformed Teaching Observation Protocol (RTOP). The RTOP was designed and is used as an observation instrument to measure “reformed” teaching in mathematics and sciences (see Appendix A). Although RTOP did not guide my efforts, it most certainly validated my thinking about discourse as a key component of mathematics reform.

Certainly, reform-minded teachers must be facilitators of classroom discourse. Meaningful discourse helps “students to concentrate on sense making and reasoning [as well as] allows teachers to reflect on students’ understanding and to stimulate mathematical thinking” (White, 2003, p. 37). A deeper understanding of mathematics can be afforded to students by supporting and encouraging them to “use their own statements, as well as those of their peers and teacher, as thinking devices” (Knuth & Peressini, 2001, p. 325). With the ultimate goal of the mathematics reform effort being improved mathematics learning for all students, promoting productive mathematical discourse in the classroom can be an effective means to that end.

No doubt, a look back at the NAEP and TIMSS findings illustrate that there is a clear need for reform in mathematics instruction if American students are going to be successful in mathematics and therefore competitive in today’s global society. This chapter provided the rationale as to why I chose to listen to students and the context in which I listened. Additionally, the reader was presented with a review of salient research as well as the history of the reform effort in mathematics instruction. A number of significant components of the reform effort were also identified.
Further, this study sought to explore the perceptions of a small segment of American schoolchildren in the midst of reform in an effort to listen to what they had to say about their learning in mathematics. The paucity of literature highlighting student voices suggests that we as educators have ignored this valuable input for many years. The following chapter will walk the reader through the steps taken in order to listen to the fifth graders of Sunburst Elementary so that their important voices can now be heard.
CHAPTER TWO: STEPPING THROUGH THE LISTENING PROCESS

This study spanned an entire school year and involved accomplishing a number of tasks in order for it to come to fruition, from acquiring a variety of approvals, gaining access to the students and conducting interviews to transcribing, analyzing and interpreting data. This chapter presents the steps followed during the course of this study as I listened to students talk about their mathematics learning.

Early Steps

Knowing the importance of the topic and my passion for including student voices, I pursued gaining approval for my study. The required form was completed and submitted to the university Institutional Review Board (IRB) in early August 2004 (see Appendix B). Approval was received shortly thereafter (see Appendix C). While awaiting approval from the university, I sought approval to conduct my study from the school district in which Sunburst Elementary is located. A research request form was submitted to the appropriate district official and subsequently approved in mid-August 2004 (see Appendix D).

In mid-September, following the students return to school after the second hurricane, I distributed parental consent forms to all 48 regular education fifth graders (see Appendix E). I went into each class and talked with the students. I reintroduced myself and briefly explained my study. I asked that the students share the consent form with their parents and return them signed if they were interested in participating in my study. I made it clear that participation was completely voluntary and no one would be penalized if they chose not to participate.
During the next few weeks, I collected signed parental consent forms. I returned to the fifth grade classrooms at the end of September to remind the students to turn in their consent forms as I would be beginning the project the following week. In total, I received 16 affirmative consent forms. In early November, I began my foray into listening to the students after recouping from the third hurricane.

In accordance with research ethics, the students were invited to choose pseudonyms for use in this project. This way I would not reveal their real names, but their own pseudonym could provide a flavor of who they are. In early November, as we gathered in small groups for the first time, I explained the concept of choosing a pseudonym and how it would help protect their identity when I used their words in my project. The students had a grand time choosing their new names. When interviewed, the teachers were also invited to choose pseudonyms and asked to sign consent forms as well (see Appendix F). The participants chosen pseudonyms are used throughout this dissertation; likewise the participant school, now known as Sunburst Elementary was renamed as well.

How I Listened…

In an effort to hear and present the student voices as well as to help ensure the credibility of this study, a number of ethnographic methods and practices were employed. One such practice is that of methodological triangulation, coined by Denzin in the 1970s (Janesick, 2000). Triangulation refers to the practice of implementing a number of data collection techniques within a single investigation in order to triangulate, or converge upon, data points (Glesne, 1999). Other methodological techniques used to enhance the credibility of this study will be discussed later in this chapter. However, the data gathering methods used in this study included
the use of focus groups, one-on-one interviews, and classroom observations as well as the use of a student survey. Table 2 below presents the timeline of this study.

Table 2
Study Timeline

<table>
<thead>
<tr>
<th>Date Range</th>
<th>Activity Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early November 2004</td>
<td>Four initial small group meetings with students</td>
</tr>
<tr>
<td>Mid November – Mid December</td>
<td>Fifteen one-on-one interviews with students</td>
</tr>
<tr>
<td>Late December – Mid February 2005</td>
<td>Nine classroom observations of mathematics lessons</td>
</tr>
<tr>
<td>March 31 – April 1</td>
<td>Four focus groups with students</td>
</tr>
<tr>
<td>March 31 – April 4</td>
<td>Four one-on-one teacher interviews</td>
</tr>
<tr>
<td>April 21 – April 22</td>
<td>Fifteen student surveys administered</td>
</tr>
<tr>
<td>Early May 2005</td>
<td>First member checking activity</td>
</tr>
<tr>
<td>End of May 2005</td>
<td>Five one-on-one follow-up interviews with students</td>
</tr>
<tr>
<td>End of May 2005</td>
<td>Second member checking activity</td>
</tr>
</tbody>
</table>

Glesne (1999) explains that a focus group is a small group of people gathered for a discussion on a particular topic. Focus groups were used in this study for both personal and research-based reasons. I had conducted focus groups with children in previous studies and found them to be quite successful, thus supporting Glesne’s (1999) claim that “children often need company to be emboldened to talk” (p. 68). My observations were that the children felt comfortable sharing their thoughts and ideas within the groups. Madriz (2000) offers an
additional benefit to using focus groups: the issue of the imbalance of power between the researcher and the participants is addressed. A decrease in the amount of power the researcher holds is realized and an increase in the power afforded to the participants of focus groups, in this study, the children. In the four focus groups that were conducted during the last week of March and the first week of April, the children’s perceptions of their mathematics learning and the ways they learned mathematics while in fifth grade was explored (see Appendix G for focus group questions). For example, I asked the students to tell me about how they learned mathematics during the year. I probed further by asking the students to explain, and give examples if possible, how their mathematics learning was the same or different than previous years. Throughout this study, and outside of my work hours as mathematics coach, I met with students at convenient times determined by their classroom teachers.

The use of one-on-one interviews with the children was also utilized in this study. The first phase of 15 one-on-one interviews took place early in the study, beginning in mid-November and continued through mid-December. This phase of interviews was conducted in order to gather information concerning students’ perceptions of their previous mathematics learning experiences (see Appendix H for one-on-one interview questions). For instance, in the early phase of the one-on-one interviews, I asked the students to tell me what they learned in mathematics the previous year. I then probed for conceptual understanding of topics they offered. I also asked the students to share with me what their teacher did or said to help them understand the concepts they taught.

A smaller number of one-on-one follow-up interviews were conducted in May, subsequent to the focus groups, and offered a more in-depth view of how each child perceived their mathematics learning within the context of the reform effort. Questions asked were based
on information gathered during focus groups and allowed for clarification of ideas or thoughts shared in those sessions (see Appendix I for follow-up interview questions). In addition, the follow-up interviews offered the opportunity to ask probing questions that further elucidated the child’s thoughts and ideas.

Although the focus of this study was students’ perceptions, four one-on-one interviews were also conducted with teachers as a means to further inform this study by gathering their input with regard to the mathematics instruction reform effort. Although as the mathematics coach, I had a strong sense of their perception of the reform effort, I wanted to formally interview them in order to document their thoughts. The two original fifth grade teachers were interviewed. I chose not to interview the new fifth grade teacher because he had only been teaching at the school a mere two and a half months at the time I conducted the teacher interviews. Two additional teacher interviews were conducted with teachers of fifth graders in self-contained specific learning disabilities (SLD) classrooms because of the unique perspective I felt they could bring to the study. Many of their students were of the same chronological age as the participants in the study, but had learning differences. I was interested in hearing from the SLD teachers concerning their experiences after implementing the new curriculum with their students in order to discern any parallels or differences when compared with the experiences of the regular education teachers (see Appendix J for teacher interview questions).

Although not included in the original data collection plan, a student survey was also included in this study (see Appendix K for student survey). During the month of February, I was beginning to think I may need a data source in which I was not so closely involved. I conjectured that the results from the survey would either further support my findings or reject them. I presented my thoughts to Dr. Jennifer Deets, my trusted advisor on qualitative research matters,
and she agreed that a survey could be a good way to “augment or round out what [the] other data collection techniques [were] bringing in” (J. Deets, personal communication, March 4, 2005), though with the added caveat that sometimes survey data is not as helpful as anticipated.

Subsequent to my communications with Dr. Deets, my major advisor and I set out to develop the survey. The survey was administered to 15 students in mid-April. Only 15 students were surveyed due to the repeated absence of one participant. The survey data were tabulated and analyzed shortly thereafter (see Appendix L for student survey results).

Finally, my role as mathematics coach at the participant school provided the unique opportunity of being a participant-observer for the duration of this year-long study. As mathematics coach I was responsible for helping the teachers implement the new standards-based curriculum as well as for helping improve the overall mathematics instruction at the school. This position enabled me to observe kindergarten through fifth grade students in the more comfortable setting of their own classrooms as they worked individually and in both small and large groups. The discourse that occurred throughout was vital as I gathered information regarding the students’ perceptions of their mathematics learning. Observing the students as they worked in a more natural setting allowed for crucial data to be collected that was not accessible through the use of interviews. To capture this data, I took field notes during classroom observations. These field notes detailed the events and as much dialogue as possible that occurred during my visits. In addition to field notes of classroom observations, I also maintained a journal during the course of this study. The use of a personal journal helped me in bracketing my thoughts and feelings. Bracketing is a practice developed by phenomenologists and refers to the way “we work to become aware of our own assumptions, feelings, and preconceptions, and then, that we strive to put them aside- to bracket them- in order to be open and receptive to what
we are attempting to understand” (Ely, 1991, p. 50). Excerpts from my journal will be shared later in this chapter and in subsequent chapters as well.

Steps Taken During and After Listening

Although quantitative research is fundamentally and philosophically different from qualitative, those who conduct qualitative research are just as concerned as experimental researchers with executing quality studies. Some choose to retain the conventional terms (i.e., internal validity, external validity, reliability, objectivity) of quality control (Goetz & LeCompte, 1984), while others choose to use alternative terms and methods (Ely, 1991; Eisner, 1991; Lincoln & Guba, 1985), and still others seek only understanding. They are distracted by and actually reject conventional terms such as validity (Wolcott, 1990). I was guided by the work of Lincoln and Guba (1985) in my efforts to conduct a quality study. Lincoln and Guba use the alternative term trustworthiness to refer to the credibility of the study. A number of techniques were used to insure the trustworthiness of this study.

a) persistent observation: Spending enough time observing in the field to build trust with the participant, learning the culture, and checking for or recognizing distortions due to misinformation given by participants (Creswell, 1998; Lincoln & Guba, 1985).

b) triangulation: As mentioned earlier, triangulation refers to employing a number of data gathering techniques in order to triangulate or converge on themes or topics as they arise (Ely, 1991; Glesne, 1999; Lincoln & Guba, 1985).

c) peer debriefing: The use of a peer to keep me “honest,” to ask the hard questions, and to act as a devil’s advocate during the course of the study (Lincoln & Guba, 1985).
d) member checking: Sharing study products (i.e., analytic categories, interpretations, conclusions) with participants for their feedback. This practice is considered to be “the most crucial technique for establishing credibility” (Lincoln & Guba, 1985, p. 314). Member checking activities conducted in this study will be discussed in later chapters.

In any qualitative study, data analysis is an ongoing and lengthy process. Some qualitative researchers choose to use computer-assisted programs (i.e., *The Ethnograph, NUD.IST*) to carry out their data analysis (Glesne, 1999). My approach to analysis is much more organic. I learned how to completely immerse myself in the data early on in my academic career from two sources. First was my work during one of my fellowship assignments for the university. I was a member of a team working on a program evaluation project. There I learned about observing participants, using a protocol, taking field notes, expanding raw data, and using color coding to help with analysis.

Second was my experience with a wonderful teacher and wise qualitative researcher, Dr. Jennifer Deets, conducting focus groups with home schooled families. This experience allowed me the opportunity to listen to the voices of both adults and children. Working with her expanded my knowledge of qualitative research and confirmed my belief in staying close to your data.

Preliminary analyses of the data for this study began soon after I started listening to the fifth graders at Sunburst Elementary and continued for a number of months. After meeting with the students, I read over and expanded my field notes and jotted down thoughts and feelings in my journal. For example, the following is an excerpt from my journal from early January. At this point, I had completed the early phase of the one-on-one interviews and was in the midst of classroom observations.
“Looking over and thinking about kids/responses [from one-on-one interviews] so far-lots of ‘mathematical powerlessness.’ [The students] just don’t act or ‘feel’ like they can do it. They shut down, disengage, turn off when they have to think.

Thoughts: barriers to reform, mathematical powerlessness”

The analysis process continued with the audio recording of each meeting with the students, both one-on-one interviews and focus groups, as well as the teacher interviews. Those extensive audio recordings were subsequently transcribed. My apologies to any reader who might be distracted or offended by the student quotes in this study, but I felt it necessary to honor these students’ voices by transcribing their words exactly as they were spoken. Every effort was made to transcribe the recordings in a timely fashion; unfortunately the sheer number of recordings became overwhelming. In order to complete the transcription process, I enlisted the help of my advisor’s work study assistant and eventually a professional transcriptionist. In all, over 30 documents were transcribed encompassing hundreds of pages. In addition to the transcription process, classroom observation notes were expanded and the quantitative data from the student surveys analyzed.

With the end of the school year and the completion of the transcription process, the final analysis process began. After organizing the data into chronological order following the study timeline (see p. 25) and completing an initial read-through of all data, I set up a color coding system to identify the various data sources. Yellow tags denoted the early phase of one-on-one interviews; salmon-colored tags denoted classroom observation data; orange tags identified focus group data; fluorescent yellow tags signified the teacher interviews; and finally, pink designated data from one-on-one, follow-up interviews.
During subsequent readings of the data, I underlined significant phrases, sentences or passages. Phrases, sentences or passages were deemed significant if they in any way represented students’ thoughts, feelings or perceptions of their mathematics learning. Once underlined the entries were flagged with the colored tag that corresponded to its data source, so that student one-on-one interviews were on yellow tags, for example. The tags were coded with a short phrase to represent the actual text, the specific data source, and the speaker if appropriate and finally the line number(s).
Completed tags were then placed in the right margin of transcribed documents near the original text. Once all documents of each data source were tagged, analysis of these tags began by removing and sorting them into emerging themes or categories. Hopefully, the following pictures capture my analysis process and show the organic nature of finding emerging themes or categories.

Figure 3: Tags sorted into themes

My experience in prior studies as well as the present study has been that the color coding of the tags is both beneficial and highly effective when dealing with a number of data sources. As the various data sources are analyzed and tags sorted, the triangulation of the data and significant emergent themes are very apparent in that multiple colored tags are visible.
After the tags were initially placed, the categories were given temporary headings based on emerging themes. The data were then further analyzed; categories were expanded, others may have been collapsed or the headings changed. This further analysis involved reflection upon what I learned during the project, discerning connections within the data, and frequent referral back to the original source documents.

The process described above may sound mechanical or perfunctory, but in reality it is a very fluid, time-consuming, thought-provoking and enlightening process. Once satisfied with my efforts and with new insights gained from the process, I was able to start putting into words the student voices thus revealing the findings of this study. The following three chapters will present the fruits of my labor during the analysis process. The third and fourth chapters present the students’ thoughts about mathematics and their perceptions of their previous mathematics experiences, respectively. Chapter Five presents the students’ perceptions of their mathematics
learning as fifth graders at Sunburst Elementary and as the most important participants in the beginning steps of a mathematics reform effort.
CHAPTER THREE: FIFTH GRADERS’ PERCEPTIONS OF MATHEMATICS

Although I had been visiting classrooms and building relationships since school began in August, in order to properly frame my study, I needed to probe deeper to understand how the students felt about mathematics. I wanted to understand what mathematics meant to them and how it fit into their lives. This chapter reveals, often in their own words, the perceptions of mathematics of the fifth graders at Sunburst Elementary; the “good”, the “not so bad”, and unfortunately, the “ugly” as well. Additionally, I will share one of the activities that offered support for the credibility of this study.

