USING COMMUNICATION TECHNIQUES IN THE LOW-PERFORMING MATHEMATICS CLASSROOM: A STUDY OF FRACTIONS, DECIMALS, PERFORMANCE AND ATTITUDES

by

PAMELA J. GUYTON
B.S. Mississippi University for Women, 1990

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ABSTRACT

Within a low-performing seventh grade mathematics classroom, communication techniques including discourse, collaborative groups, listening, reading, and writing were implemented during a six week period. This study shows how the use of these techniques led to the twenty four students' conceptual understanding of fraction and decimal concepts. This research study provides insight to the deep-seeded beliefs of low-performing students. It provides a record of how the teacher used communication techniques in the classroom and had a strong positive impact on the attitudes and performance of these struggling students.

I dedicate this paper to my wonderful husband, Michael. Everything I am and everything I do,

You're My Inspiration.

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CHAPTER ONE

Introduction

Deon: *"We wouldn't be so dumb, if math wasn't so boring."*

Our "low" kids are often a topic of conversation in the teacher's lounge. Most specifically these teachers are referring to the group of students that make up a school's bottom quartile as determined by the state's yearly standardized tests. This is a population that is focused heavily on for the purpose of school accountability. Generally, it is discussed that many things contribute to a student's lack of high performance on the state's standardized test including background, behavior, apathy, intellect, and maturity. But are there other factors often missed? What if the "blame" could be simply put upon the educational processes the child goes through?

The quote at the beginning of this paper was spoken by a seventh grader who is in the bottom quartile. His words show the beliefs that he had about why he and his peers were so far behind in mathematics. This quote and others you will read are part of the qualitative study I conducted as a seventh grade mathematics teacher at a school in the Central Florida area during the 2007-2008 school year. The purpose of this thesis was to focus on the impact that various communication techniques had on the low-performing students' connections between decimals and fractions, and the attitudes of these students as they developed these connections using such techniques. The existing research related to effective mathematics instruction and student attitudes toward mathematics was reviewed. The effect of using communication techniques in the classroom as a means to impact student performance and attitudes was investigated and reposted. Finally a discussion of the results of this study and possible implications is offered.

As I conducted my research, I attempted to answer the following questions: 1) How did communication strategies affect my low-performing students' performance of decimals and fractions? 2) What impact did a classroom environment using communication techniques have on my low-performing students' attitudes toward mathematics?

I chose this topic of research because of my intrigue of low-performing students and their drive, or lack thereof, for academic success. Personally, I cannot recall a time in my life when the "grade" was not important to me. I am also curious how someone could dislike a subject so much, that they often disengage and refuse to even try for success. How can a group of students literally not care if they pass or fail? My belief is that this apathy is a façade, and they do in fact care. Then where does the problem really lie? Perhaps it is with the teacher, the teaching style, or the students' fixed mindset. To research this, I would have to consider how these students had been taught, and deviate from that method. I needed to veer away from the traditional teaching style that many teachers use, and try something completely new. After listening to the students, and spending time with current research, I decided that my approach with these students would be one of communication.

The National Council for Teachers of Mathematics (NCTM, 2000) has taken the position that all students who have opportunities to engage in mathematical communication including speaking, reading, writing, and listening receive a dual benefit of communicating to learn mathematics and learning to communicate mathematically. I believe that there is an additional benefit, improved attitude. I believe that these benefits would show up in my study, as I implemented mathematical communication in the classroom.

As I conducted this study, the students made me aware that there was a certain type of standard classroom environment that they had been a part of for many years. Traditionally they were placed in silent rows and provided their mathematical knowledge through the use of the overhead projector, and a textbook. I vowed that my classroom would most likely be very different from those that these low-performing students had been in previously. I would provide my students with a comfortable environment that fostered the sharing of ideas, questions, and applications of knowledge. I would get to know my students and seek to discover what had led them to dislike mathematics in the first place. My intention was to teach students to appreciate mathematics as they developed the skills and ability to think critically about their work and communicate their mathematical thinking. It was also my intention have the students create a positive mindset toward mathematics.

The concepts that I chose for implementation of this research project were fractions and decimals. These are interconnected and are widely used in everyday living. Students need to understand that fractions and decimals can be representations of the same number. Researchers have reported that middle-grade students have difficulties in developing conceptual understanding of fractions and decimals (Condon & Hilton, 1999). Even students in junior college have difficulties dealing with fractions, which can be connected to their earlier experiences in elementary school study when they first learned fractions (Haas, 1998).

It has been my experience that many low performing students cannot see the connections between most mathematical concepts. Perhaps this is because traditionally teachers teach mathematical concepts in isolation of each other. State adopted textbooks separate concepts page by page with little or no blending. Most curriculums do not reinforce the understanding that all mathematical concepts are related to each other. Educators, who only teach from the textbook, rarely address these relationships. This type of "isolation" teaching created a blank look on my students' faces when I told them that a fraction is actually a form of division problem. "Huh?", "What?", and "How do you know the difference?" were the responses I was given. I intended to change that.

In a study by Peck and Jencks (1981) a group of sixth graders were asked to draw or use models to explain their answers for operations of fractions. Peck and Jencks found that not more than ten percent were able to accurately indicate understanding of basic fraction concepts. Fewer than half knew that the subdivisions must be equal shares or were able to draw representations of simple fractions. Haas (1998) reported that the reason middle school students have difficulties with fractions is that instruction on fractions was delivered neither appropriately nor adequately in order to build up the connections between manipulation materials representation and symbolic representations. Taber (2001) also indicated that addressing the connection among different forms of representations was important in order to develop the conceptual understanding of fractions. Research findings led to the publication of the National Council of Teachers of Mathematics, *Principles and Standards for School Mathematics* (2000), discussing the need for students to, "work flexibly with fractions, decimals, and percents to solve problems..." in grades six to eight (p.214). It was this research, and much more, that led me to implement my communication goals during the six weeks I taught fractions and decimals to my low-performing class.

The group of students used in this study was chosen because of their history of mathematical performance. Annually students are given a standardized test for the purpose of identifying their performance levels in mathematics. The performance levels range from one to five. The Florida Department of Education indicates that a level one suggests that the student is a minimum of two years behind in mathematics; a level three indicates the student is on grade level, and a level five indicates that the student is two years ahead of the average student in his grade in mathematics. Purposefully I was given a classroom of 24 seventh grade students who had achieved a level one on the mathematics portion of the state standardized test a minimum of two years in a row. This class consisted of 13 boys and 11 girls. 75% of the students were African American, and 25% were white.

Significance of Study

This study is significant because recent research into student performance on the Florida Comprehensive Assessment Test (FCAT) shows that Florida students still struggle to meet state academic standards in mathematics. Nationally, it is estimated that 44 percent of the students tested scored below grade level in mathematics (Associated Press, 2004). With accountability becoming increasingly important at the national and local level within the instructional area of mathematics, the United States Department of Education says that we must ensure that schools employ scientifically based methods with long term records of success (2005). This study of my use of communication strategies in the low-performing mathematics classroom should provide a means for raising FCAT scores by addressing students' needs.

In addition, this study adds to the body of knowledge concerning attitudes of middle school students. It addresses the question of why. Why do so many students appear not to care about math, and continue to perform poorly in the classroom and standardized tests? This study should provide a means for improving the mindset of the low-performing middle school student toward mathematics.

Overview of this Study

The purpose of this study was to focus on the impact that various communication techniques have on the low-performing students' connections between decimals and fractions. This study addressed the attitudes of low-performing students' in mathematics within a classroom which uses various communication strategies.

A review of the literature, found in chapter two, presents past research in the areas of mathematical communication and decimals and fractions. Literature will also be presented as related to student attitudes toward mathematics. Emerging from the literature regarding low-performing students is how teacher expectations, communication, and classroom environment impacts achievement and attitude.

Chapter three describes the design of the study. More specifically, states the research methods used and the rationale for choosing those methods. It includes setting, instrumentation, data collection and how data was analyzed. Chapter four of this thesis provides a systematic description of the information collected and explanation of results, interrelationships and influential factors. Finally, chapter five addresses the results of the project and considers possible implications of the findings.

Next the literature review for this study is presented. This review is divided into three sections and the first section begins with the discussion for the need for mathematical communication in the classroom. The research clarified the pedagogy considered as communication. The researcher narrowed the definition of communication as it is used in this study, focused on written and verbal explanations in the classroom, and discussed how the use of the voice is necessary for achievement in the mathematics classroom. The second section of the literature review focused on decimals and fractions. The researcher discussed misconceptions as well as discussing instructional strategies that have been found successful in the classroom. Finally, the researcher explored literature that addressed attitudes as it relates to mathematics.

CHAPTER TWO

Literature Review

Traditional mathematics classrooms often look the same. There are rows of desks, in which silent students are working independently. The teacher is the one with the power, as well as all of the answers. The students are there to "receive" their education. Students are discouraged from interacting, because that can be interpreted as cheating or wasting time. Although this method of instruction works for some, often it is the low-performing student that cannot absorb enough information to be successful. The low-performing student needs a different classroom environment. He needs one filled with questioning, explaining, collaboration, listening, reading, writing and relating. He needs one filled with communication.

Communication

Thompson (2007) suggests that communication is an essential ingredient in the development of mathematical literacy. In the current mathematics curricula, there is no longer a singular focus on skills, but it is rather a balance of skills and conceptual development. Students should be a part of a mathematics learning community. They should be expected to share understanding. This sharing should focus on fluency with mathematical language and should be used in speaking, and writing. As students communicate, it provides the teacher with insight into their emergent understandings. These insights should guide instruction. If mathematical literacy is the goal of the classroom; both teacher and student communication should be evident.

Unfortunately, many teachers still rely on explain-practice instruction. If teachers are to simply explain a concept and then provide time for the practice of the concept, the students are missing some fundamental experiences. They are essentially taught to regurgitate information. The result of this type of practice is procedural knowledge rather than true understanding of mathematical principles. Speaking, listening, writing, and reading are different forms of communication that should occur regularly in the mathematics classroom. Since the debut of the Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989), issues of literacy have played a more prominent role in the mathematics classroom than in previous years. In this Standards document, communication was recommended as a standard at each of grades K–4, 5–8, and 9–12. In the revised Principles and Standards for School Mathematics (NCTM, 2000), communication was again recommended as a standard, with the recommendation that mathematics programs at all grades pre K–12 enable students to:

- Organize and consolidate their mathematical thinking through communication;
- Communicate their mathematical thinking coherently and clearly to peers, teachers, and others;
- Analyze and evaluate the mathematical thinking and strategies of others;
- Use the language of mathematics to express mathematical ideas precisely. (p. 348)

Emphasis on communication is not only recommended for students, but for teachers as well. In the Professional Standards for Teaching Mathematics (NCTM, 1991), one standard focuses on discourse, with the teacher of mathematics having the responsibility to orchestrate discourse by:

- Posing questions and tasks that elicit, engage, and challenge students' thinking;
- Listening carefully to students' ideas;
- Asking students to clarify and justify their ideas orally and in writing;

- Deciding when and how to attach mathematical notation and language to students' ideas. (p. 35)

Hence, the teachers have a responsibility to use a variety of methods to engage students in communication about mathematics. The connection between students' ownership of mathematics and classroom communication is the teacher. Carpenter and Lehrer (1999) considered teachers' classroom communication practices vital to fostering students' sense of ownership of the mathematics being communicated. Williams and Baxter (1996) assert that teachers and students belong to different societal groups and that one of the primary obstacles for teachers is how best to minimize these differences by fostering a dual student membership in the different groups. Legitimate student participation in mathematical discussions requires that the student first learn how to use the language of classroom discourse (Zevenbergen, 2000).

Forman, McCormick, and Donato (1998) studied the patterns of classroom communication during a lesson on algebraic patterns in an urban middle school in the first year of an educational reform project intending to help teachers cultivate student mathematical discourse. In this study, Forman et al. demonstrate that classroom discourse tends to lose importance for students if the intention of teachers is only to transmit knowledge of mathematics.

Similarly, Turner (2003) reported a study on examining the relationship between the nature of teacher discourse and thirty four students separated in two sixth grade classrooms. Classrooms were observed and recorded. Findings suggested that supportive instructional discourse that focused on student understanding was associated with student reports of self regulation, positive behaviors, and positive mathematics performance.

Speaking and Listening

Two of the most natural forms of mathematical communication are speaking and listening. Sstudents should regularly engage in talking mathematics in the classroom. This includes both in terms of student-to teacher talk and student-to-student talk. Hearing mathematics is important. When students discuss mathematics concepts aloud with others, they are more likely to be able demonstrate a deeper understanding of the concepts as compared to when they simply solve a problem (Thompson, 2007).

Kieran's (2001) study conducted during a ten week period with six pairs of thirteen year old students in algebra indicated that interactions between students provided evidence that adolescents within novel problem situations can experience some difficulty making their thinking available to others. The interaction, however, did prove to be highly productive for both students' mastery of algebra concepts.

Because the act of listening engages both the teacher and the student, how a student listens is as important as how the teacher listens. Although listening may initially seem odd as a mode of communication, ‘‘it is itself a kind of speaking, a means of probing and checking emerging understandings’’. Students must listen not only to the mathematics ‘‘text’’ of what is spoken, but also to the ‘‘subtexts’’ (gestures and tones) and ‘‘contexts’’ (backdrop, history) in which the text is spoken (Davis, 1994, p. 279).

Writing

Another form of communication in the mathematics classroom is writing. Writing in mathematics can be represented in many different forms. These include, but are not limited to journals, logs, daily diaries, and explanations about problems and processes. Students can also be encouraged to construct personal dictionaries in which they write a vocabulary term, give its definition, include any symbolic representation for the term, draw a diagram, provide an example, and provide non-examples (Murray, 2004). Rose (1989) indicates that ‘‘writing down mathematical concepts, processes, and applications in order to inform, explain, or report invites students to record their understanding through written language, a process that improves fluency’’ (p. 17). She describes two broad categories of writing: transactional and expressive. Transactional writing is writing for an audience, such as the teacher or other classmates; common examples of such writing include questions and word problems, explanations and definitions, reports and term papers, and writing to complete projects. In contrast, expressive writing is intended for a student’s own use, such as the exploratory writing when students are beginning to record ideas on paper, letter writing, and autobiographical writing. Some writing, such as journals, can be either transactional or expressive, depending on their purpose and the intended audience of the writing.

“Writing takes different forms in mathematics classes, ranging from more formal assessments, where carefully edited papers that present a logical argument are the goal to less-structured, impromptu writing that provides students with the opportunities to explain their thinking about mathematical ideas” (Shield and Galbraith, 1998, p. 117).

Collaboration/Discourse

Perhaps the most important form of communication in the classroom is student collaboration. By defining, comparing, contrasting, elaborating, and refuting mathematical ideas, students become initiated into the community of mathematics inquirers (Borasi, 1994). Learning opportunities arise as students participate in classroom social interactions. These interactions provide opportunities for students to reflect on their methods, justify solutions, and share their information with others. When students participate in this way, they strengthen and extend their understanding as well as the understandings of others in the class as they listen to the presentations (Peressini & Knuth, 2000). When students share their strategies, and are challenged by peers, they build a stronger understanding. They not only learn how to solve problems on their own, but they actively attempt to reconstruct their knowledge as they share it. “Teachers should consider classroom strategies that encourage students to think deeply, to struggle with ideas, and to test ideas out loud” (Rop, 2002, p.718). The teacher must learn to act as facilitator so students can begin to rely on their own intellectual reasoning and build conceptual understanding (Kazemi, 1998).

Decimals and Fractions

According to Kerslake, “The system of decimal fractions is so eminently simple that when it is generally understood will entirely displace the clumsy system of common fractions". (1991). Fractions and decimals are often included in discussions about middle school mathematics. Unfortunately, these discussions also include groans of dissatisfaction, stemming from the lack of success that teachers often have in teaching these concepts. Many students fail to see the relationship among fractions and decimals. As one student put it, a decimal is “a thing that makes numbers even more confusing,” whereas another characterized a percent as “the way teachers give you points.” The fact that these topics are typically taught in isolation is the main source of dissatisfaction. Often, the only connection mentioned by textbooks is a cursory discussion of conversions (Sweeny, 2000).

Lack of Understanding

The body of research agrees that there is a documented lack of understanding in the areas of decimals and fractions. The National Assessment of Educational Progress (NAEP), a United States report, raises concerns regarding trends in student achievement over the past twenty years (NCES, 2000).The results indicate that students of age seventeen consistently demonstrated a lack of proficiency with fraction concepts. In addition, an analysis of the 1990 NAEP mathematics achievement by Mullis, Dossey, Owen, and Phillips (1991) found that only 46 percent of all high school seniors demonstrated success with a grasp of decimals and fractions.

Despite the great amount of time that the middle-grade teachers devote to teaching fractions and decimals**,** converting between these two representations continues to be a difficult task for students. According to the results of the sixth National Assessment of Educational Progress (NAEP) conducted in 1992, although 90 percent of eighth-grade students correctly paired a simple fraction with its pictorial representation, only 63 percent of students successfully shaded a fractional portion of a given rectangular region using equivalent fractions. Likewise, 92 percent correctly identified 14.9 seconds as being the decimal representation closest to 15 seconds, but when comparing common fractions with decimal notation, only 51 percent of eighth-grade students chose 1/2 as being the fraction closest to 0.52. Twenty-nine percent of eighth graders chose the fraction 1/50 as being closest in value to 0.52 (Kouba, Zawojewski, and Struchens 1997).

In Brown and Quinn's study (2006), involving 100 middle school students, students were asked to answer a twenty-five question test to analyze decimal and fractional competency. The test was a pencil and paper instrument in which calculators were not allowed. Students were encouraged to show all of their work. The questions were designed to test concept knowledge and computational fluency. The study showed that the students struggled with simple algorithms. When asked to Subtract 3/5 from 8, sixty-seven percent of the students gave an incorrect response. When asked the sum of 5/12 and 3/8, nineteen of the 27 students added the numerators and added the denominators. The results of this analysis magnify the existence of a problem in the learning of mathematics that must be rectified. The analysis revealed a large number of misconceptions that students have related to the subject of fractions and decimals.

Misconceptions

Brown and Quinn's, (2006), study revealed commonly held misconceptions about decimal fractions:

- Longer decimal fractions are necessarily larger.
- Longer decimal fractions are necessarily smaller.
- Putting a zero at the end of a decimal number makes it ten times as large.
- Decimals act as "a decorative dot" (Bell, Swan & Taylor 1981); when you do
- Decimal fractions are "below zero" or negative numbers.
- Place-value columns include "oneths" to the right of the decimal point.
- One hundredth is written 0.100.
- 1/4 can be written either as 0.4 or as 0.25.

Why is this task so difficult for students? As students progress through school, teachers begin to use symbols to represent mathematical ideas, and the symbols begin to take on a life of their own. Students no longer expect mathematics to make sense. Instead, they find themselves immersed in learning that focuses heavily on the rules for working with fractions and decimals. In a study analyzing the addition and subtraction of fractions in two sixth grade classrooms, students looked for meaning in the patterns of the symbols and the syntax rather than trying to understand what they are doing (Lappan & Bouck, Sharp, 1998). Confusion arises when the symbolic configuration of a problem is similar to problems learned earlier, and students end up using inappropriate rules. It was noted that most errors are not a result of the incorrect use of a rule but rather the use of the wrong rule for a particular situation. Another common error that students made was trying to modify a rule to get it to produce the answer that they think looks right. These errors occur so frequently that educators can predict the type of mistakes that are likely to be made, which explains why students tend to make the same errors throughout their schooling.

Solutions

So how do we correct this in the classroom? The research suggests that in middle school, the development of fraction operations as an extension of whole number operations should provide experiences that guide and encourage students to construct their own algorithms (Lappan & Bouck, 1998). Also, more time is needed to allow students to invent their own ways to operate on fractions rather than memorizing a procedure (Huinker, 1998). Progressively this development should lead to more formal definitions of fraction operations and algorithms that prepare students for the abstractions that arise later in the study of algebra (Wu, 2001).

The relationship between fractions and decimal is not being mastered among students today. Misconceptions and skill deficits are apparent. How fractions should be taught is linked to when the concepts are being presented and how. Change is needed in the classroom before students will have a solid foundation of understanding of decimals and fractions and therefore be ready for higher mathematics courses.

Attitudes in Mathematics

Attitude is defined by dictionary.com as one's manner, disposition, feeling, position, etc., with regard to a person or thing; tendency or orientation. "Dealing with the true cause of a problem often involves understanding and fostering attitudinal changes in people." (Oakley and Krug, pg. 45). Oakley and Krug suggest that an individual's performance is directly related to his or her attitude or state of mind and an effective mindset creates good performance and desirable results (1991). By the same token, a poor or negative attitude can result in poor performance. Low-achieving students often display a poor attitude toward math and their ability to do well in that subject, blaming their performance on the fact that "math is boring".

Boredom in the Classroom

Rothman (1990) reported that nearly half of the 25,000 eighth graders in the 1988 National Educational Longitudinal Study said they were bored in school at least half of the time.

Within a study conducted over a five year process, boredom is defined as an emotion. It is a global phenomenon and it happens in and out of school. At various times, everybody is bored; however, some people are more prone to boredom than others (Farmer & Sundberg, 1986). These findings suggest boredom is dispositional (related to the nature of the individual), however others believe it is situational, attributing boredom to the nature of the setting (e.g., the school system, classroom, or the teaching). It is likely that there are interdependent characteristics of the individual and context that result in what we each call boredom.

Concerns about boredom emanate from the unpleasant feelings we associate with it: frustration, anger, disengagement, and the like. Not surprisingly, boredom is one of the most frequently identified causes for students leaving school temporarily (e.g., skipping classes, feigning illness) or permanently. In classrooms it is associated with diminished attention and interferes with student performance (Farmer & Sundberg, 1986).

Summary

A review of the literature suggests that a classroom environment enriched with communication is essential to the mathematics classroom. Educators should strive to create an environment that fosters the construction of true mathematical understanding (Kazemi & Stipek, 2001). There is also much evidence that two of the most difficult concepts that middle school students struggle with are decimals and fractions. The NAEP documents a significant lack of proficiency with both fraction and decimal concepts (NCES, 2000).

The literature connects boredom to unpleasant feelings associated with frustration, anger and disengagement. The research states that this boredom is one of the most frequently identified causes for students leaving school.

By fostering an environment enhanced with communication, the researcher intended to engage a group of low-performing students and assist them with understanding the concepts of decimals and the connections between them and impact the students' mindset as they did so. Chapter three will detail the methods by which the researcher conducted this study and explain both the data collection and data analysis.

CHAPTER THREE

Methods

The research of fraction and decimal concepts supported the need to present students with instruction that ties their real-life experiences and prior mathematics knowledge to new problem solving situations. Students needed to be provided with opportunities to solve problems, using concrete materials, create symbolical representations, and collaboration with peers. The research question, "How did communication strategies affect my low-performing students' performance of decimals and fractions?" was researched using communication in the classroom. The question, "What impact did a classroom environment using communication have on my low-performing students' attitudes toward mathematics?" was also addressed using various methods throughout the study. In this chapter the researcher will describe the setting and methods used to gather the information necessary to answer these questions.

The researcher chose to conduct an action research project with her students. The researcher wanted to "Take action and effect positive educational change based on my findings, rather than being satisfied with reporting my conclusions to others" (Mills, 2003, p.3). It was the goal of this researcher to study her teaching as she worked to improve the mathematical literacy of her low-achieving seventh grade students. Mathematical literacy includes the five processes the NCTM (1989) states as necessary for obtaining information: "valuing mathematics, becoming confident in one's ability to do math, becoming problem solvers, communication mathematically, and reasoning mathematically" (Pugalee, 1999, p.20) The data were collected using multiple sources. Students' journals, student one-on-one interviews, focus groups, teacher field notes, a pre- and post attitude survey and evaluative assessments were used to collect data on student mathematics attitudes and mathematics performance.

Setting

The public school selected for this study was a large**,** neighborhood middle school located in a suburban area of central Florida. The participant school was a historically high-performing school continuously earning the highest obtainable school grade of an A by the Florida Department of Education's Grading Scale since its opening in1999 (Florida Department of Education, 2008).

This school enrolled close to1600 students: approximately 8 % African-American, 45% Hispanic, 45% White, and 2% other. During the 2007-2008 school year, approximately 39% of the students received free or reduced price lunches.

The low-performing students that participated in the study were placed into the researcher's class on the base of qualifiers. These qualifiers included a minimum of two years with a level one on FCAT (criterion-referenced state comprehensive achievement test) in mathematics, but a level of three or better on the FCAT in reading. A level one out of five reflects a minimum of two years below grade level, while a level three out of five reflects on grade level. These students had never repeated a grade or course, and were in the appropriate grade for their age. None of these students had a diagnosis of any of learning disability. There were a total of 24 students, 13 boys and 11 girls. 16 of the students were African American and 8 students were white.

The students were in the researcher's classroom 50 minutes each day, five days of the week. The mathematics instruction took place during the 1:00 p.m. hour, immediately after the student's lunch period. The research was conducted during a continuous six week period.

Getting Started

Following approval from the Institutional Review Board (IRB), the researcher distributed parental consent forms to all 28 students in the class (Appendix C). The researcher talked with the students, and briefly explained the study. The researcher asked that the students share the consent form with the appropriate adults and return them signed if there was interest in participating in the study. The researcher made it clear that participation was completely voluntary and no one would be penalized if participation was not chosen. During the next few weeks, 25 signed parental consent forms were collected. As each parental consent form was received, the researcher asked the students to verify that they in fact wanted to be part of the study, and reiterated that there was no penalty if they did not choose to participate. Students who wanted to be in the study were asked to sign student assent forms (Appendix D). In total 24 affirmatives were received for the study.

Curriculum studied during this period included representation of fractions, and adding, subtracting, multiplying, and dividing fractions. Each of these also included improper fractions and mixed numbers. Also covered was representation of decimals, and adding, subtracting, multiplying and dividing decimals. The focus of the six weeks was the interrelationships between the concepts of fractions and decimals. Simply stated, finding the connections. Table 1 represents the study Timeline.