In early November 2004, with the goal of deeper understanding in mind and signed parent consent forms in hand (see Appendix E), I began meeting with the fifth graders in small groups of three or four. I was only able to meet with 14 of the 16 students due to the repeated absences of two students. The repeated absences of several students proved to be an issue for the duration of the study; therefore, they were often not included in the various study activities. In these initial small group meetings, structured similar to a focus group, I explained to the students what the study would entail. I asked if they would like to participate and all agreed. I then had the students sign the child assent forms (see Appendix M) and choose their own pseudonyms for the study. After completing the necessary paperwork, I then asked the students to share with me their thoughts about mathematics and what it meant to them. I simply asked the students: What is mathematics and what does it mean to you?
As I met with the groups I was both impressed and pleased with the students’ openness and willingness to share their ideas. I noticed the large number of responses that related to the context of school. This musing was noted in my journal entry from November 1:

“Most talked about it [mathematics] in the context of a school subject. A couple talked about how you need it [mathematics] in life everyday/all the time.”

This impression became more obvious after analysis. In fact their responses fell into two general categories, those with a real-life context and those with a school-related context; though several more distinct themes emerged within those general categories as well.

The “Good”

A small number of students were able to articulate some of the real-life connections they saw for mathematics in their own lives. A few saw mathematics as being beneficial in their lives, though only vaguely so, with the exception of Shawn. He explained specifically how mathematics can be helpful.

*If you can’t count that good, then people could just cheat you out your money.*

Shawn, IM2, lines 6-7

The others saw mathematics as beneficial, though did not express their thoughts as clearly as Shawn.

*It’s good to learn mathematics.*

Tommy, IM1, line 36

*You can learn a lot of stuff with mathematics.*

Jasmine, IM1, line 16
Only three of the 16 students expressed the importance of knowing and understanding mathematics in order to get a job later in their lives.

*If you don’t know mathematics, you won’t be able to get a job.*

Yami, IM1, line 26

*You have to know it if you want a job.*

Ashley, IM4, line 10

*Something you have to use because... most jobs have to do with mathematics.*

Sandra, IM4, line 6-7

Recognizing and understanding the value of mathematics in their daily lives is vital for students as they work towards attaining mathematical literacy and developing mathematical power (NCTM, 1989). “In this changing world, those who understand and can do mathematics will have significantly enhanced opportunities and options for shaping their futures. Mathematical competence opens doors to productive futures. A lack of mathematical competence keeps those doors closed” (NCTM, 2000, p. 5).

The “Not So Bad”

Although a few students shared the real-life connections they perceive with mathematics, the majority of the ideas the students talked about and the themes that emerged related strictly to academic topics. Not necessarily a larger academic context, but the narrow yet intense context of high stakes state testing was noted by some of the students in relation to preparing and taking the Florida Comprehensive Assessment Test (FCAT).

*It’s the biggest thing in all the subjects.*

Tommy, IM1, line 32
Something all kids should know.

Shawn, IM2, line 42

Something you learn from the time you’re in Pre-K or Kindergarten.

Crystal, IM3, line 34

Something to get you ready for FCAT.

Leah, IM2, line 18

Something you have to know before the FCAT comes.

Shawn, IM2, lines 33-34

Helps you during the FCAT.

Shaquille, IM2, line 44

While this category was obvious, in later reflection I was struck by the fact that a whole category was devoted to the Florida Comprehensive Achievement Test (FCAT). Certainly its importance is predominant in these students’ minds. One might note the emphasis placed by students on the FCAT which ultimately determines the school grade, student promotion to the next grade as well as related additional funding.

Additionally, the students expressed their perception of mathematics as highly content-oriented and school specific. This view was expressed more often than any of the others. John views mathematics as “a whole bunch of numbers you have to add” (IM4, line 24), whereas, Azariah explains “it’s a subject” (IM1, line 10) that includes operations “like division and multiplication” (IM1, line 12). Shawn shared that mathematics meant that “you have to learn to count stuff” (IM2, line 5) and Jasmine expressed that mathematics is simply, “your fractions” (IM1, lines 18-19). Montana sees mathematics as strictly “something that you do in school” (IM3, line 8).
Unfortunately, the “Ugly”

Finally, negative feelings toward mathematics were shared by some as well. Sandra shared that she did not like mathematics, but it was something she had to do. She explained “mathematics [was] a struggle” (IM4, line 101) and that it’s just “something you have to go through” (lines 3-4). Ashley simply and succinctly stated, “I’m not good at mathematics” (IM4, line 102).

Although the students’ perceptions showed, for the most part, they understood the importance of mathematics, the overall impression I got from them with regard to mathematics was not a positive one. This contradiction seems most likely the result of their lack of mathematical power and confidence necessary to be successful. It seemed to me that mathematics controlled them, they did not control it.

Was I interpreting their perspectives correctly? My concern for properly interpreting the students’ perspectives was foremost in my thoughts. The students’ voice has been absent in the literature for too long. It was vital to my study that I truly understood the students and “got it right” as I shared their perspectives, so I pressed for more data.

How Could I Be Sure?

As mentioned previously, the work of Lincoln and Guba (1985) guided my efforts in this study, as well as in my previous work with Dr. Deets. Lincoln and Guba use the alternative term trustworthiness to refer to the credibility of the study. A number of techniques were used to ensure the trustworthiness of this study, but the technique of member checking, in particular was used with the data from the initial meetings. Member checking refers to sharing study findings (i.e., raw data, analytic categories, interpretations, conclusions) with participants for their
feedback. This practice is considered to be “the most crucial technique for establishing credibility” (Lincoln & Guba, 1985, p. 314).

In order to make sure I understood what the students had to say during our initial meetings and that my interpretations of their words were valid, I asked them to participate in a member checking activity. In this case, my use of member checking utilized the students’ own words to enhance validity. After a preliminary analysis and interpretation of the initial data, I wrote down each student’s response that addressed the original question: What is mathematics and what does it mean to you? I enlarged the responses, made several copies, cut them apart, and placed each set of 23 responses in a baggie. During the activity the students were asked to categorize the responses. I wanted to see how they interpreted the responses and how they saw them fitting together.

In order to be certain the students understood the concept of categorizing, I conducted a warm-up activity with them. We gathered together as a large group in my office and I handed out attribute blocks to the students. We talked about the concept of sorting or categorizing. I then asked them to sort or categorize the blocks and label the groups they created. We talked about the groups and labels. Some of the students grouped the blocks by color and others by size or shape. I then asked them to sort the blocks again, only this time create different groups with new labels. They did so successfully and we discussed the new groups and labels. I was then confident they understood the concept and explained to the students I wanted them to do the same thing with some of their own words and statements from our initial meetings. I asked the students to break up into small groups of their own choosing and then distributed the materials they needed.
Each of the four groups had a baggie with the responses printed on strips of paper, their own chosen color of construction paper to mount their final categories, glue sticks and markers. The groups ranged in size from two to four students. At this point the students began working, manipulating the strips of paper and talking about how they should categorize the responses.

Figure 5: Pink group working on member checking activity.

Figure 6: Blue group working on member checking activity.

Later that day I recorded the events in my journal:

The students “needed a bit of reassurance about what to do at the beginning, but then really got into it. They talked together in their groups and decided how various phrases fit
together. [They] pasted the phrases on construction paper and then decided how to label each group. [I] found they had the hardest time finding appropriate labels. I helped by asking why they thought the phrases went together, why they put them together in a group. That seemed to help them find labels.”

The member checking activity proved to be both enjoyable and enlightening. Watching the students as they worked and listening to the discourse was fascinating. The experience reemphasized to me that children, all children, can think critically when presented with an interesting and authentic task. The results of their work were fascinating as well. As I reviewed the categories and labels the students created, it gave me further insight into their thoughts and perceptions about mathematics. Although their categories may not have precisely matched my preliminary analysis, many came very close. For example, in my analysis I separated my real-life connections category into two subcategories, the beneficial aspects of math in their lives and job related comments; whereas, the students tended to groups those comments together. Two of the four groups clearly saw the significance of the FCAT statements, just as I did (see Appendix N for legible text of FCAT categories).
The importance of mathematics and its impact on future job opportunities was apparent with three of the groups and closely matched my preliminary analysis (see Appendix O for legible text of the importance of mathematics and job opportunities categories).

Figure 8: Importance of mathematics and future job opportunities (Part 1)

Figure 9: Importance of mathematics and future job opportunities (Part 2)
This member checking activity was invaluable in that it allowed me another opportunity to hear the students discuss their own thoughts and perceptions about mathematics. Additionally, by having the students analyze and interpret their own responses, there was no danger of adults defining their thoughts for them. Further, due to the success of the member checking activity, as I analyzed their interpretations I was able to feel confident in the validity of my interpretations.

With the students’ perceptions of mathematics as the focus of our initial meetings, my next step on this journey towards understanding the students’ perceptions of mathematics learning was to talk one-on-one with the students to learn about their prior mathematics experiences. The next chapter will present, again largely in their own words, the students’ thoughts and recollections of their mathematics experiences prior to fifth grade.
CHAPTER FOUR: PERCEPTIONS OF THE PAST

As the old saying goes, “It’s important to know from where you’ve come in order to know where you’re going.” In order to fully analyze the impact of the reform effort, I felt it necessary to understand where the students had come from with regard to their prior mathematics learning experiences. With this goal in mind, I decided one-on-one interviews with the students would be the best way to gather data for this facet of my study. This chapter unveils, as often as possible in their own words and at times with their own drawings or computations, the students’ thoughts and recollections of their mathematics experiences prior to entering fifth grade at Sunburst Elementary. We will see that though many of the students’ previous teachers employed various techniques to aid student understanding, their heavy reliance on traditional pedagogy perpetuated a number of mathematical misconceptions.

I began the one-on-one interviews in mid-November and continued through mid-December (refer to Table 2 for Study Timeline, p. 25). I was able to conduct the interviews with only 15 of the 16 participants due to the repeated absences of one student. The themes that emerged upon analysis and are offered as subheadings for the reader, though interesting, were not surprising based on my twenty-plus years of experience as an educator.
Teachers’ Efforts to Aid Student Understanding

Use of manipulatives

It was obvious, based on the students’ perceptions, that their previous teachers used a variety of techniques to help the students understand the lessons they taught. Ten of the fifteen students interviewed talked about their teachers using manipulatives during lessons, including counters, Cuisenaire rods, and base ten blocks.

*She used the base ten blocks, and ruler. Sometimes she got shape thingys.*

Shaquille, OO, line 102

*She’ll give us des blocks that have ½ and four-fourths and all that.*

Jasmine, OO, line 42

*I used counters too for like, division. I threw them up and if they land on yellow, I had twenty counters, and if they land on yellow, then I need to tell how much yellow is up.*

John, OO, lines 364-365

A few of the students were also able to articulate how using the manipulatives helped them. Azariah explained using the base ten blocks with division helps “because it was more like you could look and see if you were doing it right” (OO, line 343). She goes on to explain the manipulatives are “something you can move, then write down because it’s harder when you’re writing it down than when you’re using the base ten blocks” (OO, lines 347-348). Shaquille explained, “I just started remembering them in my head” (OO, lines 129-130) when he used pattern blocks during a lesson. And finally, Briangeline shared if there is “some problem that I don’t know and need to find the answer or figure out the answer, I asks [the teacher] can I go get
the fraction cubes or the base ten logs and I get them and I put them together to figure out what the problem is” (OO, lines 33-36).

Use of pictures

A number of students discussed how previous teachers would draw pictures in an effort to aid understanding of the lessons presented. Sandra explained her teacher “made a visual on the board” (OO, line 260) when presenting new concepts while Montana’s teacher “would take a piece of paper and make little pictures” (OO, line 42). Drawing pictures is one way to make abstract concepts more concrete and hopefully easier for students to grasp. The teachers’ efforts apparently made an impression on several of the students based on their comments:

In mathematics we use pictures ’cause pictures help make something connected, but if we don’t do like pictures, I get kind of frustrated.

Briangeline, OO, lines 179-180

...it’s more easier to do with pictures than with problems....Because you can actually see what is going on with the picture.

Allen, OO, lines 172, 176

Mostly she did it with pictures...so that we’d understand it better.

Crystal, OO, lines 416-417

Because it gave me a clearer way to understand. Because if she just write numbers it would be too hard because it would be a little bit harder because I don’t got a picture to see what the numbers mean.

Yami, OO, lines 164-166
Use of grouping techniques

In their efforts to improve student understanding of mathematics concepts, the previous teachers also employed a number of grouping techniques in their classrooms. As part of their prior mathematics learning experiences, the fifth graders discussed working in small groups and also with partners, but their most positive comments pertained to working one-on-one with the teacher as part of their prior mathematics learning experiences.

*She set us up in groups and there have to be three to a group. ...we do different problems or sometimes we do the same problem and I get a different answer and somebody else get a different answer and then we have to decide how we are supposed to get the answer.*

Rebecca, OO, lines 285-288

Jasmine shared why she liked working with a partner.

*I worked with a partner beside me and we like doing worksheets together... we have like two worksheets, either her or she do one or I’ll do one and din we’ll trade papers and see if they got all the right answers and see if I got the right answers and see what we did wrong... and we’ll fix it* (OO, lines 136, 138,140, 142-143, 145).

The following quote explains why Shaquille likes working in small groups.

*Because you have partners to talk to instead of just, “I guess I should do this- no, I don’t know how.” Because when you just saying that stuff, you, ‘cause you don’t believe yourself, but when you have partners, they say, “That doesn’t go there; that goes there,” and then you have to listen to the leader or someone in the group* (OO, lines 152-155).
The benefits of one-on-one attention

Three students also expressed how helpful it was to have one-on-one attention from their teachers as they struggled to grasp the mathematics concepts. Sandra explained, “... if we don’t understand it, she will... she’ll find some time to teach you. I mean alone, like after school to teach you” (OO, lines 221-222). Shaquille related how his self-esteem was bolstered when he asked for help with fractions: “When I asked my teacher, she helped me and I learned more about fractions.... It made me feel a little better about myself” (OO, lines 115, 117). Briangeline also shared how one-on-one time with her teacher was helpful: “I have time with my teacher...and we work together doing [the mathematics] together. It make me feel like I know what I’m doing, that I won’t get confused... I won’t quit” (OO, lines 171-173).

Reliance on Traditional Pedagogy

Although the students shared a number of strategies their teachers employed that may not necessarily be seen in traditional classrooms, the overarching theme that emerged was that of typically traditional pedagogy. Based on the perceptions of eleven of the sixteen participants much of their prior mathematics instruction consisted of “teaching by telling.”

...we get out our books, we have to turn to a certain page and she’d tell us what to do, how to do it.

Briangeline, OO, lines 221-222

She said these two numbers have to stay the same and all you have to do is add the top numbers and then equal it.

John, OO, lines 319-320
Then I had got it when she told me what to do and how to do it.

Ashley, OO, line 39-40

She would tell us like, she would say, “Well all right class, we’re gonna learn something new today.”... Then she would review it for us. Then she would tell each of us to do the same thing.... She would erase hers and then she would tell us to do ours.

Shaquille, OO, lines 71-73

Understandings versus Misconceptions with Fractions and Division

During the one-on-one interviews, I also talked with the students about their learning experiences with division and fractions. I chose to focus on these two concepts because they are typically introduced prior to fifth grade. I wanted specific content that would serve as a common set of knowledge as I talked with the students about their previous mathematics learning. All of the students confirmed that they had been introduced to division and all but one student had learned about fractions. As we talked, it was apparent that the students did understand and were able to explain a few basic concepts such as unit fractions and the inverse relationship between multiplication and division, but unfortunately misconceptions about fractions other than unit fractions and computation with division abounded.