Table 1

Progression of Curriculum

Week One	**Representation of Fractions and Decimals with focus on pictorial and symbolic representation.**
Week Two	**Adding and Subtracting of Fractions and Decimals, with focus on pictorial and symbolic representation.**
Week Three	**Connections between Fractions and Decimals, using problem solving.**
Week Four	**Multiplying Fractions and Decimals, with focus on pictorial and symbolic representation.**
Week Five	**Dividing Fractions and Decimals, with focus on pictorial and symbolic representation.**
Week Six	**Connections between Fractions and Decimals using problem solving.**

Instructional Techniques

Each day of instruction, the researcher attempted to engage the students with the mathematics. The concepts were not taught through the use of a textbook. Throughout the study, the researcher provided the students with fraction strips, Cuisenaire rods, number lines, dimes, nickels and pennies, fractional parts, dry erase boards, and calculators to assist in their discussion and discovery of the connections of basic fraction and decimal concepts. Daily the researcher added to the students' body of knowledge by extending the earlier instruction, asking probing questions, and presenting new problems or situations. The students were constantly asked to investigate, collaborate, and then provide proof of understanding by explaining their thinking and showing how they had arrived at those perceptions. The researcher filled in the "gaps" and clarified when needed, but the focuses of the lessons were drawn from the students' connections and discoveries, as they were led through basis fraction and decimal concepts.

Specific Communication Techniques Used

Collaborative Bell Work

Because the participating school instituted the policy of "bell to bell" time on task, routinely, within the researcher's classroom, students were immediately prompted with a problem solving activity displayed on the screen by an overhead projector. Each student knew that this was an independent task that they were required to complete. Before the study, after allowing three minutes to work on the problem, the researcher would discuss the solution of this activity. This activity served a dual purpose, one of calming down the class and transitioning them to the structure of the researcher's class, and the other to review or introduce the concept planned for the day's lesson. On the first day of the institution of communication techniques, this beginning procedure was changed. When it was time for the researcher's explanation, students were informed that a new routine was going to be implemented. Students were directed to draw a bold line under their work, then turn to another student and discuss the solution that each had derived. Any insights or changes that came about because of the conversation were to be put under the bold line. After the students had time to collaborate, a student from each pair was called on to present their solution to the class. Once the pairs presented, the researcher led a classroom discussion detailing the solution, with reference to specific explanations provided by the students. The researcher was looking at the difference between the two halves of the paper to distinguish if this group collaboration actually assisted in more understanding. It was the researcher's goal at this point to make sure that each student had conceptual and procedural understanding of the concept at hand. She did this by listening to the explanations, asking probing questions throughout the discourse, and examining the written work.

Speaking and Listening through Collaborative Groups

Students were informed that each of them would be expected to form collaborative groups with four students in each group. The group members were expected to work together and help each other master the upcoming concepts involving decimals and fractions. Methods that the members of the groups were required to use for enhanced understanding would include the use of manipulative materials, discussions, questions, explanations of mathematical thinking, and the presentation of those ideas to the group as well as the class. The students were asked to write down their thinking and thoughts about the processes of the next six weeks. Their conversations were taped plus the researcher interviewed them to document every aspect of their mathematics thinking, writing, speaking and listening.

The researcher allowed the students in this study to choose groups of four and name them. The participating students were grouped in six groups of four. The researcher assigned a pseudonym to each student. (Table 4)

Table 2
Collaborative Groups (Student Pseudonyms)

Bad Boys	***Skaters***	***FFF (Future Famous Females)***	***Chocolate***	***Mathematicians***	***Slayers***
Blake	Scott	Lacy	Kim	Macy	Matt
Deon	John	Mary	Angela	Becky	Aaron
Kris	Mark	Tia	Jean	Luke	Anthony
Casey	Lee	Kyah	Ashley	Carla	Corey

The group members were expected to help each other complete selected exercises. Research has shown that contributing, supporting ideas with reasons, working to understand others' ideas, and building on the ideas of others has been shown to increase a student's conceptual understanding (Palinscar, Anderson, & David, 1993). The students were told that once groups were formed, they would be allowed to change groups once, but only if they could explain that need to the researcher; such changes were not requested. As the researcher collected data, patterns related to understandings, misconceptions, and attitudes emerged. These patterns are discussed in chapter four of this thesis.

During each class period, there was at least one activity designed for utilizing this teamwork. Being encouraged to get help from their peers was a new experience for most of the students. This group work required the students to speak and listen to others. The researcher also required verbal explanations from a representative of the group. Each member was given a number, and the researcher called one of the numbers at random to select the representative. It was the groups' responsibility to ensure that each member could respond effectively.

The instituting of the collaborative groups in the classroom did not go well at first. The researcher was approached as a needed mediator often. However, the researcher insisted the students rely on each other. Resource use, such as manipulative materials and notes, were also encouraged. The researcher had to model appropriate listening techniques and have the students role-play several times to show how proper communication skills needed to be used within the collaboration. The noise level was another obstacle to which the researcher had to adapt. The classroom became noisy, and often the groups were off topic. The researcher had to set time limits for many of the activities, hoping that would assist with staying on task. Then the researcher had to relax and allow the study to develop as it naturally would.

The Development of the Frequency Chart

The researcher was committed to engaging all students in challenging mathematics. The goal was for each student to demonstrate conceptual understanding of decimals and fractions. By implementing collaborative discourse, the researcher would explore the belief that communication techniques are an effective way of teaching. Opportunities for students to talk about mathematical ideas were included in every class period. Most days the students discussed problems and the correct and incorrect solution strategies. The researcher guided the focus on the processes of listening to each other and seeking alternative solutions rather that assuming there was only correct way to do things. The researcher attempted to impress upon each group the importance that *everyone* must understand everything, and it was the responsibility of the group to make sure that occurs.

Within a short period of time, the researcher came to realize that several group members were getting correct solutions without complete understanding. She them implemented a "Written Proof of Understanding" (WPU). Daily the teacher would provide a WPU question in which students had to answer independently. They were required to provide the solution as well as show evidence of understanding. They could do this by the use of written words, pictures, or algorithms. The researcher would keep a running total for each group, and determine which group was the most effective at facilitating learning. The ongoing accumulation of these "tallies" was recorded on a frequency chart displayed in the room.

The Development of the Rubric

In the spirit of communication, the students quickly communicated that they though several tallies should have been awarded, when the researcher had not. It became apparent that the researcher had not relayed complete understanding to the participating students as to what the teacher valued most on the WPU questions. The students believed that a correct answer automatically provided evidence of true understanding. The teacher disagreed. The researcher led a classroom discussion on what it takes to show complete understanding. Together with the class, a rubric was developed (see Table 5). By using a rubric, the researcher was able to answer the question, "What does she want?" On the topic of rubrics, Andrade (2000) stated that rubrics tend to be quite informative for students, thereby helping them think, learn, and produce high quality work (Andrade 2000). The researcher then took student work and worked with the other twelve teachers in the mathematics department in order to validate the rubric. The department assisted with the face validation of the rubric, as they decided to implement the use of this rubric in every mathematics classroom in the school.

Table 3 Rubric Developed by Researcher and Class

Level One	Level Two	Level Three	Level Four	Level Five
Incorrect answer/No Proof of Understanding	Correct Answer, but No Proof of Understanding Or Misconceptions Evident	Correct Answer, but limited Proof of Understanding or Little Evidence Provided.	Incorrect Answer but Proof of Understanding/ simple mathematical errors only	Correct Answer with Complete Proof of Understanding. Evidence is Provided.

Because the students were involved in the creation of the rubric, the understanding between the different levels seemed to exist. It was determined that a level one represented an F, a level two represented a D, a level three represented a C, and level four represented a B and a level five represented an A. A zero would be awarded if the student did not attempt a response. Students became aware that understanding was the priority in the classroom, and the rubric supported that idea. At least once a week, the researcher would display "Good Writing about Good Thinking in Mathematics". The researcher worked with the mathematics department chair person and chose quality examples of student work as evaluated by the rubric. The researcher created a transparency of these works as a means to display and discuss these examples. The students were required to use the rubric and evaluate them. The researcher then compared their evaluations to the official level given. This provided constant opportunities for the students to see what was considered "Good". This also provided practice with the rubric that the students were evaluated by during their writings. The students were eventually required to self-evaluate their own solutions before submitting a completed paper to the researcher. The researcher could easily see if the students thought they were doing a good job, or if they were insecure about their thinking. This was information that the researcher used to add to the depth of discussion in the one-on-one interviews.

Speaking, Reading and Writing through Attitude Surveys and Journals

In order to investigate the research questions, the researcher began by giving the students an attitude questionnaire (see appendix G). This questionnaire was adapted, with the help of the seventh grade counselor, from several different surveys. The researcher and the counselor found that many of the published attitudinal questionnaires were phrased for very young children, or did not address the researcher's study. Because of this, the researcher and the counselor worked together to create questions that met the researcher's needs and made sure to phrase the questions for the middle school student. The results of this questionnaire were tabulated and put into percentages. They were used to determine pre-existing attitudes and beliefs that the students held before the study, and investigate if any change in those attitudes occurred as a result of the study. These results are discussed in chapter four (see appendix H) along with the results of post attitudinal questionnaire (see appendix I).

The researcher had students keep a journal during this study. As a start to the journal keeping, the students were prompted to finish the following statement in their student journals: My past experience in math class was….. The students were informed that no "grade" was ever to be taken from the journals; they were just a means for the teacher to meet individual needs. Throughout the study, students were encouraged to ask questions, comment about feelings or frustrations, or just "talk about the class". Journals were placed in a designated part of the room. Each student had to write in their journals a minimum of once per week, but could as often as they would like. The journals were always responded to and returned the following class period. Most students wrote at least three times a week. In addition to the "free writing", all students were required to respond to several prompts from the researcher (see Table 3).

Table 4

Journal Prompts

Week One	**My past experience in math class was…..**
Week Two	**How do you feel about your ability to complete decimal problems?**
Week Three	**How do you like working with your group?**
Week Four	**What do you think would make this math class work better in order for you to understand more?**
Week Five	**What is your most favorite and least favorite thing about this class?**
Week Six	**Please complete the following sentence. My Present experience in math class is………**

The journal writing became an intricate part of this study. It was through this process, the researcher developed a true understanding of the student's beliefs and understanding toward mathematics. This writing also led to the researcher's understanding of the students' mindsets as they went through this process.

Speaking and Writing through Evaluative Assessments

Periodically, the students in the study were required to complete a written evaluative assessment. These assessments were teacher made and focused on the conceptual understanding of concepts. Students were required to use words, pictures, or examples to show their understanding. Each answer had to be explained and justified. Assessments were evaluated by the use of the class developed rubric. The rubric was also placed on the assessment itself, allowing students to self-assess. The assessments were returned to the students, and discussed during a one-on-one interview. Students were allowed to ask questions, request reevaluation of test items, and verbally explain misconceptions. These sessions allowed the researcher to compare verbal explanations to the written ones. Data was collected and analyzed in order for the researcher to evaluate conceptual understanding of the connections between decimals and fractions. This also afforded the researcher the opportunity to ask probing questions and take field notes regarding the students' attitudes toward the class environment as well as mathematics instruction, as well as, clarify statements made during focus group sessions.

Speaking and Listening through Focus Groups

Focus groups were conducted three times throughout the study, during the second week, fourth week, and the sixth week. Glesne (1999) explains that a focus group is a small group of people gathered for a discussion on a particular topic. Only one student from each collaborative group was chosen, and met all three times. The students were chosen so that gender and race were equally represented. In the three focus groups that were conducted during this study, the students' perceptions of their mathematics learning in this classroom and the ways they learned mathematics previously were explored (Appendix E). The researcher was able to probe further and gain explanations from the group. The data was audio recorded and field notes were taken. This data was transcribed and patterns or themes were looked for. The findings are discussed in further detail in chapter four of this study.

Triangulation

The practice of methodological triangulation, coined by Denzin in the 1970s (Janesick, 2000), was used for this action research project to answer the research questions. 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). The data gathering methods used in this study included the use of audio taping, focus groups, and student one-on-one interviews. Other methods included the use of student journals, classroom observations with teacher field notes, evaluative assessments and the use of a student questionnaire. Table 2 displays the methods of triangulation used for this study (Table 2).

Table 5

Research and Triangulation

Research Question	Data Source One	Data Source Two	Data Source Three	Data Source Four	Data Source Five
Performance	Audio taping and Field notes on: Collaborative Groups, Focus Groups, and One-on- One Interviews		Evaluative Assessments including Tests and Written Explanations		Observations/ Field Notes
Attitudes	Audio taping and Field Notes on: Focus Groups and One-on- One Interviews	Student Journals		Student Attitude Questionnaire	Observation/ Field Notes

Data Analysis

In chapter four of this thesis, the researcher documents how this action research project proceeded. Evidence for each research question is displayed and explained. The researcher explains how discourse, written evaluations, and interviews led to the emerging themes in this study. Finally, in chapter four, the themes established by student work and dialogue are discussed. In chapter five of this thesis, findings of this research and interpretations thereof are presented.