Examples with fractions

Most of the students understood and were able to illustrate their understanding of unit fractions by drawing a picture. Three of the students connected this concept to real life by
discussing the unit fraction as one piece of a whole pizza. The others talked about the fractions as one part shaded out of the whole. For example for the fraction \( \frac{1}{4} \), it was explained as one part shaded out of four parts all together. Though the students were able to illustrate the unit fraction and some were able to recall the terms numerator and denominator, they lacked true understanding of their meanings.

Representing fractions other than unit fractions presented problems for some of the students as well. One of the fundamental concepts children need to understand about fractions is they must be made up of equal-sized parts. Although Tommy, Crystal and John were able to correctly represent two-fifths with their models divided into five relatively equal portions, several other students lacked this understanding. Their models did not represent equal-sized portions and even when questioned, the students did not recognize this error. When questioned about the fractions they drew, each student simply counted the total pieces to check for accuracy without concern as to the sizes of the pieces. As I talked with Briangeline, whose work appears at the right below, and probed further, she gave a very convoluted and confused explanation for

Figure 10: Unit fractions illustrated correctly.
the numerator and denominator of a fraction, but was able to explain that fourths are larger than fifths when working with fractions:

Because, even though when you count five is greater than four, but it's different in fractions, a four is bigger than a five because you would never, you would never want a piece of candy bar this big [indicating a one-fifth piece], and instead you would want a big piece [indicating a one-fourth piece].

Briangeline, OO, lines 147-149

Figure 11: Fractions drawn with unequal-sized portions.

I also asked the students if they had learned to add fractions; most affirmed this concept had been introduced to them. However, only John and Leah were able to correctly add two fractions with like denominators and only John was able to add two fractions with unlike denominators. Although John was able to correctly add the fractions with unlike denominators one of the problems associated with “teaching by telling” was quite apparent in his explanation.

First I gotta make five and three, the numerators the same. What does that equal up to? Fifteen. How do I get fifteen out of five? I multiply by three. How did I get fifteen out of
three? I did five. So what you have to do to the bottom, you have to do to the top. Do three and five...

John, OO, lines 299-301

And, his explanation for adding fractions with like denominators reflected the same problem; rote learning with little or no conceptual understanding.

She said these two numbers have to stay the same and all you have to do is add the top numbers and then equal it.

John, OO, lines 319-320

Examples with division

Division was even more problematic for these students. A few were able to express their understanding of the inverse relationship between multiplication and division. Allen explained “that if you know your times tables, you know your division” (OO, lines 27-28). When asked why this is so, he responded, “Because the answers to your multiplication is to your division” (OO, line 32). Though not terribly articulate, he did understand the relationship.

I also asked the students to divide a 3-digit number by a 1-digit divisor in order to determine their level of understanding of computation with division. Only two students were able to solve the problem correctly. Leah and John both solved the problem using the traditional algorithm for division, or what is commonly called long division, though only John was able to explain the steps of the algorithm as he completed them. Leah worked the problem in her head as she wrote, but was unable to clearly explain the steps. Although both students correctly
solved the division problem, there was little conceptual understanding of the process. They simply carried out a series of steps they had memorized.

These memorized steps were based on a mnemonic their teachers taught them as a way to remember the steps for the traditional long division algorithm. The mnemonic represents the steps of the algorithm: D for divide, M for multiply, S for subtract, B for bring down, and often R is included for remainder. Next, a catchy phrase or easily remembered words are substituted for the names of the steps. For example, some of the fifth graders recited the following mnemonic as we talked in the one-on-one interviews: Dad, Mom, Sister, Brother, Relative. Another mnemonic I have heard students use in the past is Dear Mrs. Smith Brings Roses.

Some of the students were more successful at remembering the mnemonic than others. And for those that did remember the mnemonic correctly, it did not guarantee success when actually solving the division problem.

Figure 12: Examples of student use of division mnemonic.
I have personally witnessed how this approach has proven confusing and quite frustrating to myriad students. Again and again I have observed students solve, or attempt to solve, division problems with the traditional long division algorithm, some using various versions of the mnemonic, others just following the memorized steps of the algorithm. Invariably, whether the problem was solved correctly or not, when questioned about the process or the numbers used the students had no clue as to the rhyme or reason of these steps. I have seen this occur not only with intermediate-aged students, but with very intelligent adults as well. For example, my daughter, a freshman in the Honors Program at the University of Florida and a very bright young woman, can compute using the traditional long division algorithm, but has no understanding as to where the numbers come from or their meaning. Similarly, the majority of preservice elementary teachers I taught in an undergraduate mathematics methods course, though intelligent adults, had little or no understanding of the meaning behind the steps of the traditional long division algorithm.

The fifth graders of Sunburst Elementary were quite clear in expressing their confusion and frustration with this process.

...a lot of steps you had to do with division and I'm like, this is too long.

Crystal, OO, lines 483-484

I got it when she told me how to do it, but I forgot.

Ashley, OO, line 96

We would usually do something like this...b, bring, no (erases her work), b-r-i-n-m-r....That stands for, ummm, I can’t think of the m or I, but I know m is multiplication and r is remainder.

Briangeline, OO, lines 252-254, 255-256
They mean, they just mean, this means (pointing to each letter she wrote) divide, this means multiplication, this means subtraction, this means bring down, this means remainder.... It’s just something easy to do, like they tell you to divide.... I don’t know how to use this... I just don’t know how to use them.

Sandra, OO, lines 379-380, 387-388, 393, 395

...we did a little bit of division, but it was hard to do it and I didn’t get it.... When she would do it, puttin’ all the numbers together I didn’t get what order they would go in.

Rebecca, OO, lines 115-116, 121-122

Historically, teaching mathematics through traditional methods such as “teaching by telling” and asking students to memorize algorithms without conceptual understanding has not proven successful, hence the calls for reform. The difficulties and struggles I highlighted through the words and work of the fifth graders in our one-on-one interviews are evidence of this fact.

As mentioned previously the district in which Sunburst Elementary is located, began the implementation of a new standards-based, reform-oriented mathematics curriculum during the 2004-2005 school year. The following chapter will present the students’ perceptions of their learning within the context of that reform effort.
CHAPTER FIVE: LEARNING AND THE BEGINNINGS OF REFORM THROUGH THE STUDENTS’ EYES

As we all know, change is sometimes a slow and difficult process, but fortunately the work toward reform is worth the effort. As Sunburst Elementary took its first tentative steps towards mathematics reform during the academic year of 2004, I listened carefully for the voices of the students. The following chapter will present the differences that students shared with me. Students noticed differences in their mathematics learning during this beginning effort toward reform as well as some resulting benefits.

The data used to compile this chapter was gathered from a variety of sources including classroom observations, focus groups with students, teacher interviews, and finally follow-up interviews with individual students (refer to Table 2 for Study Timeline and Chapter 2 for more information on data gathering techniques used). These various data sources provide access to the different voices captured in this study; with the most significant being the voices of the students offered in the focus groups, follow-up interviews and student surveys. Whenever possible, the speaker is identified throughout the chapter. However, because up to four students were involved in the focus groups, at times a specific speaker cannot be identified. The teachers’ voices are shared through the teacher interview data, and finally my interpretation of events will be offered with classroom observation data and excerpts from my journal. For the sake of clarity and to aid the reader, I have carefully identified each source throughout the chapter. I begin with my thoughts, as recorded in my journal in early August as I anticipated the year ahead:

“I’m anxious to get started. Let the teachers get into [the new curriculum], see how I can help, see how the kids do. I so hope it helps them learn mathematics!”
Differences Noticed

The previous chapter presented the students’ thoughts about their prior mathematics experiences as shared during the one-on-one interviews. With those recollections in mind and as I began the focus groups at the end of March, I was interested in whether or not the students noticed any differences in their mathematics learning as fifth graders in juxtaposition to their prior mathematics learning experiences. The findings clearly illustrate that the students did notice differences, though as they talked about the differences some comments were more specific than others. A few students noticed a difference in the mathematics teaching or their learning, but couldn’t quite put their finger on what exactly was different, while others were able to explain specific differences they noticed. Leah shared “it was harder” (FG1, line 28) and “it didn’t look the same as what we did in fourth grade” (FG1, line 36). Similarly and without noting specifics, Montana explained, “Mathematics is harder than last year” (FG3, line 35) and another shared, “It’s a lot different” (FG1, line 763). These themes of differences were heavily supported and noted in all data sources as illustrated by all colored tags appearing in the categories (see p. 34 for a visual of this concept). As the focus groups continued, the students talked at length about a number of specific differences including games played, manipulatives used, and alternative algorithms learned. Some thoughtful insights as to the benefits of having choices in their mathematics learning were also shared by the fifth graders and their teachers.
As we talked in the focus groups, at least 10 different students mentioned how playing the games helped them as they worked to remember and retain previously learned concepts as well as in learning new concepts.

Instead of writing, you know like writing and stuff, you can have games that show you it [the mathematical concept]. Like for-like, like if-say if you don’t get it, you could play a game. Then it would get you to learn it, to do it more.

Azariah, FG2, lines 196-198

What I like about it is when you don’t get it, she pulls out the – a – she pulls out a game that will help you.

FG2, lines 170-171

So the game visualize it for me.

FG2, line 183

Well, like Montana said earlier…mathematics games. She taught us like [game dealing with exponents] to help us on our exponents and stuff and our squares and powers.

Shaquille, FG3, lines 341-342

…it taught [us], when I was playing a game with like Allen, …. We could use our division, our multiplication, the multi-skills.

Yami, FG4, lines 370-371

It [playing the game] helps me like when we play “[game dealing with factors].” It helps me win. We have to pick a number and then get all the factors that you can find.

Jasmine, FG4, lines 378-379
The perception of the games helping the students learn concepts was offered in the follow-up interviews as well. Azariah felt the games helped she and her classmates because “… we got every different mathematics game for like every different um, a[l]gorithm” (FI, lines 116-117) and when they are learning new concepts “… we always have a game to go wid it” (FI, line 125). For Rebecca, the games were a true favorite. Her face lit up every time we talked about the games. She explained why they were her favorite: “’Cuz not only do we get to have fun, but we get to learn at the same time” (FI, line 82).

The notion that Rebecca offered of having fun and learning at the same time was also supported in the focus group data.

… you can learn stuff and laugh and have a good laugh at the same time.

FG2, lines 214-215

… you having fun and you learning.

FG2, line 185

Not surprisingly, the games made an impression on the students because they were designed to be an important component of the new curriculum that was implemented. In the new reform-oriented curriculum, the playing of specific games aligned with the curriculum was presented as an enjoyable way to help students become fluent in essential skills such as mastering basic facts as well as continued practice of new concepts such as understanding exponents. By design and as the students noted, playing the games was a pleasurable alternative to the traditional “drill and kill” methods of mathematics practice.

What was surprising, however, was how much the students truly enjoyed the games. Their enjoyment was genuine and apparent in the comments shared above. It was further illustrated by remarks in the follow-up interviews and the results of the student surveys. For
example, when asked what they might change about their mathematics learning in the follow-up interview (see Appendix I for follow-up interview questions), two of the five students wished they could include more mathematics games. And with respect to the student survey data, all of the 15 students surveyed “agreed” or “absolutely agreed” to the statement “I like playing mathematics games” and again, all 15 “absolutely agreed” that playing mathematics games helps them learn or understand mathematics (see Appendix L for student survey results).

Finally, the impact of the games was also noted by the teachers. Ms. Nees, one of the fifth grade regular education teachers, explained how the students were not terribly enthused about the games at the beginning of the school year, but once they played them a few times their attitudes definitely changed, “Now they just go directly to the one they want to play. It’s usually a favorite one, or one they’ve kinda, sorta, they’re getting better at. [Game dealing with factors] used to be one they hated to play, but now they’ve started to get it and understand that particular concept” (TI, lines 141-144) and “…now they seem to be, actually, they enjoy them” (TI, line 158). Ms. Nees also noticed how playing the games helped the students learn to work and cooperate together, something that did not come easy to them at the beginning of the year.

Playing the games not only helped the regular education fifth graders, but also the students in the Specific Learning Disabilities (SLD) classes as well. Ms. Pauls explained that her students “like the games” (TI, line 141). A second SLD teacher, Ms. Wilson shared that her students “were extending the games on their own” (TI, line 86), which was wonderfully heartening to hear and witness personally as it illustrated the students’ ability to truly understand the concept and think more deeply about it as they took the original game a step further or created their own game based on the original. This would be similar to what children might do in language arts when they write parallel stories based on an original story they have read or heard.
Additionally, Ms. Wilson noted, as did Ms. Nees, the positive affects of playing the games, “It’s helping their social skills even, because of all the group stuff and the games and they take turns and share” (TI, lines 95-96).

Evidence exists in the literature to support the comments offered by the students and teachers of Sunburst Elementary regarding the positive impact of playing games in mathematics (Lewis, 2005; Shaftel, Pass, & Schnabel, 2005). Shaftel, Pass, and Schnabel (2005) offer a list, gleaned from the literature, of benefits that playing mathematical games can provide such as providing students with immediate feedback, supporting positive attitudes toward mathematics, and allowing students to try new problem-solving strategies. Additionally, the use of mathematical games can help improve social skills such as taking turns and cooperating with others (Shaftel, Pass, & Schnabel, 2005), just as both Ms. Nees and Ms. Wilson reported. Another difference in their mathematics learning that the students noticed, besides the games they played, was the manipulatives they used throughout of the year.

Manipulatives They Used

During an afternoon of analysis, as I sat at my kitchen table scrutinizing the numerous color coded tags, the use of manipulatives was another difference that was quite apparent as it emerged. This theme was noted by both students and teachers and observed in the classroom observations as well. It was supported in all data sources: focus groups, classroom observations, follow-up interviews, and teacher interviews. Although students highlighted manipulative use as perceptions of their past learning experiences in mathematics, the use of manipulatives within the
new curriculum was distinctly linked to specific content; therefore, making the use of manipulatives more effective.

John often avoided answering direct questions; however, during a follow-up interview, I asked him about any differences he noticed in his mathematics learning in fifth grade. He thought about his answer and stated: “We do stuff more with blocks and stuff” (FI, line 55). Rebecca also noted, again in a follow-up interview, the different types of manipulatives used. She explained, “We have different kinds [of mathematics manipulatives] in our class...” (FI, line 106). And by example she offered, “...we have like little cards an’ stuff to help us.... On the back it gives you fractions and on the front it gives you whole numbers and stuff...” (FI, lines 116, 120-121).

As in the one-on-one interviews about their previous mathematics experiences, the students were quite articulate and insightful as to why the manipulatives were helpful in learning mathematics concepts. Briangeline and Shawn offered the following comments during a focus group.

*I think those things [manipulatives] helped because it’s like if we didn’t really understand it [the mathematics concept presented], how our teacher showed us,... it [the manipulative] gave us like a better view of how we can do it, much better.*

Briangeline, FG3, lines 399-400, 401-402

*The activities and things help me because it like gives me an experience to get a closer view of mathematics.*

Shawn, FG3, lines 415-416
Further, three of the five students in the follow-up interviews talked about why the use of manipulatives was both important and helpful in their mathematics learning. Sandra and Rebecca were quite clear in explaining their need for manipulatives.

... I’m one of those people that can’t learn without any kind of like vision, a visual, like a visual thing. If I was doing mathematics and there was no visual aid, I would have to draw it out.

Sandra, FI, lines 207-209

So I used the little counters so I could put ‘em in groups and dat way I can see what I’m doin’ and see when I mess up.

Rebecca, FI, lines 138-139

Rebecca went on to explain why manipulatives helps other students as well.

... ‘cuz when they know what they doin’ and dey see it in front of dem, that way they won’t get lost and they know what they doin’ ‘cuz they know they mistakes.

Rebecca, FI, lines 152-153

Sandra and Azariah commented further on the helpfulness of using manipulatives.

...it helps because I know if I get stuck on a problem I can figure it out with the fraction circles...

Sandra, FI, lines 175-176

You ken have the fractions in front of you. You ken take them apart an’ stuff like that.