CHAPTER FOUR

Findings and Analysis

Preliminary analysis of the data for this study began soon after the researcher began listening to the 7th graders at the participating school. It was easy to discern their negative attitudes toward mathematics and their perceptions about their competency. Immediately the ability to communicate with their peers became a theme associated with their attitudes. This became apparent in the classroom discourse, journal writing and also the focus groups. Their bell work, evaluative assessments and focus group discussions were also revealing as to their conceptual knowledge. In addition, the analysis of the classroom discourse, the journal reading, and the one-on-one interviews, provided insight and guided the researcher to the implications of this study.

This study enlightened the researcher more than anticipated. Before conducting the study, the researcher anticipated an affirmation that using communication in the classroom was an effective way to teach decimals and fractions. She also expected that the students would develop a more positive mindset toward mathematics. But never had the researcher imagined the insights that would be obtained about what low-performing middle school students believe and think. "Action Research, like any other problem-solving process, is an ongoing creative activity that exposes us to surprises along the way. What appeared to matter in the planning stages of an action research investigation may provide us with only a hint, a scratching of the surface, of what is *really* the focus for our investigations" (Manke,2003, p. 2). The *real* focus of the researcher's investigation became the understanding of how using communication techniques in the classroom impacted the student's achievement and the perception of the students as to *why* this impact took place. It also led the researcher to pose a possible explanation of why these mathematics students were greater than two years behind their peers in the conceptual understanding of most skills in the first place.

The researcher's questions for this study were addressed by seeking out patterns in the evidence collected throughout this process. The questions that guided this study were: 1.) How did communication strategies affect low-performing students' performance of decimals and fractions? 2.) What impact did a classroom environment using communication techniques have on low-performing students' attitudes toward mathematics?

In this chapter, the researcher described the patterns that were noticed as well as the conceptual understanding that was evident as students participated in the establishment of a communication based classroom. First, the researcher examined the practice of instituting and implementing communication techniques in the classroom. Next, the researcher discussed the practice of those techniques as they relate to the students. Then the researcher illustrated the attitudes of the students as the study progressed. Finally, the researcher reflected and responded to the evidence collected.

Understanding Decimals and Fractions while Using Communication

Instituting Collaboration

When the switch was made from independent bell work to collaborative bell work, immediately the excitement in the air changed. The researcher instantly noted that the students liked being able to talk to another about the work. What was not immediately apparent was that only 60% of the class had attempted the work. The remaining 40% had no intention of ever attempting to solve the question. This fact came out once the pairs were required to present to the class their combined solution. The students that did complete the work, most often did not write down the complete word problem. They tended to pull the math problem out of the written situation and then attempt to solve the algorithm. At the beginning of the study, the students showed very little work. When working collaboratively, the students tended to jot down short notes. When asked why the words were written, this student responded with the fact that it helped him explain if he was called on to present in class (Figure 1). Students also tended to add to their work at the bottom of the page as the teachers and others talked. (Note: two different answers considered right)

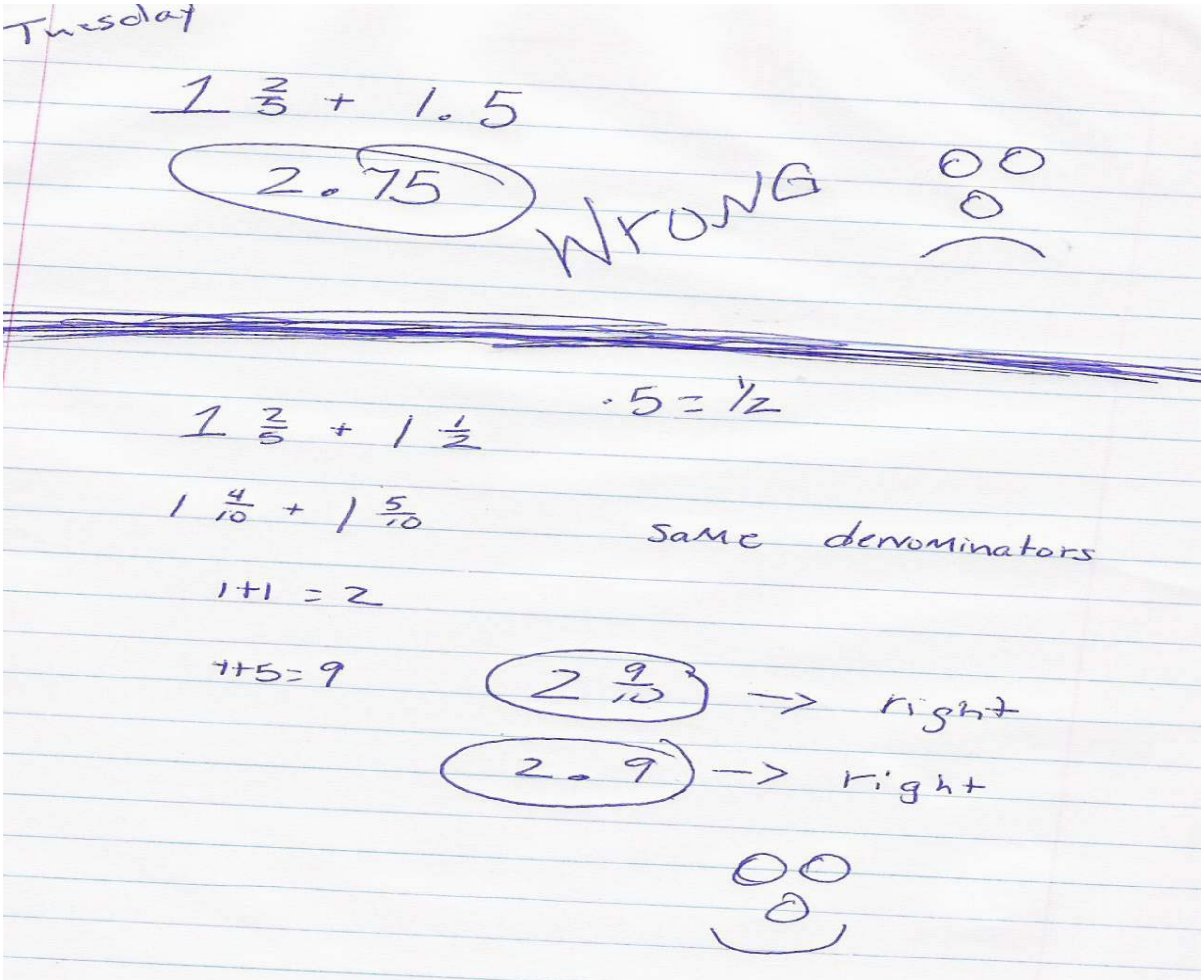


Figure 1 Bell Work

Collaborative Groups

The researcher began her audio taping once the groups were chose, and required each group to come up with a name. After transcribing the tapes, the researcher noted that the dynamics of the groups were already being identified. One group voted on the name, and majority ruled (Bad Boys). Another group picked a leader, and the leader chose the name (Slayers). The remaining groups combined the various suggestions to come up with a collaborative title (FFF, Chocolate, Skaters, and Mathematicians). The researcher was curious if the dynamics of the group would continue as such.

In the beginning of the study there were difficulties with the implementation of the collaborating groups. This included the need for mediation, a high noise level and a lack of focus within the groups. The researcher field notes detail her initial doubt in this process. “I have to come to the realization that using communication in the classroom may affect attitudes, but may not be an effective way to teach decimals and fractions to low-achieving students. They need much more structure.” At this time, the researcher became less anxious about the *outcome* of the study and became focused on the *progression* of the study.

During week four, the researcher’s field notes state, “The groups are really meshing well. They seem to be talking and listening to each other. I can tell that they are learning! Perhaps I should not have doubted them at the beginning.”

Discourse within Collaborative Groups

Beginning with week one of the study, the researcher used a recording device to record many of the conversations within the collaborative groups. The following conversation was in response to the question, “Describe the relationship of 0.3 as compared to 0.003?

Ms. G: (After looking at the group’s answers) “We don’t all have the same answer so we need to talk to each other.”
Matt: *To Aaron,* “Because point 003 is longer so I know it is bigger, but Aaron won’t listen.”
Ms. G: “Aaron, talk to him about your thinking. Group, when someone says something you should share your thinking also.”
Aaron: *To Ms. G,* “Tell him I’m right.”

Ms. G: "If you think you are right, you have to explain it to him. It is the responsibility of each group member to make sure everyone understands how to get the solution properly. Each of you should discuss your thinking." (Ms. G. walks away)

Corey: "Matt is right, cause it's bigger."

Anthony: I don't know. I don't get it.

Aaron: "I'm telling you I'm right."

Matt: "Are you sure?"

Aaron: "Yes".

Matt: "Then we will go with your answer."

When the group time was extinguished, the researcher called on Matt to provide his group's answer and verbally explain how that solution was derived. Although Matt gave the correct answer (that 0.3 was greater than 0.003) he could not explain his solution. After the researcher translated the conversation, it was easy to see why Matt could not provide a verbal explanation. He never understood. The use of collaboration had not helped the group understand at all. Looking back, the researcher compared this to the way the group had chosen their name. Again, the group had gone with the leader's decision. Even though the leader was correct, he did not facilitate understanding for the other members of the group. But Matt was accustomed to not understanding. That was why he was two years behind his peers. The researcher was aware that using communication in the form of collaboration was not effective in this case, and something else had to be done to improve the situation. The researcher was unsure if the teacher led discourse in the classroom that followed this conversation had assisted Matt in his understanding.

The researcher did not give up. It was at this time that the researcher instituted the Written Proof of Understanding problems and created the frequency chart. The researcher noted that the students showed a new interest in their efforts for shared understanding.

The following conversation was recorded occurred during week two of the study, after the frequency chart was displayed. It was in response to the following prompt: Which is greater ½ plus ¼ or 0.6 plus 0.8?

Aaron: "The answer has to be 6 tenths plus 8 tenths" because those numbers are bigger."

Matt: *To Aaron,* "It may be a trick, let's do them both separately and find out, you do the fractions."

Aaron: "You do the fractions, I'll do the decimals."

Matt: "Okay."

Corey: "It's easy; you can just look at it!"

Anthony: "That's what I did."

Aaron: "What did you get?"

Corey: "The decimals are bigger."

Matt: "Are you sure?"

Corey: "Yeah, look, they will be more than one; the fractions don't go that big."

Anthony: I did it like money 50 cents plus 25 cents is 75 cents. Then point 6 and point 8 is 1.4 and that's bigger than 75 cents.

Matt: "How is 1 point 4 bigger than 75? Man, you don't know nothing. Besides, I got ¾ not 75 cents.

Anthony: (*raising his voice)* "Yes it is! Look, 1 point 4 is like one dollar and 40 cents. ¾ is like 3/4th of a dollar. That's 75 cents, and one dollar and 40 cents is more than 75cents."

Matt: "Man you need to calm down! Just show me again, so I can get a tally."

Corey: "I'll show him, look if you can't just see how much it is, then get a common denominator. Then see if it is bigger than one."

Matt: "What? How do you know if it's bigger?"

Anthony: "Man, you're stupid. The top has to be bigger than the bottom."

Matt: "What?"

Anthony "Like 5/4 is bigger than one. And ¾ is smaller. If the top is bigger, then it's bigger than one.

Corey: "We're never going to get tallies on this one."

Matt: “I get it now.”

Aaron: “Good.”

Corey: “Yeah right.”

When the researcher asked the group for the explanation, Anthony was called on and explained the problem using a comparison to money. The following independent question was given: Which is greater, ¾ plus ¼ or .3 plus .45? See Figure 1 below for Matt’s response.

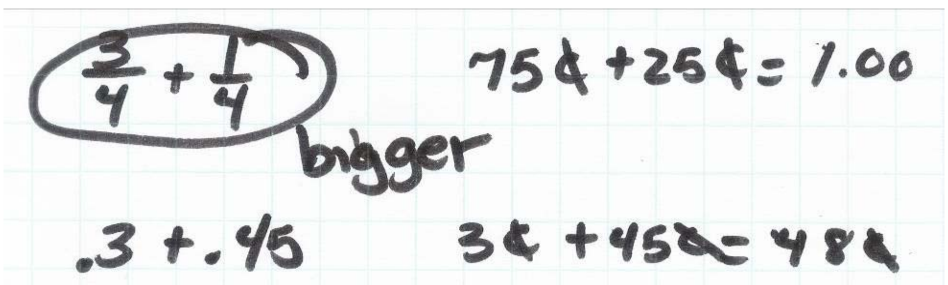


Figure 2 Matt's Response to Independent Question

Although complete understanding is not apparent, the researcher can see that growth has taken place. By relating to money, Matt has a better understanding of an effective way to compare decimals and fractions.

The pattern of lack of understanding was prevalent in many students work.

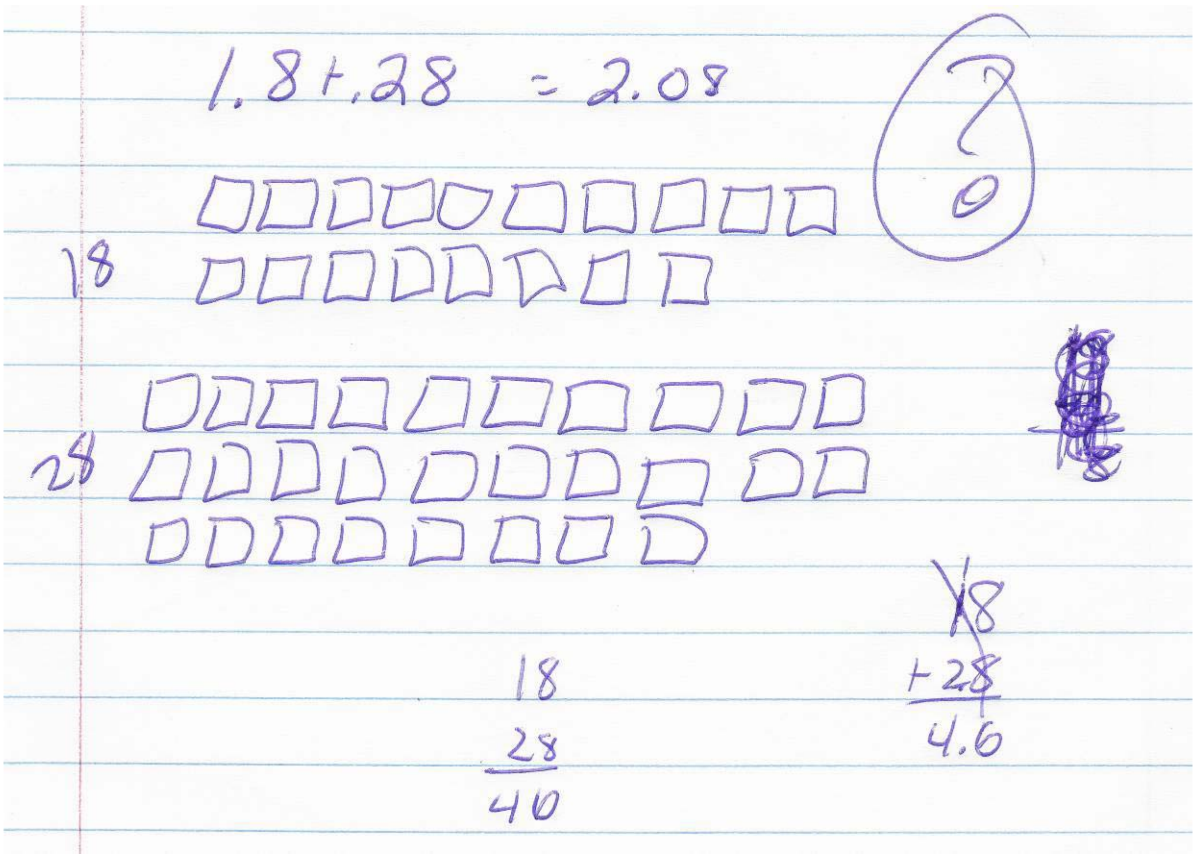


Figure 3 Lee's Response to Independent Question Involving Addition of Decimals

The researcher could easily deduce by only looking at the answer, that Lee knows how to add decimals. But upon further investigation, the researcher can tell that Lee's explanation does not make sense.

In the two examples above, the researcher noted that she had awarded Matt a "tally" for his answer, but did not award Lee. During a focus group, several students stated that they felt that the teacher was not always fair while awarding the tallies. "You like the boys better and give them more tallies," Carla noted. The researcher noted a need for a consistent evaluative system in order for the student to understand how to demonstrate complete understanding.

It was these events that led the researcher to work with the class and develop the rubric that became the tool used for evaluation of proof of understanding. This tool was used by the teachers and students alike.

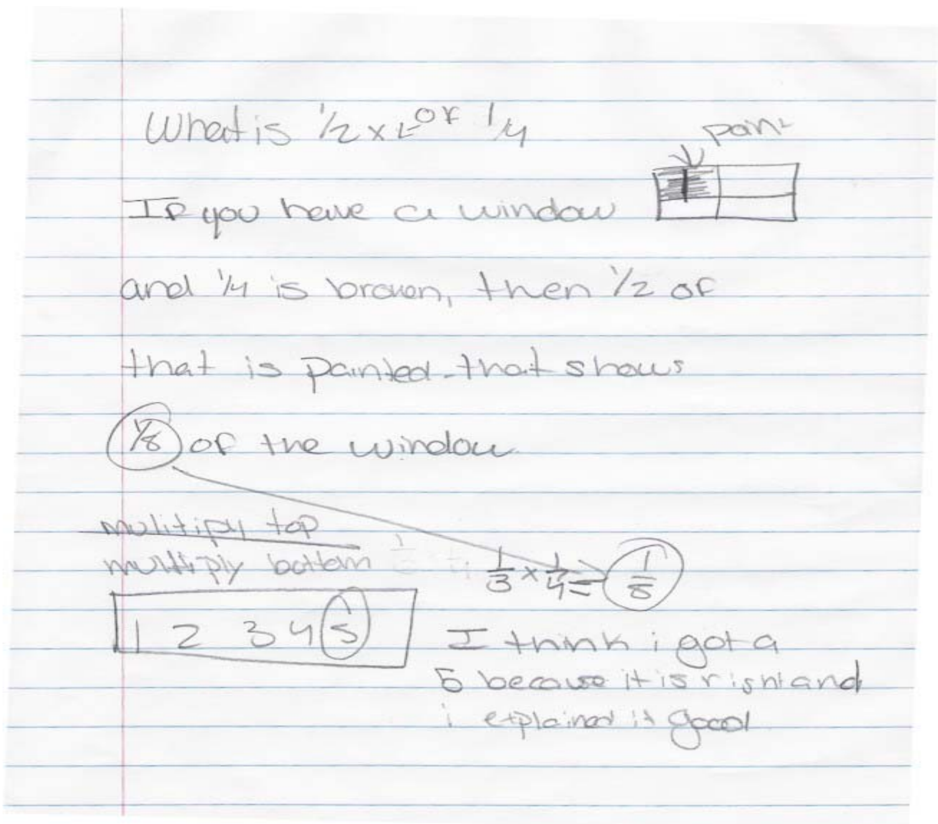


Figure 4 Written Explanation with Self Evaluative Rubric Scoring

The researcher could easily see that Macy believed in her understanding of the concept of multiplying fractions. This was helpful when the researcher re-taught the concept to the students who did not understand. The researcher used Macy’s thinking to help further others understanding.

Progression with Written Explanations

Using the Written Proof of Understanding questions to explore mathematical thinking and as a means of evaluation enabled the researcher to truly understand the many misconceptions that the students had about fractions and decimals. The use of mathematics vocabulary became an important part of the explanations given. The researcher was able to address common misconceptions because they were easily identified.

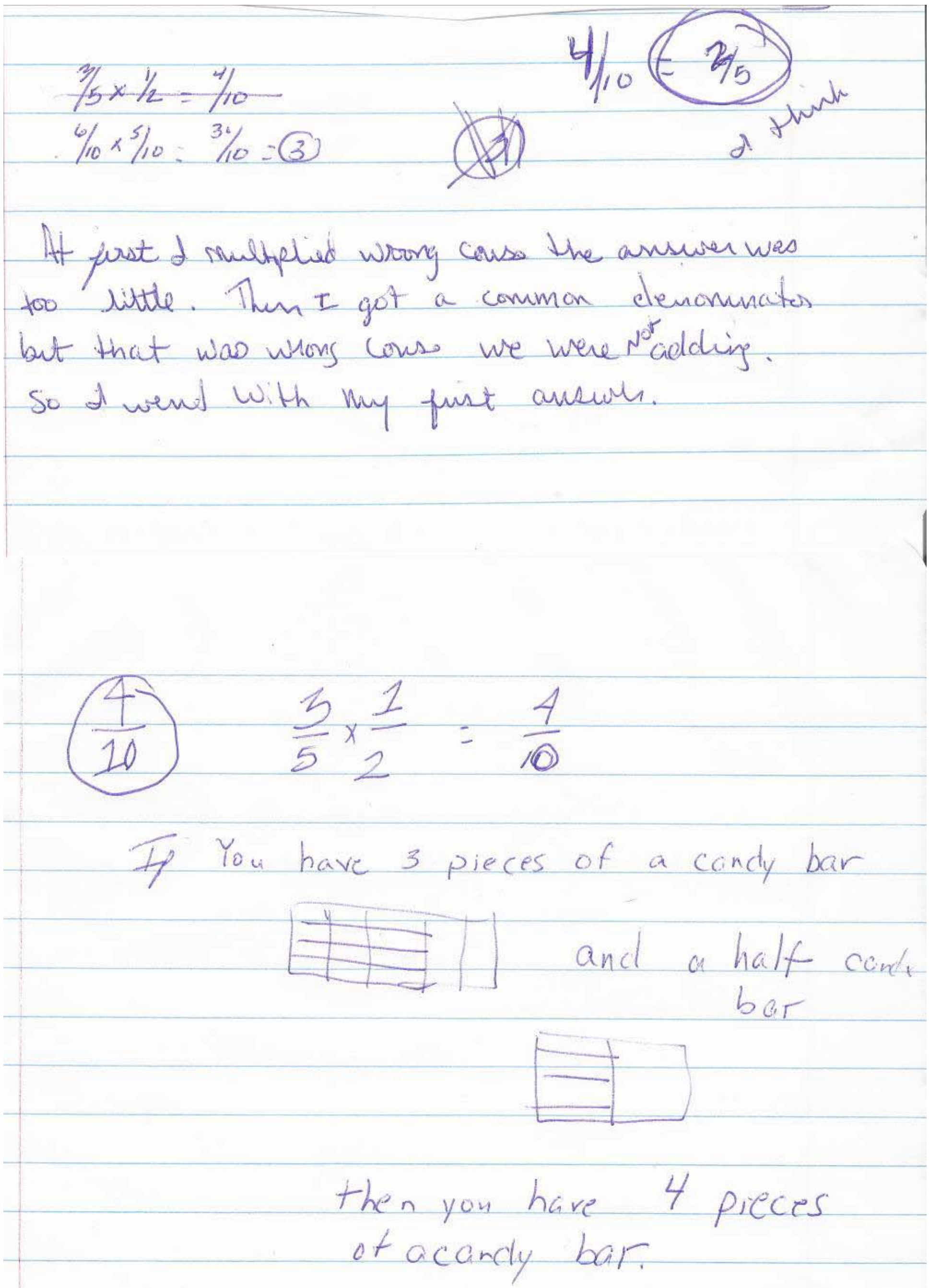


Figure 5 Common Misconceptions

Both of the students above missed the multiplication problems because there was no understanding that when a fraction is multiplied by another fraction, the ending result will be smaller than the original fraction. Although they each got the correct answer, the researcher could easily see that there was no conceptual understanding. The two students are only able to show the ability to properly use the algorithms. Using the rubric, the researcher awarded the students with a level 3 (correct answer, but little or no proof of understanding). If focus had not been on the understanding, both students would have received full credit for knowing how to multiply fractions.

Table 6 represents the average level on the written assessments received by the participants throughout the week. The students were required to provide answers as well as written explanations to a minimum of one question daily.