Azariah, FI, line 150

The survey data also supported the findings concerning the use of manipulatives. Two questions on the survey refer directly to the use of manipulatives in learning mathematics (see
Appendix L). The first states: I like using manipulatives, or learning tools, in mathematics. Only one of the 15 students surveyed marked the “No Way!” category with three classmates agreeing to the statement and the remaining 11 absolutely agreeing. Similarly, only one student indicated absolute disagreement to the second item stating that using manipulatives helps the students learn or understand mathematics. The remaining students absolutely agreed with one exception, that student simply agreed with the statement.

In addition to the students’ comments and the student survey data, the teachers’ comments further supported the findings with regard to the use of manipulatives. Ms. Nees spoke quite passionately about one of her students in particular. This child was in the regular classroom, but had an Individualized Education Plan (IEP) to address his specific learning needs. He often struggled with mathematics concepts. She explained how the manipulatives helped him understand a number of geometry concepts.

_He would get very confused, but we got out shapes, and so when we’re talking about shapes he could run his finger along the side of it and he would say, “Okay, that’s the side.” Or he would have to point to the tip and say, “Okay, that’s where the angle is at.” And so even now when we play it [game dealing with polygons] he sometimes pulls out manipulatives to think about it because he rubs his finger and you can see him thinking._

Ms. Nees, TI, lines 228-233

Similarly, the SLD teachers discussed the benefits of using manipulatives. Ms. Wilson explained that the new curriculum, with its emphasis on using manipulatives, was helpful because “it’s all very concrete for them [the students]” (lines 439-440). And Ms. Pauls offered, “… I have very concrete learners. Getting all the materials out so they can touch and move has
been helpful in [the new curriculum], because it really wasn’t in the other mathematics program that I’ve used” (lines 131-133).

Finally, I noted the use of manipulatives a number of times during classroom observations, but as Stein and Bovalino (2001) point out, “Simply using manipulatives, however, does not guarantee a good mathematics lesson” (p. 256). Therefore I paid close attention to the way the manipulatives were being used in the fifth grade classrooms. As I visited in my capacity as mathematics coach, appropriate use of manipulatives was observed in all fifth grade classrooms. Their appropriate use was also noted during formal observations conducted for this study.

The following example relates events observed while conducting a formal observation. During this particular lesson Ms. Smith repeatedly connected the day’s lesson back to the manipulative activity they had completed the previous day in which the students explored using pattern blocks to represent fractional parts of a whole. She reviewed the concepts from the previous lesson then extended the lesson into comparing and ordering fractions. As she and the students talked, Ms. Smith continued to make those all important contextual and physiological connections that Caine and Caine (1991) deemed so important for meaningful learning to occur. Additionally, she helped two students who seemed to be struggling with a concept by offering them the use of a different manipulative, an egg carton, and an alternative explanation. This procedure exemplified Caine and Caine’s concept of redundancy in action, in other words, presenting information in a number of ways to ensure meaningful learning.

Ms. Smith was also observed drawing pictures on the whiteboard in her efforts to help the students understand the lesson. Later in the lesson, the pattern blocks were taken out again and the students used them to complete an assignment. I walked around as the students worked
together to complete the assignment. I noticed a variety of strategies being used to solve the problems. Some of the students drew pictures while others used the pattern blocks and a few were able to solve the problems without the aid of pictures or pattern blocks.

Using the pattern blocks and pictures as a way to help students understand fractional parts of a whole illustrates a commonly used and developmentally appropriate pedagogy used in teaching children mathematics. This practice involves moving gradually through the levels of abstraction from concrete (manipulatives) to semi-concrete (pictures) to semi-abstract (symbolic representation such as tally marks) to abstract (numbers or letters) when presenting mathematical concepts (Heddens & Speer, 2006). This progression is developmentally appropriate in that it closely follows Piaget’s (1962) theory of cognitive development. Piaget explains that children move through four levels of cognitive development. He cautions that children will not understand if pushed or forced to learn concepts beyond their stage of development.

Presenting mathematical concepts to children in ways that follow this progression can help ensure meaningful learning of mathematics. Another way to help students understand concepts and processes in mathematics is through the use of alternative algorithms.

**Alternative Algorithms They Learned**

Historically, traditional algorithms have been taught in schools as fast, efficient methods for computing numbers. Unfortunately, the teaching of these algorithms has focused on rote memorization of procedural steps to follow, as in the memorization of the mnemonic for long division discussed in Chapter Four, and essentially forsaking conceptual understanding. As a result, children often become confused and make errors in computation. With the advent of
calculators and computers, reliance on traditional algorithms was no longer a necessity. The call for reform stressed a new emphasis on understanding and meaningful learning of mathematical concepts.

Studies have shown that children can and do construct their own accurate strategies for computation (Carpenter, Franke, Jacobs, Fennema, & Empson, 1998; Carrol, 1996). These child-developed strategies are often called invented strategies. Van De Walle (2004) reports along with these research efforts, reform-minded curricula have also included within their materials, the use of student-invented strategies in the development of computational methods. Similarly, alternative methods or algorithms for computation are also offered in the reform-oriented curricula, as was the case with the new mathematics curriculum implemented by Sunburst Elementary during the 2004-2005 school year. Alternative algorithms are included in reform-oriented curricula because they are often easier for students to understand and learn. Their use over time can also help children understand that not everyone learns the same way and that many times there is more than one way to solve a problem.

These alternative methods or algorithms for computation were the focus of another difference noticed by the fifth graders in their mathematics learning. One of the students offered, “They’re [alternative algorithms] helping you learn mathematics in a new way” (FG2, line 17). Whereas, when learning about multiplication in fourth grade, one of the students shared, “We learned just that [traditional algorithm] way” (FG1, line 273).

During the focus groups, the students discussed a number of the alternative algorithms they learned as well as some of their likes and dislikes of the different methods. An alternative method for multiplication mentioned by the students was lattice multiplication (see Appendix P for explanation). Lattice multiplication is an alternative method for
multiplication. Although it does not necessarily enhance conceptual understanding of multiplication, it is easier and faster for some students than the traditional algorithm for multiplication. Ashley shared, “Lattice’s easy; it’s easy” (FG1, line 73). Then, by way of a reminder to her classmates, she explained, “You know where you ummm... make the box and the numbers” (line 75) and again with feeling and a snap of her fingers, “It’s just easy!” (line 79). Ashley found lattice multiplication easy as did a classmate in a different focus group, but with one caveat. Her classmate explained, “I know how to do them awesome, but I don’t know how to set them up” (FG3, line 211).

A second alternative method for multiplication the students discussed was what they referred to as “chunking,” although it is also known as partial products multiplication (see Appendix Q for explanation). During the first focus group, John asked if he could demonstrate the method of multiplication he and some of his peers referred to as “chunking.” He solved the problem 32 x 16 in a matter of moments and quite easily. Though John found the partial products method of multiplication simple enough, one of his classmates did not. He was quite clear as he expressed, “I don’t wanna do the chunking it” (FG1, line 194).

In addition to the alternative methods for multiplication that the students considered during the focus groups, they also talked about division with partial quotients, an alternative algorithm for division introduced to them earlier in the school year (see Appendix R for explanation). Partial quotients division allows students to work with numbers that are more comfortable for them. Students typically choose multiples of ten that are easier for them to multiply and then subtract from divisors. Rebecca shared that, for her, division with partial quotients “…was the easiest one [method of division]” (FG2, line 307) and “That’s what I do
every time I do ...division” (line 317). Further, when asked about the traditional algorithm for long division she explained, “That’s the hardest one; I don’t know how to do that” (line 313).

During a different focus group the students offered that division with partial quotients was easier and when asked to explain why they felt that way, one of them explained, “It’s like a short cut to it [the answer]” (FG3, line 120). I was slightly confused by this response in that the partial quotients method can actually involve more steps than the traditional algorithm for division. So, for the sake of clarity, I asked if it was easier to figure out the numbers, in other words to solve the problem with partial quotients. Around the table, heads nodded and with a chorus of “Mm-hmms,” all agreed with feeling and in unison.

Although many of the students found learning and using the alternative algorithms easier than the traditional algorithms, it was not always smooth sailing. In speaking about the alternative methods for multiplication, Shaquille explained how it was difficult at first, but with time he was able to understand.

Yeah, it [lattice method] helped me figure it [multiplication] out, but the other methods were kind of confusing ‘cuz I didn’t understand them at first, like Briangeline said earlier. But then when she [the teacher] showed examples at the board, I just looked down and then I got it.

FG3, lines 278-280

And as the following comment clearly shows, not all the students liked using the alternative methods.

I don’t like the lattice; I don’t like the partials; I like the standard [traditional algorithm]....

FG4, line 307
As pointed out by the students, the alternative algorithms introduced during the year often made computation easier for them. Both the students and the teachers recognized a number of benefits from having choices when faced with computation.

**Benefits of Having Choices**

Although not all the students agreed about the alternative algorithms, several were quite articulate about the advantages of having choices when faced with computation. They were clear in their understanding that mathematics learning is not a “one size fits all” situation.

*Because then I can use, it would be easier, so I wouldn’t get frustrated, because if it’s a hard [problem] you can make it into an easy one.*

FG1, line 468-469

*Because like the, because some ways you can’t do. You can’t, like the regular way where you do the division part, sometimes, some people, all people can’t do that, so different ways help you to do more.*

Azariah, FG2, lines 58-60

*Because not only that you could do it one way, but you can have friends that do it another way that still have the same, the same answer and doing it correctly.*

FG2, lines 75-76

*...because one way don’t fit for everybody.*

FG2, line 80

Two of the teachers, Ms. Smith and Ms. Nees, also had a number of comments about offering their students choices in their mathematics learning. Ms. Smith felt strongly that “... the
children get it [the concept presented] quicker and easier when it’s their turn, if that makes any
sense. When it’s their turn, when it’s presented their way, those children jump on it” (TI, lines
59-60). She expounded further on the subject as we continued talking.

There’s not one way and you [the students] don’t do it [solve problems] like this because
I said you do it like this. It’s all about discovering new ways of doing it. Which is easier
for you? Which do you understand? Which can you pick up? And so that is gonna
eventually give them confidence in themselves to think they can go on and do other
things, not just try to get through it; which is what most mathematics, most people do
with mathematics.

T. Smith, TI, lines 105-109

Ms. Nees related the value of alternative algorithms with an anecdote of one of her
students.

I have [a student] in my room. She cannot do your traditional division. She gets very
confused, and she almost always messes it up. But she does partial quotients... 90% of the
time [she’s] dead on with it. She can actually- that method works for her.

TI, lines 101-105

She went on to talk about the lattice method for multiplication and how it helped some of
her students as well.

I have some kids who cannot get the typical multiplication algorithm. But they can do
[the] lattice method, and like that, [snapped her finger] quickly, very quickly- you know
probably more quickly than some of my kids that did the standard algorithm. So that,
even though initially again, for me, was difficult because I’d never seen those things,
huge in helping them to figure it [multiplication] out.

S. Nees, TI, lines 105-106, 110-112

Offering students choices in their mathematics learning can promote both confidence, as Ms. Smith pointed out, and intellectual autonomy. Studies have shown the importance of choice and intellectual autonomy in mathematics learning (Moyer & Jones, 2004; Yackel & Cobb, 1996). In their discussion of choice in the mathematics classroom, Moyer and Jones (2004) explain when students are given choices in their mathematics learning it allows them “to be active participants in the classroom community and to draw on their own capabilities when making mathematical judgments and decisions” (p. 17). The value in the choices offered and the benefits reaped in the students’ mathematics learning due to these alternative methods cannot be denied. The games, manipulatives, and alternative algorithms introduced during the reform year allowed the fifth graders a first taste of their own mathematical power.

The differences noted by the fifth graders in their mathematics learning came as a result of a district-wide effort toward mathematics reform and the implementation of a new, reform-oriented curriculum. The new curriculum, in order to be implemented properly, required some changes in the way teachers had been teaching mathematics. Sunburst Elementary had been using a highly scripted mathematics program that required little teacher preparation or initiative. The following chapter presents the struggles and celebrations experienced as the teachers of Sunburst Elementary worked to move from traditional mathematics instruction to a reform-oriented pedagogy.
CHAPTER SIX: SHIFTING FROM TRADITIONAL MATHEMATICS INSTRUCTION TO A REFORM-ORIENTED PEDAGOGY

Any change, even for the better, is always accompanied by drawbacks and discomforts.

Arnold Bennett

As noted at the beginning of Chapter Five, change is difficult and Festinger’s (1957) theory of cognitive dissonance notes that discomfort often accompanies our working to learn something new. From my vantage point as the mathematics coach at Sunburst Elementary, I observed the times of strife the teachers encountered during the first steps toward mathematics reform, but moments of happiness and celebration were documented as well. I begin this chapter with an explanation of my role in mediating the cognitive dissonance that occurred during the beginnings of the reform effort. This chapter will also share those times of celebration and pride in new learning as well as the growing pains and frustrations felt by both students and teachers during the first year of the reform effort. The teachers’ growth in reform-oriented pedagogy will be presented along with concerns they expressed during the reform process. Their slips back to traditional instruction and the students’ frustrations will also be shared. In addition, the positive aspects of the reform effort, as acknowledged by teachers, will be offered for the readers’ consideration.

Mediating the Cognitive Dissonance

My job as mathematics coach at Sunburst Elementary was to support teachers in the implementation of the new curriculum and to help usher in the mathematics reform effort.
Although I had never taught using this particular curriculum, I taught using constructivist strategies with much success and was very comfortable with the reform-oriented pedagogy and philosophy needed to help the teachers understand mathematics reform. One of my first goals was to meet with grade level teachers on a monthly basis. The purpose of these meetings was twofold. First, I wanted to share planning tips for each chapter of the new curriculum. I received these tips in special training sessions offered by the district to help ensure a smooth, district-wide implementation of the curriculum. Second, was to mentor and guide the teachers in any way they needed in their efforts to move toward mathematics reform. So, I answered questions they posed, explained new concepts they were not familiar with, modeled using manipulatives and alternative algorithms, and listened as they shared their experiences. When faced with teaching alternative algorithms they had never learned, I offered suggestions to ease their anxiety and confusion. I celebrated with them over the small triumphs their students experienced, for instance, when several of Ms. Smith’s students excelled at lattice multiplication.

In addition to the monthly grade level meetings, I also met periodically with teachers on an individual basis and visited classrooms. Furthermore, I conducted four professional development sessions after school with all grade level teachers including topics such as assessment and using manipulatives effectively in the classroom. All of these efforts went to supporting the teachers as they moved from traditional mathematics instruction toward reform-oriented pedagogy.

Shifting paradigms from traditional-minded pedagogy to reform-oriented pedagogy is not an easy task, and harder still when the shift is not of one’s own choosing. This was the situation faced by the teachers of Sunburst Elementary due to the district mandated implementation of the new mathematics curriculum. Many were ready and waiting for the changes, but others were
quite reticent and reluctant. I personally experienced this paradigm shift as an eye-opening experience during my Master’s coursework, although a few of my colleagues truly struggled with the shift. In my doctoral fellowship experience as an instructor for an elementary mathematics methods course, I saw how preservice teachers struggled with this paradigm shift. Some were better able to make the shift than others, as was the case at Sunburst Elementary.

Regardless of their success or lack thereof to truly shift paradigms, I must say that I was, and still am, extremely proud of the hard work all of the teachers put forth during the first year of the reform effort. Implementing a brand new mathematics curriculum is always a challenge, but add to that challenge trying to learn new teaching methods and philosophy. Further, these teachers had to deal with the incredible pressure felt from the district level to improve students’ standardized test scores, yet the majority of the teachers worked assiduously to learn and grow professionally. Their efforts did not go unnoticed. The principal visited classrooms frequently and often made positive comments about the wonderful efforts both the students and teachers were putting forth with the new mathematics curriculum. In my visits as mathematics coach as well as during formal observations conducted for this study, I observed teachers diligently working to implement the new curriculum and embrace reform-oriented teaching practices. The teachers often referred to their teachers’ manuals as they taught a lesson in an effort to teach the new curriculum with as much fidelity as possible. They also adjusted and readjusted their daily schedules in order to include all suggested components of the new curriculum, such as the games and the mental mathematics exercises.
Reform-oriented Pedagogy Observed

During the nine classroom observations of mathematics lessons that I conducted from late December through mid February, I was pleased to see evidence of reform-oriented pedagogy that I had been encouraging during the year through our meetings and workshops as well as through the guidance offered in implementing the new curriculum. All of the fifth grade teachers observed consistently required the students to justify their thinking and solutions offered in both oral and written formats. In one of the first lessons observed in Ms. Smith’s classroom, a lesson on comparing and ordering fractions, one of the students offered that five-fifths makes a whole. Ms. Smith responded by asking the student to justify his answer. She asked, “Why do five-fifths make a whole?” (CO1, line 35). The student was able to clearly explain his thinking. In a later lesson connecting a clock face and fractions, after a student offered an answer, Ms. Smith asked, “Why? Explain your thinking,” (CO5, line 22).