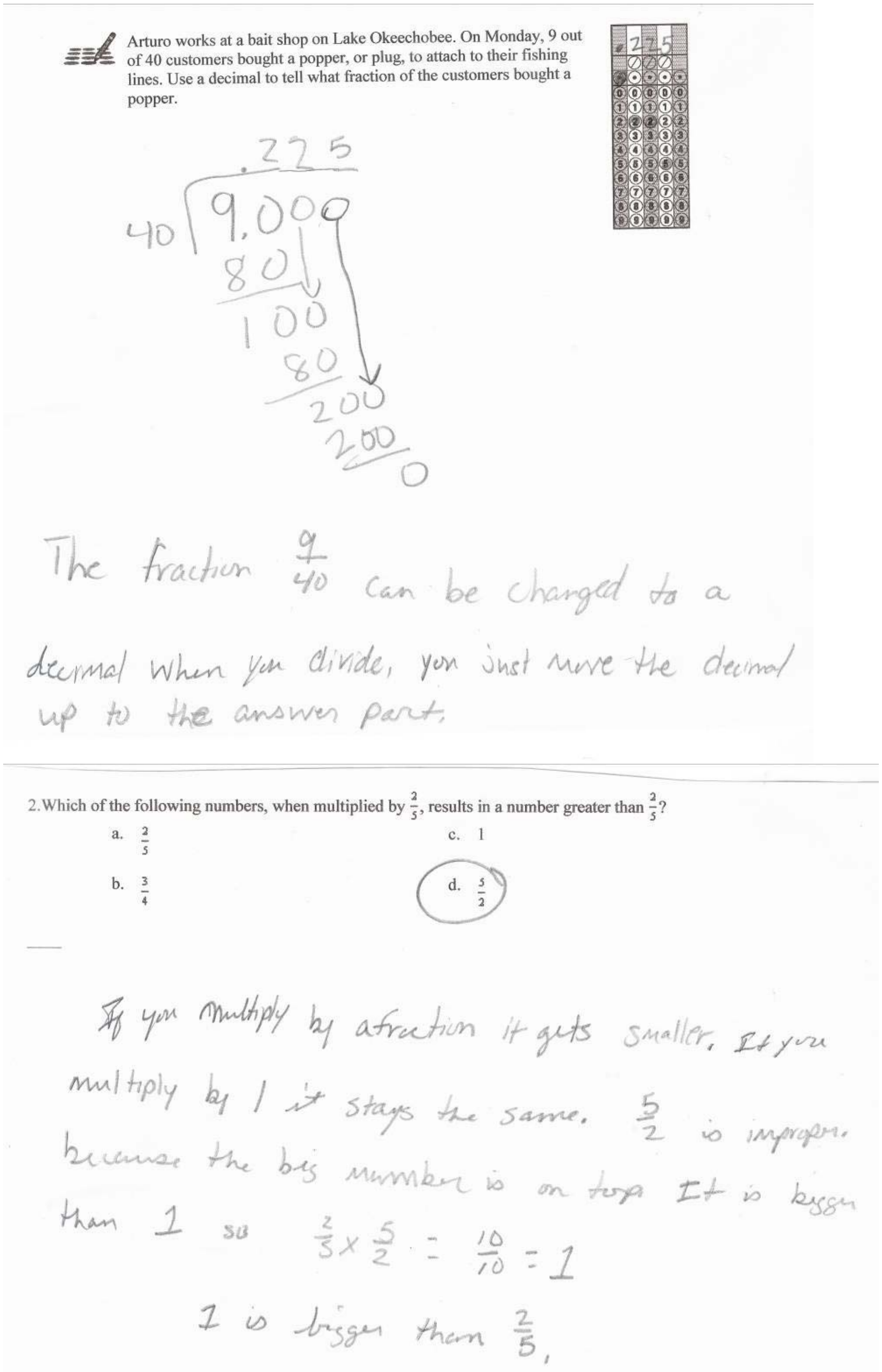
Table 6 Average Levels for Written Assessments

Weekly Quiz	**Average Levels using Rubric**
Week One: Representing Fractions and Decimals	No rubric used
Week Two: Adding and Subtracting Fractions and Decimals	Level 1.3
Week Three: Connecting between Adding and Subtracting using Problem Solving	Level 3.2
Week Four: Multiplying Fractions and Decimals	Level 3.5
Week Five: Dividing Fractions and Decimals	Level 2.1
Week Six: Problem Solving Using both Fractions and Decimal Concepts	Level 3.2

The researcher was encouraged that the group as a whole progressed from an average level of 1.3 to a level 3.2 throughout the study. Although occasionally still getting the algorithms wrong, students were beginning to show understanding of mathematics vocabulary and understanding of basic decimal and fraction relationships. The dividing of decimals and fractions seemed to provide the most difficulty for the students. Most surprising to the researcher were the results of the assessments given in week six.

Problem Solving: Week 6

Week six focused on problem solving. The researcher used word problems pulled directly from the county adopted text book supplement titled FCAT Prep. Most of the students showed in-depth understanding of what the problem was asking them to do, and were able to solve many of the problems easily. Below are Becky's solutions and explanations for two problems (see Figure 4.) The researcher was excited to see that Becky had developed some conceptual understanding of decimals and fractions. Becky's solutions are similar to the majority of solutions presented. As a whole the entire class was showing an improved level of true understanding.



Arturo works at a bait shop on Lake Okeechobee. On Monday, 9 out of 40 customers bought a popper, or plug, to attach to their fishing lines. Use a decimal to tell what fraction of the customers bought a popper.

.225

40) 9.000

The fraction $\frac{9}{40}$ can be changed to a decimal when you divide, you just move the decimal up to the answer part.

2. Which of the following numbers, when multiplied by $\frac{2}{5}$, results in a number greater than $\frac{2}{5}$?

a. $\frac{2}{5}$

b. $\frac{3}{4}$

c. 1

d. $\frac{5}{2}$

If you multiply by a fraction it gets smaller. If you multiply by 1 it stays the same. $\frac{5}{2}$ is improper. because the big number is on top It is bigger than 1 so $\frac{2}{5} \times \frac{5}{2} = \frac{10}{10} = 1$

1 is bigger than $\frac{2}{5}$,

Figure 6 Becky's Problem Solving

Evaluative Assessments Created by Textbook

In addition to the researcher created evaluative assessments, the researcher utilized the testing program that came as part of the county adopted textbook. The procedure of creating tests this way is commonly used by most middle school math teachers across the district. It is the teacher's easy way out, because the test questions are randomly selected by the textbook program to match the chapter being covered. These tests are also typically in the format of multiple choice questions, and therefore are quickly graded. The researcher administered three tests over the course of the study. The researcher was curious to see if the participants in the study would be able to utilize the knowledge being taught, discussed, and written about, on a standard multiple choice test

Table 7 Student's Average Test Scores on Three Tests

[redacted]

The researcher found that twenty two students (92%) had a passing average on the three tests. The researcher concluded that by using the standard evaluative measurements used in most seventh grade classrooms, a basic conceptual knowledge of decimals and fractions had been demonstrated by most students. This led the researcher to affirm the belief that using communication techniques in the classroom had a positive impact on this understanding. Further discussion of these implications will be discussed in chapter 5 of this thesis.

Table 8 Teacher Evaluations vs. Students Self Evaluations

[redacted]

The researcher also wanted to compare her scores to the average score that the students had given themselves. Both evaluations were remarkably close, and led the researcher to determine that the students accurately understood the quality of their work.

Focus Groups and Interviews

The researcher utilized three focus groups throughout the study and conducted more than 50 one-on-one interviews. Recording these conversations and taking field notes during these processes, the interviewer was able to probe and discuss how the students felt their new roles in the classroom were affecting understanding (Appendix E and F). The following statements, and many more, were noted by the researcher.

> Becky: *"Cause we are all trying to get a tally, we all try to learn how to do the new stuff."*
>
> Matt: *"Sometimes you talk too fast, but Aaron is smart and he talks slower, so I learn it. Aaron makes it easier."*
>
> Lacey: *"I got too much stuff in my brain, my mind, but the group gets mad if I'm not paying attention so I have to or they will not be my friends anymore."*
>
> Lee: "*In the beginning I didn't care, but now it is easier to learn. I used to just circle whatever; but now I'm like, "oh, we did this. Writing it out is hard, but it helps."*
>
> Mark: *"I hate to have to write everything. It takes too long. But at least I know that I know it."*
>
> Macy: *"Now that I can talk in math, I love coming to class. Math is easy now. I used to always get detention, now I get 'A's! If we didn't have to show all of the work, it would be perfect."*

Although many students were vocal about the dislike for writing and "showing all of the work", without exception, the students were in agreement that having to do the writing and being able to talk about mathematics made it easier to learn. The researcher concluded that the students perceived the use of communication techniques in the classroom was an effective way to learn the concepts of fractions and decimals.

Attitudes toward Mathematics

At the beginning of this study, the researcher provided the participating students with a questionnaire that surveyed attitudes toward mathematics (Appendix G).The students were told not to identify themselves, and be completely honest. The results of the questionnaire (Appendix H) provided insight for the researcher. Overwhelmingly (96%) the students noted that they believed that “My math teachers have always been good teachers.”, yet sadly only a small few of the students noted that they were “Smart in math” (8%). Another interesting piece of information noted by the researcher was the fact that 83% of the students stated that they rarely or never talked or worked in groups a part of their mathematics education.

In the comments portion of the survey, ten different students claimed that math was “boring.” When interviewed one-on-one, several students also reiterated this statement. Upon probing, the researcher was told that math was boring because of all of the worksheets, and the fact that, “we never get to do what we want; we always have to just work.”

In the early 1950's, Fenickel (as cited in Mikulas & Vodanovich, 1993) noted the relationship between control and boredom. He felt boredom "arises when we must not do what we want or we must do what we don't want to do" (p. 359). This is consistent with the findings of Larson and Richards (1991) indicating boredom was greatest in teacher-directed activities. Kohn (1993) examined the "powerlessness" many students experience in their education. The effects of keeping students powerless include diminished physical health, depression, difficulty making decisions, and reduced motivation to achieve in school assignments.

The researcher transcribed many of the interviews and focus group conversations. Although there were hundreds of comments that addressed the dislike of mathematics, a reoccurring theme was undeniably, boredom. Many of the students blamed boredom to be the sole reason for them not doing well in math!

Deon***:*** *"We wouldn't be so dumb, it math wasn't so boring."*

Matt: *"I just want to fall asleep all of the time."*

Lacy: *"nothing is interesting, nothing."*

Lee: "*All the teachers do is sit at their desk and make us do problems."*

Mark: *"I can just copy the answers from somebody else if I want to pass. That's better than being bored"*

Becky*: "I just draw during class that keeps me awake"*

Deon***:*** *"We can use calculators and get all of the answers, then it won't be so boring."*

Matt: *"My favorite math teacher let us play our Game Boys all of the time, that way we wouldn't be bad If someone was bad she made us work."*

During week four of the study, the researcher went back to the question of boredom in the classroom. The conversations were definitely different.

Matt***:*** *"Math is so cool. It's my favorite class."*

Deon: *"I like math now, I'm getting real good."*

Luke**:** *"I hate to write it out 'cause I can't draw, but other than that it is fun."*

Lee: "*We don't even do much work anymore. We just talk about decimals and stuff."*

Mark: *"I wish I could just stay in this class. You care about us. You really want us to learn."*

Becky*: "I bet I get a level 5 on the FCAT. Now I get it. I didn't know that math was the cool subject, I always thought it was P.E."*

Deon***:*** *"Math used to be whack, but not anymore."*

Carla: *"I don't like being in Luke's group cause he messes around too much, and it sometimes keeps me from hearing about the new stuff we're doing."*

Lacy**:** *"If we could talk in our other classes we would be geniuses!"*

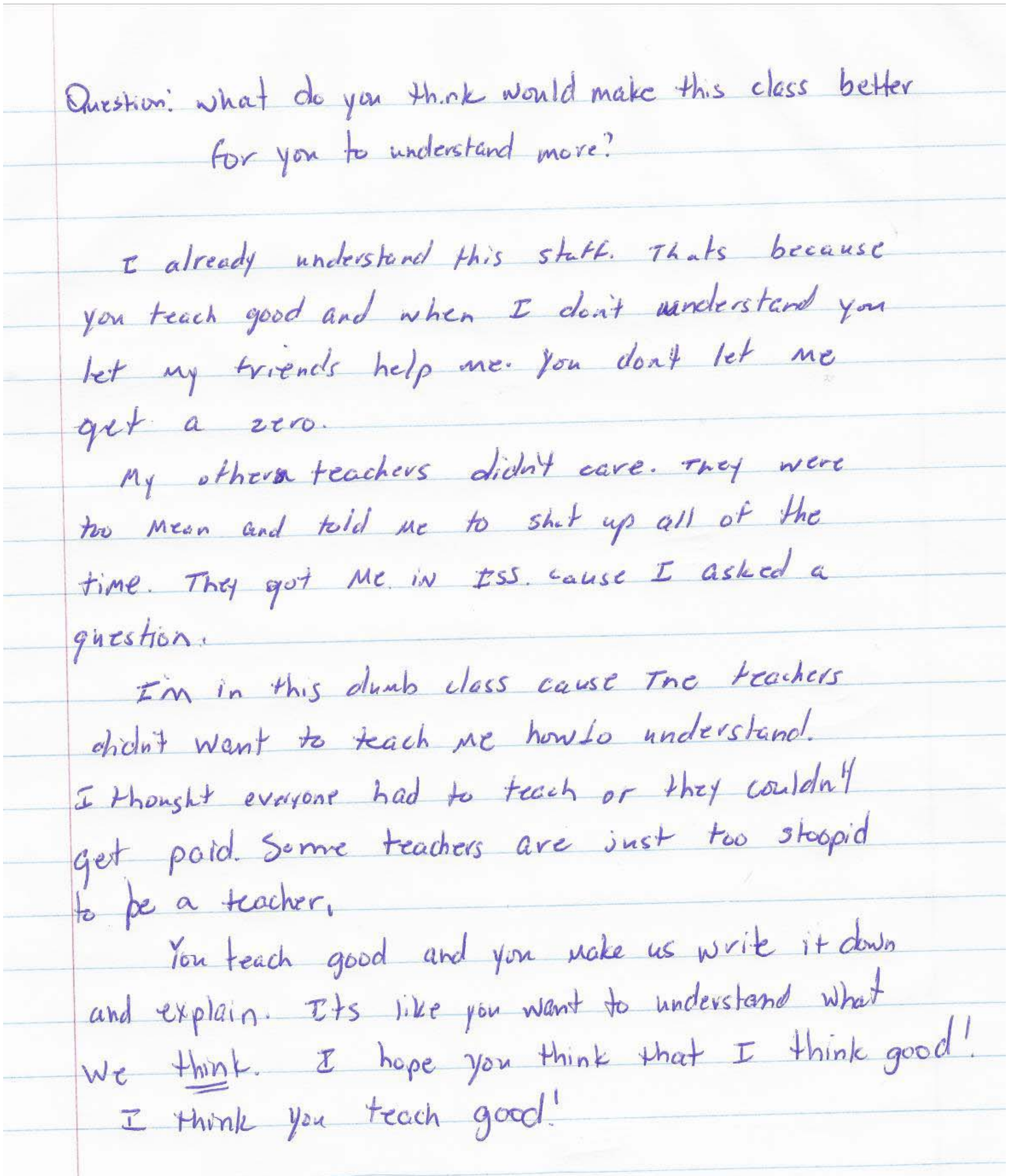
Lee: "*I didn't know that everyone else was good in math. I thought they were dumb like me but they can explain everything good."*

Corey: *"If you let us eat, this class would be perfect."*

Deon*: "I know I'm smart in math now,' cause I don't fall asleep anymore and I learn things. It's like its easy now! "*

The researcher also noted in field notes that the entire demeanor of the class had changed. The excitement the students displayed while entering to class was impossible to overlook. Students were engaged in the activities with only an occasional groan when asked to "write it out". Only twice did a student not complete a written assignment, which is quite a difference from the self-reported 50% who stated they "rarely or never" completed a class assignment in math.