I also noted Mr. Thomas, the fifth grade teacher hired mid-year in January, consistently asking the students for justification of their answers or thinking. In a lesson on equivalent fractions, I recorded Mr. Thomas asking a student, “What was going on in your brain to help you figure that out?” (CO7, line 73). Later, in the same lesson, he asked another student, “How’d you find that [the solution]?” (CO7, line 77). Overtime I noticed that the students grew more comfortable with articulating their thinking. In my own experience as a fifth grade teacher, I found that because previous teachers had not required my students to justify or even talk about their thinking, it was strange and difficult for them to do so in the beginning; however, as time went on they seemed more comfortable and able to talk about and justify their thinking about mathematics. The same thing happened with the fifth graders at Sunburst within a few months. Encouraging and requiring that students justify their thinking about mathematics and the
solutions they offer helps students understand and expect that mathematics makes sense (NCTM, 2000).

The fifth grade teachers not only encouraged students to justify their thinking about mathematics, but they pushed them to think more deeply and critically about mathematics. During one part of a lesson, I observed in Ms. Smith’s class on comparing fractions she listed four fractions on the board: \(\frac{1}{6}, \frac{1}{4}, \frac{1}{2}, \frac{1}{3}\). Her goal for this part of the lesson was to help the students understand the inverse relationship between the number of parts and the size of parts in fractions. This concept must be constructed by the students themselves. It cannot be told to them and memorized as an arbitrary rule (Van de Walle, 2004). Ms. Smith asked the students to tell her what they observed about those numbers. Several students offered the obvious: they all had the number one as the numerator. In other words, they were all unit fractions. Another noticed the common multiple was 12. Two students then began to pick up on the fact that the denominators were getting smaller. Ms. Smith probed further by asking, “What does that mean?” (CO1, lines 152-153). The students seemed to get stuck there.

So in an effort to facilitate a deeper understanding, Ms. Smith pulled out the pattern blocks they had used the day before in a lesson exploring fractions. She laid out the pattern blocks to represent the four fractions and she connected the concept to the real-life context of pieces of pizza. She asked the students which piece they would rather have. At once they realized that the one-half piece was the largest and they would want that one. At this point, a few students realized that as the denominator gets smaller the fractional parts get larger with fractions. They discovered this concept with the help of manipulatives and they constructed it themselves. As a result, the students will both remember the concept and be able to better articulate it. Ms. Smith had avoided telling the students this rule and allowed them to understand it on their own.
Another technique I observed being used to help students think deeply and critically about mathematics was the use of webbing. Webbing allows students to see connections in mathematics and supports the notion that mathematics makes sense. Further, webbing is a technique often used in language arts to help students comprehend or compose text. As an introduction to a unit on fractions, Ms. Nees brought the students to the front of the class and together they created a web of what they knew about fractions (see Appendix S for recreation of web). She used this technique as a way to engage and document her students’ prior knowledge of fractions. As the lessons on fractions progressed, she and the class added to their fractions “web” and throughout the unit on fractions, I often heard her encourage the students to refer to the web when they had questions about fractions.

Evidence of a shift toward reform-oriented pedagogy also surfaced during my one-on-one interviews with the teachers. The teachers understood the need for reform and Ms. Smith expressed this need clearly:

*For us to be a competitive nation, our mathematics [instruction] has got to change…. And basically I don’t feel we’re gonna get visionary people if we’re a drill and kill nation. There has to be development of creativity in mathematics. And every now and then you’ll see a child with this teaching [the new curriculum], and I’ve not seen this before, when they’ll like spark off and go, “Well if you could do that, you could do this,” and so they’re not even really sure what they’re doing yet, but they’re trying to find their own rules for doing it because it’s [the new curriculum] freed them up. Any way you can accomplish it is okay with this type of teaching.* (TI, lines 97-105)

Ms. Nees, a fifth grade teacher, explained how she had been used to teaching for mastery in the past, therefore the new methods were even more challenging for her. The previous
The mathematics program used at Sunburst was a completely scripted program that stressed skills mastery, whereas the new curriculum was based on spiraled skills both within and between grade levels. The teachers were encouraged to “trust the spiral” in that skills were visited again and again throughout the curriculum. Further, skills included in a unit were labeled as beginning, developing, or secure. The beginning skills were those being introduced for exposure; mastery was not expected. Mastery was not expected with skills labeled as developing, though students’ competence with those skills was expected to be moving forward. Only the skills in the unit labeled secure were expected to be mastered. This varied level of mastery within a unit was a new and often confusing concept for teachers to grasp and unfortunately tended to slow the pace of instruction.

Ms. Nees went on to share how one of her goals was to improve her ability to assess her students’ learning. She shared that she had “taken more anecdotal records this year than ever” (TI, lines 25-26) and how it helped her “to better understand what it is they [her students] don’t get about a concept” (TI, line 30). “I could hear some of their thinking” (TI, lines 40-41). She was learning to listen to her students and she was also beginning to understand the importance of writing in mathematics. She began using a closure technique suggested in the new curriculum called exit slips. Exit slips are used at the end of a lesson or unit for the students to demonstrate, in writing, their understanding of the concept. Ms. Nees began using exit slips as a way to assess her students’ understanding of concepts: “I’m learning they [exit slips] are very, ...very important for them to write about it [the concept presented]. Because if they can write about it, then they can usually do it” (TI, lines 68-70).

Both SLD teachers also shared the ways their teaching had evolved during the year. Ms. Wilson shared:
“Well, I noticed that my kids picked up the concepts a lot faster when they had all the manipulatives to use and that I like teaching mathematics more than I did with [the previous mathematics curriculum]…. I notice that I like to teach mathematics more. I have more fun with it, and so then the kids have more fun with it, and they are really picking things up, and they remember them, which is huge.” (TI, lines 19-23)

She also shared how the changes positively affected her students’ mathematics learning: “They’re learning it instead of just doing it, which is a big jump for them” (TI, line 49) and further, “It’s helping them because I think they’re thinking more about how they’re doing it [the mathematics]” (TI, line 93).

Finally, Ms. Pauls shared how, similar to Ms. Nees, she learned the importance of individualized assessment. She learned to use an assessment program provided by the curriculum and was able to develop assessments to “target everything [she] taught” (TI, line 219-220). This was important because the end of the unit tests provided within the curriculum included all skills presented, whether beginning, developing, or secure. Ms. Pauls explained this made it difficult for her students to be successful. However, by using the assessment program, she was able to create an assessment that targeted the secure goals of the unit or goals targeted for individual students. She was so excited as she shared how her students were able to complete the alternative assessments she was able to create: “…they can do it- they can do it!” (TI, line 220). Although the teachers recognized the value and benefit of working toward reform and implementing the new curriculum, they had concerns as well as evidenced by the comments shared during the teacher interviews.
Teacher Concerns

As stated previously, the work toward reform in mathematics instruction is difficult, though necessary. The teachers understood this fact, yet understandably, still had moments of doubt and struggled with the enormity of it all. Ms. Smith shared how at times she felt “a little overwhelmed” (TI, line 10) by all that was involved. Similarly, Ms. Pauls expressed feeling overwhelmed: “...We only have so many minutes in a day, and sometimes it’s just very hard to get in what I want to get in” (TI, lines 283-284). Ms. Smith honestly shared how the process was “scary for the teachers” (TI, line 47). Unfortunately when people get scared and overwhelmed, they tend to fall back on what is comfortable and easy. As Ms. Smith pointed out when teachers feel this way about the reform process they tend to “go back and pound it the old traditional way” (TI, line 49).

Reverting Back to Traditional Instruction

Despite their best efforts, I observed moments when the teachers reverted back to using traditional teaching methods. These moments did not change the fact that they continued to move forward in their efforts toward reform. My impression is that this is natural part of the growth process; as expressed in the old adage: “Two steps forward, one step back.” Some of these lapses were observed during the formal classroom observations.

Although Ms. Smith often asked the students thought-provoking questions, more than once I noted she did not offer the appropriate and suggested wait time. She did not allow the students time to think and jumped in to answer the question herself. For example, during one particular lesson, she asked the students, “How many one-quarter inches are in 3¼ inches?” One of the students offered an answer, and Ms. Smith then asked the student to explain how he got
his answer. Instead of allowing the student time to explain and demonstrate his solution, Ms. Smith went to the board and demonstrated on a number line how to solve the problem. Though this situation did not occur often, it was a regression to the teacher-controlled traditional method of instruction.

Several other instances of reverting back to the traditional method of “teaching by telling” occurred during times when the students were practicing for the FCAT exam. I observed one such instance as Ms. Nees conducted a review of dividing with decimals for one of the FCAT practice problems. She asked the students how to set up the division problem and then without any student participation, proceeded to explain the traditional long division algorithm step-by-step, writing and demonstrating each step on the board.

She asked students questions about each step as she wrote it on the board. It was obvious by their answers the students were not following along and did not understand the steps of the algorithm. After the last step, she asked the students if they noticed a pattern in the division process. Several students noticed the pattern of adding a zero then dividing again and repeating this in the division process, but there seemed to be little if any conceptual understanding of the process. Ms. Nees did not use the alternative algorithm of partial quotients which the students learned earlier in the year and which allowed them to divide with more comfortable numbers, to support their understanding of division. Nor did she link their existing knowledge about partial quotients to this direct instruction algorithm. Interestingly, none of the students asked about using the alternative algorithm; that is, the one they understood and could use on their own. The students fell back into old patterns, just as the teachers did. The students were simply calculating and doing the mathematics because that was the way Ms. Nees said to do it. Further evidence of falling back into old patterns was offered by two of the students in the follow-up interviews.
The data show that most of the slips back to traditional methods of instruction occurred when the teachers were presenting traditional algorithms. During one of the follow-up interviews Sandra explained her understanding of dividing fractions. She explained the process, with a number of errors, and when I asked why she tried dividing fractions this way, she stated: “Because that’s how I learned to do it. Ms. Smith was teaching us how she does it, not the way the book does it” (FI, lines 356-357). Later, when I asked her why she flipped the second fraction, in other words used the reciprocal of the original fraction, she responded, “You flip it… well I have no clue. … Ms. Smith didn’t tell us” (FI, lines 367 and 371). Obviously, based on Sandra’s own words, this exemplifies a case of teaching by telling. Sandra did not fully understand what she was doing nor why, and might not remember it when faced with a test. Granted this is a difficult concept for even adults to understand or successfully explain, further reason it should be taught in a way that students can truly understand and that make sense to them. This perpetuation of not understanding mathematics must end.

Azariah spoke to this same issue as we talked in a follow-up interview: “I’ll like, I’ll git it at first, den I’ll lose it. I lose it and den [we’ll] be takin’ a test and I forgot the algorithm” (FI, lines 197-198). As one might imagine, these lapses back into old patterns of traditional instruction as well as trying to learn mathematics in a way that was unfamiliar caused frustrations for the students. The following section reveals the related frustrations of the students.

Students’ Frustrations

The teachers were not the only ones who had to deal with change, the students had to as well. These students had never been exposed to the kind of depth or breadth of mathematics that they were with the new curriculum. In previous years, these fifth graders had already learned a
number of traditional algorithms and although they liked and understood the new algorithms, the process of learning in new ways was a source of frustration for the students. Ashley shared that she struggles because when she doesn’t understand something, she asks her teacher for help. However, “sometimes she be confusing” (FG1, line 625) and so unfortunately, Ashley remains confused.

The topic of being overwhelmed while trying to remember the appropriate algorithm or mathematical process surfaced in both the focus groups and follow-up interviews. In the third focus group, both Shaquille and Briangeline expressed their frustrations in trying to remember all that was required.

‘Cause we are all in a new skill now, but you forgot about the old skills, then I try to remember, but they’re not quite in my head that much.

Shaquille, FG3, lines 424-425

Well, I think that it’s because sometimes if we have like so much that we have to remember from the last- last week. And then we have to come up for another week, we have to think about all the new things that we have done, and then like come time for a test that we have to take, and we’re gonna have to think of all the things we did before, and then we gotta think of all the things we did now. And it’s gonna like be confusing. We like, dang! We gotta think about those, and this and all the other things.

Briangeline, FG3, lines 438-443

In follow-up interviews, Sandra, Azariah, and Jasmine all shared their thoughts on being overwhelmed by trying to remember the strategies and material they learned in the past as well as the present.
...the teacher has to rush and do all this and do all that and even when she reviews, she gets frustrated because we don’t remember.

Sandra, FI, lines 57-58

I got too much stuff in my brain, my mind.

Azariah, FI, line 202

‘Cuz it’s like she’ll [the teacher] explain it and then the next time you do it she’ll say, “you guys, we did this again and you should remember it,” so sometimes I don’t remember it….I asked why she thought she didn’t remember] ‘Cuz say like we doing a lot of work that day and that was one of the first things we did and then I have to go back in my mind and say what was the first thing that we did in this step.

Jasmine, FI, lines 81-83, 87-88, 92

Another frustration expressed by the students dealt with the teachers moving too quickly through the lessons. Shawn explained, “... then my teacher, she would just move on to another method, and my head was just getting stuffed with nothing but mathematics methods and I couldn’t think of nothing” (FG3, lines 466-468). This issue of the teachers moving too quickly was one of the things Azariah wished she could change about her mathematics learning.

I would change the way they jus’ tell you another thing, a algorithm, an’ then they jus’ leave it alone and go to the next algorithm den the next one, then the next one an’ next one. I would make them stay until everybody in the classroom git it, and then go to the next one an’ everybody git it, then go to the next one.

FI, lines 300-303
Both the teachers and students were unaccustomed to the pacing and content of the new curriculum. Due to the support of the spiraled curriculum, it was suggested that teachers move through the curriculum at a brisk pace, but because of their previous experience with the scripted mathematics program and teaching for mastery this was problematic for teachers and students alike.

Although both teachers and students experienced struggles and frustrations during the first year of the reform effort at Sunburst Elementary, both groups realized the benefits resulting from the challenging process of reform.

Positive Aspects of Reform Effort from the Teachers’ Perspective

Chapter Five pointed out the students’ perspective on the benefits of the reform effort and the new curriculum, including playing games, using manipulatives, and learning alternative algorithms as well as the advantage of having a number of choices when faced with computation. The teachers recognized a number of benefits despite the challenges faced during the year. They shared these positive points of view during the teacher interviews. All four teachers, separately and unsolicited, noted the growth and improvement in the mathematics learning of their students. Ms. Smith shared, “I have seen success in the room with the students. I’ve watched them grow. I’ve seen them become more comfortable” (TI, lines 162-164). Early in the interview Ms. Nees stated: “I do see progress in their understanding of concepts” (TI, line 93). Later, she explained that although many of her students may still have been below grade level, she and the students both saw growth and improvement in their mathematics learning: “There is growth there, and
they can see they are improving” (TI, line 267). Ms. Pauls and Ms. Wilson mentioned specific areas of growth they noticed during the year.

Well, I can see how it’s making a difference in some of my students, because we play “Name That Number.” So I’ll lay it out, and now that they have multiplication under their belt, they have been doing two steps to get the answers.

Ms. Pauls, TI, lines 360-362

This growth was significant because earlier in the year the students were only able to play the game using simple, one-step addition or subtraction problems to name the number. Later they were able to use multiple steps and multiplication to solve for the number when playing the game.

Ms. Wilson talked about her students’ improvement in their ability to complete the benchmark assessments they were required to take on a biweekly basis.