The Revelations of the Student Journals



Question: what do you think would make this class better for you to understand more?

I already understand this stuff. Thats because you teach good and when I don't understand you let my friends help me. You don't let me get a zero.

My other teachers didn't care. They were too mean and told me to shut up all of the time. They got me in ISS. cause I asked a question.

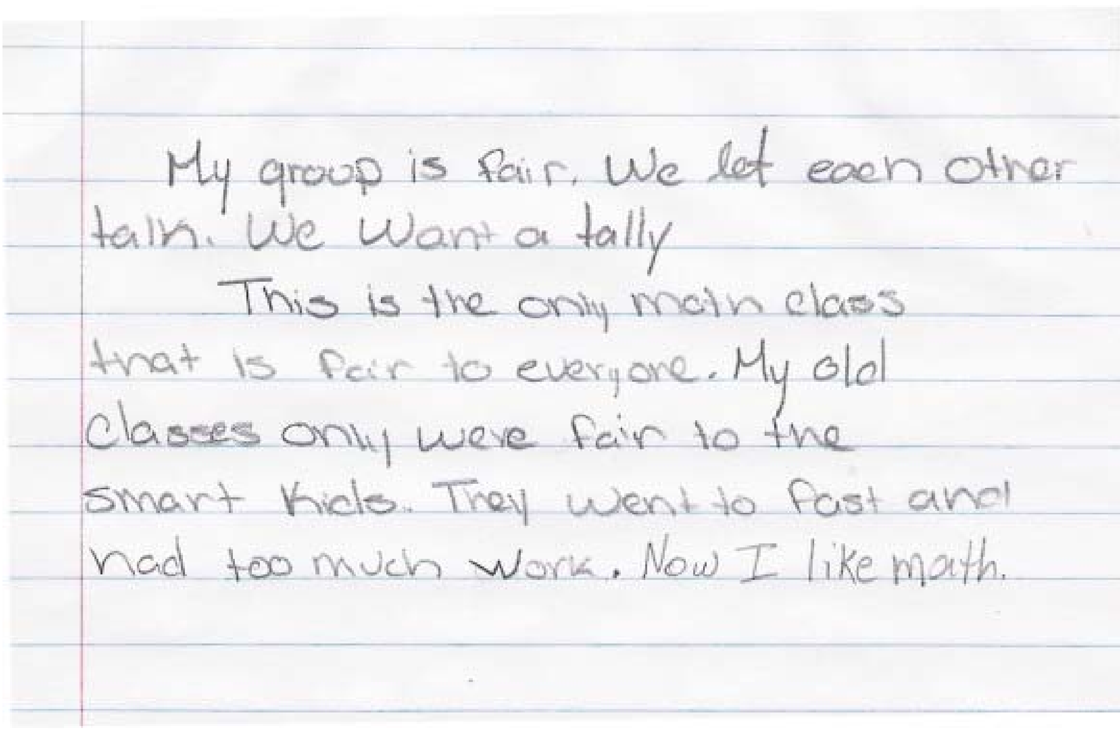
I'm in this dumb class cause The teachers didn't want to teach me how to understand. I thought everyone had to teach or they couldn't get paid. Some teachers are just too stoopid to be a teacher,

You teach good and you make us write it down and explain. Its like you want to understand what we think. I hope you think that I think good!

I think you teach good!

Figure 7 Blake's Discussion of Failure

The researcher was surprised by Blake’s fourth week journal entry. The prompt had been, “What do you think would make this math class work better in order for you to understand more?” Blake seemed very angry with his response, yet quite candid about where he placed the blame of his previous failures in mathematics. The response led me to write others in the classroom and determine if his feelings were in isolation. Fearing “opening a can of worms” the researcher attempted not to lead the students to respond in a certain way. Leading was not necessary.



My group is fair. We let each other talk. We want a tally
This is the only math class that is fair to everyone. My old classes only were fair to the smart kids. They went to fast and had too much work. Now I like math.

Figure 8 Jean's Discussion of Fairness

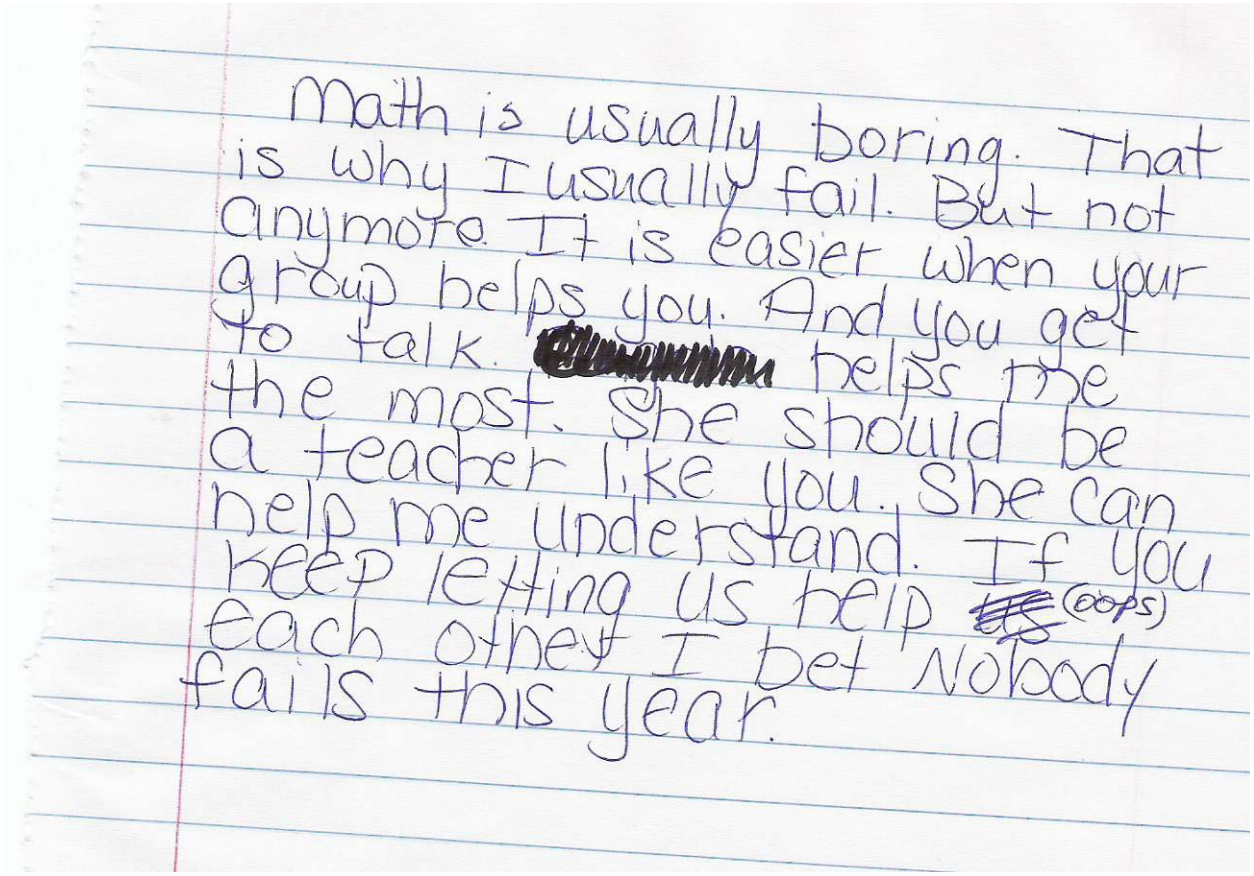

Math is usually boring. That is why I usually fail. But not anymore. It is easier when your group helps you. And you get to talk. [redacted] helps me the most. She should be a teacher like you. She can help me understand. If you keep letting us help ~~us~~ (oops) each other I bet Nobody fails this year.

Figure 9 Ashley's Discussion of Failure

Over and over, the researcher kept reading about how the students felt as though they had tricked out of enjoying math. Becky commented that she had been “cheated out of college” because she was in the dumb class. The researcher was deeply saddened that Becky felt such a strong sense of hopelessness, and continued writing to her and many others daily. The researcher quickly became aware that most of the students wanted to learn, but felt that they had not had a real reason to before now. Perhaps, as Deon stated, all it takes is having a teacher that, “wants us to learn more than she wants to talk”.

Summary

The data revealed a wealth of information about the building of conceptual understanding that occurred in the context of classroom where communication techniques were implemented. Written evaluations, interviews and transcribed tapes provided proof that students were able to think deeply about math and explain their thinking. They also provided an abundance of evidence that the students had a basic understanding of most decimal and fraction concepts.

Several misconceptions were identified through the use of written explanations. Students were able to clarify these misconceptions by talking directly to each other, explaining their reasoning, and challenging the work of others. Students began to demonstrate the ability to clarify their thinking and to positively affect the acquisition of understanding for other students as demonstrated through focus groups and transcriptions of taped collaborative groups.

The journals, focus groups, one-on-one interviews and attitude questionnaire provided a wealth of information concerning the pre-existing mindset the students had toward mathematics. Students thought math was boring, and they were bad at it. Throughout the study, the journals and interviews showed an improved mindset towards their proficiencies in mathematics and their opinions of the subject matter itself. A genuine dislike for math was replaced with an excitement generated by being able to communicate effectively about decimals and fractions. Overall attitudes improved as student performance improved.

In the final chapter of this thesis, the researcher reviews key factors of the study, highlights implications, and provides recommendations for future study.

CHAPTER FIVE

Conclusions

The researcher investigated using communication techniques in the classroom. The research questions: 1.) How did communication strategies affect low-performing students' performance of decimals and fractions? 2.) What impact did a classroom environment using communication techniques have on low-performing students' attitudes toward mathematics? were answered. In this chapter results of the study are reviewed, implications are explored, and recommendations for future study are offered.

Results

The study showed that the researcher was able to implement communication techniques into the classroom. Most students were able to utilize the communication strategies, and provide proof of conceptual understanding for both decimal and fraction concepts. Furthermore, students were able to demonstrate a deeper understanding of mathematics literacy, demonstrating more of a conceptual understanding rather than just a procedural understanding. Students were able to verbally justify their understandings to both their peers as well as the researcher. Students were also able to provide written proof as to their perception of their limits of their knowledge. Within the context of this new classroom environment, students were able to "pass" these units and appeared to take pride in that fact.

Students appeared eager to share their knowledge and learn from others. The dread of coming to math class seemed to disappear, as the students began to enjoy each hour. The students' attitudes toward their individual math abilities began to improve. Many, for the first time, stated with confidence that they could "do" math. The researcher probed several students trying to understand their perception of how they got two years behind in the first place. Previous learning environments became a target of blame. Students felt that within a communication filled classroom they felt more comfortable learning. The students felt that the teacher cared if they were learning. The students felt that in this context of learning environment, their needs were met; therefore they were able to conceptually understand and provide proof of such.

Implications

Studies have shown that mathematical conceptual understanding occurs in a classroom rich with communication (Lo, et al., Murray, 2004, Rose, 1989, Thompson, 2007). It is the responsibility of the education system to ensure that students are obtaining mathematical conceptual understanding. If this means veering away from the traditional classroom, to ensure that every student is afforded the opportunity to learn, then the system must rise to that challenge. Studies have shown the power that boredom has over students. (Drory, 1982, Farmer & Sundberg, 1986) Studies have also shown that boredom can often lead to students pulling out of school temporarily or even permanently (Farmer & Sundberg, 1986; Karp & Goldfarb Consultants, 1988; Larson & Richards, 1991). In this study the researcher provided a busy, engaging atmosphere for the low-performing students to learn in. It was expected of each to understand the mathematics and to make sure others were doing the same. Sharing of ideas was not an option it was a requirement. The students were able to learn in this atmosphere, and were happy to do so.

This study also revealed that in a pre-study questionnaire the low-performing students did not blame their math teachers or the classroom instruction for their personal failures in mathematics, but when given the opportunity to write out their thoughts, they did in fact hold the teachers partly responsible. They simply believe that they are not as smart as their peers because of how they were taught. They believe that many times teachers only teach the “smart” students.