...most of them are trying to get the answers. More of them are starting to get answers than in the beginning [of the year]. ‘Cause in the beginning they just didn’t care, and they just circled whatever; but now they’re actually like, “oh, we did this.” Oh, you’ll hear them sometimes, “Oh, we did this.” And then they’ll circle the answer and get it right.

TI, lines 387-391

As Ms. Wilson explained, when the students first began taking the tests in September, they were not even attempting to answer the questions. As they gained confidence during the year it began to show in their results on the biweekly assessments. They were doing their best to read and respond to the questions. They were trying and even succeeding in getting the correct answer for some of the problems. They were beginning to feel, in a small, but important way, their mathematical power.
As mentioned previously in Chapter Five, Ms. Nees and Ms. Wilson both noticed their students’ social skills improvement as a clear benefit and outcome of the reform effort. Ms. Nees also noted improved attitudes and students taking responsibility for their mathematics learning as an additional benefit:

*I think they have a more positive attitude toward it [their mathematics learning]. I think they’re taking responsibility for learning it now.*

TI, lines 295-296

Ms. Wilson and Ms. Pauls also discussed how their students enjoyed mathematics. The students beginning to enjoy mathematics was truly a positive aspect in that it creates a positive spiral of being motivated and empowered by their mathematical abilities. The more students enjoy mathematics, the more they want to do it, therefore the more they are able to learn and so the benefits continue.

*...the kids are enjoying it [mathematics] because last year there were a lot of tears.... [The students] would complain and would have little act out time. ...But this year, you know, I’m like all right, pass out the mathematics journals, pass out this, pass out that-let’s go. And they’re happy, and they’re doing it...*

Ms. Wilson, TI, lines 413, 417-419

*I don’t have behaviors because they like to do it. They like trying. They like the learning part of it, and they like all of the games and the hands on. That’s kept them learning, and wanting to learn some more.*

Ms. Pauls, TI, lines 125-127

Finally, the teachers noted the broader, more comprehensive scope of the curriculum as a positive aspect. The students had never been exposed to many of the mathematics concepts they
encountered during the year, such as the alternative algorithms and the geometry concepts, particularly the hands-on construction activities in geometry. Likewise the teachers had never taught a number of the concepts included in the new curriculum. Ms. Pauls explained that the new curriculum “is comprehensive. It really does try to touch on all of the different areas of mathematics...” (TI, lines 11-12). Ms. Wilson felt that her students were “...getting a much more broad scope of mathematics, instead of pinpoint skills, which [was] very helpful. Very helpful indeed” (TI, lines 398-399).

This study honored the student voices as they began their journey to gain control over mathematics through a district-wide mathematics reform effort. From these voices we learned more important things than scores, we learned that if we truly listen carefully to the students they will tell us what they need in order to learn mathematics and they will tell us what works best for them as well as what does not work.

The initial year of the mathematics reform effort at Sunburst Elementary was indeed a challenging one, replete with frustrations and tears as well as smiles and celebrations. I am so thankful that I was able to present these student voices that might have otherwise been overlooked as a testament to the hard work of the reform effort. Growth and change are never easy, but based on their own words, definitely worth the effort for the students and teachers of Sunburst Elementary. In Ms. Wilson’s own words: “I think it’s big for me to say I like mathematics, I like teaching [it] because I hate mathematics. I’m horrible at mathematics...so I think it’s interesting that I am enjoying teaching mathematics as much as I am this year and the kids are enjoying it” (TI, lines 405-408, 412-143).
Making the shift from traditional mathematics instruction to reform-oriented pedagogy is an ongoing process with a number of lessons to be learned along the way. Similarly, a number of lessons were learned in the process of conducting this study. Chapter Seven will present the lessons gleaned as I listened to the students’ voices during the initial effort toward reform in mathematics instruction at Sunburst Elementary.
CHAPTER SEVEN: LESSONS LEARNED FROM LISTENING TO STUDENT VOICES

As stated in Chapter One, this study was designed to explore students’ perceptions of their mathematics learning within the context of a reform effort. Listening to student voices and empowering them in their unique perspective were the major focus of this study, and as Erickson and Shultz (1992) remind us, placing the student at the center of attention in educational research has been a rarity. I chose to listen to students because I have learned, over the years, to value students’ voices. I also knew that educators and researchers alike have investigated innumerable educational topics from almost every possible angle, though rarely from the child’s point of view. Apparently this point of view piques the interest of many non-educators just as it did mine. During the journey of my doctoral studies, I have frequently been asked the topic of my dissertation. The question may often have originally been posed out of politeness, but invariably, once I explained that I was listening to children as they talked about their own mathematics learning, people probed further with questions and wanted more information about my study. The discussion often turned to their own struggles with learning mathematics as a child. I explained it was my hope that carefully listening to students might help educators understand how important reform efforts are to the way students learn mathematics, thereby improving the way we teach mathematics.

Based on the design of my study and my personal beliefs as an educator it was imperative to listen carefully to the students. Gentilucci (2004) explains, “Understanding why [students] learn well or poorly is predicated upon clearly understanding their perspectives on learning” (p. 133). In the course of listening carefully to the students, a number of valuable lessons were
learned. This final chapter will share the lessons learned from listening to the fifth graders of Sunburst Elementary as they offered their perspectives on their own mathematics learning. Some of the lessons learned were gleaned from a second and final member checking activity I conducted with the students. Others will be offered as conclusions drawn based on my interpretations of the themes that emerged during the course of this study. Additionally, the limits of this study will be shared in this closing chapter. Finally, I will offer concluding thoughts that reveal the transformational possibilities of listening to student voices.

Lessons Learned and Implications for Elementary Mathematics Instruction

As explained in Chapter Three, member checking is a “crucial technique for establishing credibility” (Lincoln & Guba, 1985, p. 314) in any qualitative study. Some of the lessons I learned as a result of talking with and carefully listening to the fifth graders of Sunburst Elementary were tentatively confirmed through the final member checking activity I conducted with the students and then finally confirmed upon completion of data analysis.

During the last few weeks of May 2005, I began to experience redundancy in the data, or saturation (Glesne, 1999). This was fortunate due to the fact that the point of saturation coincided with the end of the school year, at which point I would no longer have access to the fifth graders. As a way to check my overall interpretations of the data, I conducted a final member checking activity with the students during the last week of the school year. To prepare for this activity, I reread and reviewed all of the data gathered and I synthesized my interpretation of the “big ideas.” These “big ideas” were the significant themes that I was hearing over and over during the focus groups and the follow-up interviews. Next, I gathered the 16 fifth graders that participated in the study. As I met with the large group, I explained that I had written down the “big ideas”
and I would present each of them, one at a time to the students. I asked the students to give me feedback as to whether they agreed with the statement and my interpretation of their perceptions, or if I was “off the mark” with my interpretation. If so, I asked them to help me understand more clearly.

The first “big idea,” or lesson learned, that I presented to the students was: Mathematics is important. They agreed with this statement, but had no other clarifying thoughts to share with me on this particular statement during the member checking activity. I was encouraged to see my interpretation was accurate because at times, fifth graders can act as though mathematics has no import in their lives, yet when asked about the importance of mathematics, they express that mathematics does have importance in their lives. I observed this ambiguity with the fifth graders at Sunburst Elementary and I have seen it in the past with fifth graders I taught. The ambiguous nature of this issue might be explained by the students’ stage of intellectual development. At this age they may be shifting between developmental stages, yet they are able to recognize both the positive and negative aspects of an issue and often express both when asked their opinion on the issue in question.

Although the students added no additional ideas for consideration on the importance of mathematics during the member checking activity, we read in Chapter Three the students’ thoughts regarding its importance. A few of the students expressed the importance of mathematics in securing jobs in the future and several others talked about its importance in a school-related context.

I present the next two ideas together for the reader’s consideration, though I presented them individually to the students. First, using manipulatives/tools is important to your mathematics learning and second, games are great! Again, the students agreed with both
statements and had no other clarification to offer. Both of these ideas were discussed at length during focus groups and follow-up interviews as well as supported in the results of the student survey. These are both significant lessons to take away from this study. Chapter Five showed us the students were clear on not only the fun they had playing the games, but they also knew and understood how the games helped their mathematics learning. We read, also in Chapter Five, how using manipulatives helped the students learn and understand mathematics concepts, but more importantly, we read how they truly need the manipulatives. This lesson cannot be denied; the research, the literature, and the students themselves all proclaim the same thing: Using manipulatives is crucial for meaningful mathematics learning.

The next lesson we can take away from this study has to do more directly with the reform effort. The “big idea” I presented to the students was: Mathematics learning/teaching is different this year. Once again they agreed with the statement. However, this time they did have additional feedback to share on the topic. One of the students made sure to let me know their mathematics learning was “harder” during the first year of the reform effort. Another explained that the mathematics “gets easier when you get the hang of it” and they felt they “catch on faster” than in previous years. Finally, one of the group shared, “You feel like you have power when you know what you’re doing.” The students definitely noticed a difference in both their mathematics learning and the accompanying mathematics teaching. Chapter Five revealed the biggest differences noticed by the fifth graders, including the games they played, the manipulatives they used and the alternative algorithms they learned. This “big idea” proves that students do pay attention not only to the content they are being taught in mathematics, but also how they are being taught. Additionally, they not only pay attention, but they have definite opinions on what
helps them in their mathematics learning and their opinions about their mathematics learning
during the first year working toward reform show those efforts were not put forth in vain.

Another significant lesson learned as a result of this study is how important it was to the
fifth graders to have alternatives when faced with computation. The statement I presented to the
students read: You like having choices in mathematics. The majority of the students agreed and
two offered additional thoughts on the subject. One of the fifth graders shared that having
choices “made me feel kind of better about myself because I [knew] what I [was] doing.”
Another explained she liked to “choose the type that I know I can understand the stuff.” In other
words, she liked being able to choose a method for computation that she understood and could be
successful using. In Chapter Five, a pattern of student quotes showed they understood that not
everyone learns the same way. Further, they clearly explained that having a variety of
computational methods to choose from and being able to use the one that works for them is truly
helpful when called on to compute numbers. This seems like a simple message, yet for years
most children in the U.S. have been taught only traditional methods for adding, subtracting,
multiplying and dividing. This important lesson shows there is a better way to teach
computational methods.

The last two statements I presented to the students were ideas inferred from the data,
unlike the previous ideas that were extracted directly from the data and had been discussed by
the students at length over the course of the study. Glesne (1999) explains, “Inference and
conjecture are mainstays of the interpretive process. Inferences are made about the relationship
of one thing to another, on the basis of carefully collected, carefully analyzed, trustworthy data”
(p. 157). Although the students spoke rarely, if at all, about the next two topics, I was able to
draw these conclusions based on my interviews and focus groups with the students and the data gathered.

The first stated: It’s hard to talk about or explain my thinking/ideas in mathematics. Most of the students also agreed with this statement and several shared further thoughts as to why they find it difficult to explain their thinking about mathematics. One of the students explained that “most of the time, it [the explanation] slips your mind,” and another classmate offered that it is difficult because “[we] have a lot of pressures.” As we continued talking, another student put it a little differently. She shared, “You can’t explain it out your mouth.” The final comment shared harkens back to one of the basic problems caused by the traditional “teaching by telling” methods and discussed previously in Chapter Three: “You don’t know the operations, the steps you’re doing, you just do it.”

Although this idea of difficulty articulating mathematical concepts did not come up explicitly during the focus groups or individual interviews, two statements on the student survey did deal directly with this topic. Interestingly, the results of the survey did not quite match the students’ responses during the final member checking activity. When we talked during the member checking activity, most if not all of the students were in agreement that explaining their thinking in mathematics is difficult, yet the results of the student survey indicated more than half of the students found it easy to talk about how they solve mathematics problems (see Appendix L for results of student survey). One of the statements on the survey related to talking about mathematics stated: I find it easy to explain how I solve mathematics problems. About 60%, nine out of the 15 students surveyed, agreed or absolutely agreed with the statement; whereas almost 40%, six out of the 15 students surveyed, disagreed or completely disagreed with the statement.
Several explanations exist as to why this discrepancy occurred. One possible explanation may be due to the timing of the two activities. The student survey was administered in mid-April and the final member checking activity took place at the end of May. The mathematics lessons near the end of the year included more complex concepts such as multiplying and dividing fractions. These are concepts that can be difficult for fifth graders, and even adults; therefore, the students’ responses during the member checking activity regarding the difficulty in explaining or talking about mathematics may have been reflecting their feelings based on the most recent mathematics lessons. A secondary explanation for this discrepancy may again be the stage of intellectual development of fifth graders and their tendency toward ambiguity at this stage.

A second statement on the student survey dealing with talking about mathematics stated: I like talking about how I solve mathematics problems. The results for the second statement were almost identical to those of the first with the same percentages resulting (see Appendix L for results of student survey); 60% of the students agreed with the statement and 40% disagreed. The difference being that three more students absolutely agreed with the statement for a total of eight responses in the “absolutely agree” category and one in the “agree” category. The total disagree responses as well as the individual “disagree” and “no way!” categories were identical to those of the previous statement. This result indicates the students could value the discourse, despite the difficulty they encountered in talking about their thinking in mathematics.

The final “big idea” that I presented to the students was also gained through inference from the data, and dealt with the concept of mathematical power. This term, as explained in NCTM’s *Professional Standards for Teaching Mathematics* (1991) document, refers to the students’
…ability to explore, conjecture, and reason logically; to solve nonroutine problems; to communicate about and through mathematics; and to connect ideas within mathematics and between mathematics and other intellectual activity. Mathematical power also involves the development of personal self-confidence and a disposition to seek, evaluate, and use quantitative and spatial information in solving problems and in making decisions. Students' flexibility, perseverance, interest, curiosity, and inventiveness also affect the realization of mathematical power. (p. 1)

The students and I did not talk specifically about this concept during the study because they did not have a true frame of reference for the concept. This was a conclusion drawn from my time spent interviewing and observing the students as well as analyzing the data. The statement I presented to the students read: You don’t have complete “power” over mathematics.

During the member checking activity, I explained what the statement meant. I also explained that I purposefully included the word complete because although the students seemed to have very little power over mathematics at the beginning of the study, as time went on there were several occasions that students exhibited more confidence about the mathematics they were doing and it did make sense to them. One such time, related during the member checking activity that they all remembered clearly, was when they mastered lattice multiplication. After explaining the meaning of the statement, the students agreed; they did not have complete power over mathematics yet. However, they noted they had a few tastes of power during the year. In my opinion and verified by the students themselves, they had begun the journey toward gaining mathematical power.

Certainly, these lessons learned are easily translated into classroom practice. These implications for elementary mathematics instruction, from the students’ mouths, cannot be
ignored. Teachers can follow the students’ lead to prioritize mathematics instruction, effectively utilize manipulatives, games, alternative algorithms, and encourage classroom discourse about mathematics. If teachers would follow this outline, provided by the students’ voices, students’ mathematical power will be more deeply realized. As a result we can easily see connections with NCTM’s standards and guidelines on reform in mathematics instruction.

Although there are a number of valuable lessons that can be learned from this study, limitations exist as with any study. The following section presents the limitations of this study.

Limitations of the Study

The primary limitation of this study was the fact that only the students’ perceptions of their learning are represented. Although the teachers’ input was used to inform the study, their perceptions were not the focus of this study, nor were the perceptions of the parents, administrators, the researcher or any other interested party. Additionally, as with any qualitative study, the results may not be generalized to any other population. The purpose of this study was to increase understanding of teaching and learning mathematics, not to generalize results to a larger population. Finally, researcher objectivity may be construed as a limitation due to my role as participant-observer in this study as well as being employed by the participant school. As discussed earlier, a number of measures were employed throughout the study to insure the credibility such as triangulation of data and member checking, in particular. However, as Ely (1991) reminds us “observation can never be objective… [nor can it be] judgment-free. This is so because observation comes out of what the observer selects to see and chooses to note. All we can work for is that our vision is not too skewed by our own subjectivities” (p. 53). Additionally, as I explained in Chapter Two, I used a personal journal to help me recognize and strive to
minimize my subjectivity as well as student survey data to corroborate student perspectives. Further, a close friend and colleague served as my peer debriefer throughout the study.

Although the results of this study cannot be generalized to a larger population, my hope is that the reader might take away a deeper understanding of the value and importance of listening to students’ voices. As Dr. Deets, my trusted advisor on qualitative research, often reminded her students by paraphrasing Shweder (as cited in Glesne, 1999), good qualitative research makes familiar what at first seemed strange and estranges us from what we thought we knew. I trust this study accomplished Shweder’s goal on two levels: first, to make students’ voices more familiar to my reader while estranging the reader from the predominant voices of researchers, educators, and politicians in the current literature. And second, for those readers not versed in the mathematics reform movement and by way of the students’ own voices, to make more familiar both the need for reform in mathematics instruction as well as identifying the beginning steps in the process of mathematics reform while estranging them from the traditional methods of mathematics instruction.

During my work on this study, I too was impacted by Shweder’s goal for good qualitative research. I believe this study made me familiar again with the day-to-day struggles and celebrations of teachers working with students in an urban setting, while estranging me from life in academia. Before becoming the mathematics coach at Sunburst Elementary and beginning this study, it had been almost five years since I had been in a school setting on a daily basis and almost ten years since teaching in an urban setting. I had been pursuing my doctoral studies and immersed in the world of academia: studying, doing research, working as a member of an evaluation team during my fellowship, and most recently teaching courses at the university. My experience at Sunburst Elementary was both enlightening and rewarding. I truly appreciated
working closely with students and teachers again. In addition, I observed how the jobs of
teachers in urban schools, in this central Florida district, have changed; unfortunately, not
necessarily for the better. I was also reminded why dedicated teachers stay in urban schools. I am
thankful for having had the opportunity to become familiar, once again, with teaching and
working in an elementary school setting. This experience not only allowed me to strive for
Shweder’s goal of good qualitative research, but also added depth and richness to my knowledge
base that I will continue to share in my future endeavors in the education realm.

The remainder of this final chapter offers my concluding thoughts on the most significant
lesson learned as a result of this study.

Concluding Thoughts

The fifth graders of Sunburst Elementary, students who in the past have been given a
variety of labels including “disadvantaged” or “at-risk,” clearly articulated, even in nonstandard
English, their perceptions of their mathematics learning. They passionately explained what
helped them learn mathematics as well as what impeded their mathematics learning and were
often incredibly insightful in their commentary. It is from the students themselves that we learn
the final and most significant lesson from this study: Student voices can no longer be ignored. It
is imperative that we listen carefully to what students have to say about their own mathematics
learning.

Student voices can no longer be ignored because there is transformational power in
carefully listening to students as they talk about their mathematics learning and acting upon the
thoughts they offer. There are a number of transformations possible if we listen carefully to
students and all possibilities support NCTM’s position on reform in mathematics instruction.
First, there is a discourse in the classroom that might not have otherwise existed. Encouraging students to talk about their mathematical thinking can help them understand and make sense of mathematics. In addition, the possibility of increased student metacognition about mathematics may be realized through encouraging this type of discourse.

Second, asking students about their mathematics learning, what works best for the student as well as what does not work, and then listening carefully to their responses takes the guesswork out of mathematics instruction. It is a clarifying process as teachers work to differentiate instruction in order to meet the diverse needs of their students.

Further, the locus of control in the classroom is shifted from the teacher to the student when their voices are valued as they talk about their mathematics learning. The students are given the responsibility for their own mathematics learning and therefore take ownership of their learning. The teachers become the facilitators of mathematics instruction as opposed to the “one with all the answers” in the classroom.

Students gain confidence when given responsibility for their own mathematics learning and in taking ownership of it as well. They gain confidence not only in themselves, but in their mathematical abilities. These positive aspects feed into the students’ feeling of mathematical power; a notion critical to mathematical competence and opportunities for success in the twenty-first century.

Finally and most significant, is the transformational power students’ voices have when valued, carefully listened to and acted upon. Their voices can promote real change in schools and classrooms. In Chapter One, we read of the paucity of research on learning from the students’ perspective and Gentilucci (2004) reinforced the notion that it is particularly lacking from the elementary students’ perspective. However, Mitra (2004), whose research involves high school
students, offers promising evidence that increasing and valuing student voice can promote change. Mitra points out that recent research has focused on the premise that efforts toward both improved student outcomes and school reform efforts at the high school level will be more successful if students have an active voice in shaping those efforts. Mitra notes that “increasing student voice in classrooms also improved students’ understanding of how they learn” (p. 653). In addition, Mitra reports Johnston and Nicholls found that by having high school students talk about how they learn best, they “can help teachers do a better job of meeting student needs” (p. 653).

Additionally, further anecdotal evidence exists, though still at the high school level, of the benefits of valuing and honoring students’ voices. McCloskey (2005) shares the story of Nelson Beaudoin, principal at Kennebunk High School in Maine and his success at school reform due to what Beaudoin “calls ‘the magic of student voice’” (p. 30). McCloskey quotes Beaudoin from his first book, Stepping Outside Your Comfort Zone: Lessons for School Leaders, as he explains “…the benefits of taking risks by listening closely to students. ‘This route may lead to high levels of anxiety and tension, … but it also leads to excitement and inspiration’” (p. 31). McCloskey reports that students and parents alike are thrilled with the changes resulting from Beaudoin’s commitment to listen to students and to implement school reforms based largely on student input, though not every teacher is completely on board with Beaudoin’s philosophy. And finally, Beaudoin is quoted from his upcoming book, Elevating Student Voice: How to Enhance Participation, Citizenship, and Leadership, as he writes about the benefits of valuing student voice, “The lesson here for educators is that seeking to inspire will pay greater dividends than seeking to control” (p. 32).
Clearly, anecdotal and empirical evidence exist, albeit sparse. Listening to, honoring, and more importantly acting upon student voices can promote change within classrooms and schools. A distinct need for further research persists with the important promise for true reform in elementary mathematics instruction to come to fruition by listening carefully to students’ voices. True reform in elementary mathematics instruction is vital for the sake of the students. As Sandra, whose quote opened this dissertation, so succinctly and precisely tells us:

*It would make me feel good if I knew what to do.*

FI, line 494
APPENDIX A: REFORMED TEACHING OBSERVATION PROTOCOL (RTOP)
Appendix II
Reformed Teaching Observation Protocol (RTOP)

Daiyo Sawada
External Evaluator

Michael Ruben
Internal Evaluator

and

Kathleen Falcioni, Jeff Turley, Russell Ranford and Irene Bloom
Evelution Facilitation Group (EFG)

Technical Report No. IN00-1
Arizona Collaborative for Excellence in the Preparation of Teachers
Arizona State University

I. BACKGROUND INFORMATION

Name of teacher ____________________________ Announced Observation? ____________________________
(Yes, no, or explain)

Location of class ____________________________
(district, school, room)

Years of Teaching ____________________________ Teaching Certification ____________________________
(K-8 or 7-12)

Subject observed ____________________________ Grade level ____________________________

Observer ____________________________ Date of observation ____________________________

Start time ____________________________ End time ____________________________

II. CONTEXTUAL BACKGROUND AND ACTIVITIES

In the space provided below please give a brief description of the lesson observed, the classroom setting in which the lesson took place (space, seating arrangements, etc.), and any relevant details about the students (number, gender, ethnicity) and teacher that you think are important. Use diagrams if they seem appropriate.
Record here events that may help in documenting the ratings.

<table>
<thead>
<tr>
<th>Time</th>
<th>Description of Events</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### III. LESSON DESIGN AND IMPLEMENTATION

<table>
<thead>
<tr>
<th></th>
<th>Never Occurred</th>
<th>Very Descriptive</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.</td>
<td>0 1 2 3 4</td>
</tr>
<tr>
<td>2</td>
<td>The lesson was designed to engage students as members of a learning community. In this lesson, student exploration preceded formal presentation.</td>
<td>0 1 2 3 4</td>
</tr>
<tr>
<td>3</td>
<td>This lesson encouraged students to seek and value alternative modes of investigation or of problem solving.</td>
<td>0 1 2 3 4</td>
</tr>
<tr>
<td>4</td>
<td>The focus and direction of the lesson was often determined by ideas originating with students.</td>
<td>0 1 2 3 4</td>
</tr>
</tbody>
</table>

### IV. CONTENT

#### Propositional Knowledge

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>The lesson involved fundamental concepts of the subject.</td>
</tr>
<tr>
<td>7</td>
<td>The lesson promoted strongly coherent conceptual understanding.</td>
</tr>
<tr>
<td>8</td>
<td>The teacher had a solid grasp of the subject matter content inherent in the lesson.</td>
</tr>
<tr>
<td>9</td>
<td>Elements of abstraction (i.e., symbolic representations, theory building) were encouraged when it was important to do so.</td>
</tr>
<tr>
<td>10</td>
<td>Connections with other content disciplines and/or real world phenomena were explored and valued.</td>
</tr>
</tbody>
</table>

#### Procedural Knowledge

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Students used a variety of means (models, drawings, graphs, concrete materials, manipulative, etc.) to represent phenomena.</td>
</tr>
<tr>
<td>12</td>
<td>Students made predictions, estimations and/or hypotheses and devised means for testing them.</td>
</tr>
<tr>
<td>13</td>
<td>Students were actively engaged in thought-provoking activity that often involved the critical assessment of procedures.</td>
</tr>
<tr>
<td>14</td>
<td>Students were reflective about their learning.</td>
</tr>
<tr>
<td>15</td>
<td>Intellectual rigor, constructive criticism, and the challenging of ideas were valued.</td>
</tr>
</tbody>
</table>
Continue recording salient events here.

<table>
<thead>
<tr>
<th>Time</th>
<th>Description of Events</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
V. CLASSROOM CULTURE

<table>
<thead>
<tr>
<th>Communicative Interactions</th>
<th>Never Occurred</th>
<th>Very Descriptive</th>
</tr>
</thead>
<tbody>
<tr>
<td>16) Students were involved in the communication of their ideas to others using a variety of means and media.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>17) The teacher's questions triggered divergent modes of thinking.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>18) There was a high proportion of student talk and a significant amount of it occurred between and among students.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>19) Student questions and comments often determined the focus and direction of classroom discourse.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>20) There was a climate of respect for what others had to say.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Student/Teacher Relationships</th>
<th>Never Occurred</th>
<th>Very Descriptive</th>
</tr>
</thead>
<tbody>
<tr>
<td>21) Active participation of students was encouraged and valued.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>22) Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>23) In general the teacher was patient with students.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>24) The teacher acted as a resource person, working to support and enhance student investigations.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>25) The metaphor “teacher as listener” was very characteristic of the classroom.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
</tbody>
</table>

Additional comments you may wish to make about this lesson.
APPENDIX B: COMPLETED IRB FORM
C. UCFIRB Form

The complete IRB packet must be submitted by the 1st business day of the month for consideration at that monthly IRB meeting. Please see page 6 of this manual for detailed instructions on completing this form.

1. Title of Project:  Students' Perceptions of Mathematics Learning Within the Context of a Mathematics Reform Effort

2. Principal Investigator(s):
   Signature: ______________________
   Name: Elizabeth S. Hoffman
   Mr./Ms./Mrs./Dr. (circle one)
   Degree: M.Ed.
   Title: N/A
   Department: TLP
   College: Education
   E-Mail: phoffmanjr@cf.rr.com
   Telephone: (407)-905-0999
   Facsimile: (407)905-0939
   Home Telephone: (407)905-0999

3. Supervisor:
   Signature: ______________________
   Name: Sherron Roberts
   Mr./Ms./Mrs./Dr. (circle one)
   Department: TLP
   College: Education
   E-Mail: 

4. Dates of Proposed Project (cannot be retroactive): From Aug. '04 to April '05

5. Source of Funding for the Project: (project title, agency, and account number) Self-funded

6. Scientific Purpose of the Investigation: The purpose of this investigation is to increase our understanding of students' perceptions of their mathematics learning, to understand what they've learned and how they learn best, through their own voices.

7. Describe the Research Methodology in Non-Technical Language: (the UCFIRB needs to know what will be done with or to the research participants), see attached

8. Potential Benefits and Anticipated Risks. (Risks include physical, psychological, or economic harm.) Describe the steps taken to protect participant. It is vitally important that we increase our understanding of how students learn best mathematically. The potential benefit of this study is that educators, when armed with this knowledge, will be able to develop and implement quality mathematics curriculum that meets the needs of students. There are no anticipated risks associated with this study with the exception of possible discomfort on the part of participants due to being audio taped during the interview process. Every effort will be made to protect the anonymity of the participants. Pseudonyms will be used and all data will be stored in a locked filing cabinet.

9. Describe how participants will be recruited, the number and age of the participants, and proposed compensation (if any): The participants of this study will be approximately 20 fourth and fifth grade students (aged 9-11 years) from a local public school. Additionally, a small
number of teachers may be interviewed in order to further inform the study. There will be no compensation offered.

10. Describe the informed consent process: (include a copy of the informed consent document)

Appropriate consent/assent forms have been developed (see attached). Parents of children and other adults asked to participate will be given appropriate forms then asked to read and sign the forms if they choose to participate in the study. All adults will be assured that participation in this study is completely voluntary. Any questions or concerns will be answered in full. After consent is given by parent(s), the Child Assent Form will be read to (or by) each child and explained. They will be asked to sign the assent form if they choose to participate. Every effort will be made to assure that each child knows participation is voluntary and if they choose to participate they may stop at any time they wish.

I approve this protocol for submission to the UCFIRB. ____________________________
Department Chair/Director Date

Cooperating Department (if more than one Dept. involved) ____________________________
Department Chair/Director Date
August 5, 2004

Elizabeth Hoffman
445 Winding Hollow Avenue
Ocoee, FL 34761

Dear Mrs. Hoffman:

With reference to your protocol entitled, “Students’ Perceptions of Mathematics Learning within the Context of a Mathematics Reform Effort,” I am enclosing for your records the approved, expedited document of the UCF IRB Form you had submitted to our office.

Please be advised that this approval is given for one year. Should there be any addendums or administrative changes to the already approved protocol, they must also be submitted to the Board. Changes should not be initiated until written IRB approval is received. Adverse events should be reported to the IRB as they occur. Further, should there be a need to extend this protocol, a renewal form must be submitted for approval at least one month prior to the anniversary date of the most recent approval and is the responsibility of the investigator (UCF).

Should you have any questions, please do not hesitate to call me at 823-2901.

Please accept our best wishes for the success of your endeavors.

Cordially,

Barbara Ward
Barbara Ward, CIM
Institutional Review Board (IRB)

Copies: IRB office
Dr. Sheron Roberts, College of Education, Teaching & Learning Principles, Room 315U
APPENDIX D: SCHOOL DISTRICT RESEARCH REQUEST FORM
**Research Request Form**

**Requester's Name:** Elizabeth S. Hoffman, M.Ed.

**Address:**
- Home: 445 Winding Hollow Ave., Ocoee, FL 34761
- Business: UCF

**Phone Numbers:**
- Home: (407) 905-0999
- Business: (407) 823-2016
- Phone: (321) 663-5755

**Project Director or Advisor:** Dr. Sherron Roberts

**Date:** 8/4/04

**Degree Sought:**
- [ ] Associate
- [x] Doctorate
- [ ] Bachelor's
- [ ] Master's
- [ ] Specialist

**Project Title:** Students' Perceptions of Mathematics Learning Within the Context of a Mathematics Reform Effort

**Estimated Involvement**

<table>
<thead>
<tr>
<th>Personnel/Centers</th>
<th>Number</th>
<th>Amount of Time (Days, Hours, etc.)</th>
<th>Specify/Describe Grades, Schools, Special Needs, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>20</td>
<td>20 min. per student, 1-2 hrs.</td>
<td></td>
</tr>
<tr>
<td>Teachers</td>
<td>2</td>
<td>1-2 hrs.</td>
<td></td>
</tr>
<tr>
<td>Administrators</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schools/Centers</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others (specify)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Specify possible benefits to students/school system:** With knowledge gained through this study educators will be able to develop and implement quality mathematics curriculum that meets the needs of students.

**Assurance**

Using the proposed procedures and instrument, I hereby agree to conduct research in accordance with the policies of the Orange County Public Schools. Deviations from the approved procedures shall be cleared through the Senior Director of Accountability, Research, and Assessment. Reports and materials shall be supplied as specified.

**Requester's Signature:** Elizabeth S. Hoffman, M.Ed.

**Approval Granted:** Yes [x] No

**Signature of the Senior Director for Accountability, Research, and Assessment:** Lee Calamari

**Date:** 8/17/04

**Note to Requester:** When seeking approval at the school level, a copy of this form, signed by the Senior Director, Accountability, Research, and Assessment, should be shown to the school principal.

Reference School Board Policy GCS, p. 249
APPENDIX E: PARENTAL CONSENT FORM
Parental Consent Form
September 1, 2004
Dear Parent or Guardian:

I am a doctoral student at the University of Central Florida under the supervision of faculty member Dr. Sherron Roberts. I am conducting a study concerning students' perceptions of their mathematics learning. The purpose of the study is to increase our understanding of students' perceptions of their mathematics learning, to understand what they've learned and how they learn best, through their own voices. The results of the study may help educators to develop and implement quality mathematics curriculum that meets the needs of students.

I will talk with participating children, in small groups and individually, about their perceptions on their mathematics learning. I will meet with the children once in small groups and once individually with the possibility of a follow-up meeting for either/both sessions. The sessions will last for about 20 minutes. With your permission your child will be audio taped during these sessions. The tapes will be accessible to only myself and will be erased at the conclusion of the study. Children not participating will remain in the classroom with the other students. I will also observe the students in the classroom in small groups and as a whole class during mathematics instruction. I will observe approximately three to four times for both small groups and whole class activities. There will be no scoring/grading involved with these activities.

Please be aware that you and your child have the right to withdraw consent for your child's participation at any time. Additionally, your child may choose not to answer any question(s) or stop at any time. There will be no consequence for choosing not to participate in the study and there will be no compensation offered for choosing to participate. Participation or nonparticipation will not affect your child's grades in any way. There are no known risks or immediate benefits to the participants. Your child may choose, or will be given, a pseudonym to be used in the final report to protect his/her identity. Copies of the final report from this study will be available in July upon request. If you have any questions about this study or your child's participation in it, please do not hesitate to contact me at (321) 663-5955 or my faculty supervisor, Dr. Sherron Roberts, at (407) 823-2016. Questions or concerns about research participants' rights may be directed to the UCFIRB office, University of Central Florida Office of Research, Orlando Tech Center, 19443 Research Parkway, Suite 207, Orlando, FL 32826. The hours of operation are 8:00 am until 5:00 pm, Monday through Friday except on University of Central Florida official holidays. The phone number is (407) 823-2501. Please indicate your choice below, sign and return this form to school with your child. Thank you.

Sincerely,

Elizabeth S. Hoffman, M.Ed.

I have read the procedure described above.
I voluntarily give my consent for my child, _____________________________, to participate in Elizabeth Hoffman's study of students' perceptions of their mathematics learning.
I do not consent for my child, _____________________________, to participate in Elizabeth Hoffman's study of students' perceptions of their mathematics learning.

Parent/Guardian Signature _____________________________ Date _____________

2nd Parent/Guardian Signature _____________________________ Date _____________

APPROVED BY
University of Central Florida
Institutional Review Board

CHAIRMAN

121
APPENDIX F: EDUCATOR CONSENT FORM
Consent Form
September 1, 2004
Dear Educator:

I am a doctoral student at the University of Central Florida under the supervision of faculty member Dr. Sherron Roberts. I am conducting a study concerning students’ perceptions of their mathematics learning within the context of a reform effort. The purpose of the study is to increase our understanding of students’ perceptions of their mathematics learning, to understand what they’ve learned and how they learn best, through their own voices. The results of the study may help educators to develop and implement quality mathematics curriculum that meets the needs of students.

I am asking you to participate in this study because I would like your thoughts and ideas about how your students learn and understand math within the context of the reform effort. With your permission, I would like to audiotape your interview. Only I will have access to the tape, which I will personally transcribe. The tape will be erased at the conclusion of this study. You may choose, or will be given, a pseudonym to protect your identity in the final report for this study. You will not have to answer any question you do not wish to answer and may stop at any time. Your participation in this study is completely voluntary.

There are no anticipated risks or immediate benefits to you as a participant in this study. No compensation will be offered for participation, nor will there be any consequences for nonparticipation. If you have any questions please contact me at (321) 663-5955 or my faculty supervisor, Dr. Sherron Roberts, at (407) 823-2016. Questions or concerns about research participants’ rights may be directed to the UCFIRB office, University of Central Florida Office of Research, Orlando Tech Center, 12443 Research Parkway, Suite 207, Orlando, FL 32826. The hours of operation are 8:00 am until 5:00 pm, Monday through Friday except on University of Central Florida official holidays. The phone number is (407) 823-2901.

Please indicate your choice below and sign. A duplicate copy of this letter will be provided to you for your records. Thank you.

Sincerely,

Elizabeth S. Hoffman, M.Ed.

[ ] I have read the procedure described above.

[ ] I voluntarily agree to participate in the study of students’ perceptions of their mathematics learning.

[ ] I choose not to participate in the study of students’ perceptions of their mathematics learning.

___________________________  __________________________
Educator signature          Date
APPENDIX G: FOCUS GROUP QUESTIONS
Focus Group Questions

1. Tell me about how you learned mathematics this year. Was it the same or different than previous years? How?

2. What did you like most about the way you learned mathematics this year? Why?

3. What did you like least …? Why?

4. Tell me about what & how you learned addition this year. Subtraction, mult., division, fractions, etc….

5. What kinds of activities/things do you do in mathematics class that helped you learn? Why did it/they help?

6. Do the games help you learn mathematics? If so how?

7. Are there things in mathematics that you wish you knew/understood that you just don’t get? Such as…?

8. When you come to something you don’t know/understand what do you do?

9. What would you like to do better in mathematics? Why?

10. If someone is having trouble with something in mathematics, how would you help them? What would a teacher do to help that person?

11. Hand out papers with next question: Who do you know in the fifth grade that’s really good at mathematics? What is it about them that makes them so good at mathematics?

12. What else would you like to tell me about what you learned in mathematics this year or how you learned it?
APPENDIX H: ONE-ON-ONE INTERVIEW QUESTIONS
One-on-One Interview Questions

• When and where do you learn mathematics/about mathematics?

• Tell me what you learned in mathematics last year. (Probe for conceptual understanding of topics offered.)

• What kinds of activities/things did you do in mathematics in previous years?

• How did your teacher(s) help you understand what they were teaching? What did they say or do?

• Do you feel like you understand __________? Asked about division and fractions. Asked student to demonstrate his/her understanding.

• What else can you tell me about what you learned in mathematics or how you learned before?

Note: Probe for further explanations as needed.
APPENDIX I: FOLLOW-UP INTERVIEW QUESTIONS
Follow-up Interview Questions

- Referring to statement from student survey: Sometimes I feel left behind in mathematics. Why might someone feel left behind in mathematics?
- If you could change anything at all about mathematics or the way you learn mathematics, what might that be?
- Do you feel confident/like you have control over mathematics?
- Is there anything else about mathematics or your mathematics learning this year you would like to share with me?

Note: Probe for further explanation as needed.
APPENDIX J: TEACHER INTERVIEW QUESTIONS
Teacher Interview Questions

• What differences do you notice in your mathematics instruction since implementing the new mathematics curriculum?

• What differences do you notice in the students? (Probe for differences in understanding, motivation, behavior, academic progress, etc. …)

• Are you satisfied with the new mathematics curriculum? Please explain why or why not.

• What else would you like to share with me about your mathematics instruction or the reform effort?

Note: Probe for further explanation as needed.
Please put a check under the face that shows how much you agree or disagree with each statement below.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Absolutely!</th>
<th>Agree</th>
<th>Disagree</th>
<th>No Way!</th>
</tr>
</thead>
<tbody>
<tr>
<td>I like working with a partner in math.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I like using manipulatives, or learning tools, in math.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I understand the math I learned this year better than last year.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I wish I could use a calculator when I am working on math problems.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I like working in small groups in math.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I understand division better this year.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sometimes I feel left behind in math.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working with a partner helps me learn/understand math.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I understand fractions better this year.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using manipulatives, or learning tools, helps me learn/understand math.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working in small groups helps me learn/understand math.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I like talking about how I solve math problems.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I like doing hands-on activities in math.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I like playing games in math.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doing hands-on activities in math helps me learn/understand the math lesson.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I find it easy to explain how I solve math problems.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Playing math games helps me learn/understand math.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please put a check in the appropriate space:  I am a girl ____ boy ____
APPENDIX L: STUDENT SURVEY RESULTS
Please put a check under the face that shows how much you agree or disagree with each statement below.

n = 15    Female = 9
Male = 6

<table>
<thead>
<tr>
<th>Statement</th>
<th>Absolutely!</th>
<th>Agree</th>
<th>Disagree</th>
<th>No Way!</th>
</tr>
</thead>
<tbody>
<tr>
<td>I like working with a partner in math.</td>
<td>86.6% 13/15</td>
<td>6.6% 1/15</td>
<td>6.6% 1/15</td>
<td>0</td>
</tr>
<tr>
<td>I like using manipulatives, or learning tools, in math.</td>
<td>73.3% 11/15</td>
<td>20% 3/15</td>
<td>0</td>
<td>6.6% 1/15</td>
</tr>
<tr>
<td>I understand the math I learned this year better than last year.</td>
<td>40% 6/15</td>
<td>40% 6/15</td>
<td>13.3% 2/15</td>
<td>6.6% 1/15</td>
</tr>
<tr>
<td>I wish I could use a calculator when I am working on math problems.</td>
<td>66.6% 10/15</td>
<td>13.3% 2/15</td>
<td>13.3% 2/15</td>
<td>6.6% 1/15</td>
</tr>
<tr>
<td>I like working in small groups in math.</td>
<td>73.3% 11/15</td>
<td>13.3% 2/15</td>
<td>13.3% 2/15</td>
<td>0</td>
</tr>
<tr>
<td>I understand division better this year.</td>
<td>53.3% 8/15</td>
<td>33.3% 5/15</td>
<td>6.6% 1/15</td>
<td>6.6% 1/15</td>
</tr>
<tr>
<td>Sometimes I feel left behind in math.</td>
<td>26.6% 4/15</td>
<td>33.3% 5/15</td>
<td>13.3% 2/15</td>
<td>26.6% 4/15</td>
</tr>
<tr>
<td>Working with a partner helps me learn/understand math.</td>
<td>80% 12/15</td>
<td>13.3% 2/15</td>
<td>6.6% 1/15</td>
<td>0</td>
</tr>
<tr>
<td>I understand fractions better this year.</td>
<td>46.6% 7/15</td>
<td>33.3% 5/15</td>
<td>20% 3/15</td>
<td>0</td>
</tr>
<tr>
<td>Using manipulatives, or learning tools, helps me learn/understand math.</td>
<td>86.6% 13/15</td>
<td>6.6% 1/15</td>
<td>0</td>
<td>6.6% 1/15</td>
</tr>
<tr>
<td>Working in small groups helps me learn/understand math.</td>
<td>60% 9/15</td>
<td>40% 6/15</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I like talking about how I solve math problems.</td>
<td>53.3% 8/15</td>
<td>6.6% 1/15</td>
<td>33.3% 5/15</td>
<td>6.6% 1/15</td>
</tr>
<tr>
<td>I like doing hands-on activities in math.</td>
<td>53.3% 8/15</td>
<td>26.6% 4/15</td>
<td>13.3% 2/15</td>
<td>6.6% 1/15</td>
</tr>
<tr>
<td>I like playing games in math.</td>
<td>86.6% 13/15</td>
<td>13.3% 2/15</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Doing hands-on activities in math helps me learn/understand the math lesson.</td>
<td>40% 6/15</td>
<td>60% 9/15</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I find it easy to explain how I solve math problems.</td>
<td>33.3% 5/15</td>
<td>26.6% 4/15</td>
<td>33.3% 5/15</td>
<td>6.6% 1/15</td>
</tr>
<tr>
<td>Playing math games helps me learn/understand math.</td>
<td>100% 15/15</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Please put a check in the appropriate space:  I am a girl   boy

Thank you for completing this survey!! 🎉
APPENDIX M: CHILD ASSENT FORM
Child Assent Form

Kids Perceptions of Their Math Learning

I agree to participate in a study about kids perceptions of their math learning. I understand that this study has been explained to my mom/dad/guardian and that he or she has given permission for me to participate in this study. I understand that if I participate I can choose not to answer any question(s) or stop at any time. Information about what I say and do will not be given to anyone else.

I understand that I will be asked questions concerning my perceptions about how I learn math while in a small group and on my own. I understand that I will be audio taped during parts of this study. I also understand that I will be observed working on math in my classroom. I understand that my scores will not be affected and nothing bad will happen to me if I choose not to participate.

When I sign my name to this page, I am indicating that this page was read to (or by) me and that I am agreeing to participate in this study. I am indicating that I understand what will be required of me and that I may stop at any time.

_________________________  ____________________________
Student Signature                  Date

_________________________  ____________________________
Investigator Signature            Date

APPROVED BY
University of Central Florida
Institutional Review Board

[Signature]
CHAIRMAN
FCAT Group (green group)

- Something you do in school
- Something you have to know before the FCAT comes
- Something to get you ready for FCAT
- Helps you during the FCAT

Mathematics help[s] with a lot of things[,] like the fcat (red group)

- Helps you during the FCAT
- Something to get you ready for FCAT
- Something you have to know before the FCAT comes
APPENDIX O: TEXT FOR FIGURE 7-IMPORTANCE OF MATHEMATICS AND JOB OPPORTUNITIES CATEGORIES
Why you have to know how to count (blue group)

- If you can’t count that good, then people could just cheat you out your money
- Without mathematics, we wouldn’t know how to count
- If you don’t know mathematics, you won’t be able to get a job
- You have to learn to count stuff
- You have to know it if you want a job
- Something you have to use because… most jobs have to do with mathematics

Mathematics and what about mathematics (red group)

- Something you have to use because… most jobs have to do with mathematics
- It’s the biggest thing in all the subjects
- You have to know it if you want a job
- If you don’t know mathematics, you won’t be able to get a job

What would you do without mathematics!!! (green group)

- If you can’t count that good, then people could just cheat you out your money
- Something you have to use because… most jobs have to do with mathematics
- If you don’t know mathematics, you won’t be able to get a job
- I’m not good at mathematics
- Something all kids should know
- You have to know it if you want a job
APPENDIX P: EXPLANATION OF LATTICE MULTIPLICATION
Lattice Multiplication

58 × 79 = 4582 displayed as a lattice multiplication problem.

Lattice multiplication is an alternative method for multiplying that uses a lattice to arrange partial products of corresponding digits labeling each row and column. The digits are summed on the diagonal, resulting in the final product (in bold).
APPENDIX Q: EXPLANATION OF PARTIAL PRODUCTS MULTIPLICATION
Partial Products Multiplication

\[
\begin{array}{c}
243 \\
\times \ 3 \\
\hline
\end{array}
\]

\[
\begin{array}{c}
9 \\
120 \\
600 \\
729 \\
\hline
\end{array}
\]

Partial products multiplication is an alternative method for multiplying in which each partial product is recorded on a separate line.
APPENDIX R: EXPLANATION OF PARTIAL QUOTIENTS DIVISION
Partial Quotients Division

\[
\begin{array}{c@{\!}c@{\!}c}
6 & 582 & \\
120 & 20 & \\
462 & & \\
300 & 50 & \\
162 & & \\
120 & 20 & \\
\hline
42 & & \\
42 & 7 & \\
\hline
0 & 97 & \\
\end{array}
\]

Partial quotients division is an alternative method for division in which partial quotients are selected and partial products are then subtracted from the dividend, until the remainder is less than the divisor. The partial quotients are added, resulting in the final quotient.
APPENDIX S: MS. NEES’S FRACTION “WEB”
Fraction Web
REFERENCES


*Teaching Children Mathematics*, 7, 108-114.