Helping these low-achieving students get back on track could be as simple as providing a venue where mathematical concepts are investigated, discussed, questioned, written about and explained. The low-performing students are bored. The traditional classroom environment does not provide an opportunity for them to engage in mathematics. Without this engagement, understanding will not take place, continuing the cycle of failure for the low-performing student.

Limitations

It is impossible for me to generalize these results with other students. Classroom demographics vary from each classroom and this class group was special. Each member of this group of students was hand selected because of their deficiencies. None of these students were behind grade level in reading, making that one less obstacle for the researcher to overcome. Most often if a student is two grade levels behind in one subject area, he is behind in others as well.

Also, often with students so far behind in an area, behavior issues come into place. One could argue that some children believe that “bad” is better than “dumb”. Because the researcher had taught for 18 years, classroom management skills had been fine tuned. With control of the behaviors, the researcher expected all students to be involved in every aspect of the lesson. The hidden agenda of control was not an issue. Students were taught and understood the differences between appropriate group behaviors and inappropriate behaviors. Without this experience, it may be difficult for another researcher to reproduce the same engagement in the room.

Motivation was a key factor in this study. As the researcher discussed in chapter four, groups were given tally marks for each member who could demonstrate some level of understanding. Even though there was no prize given to the winning group, the totals for each groups' tallies were displayed on a frequency chart and posted in the room. This chart was updated daily. Without this motivational technique, or some other in place, the researcher believes that group accountability would have been lessened.

The researcher also was diligent in forming a relationship with each student. She made it a priority to communicate openly and honestly with each student in the journals and one-on-one interviews. She did not criticize their thinking, beliefs, spelling or way of speech in any way. She allowed the conversations and journals to become personal, actually encouraging the students to open up. Without this interaction, the implications of their beliefs could not have been offered.

Just the institution of communication techniques is a limitation. The researcher had to adapt to the amount of noise in the classroom. Also the researcher had to take on many additional grading assignments, reading and responding to each journal entry plus grading each written solution. The validity of the rubric used in the study also comes into question. Although the class helped develop this system, and peer teachers were used to validate results, the factor of time tested has to still be addressed.

Recommendations

There are a multitude of students in all educational systems that are classified as some version of "Level One". Without placing blame on any one factor, educators should ask themselves if perhaps they had a role in the creation of this situation. Are the math classes truly boring in the eyes of a child? If so, how can one expect a student to want to engage? Students should be engaged in the mathematics classroom. This goes beyond taking notes and working out problems. Teachers should implement communications strategies in the classroom. It should be required of every student to explain mathematical reasoning and provide in-depth proof of understanding. This cannot be done by just giving a number for an answer. It cannot be done with only the teacher talking in the classroom. Teachers should also work hard to form relationships with each student. Find out what they believe and why. If time is taken to do this, the student becomes receptive to the fact that the teacher is *involved* in the student's learning, not just dishing it out.

Based on the results of this study, five recommendations are given. 1.) Teachers should reevaluate the effectiveness of the traditional mathematical classroom for *all* students. 2.) Teachers should provide multiple opportunities for students to explain, both written and verbally, mathematical reasoning. 3.) Teachers should understand the impact that boredom can have on the low-achieving student, and work to keep all students *engaged*. 4.) Teachers should form relationships with the students and work diligently to understand their mathematical roots. 5.) Future studies should be conducted focused on the long-term impact that a communication classroom has on low-performing, advanced, and learning disabled students as well as students who are English language learners.

Summary

Boredom is a powerful thing. By recalling the many situations that have been boring in one's life; it becomes easy to understand that disengagement takes place. Perhaps this is the mind's weapon of defense. Unfortunately many educators do not entertain the idea that boredom can actually impact a student's future. Low-performing students place boredom as the number one reason that they got behind in math in the first place. They blame the teacher for not keeping them interested.

The researcher implemented communication techniques in the classroom. Not only did these techniques effectively impact student understanding of decimals and fractions, but it also kept the students engaged. This engagement led to less boredom, leading to a better attitude towards mathematics.

This study led the researcher to the understanding that the mindset of the student in the classroom is pivotal to amount of learning taking place. If the educator wants the low-performing middle school math student to have his mind on math, then attempting to understand where the student's are coming from and providing an engaging communication saturated classroom is an effective technique will assist in those efforts

APPENDIX A: INSTITUTIONAL REVIEW BOARD (IRB) APPROVAL

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901, 407-882-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Notice of Expedited Initial Review and Approval

From : **UCF Institutional Review Board**
FWA00000351, Exp. 5/07/10, IRB00001138

To : **Pamela Guyton**

Date : **January 30, 2008**

IRB Number: **SBE-07-05352**

Study Title: **How Verbal and Written Explanations Impact Low Achieving Students in their Comprehension of the Connections between Decimals and Fractions**

Dear Researcher:

Your research protocol noted above was approved by **expedited** review by the UCF IRB Chair on 1/30/2008. **The expiration date is 1/29/2009.** Your study was determined to be minimal risk for human subjects and expeditable per federal regulations, 45 CFR 46.110. The categories for which this study qualifies as expeditable research are as follows:

6. Collection of data from voice, video, digital, or image recordings made for research purposes.

7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

The IRB has approved a **consent procedure which requires participants to sign consent forms.** Use of the approved, stamped consent document(s) is required. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Subjects or their representatives must receive a copy of the consent form(s).

All data, which may include signed consent form documents, must be retained in a locked file cabinet for a minimum of three years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained on a password-protected computer if electronic information is used. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

To continue this research beyond the expiration date, a Continuing Review Form must be submitted 2 – 4 weeks prior to the expiration date. Advise the IRB if you receive a subpoena for the release of this information, or if a breach of confidentiality occurs. Also report any unanticipated problems or serious adverse events (within 5 working days). Do not make changes to the protocol methodology or consent form before obtaining IRB approval. Changes can be submitted for IRB review using the Addendum/Modification Request Form. An Addendum/Modification Request Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at http://iris.research.ucf.edu .

Failure to provide a continuing review report could lead to study suspension, a loss of funding and/or publication possibilities, or reporting of noncompliance to sponsors or funding agencies. The IRB maintains the authority under 45 CFR 46.110(e) to observe or have a third party observe the consent process and the research.

On behalf of Tracy Dietz, Ph.D., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 01/30/2008 11:42:57 AM EST

Joanne Muratori

IRB Coordinator

APPENDIX B: PRINCIPAL LETTER OF APPROVAL

Principal Letter of Approval

Dear IRB Coordinator,

Mrs. Pamela Guyton has informed me of the action research project she would like to implement in the spring of the 2007-2008 school year with her low-achieving 7th grade math students. Mrs. Guyton will study how verbal and written explanations impact low achieving students in the comprehension of the connections between decimals and fractions.

I have reviewed the letter Mrs. Guyton will be sending home requesting parental consent for student participation. She does note that students' grades will not be affected should anyone elect to not participate in the study.

I approve Mrs. Guyton's proposed research project with her students beginning in January, 2008.

Regards,

Pati Bowen-Painter

Mrs. Pati Bowen-Painter
Principal, Odyssey Middle School

APPENDIX C: INFORMED CONSENT

Informed Consent to Participate in Research Study

January , 2008

Dear Parent or Guardian,

In addition to my responsibilities as your child's teacher, I am also a graduate student in K-8 Math and Science Education at the University of Central Florida. I am currently planning a research project for my Master's thesis that will take place within my classroom during the months of January and February. The goal of my research is to study how using verbal explanations and written explanations in the classroom help your child understand how decimals and fractions are connected. I will be asking your child to both verbally explain his/her mathematical thinking and also provide written understanding.

I will then use the responses to evaluate my teaching.

With your permission, I will video/audio tape your child taking part in whole class and small group discussions about their mathematical thinking and problem solving methods as well as interviews discussing his or her participation in class discussions. These tapes will be stored in a locked cabinet. No one other than me will have access to them. There is a minimal risk of breach of confidentially, but I will keep the cabinet locked at all times, and store the students identities separate from the tapes. I assure you that I will do what I can do to minimize the risk. I will also collect samples of your child's math work.

Participation in this study is completely voluntary. Compensation such as extra credit will not be provided, and participation will not affect your student's grades in any way. . Students or parents who do not consent to participation in this study will not be penalized in any way. The students will still receive all of the math instruction, but their information will not be used in the study.

Your child's identity will be kept confidential during this study. The purpose of this study is to analyze my teaching practices, not assess your student's mathematical ability. I do not anticipate any risks to your student during the course of the study, only the potential benefit of identifying effective teaching and learning strategies for elementary mathematics. Upon completion of the project, any connection between your student and the data collected will be destroyed.

If you have any questions regarding this study, you may contact me at anytime at (407)590-3741. You may also contact my faculty advisor, Dr. Enrique Ortiz, at (407)823-5222. You may withdraw consent at any time. If you have any questions or concerns, please do not hesitate to call me.

Thank you so much for your help in this process.

Sincerely,

Pamela Guyton

(407) 590-3741

guytonp@ocps.net

I have read the procedure described above and understand what is being asked of my child as a participant of this research study. I voluntarily agree to allow my child to participate in the study and to be video/audio taped during class and interview sessions. I have received a copy of this form.

____

Name of child (Printed)

☐ I give consent for my child to be video/audio-taped during class time and interviewed.

☐ I would like more information about this study.

Name of Parent/Guardian (Signed)	Name of Researcher (Signed)
Date	Date

APPENDIX D: STUDENT ASSENT

Student Assent to Participate in Research Study

January, 2008

Dear Student,

This semester we will both be students. I am a graduate student at the University of Central Florida working on getting a Master's degree in K-8 Math and Science Education. As a part of this program, I am conducting a research project that studies the way I teach math. During the study, I would like to video and audio tape our class to learn more about our class discussions. I may also ask you to sit with me and answer some questions about your work in math class. You may choose to not answer any of the questions asked.

You do not have to participate in this study if you don't want to. Remember that my goal in the study is to take a closer look at my teaching practices. It is not an assessment of your work in math. In fact, your name will not appear anywhere in my study and the only people who will see the videos and listen to the recordings will be me and my supervisor. There will be no extra credit given for participation in the study and your math grade will not be affected in any way.

I look forward to working with you on this study. Thank you!

Sincerely,
Mrs. Guyton

By signing below, I am saying that I understand my role in the study to be conducted by my teacher. I have asked any questions that I may have had, and those questions were answered so that I understand what I will be expected to do. By signing, I am saying that I am willing and would like to participate in this study.

____ __________________
Student Name Date

UCF University of Central Florida IRB
IRB NUMBER: SBE-07-05352
IRB APPROVAL DATE: 1/30/2008
IRB EXPIRATION DATE: 1/29/2009

APPENDIX E: STUDENT QUESTIONNAIRE

1. Tell me about how you learned mathematics this year. Was it the same or different from 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 about decimals and fractions this year.

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

6. Do the groups help you learn mathematics? If so how? What about the written exercises?

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 different 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 this class 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 F: ONE-ON-ONE INTERVIEW QUESTIONS

• How do you think 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 decimals 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 G: STUDENT ATTITUDE SURVEY

	Always	Mostly	Rarely	Never
I like Math				
My math teachers are good.				
My math teachers know what I know in math.				
My math teachers let me talk about math.				
I feel behind everybody else in math.				
I do my homework in math.				
I study for tests in math.				
I understand how to add and subtract decimals.				
I understand how to add and subtract fractions.				
I understand how to multiply and divide decimals.				
I understand how to multiply and divide fractions.				
I like word problems.				
I like to write my feelings down.				
I am used to working in groups in math.				
I like to work in groups in math.				
I am smart in math.				
I am smart in reading.				
Write and other comments that you want to add down here.				

APPENDIX H: RESULTS OF STUDENT SURVEY

	Always	Mostly	Rarely	Never
I like Math	4% (1)	4% (1)	67% (16)	25% (6)
My math teachers have always been good teachers.	96 % (23)			4% (1)
My math teachers know what I know in math.		100 (24)		
My math teachers let me talk about math.		17% (4)	50% (12)	33% (8)
I feel behind everybody else in math.		96% (23)	4% (1)	
I do my classwork in math		50% (12)	46% (11)	4%(1)
I do my homework in math.		33% (8)	67% (16)	
I study for tests in math.		33% (8)		67% (16)
I understand how to add and subtract decimals.		79% (19)	17% (4)	4% (1)
I understand how to add and subtract fractions.			67% (16)	33% (8)
I understand how to multiply and divide decimals.			4% (1)	96% (23)
I understand how to multiply and divide fractions.			33% (8)	67% (16)
I like word problems.		4% (1)	67% (16)	29% (7)
I like to write my feelings down.			33% (8)	50% (12)
I am used to working in groups in math.		17% (4)	75% (18)	8% (2)
I like to work in groups in math.	25% (6)	67% (16)		8% (2)
I am smart in math.		8% (2)	67% (16)	25% (6)
I am smart in reading.	33% (8)	67% (16)		
Write and other comments that you want to add down here.				
** math is boring	stated by 10	students	42%	
** I'm dumb in math	stated by 3 students			
** My math teachers always scream at us cause were dum				
** I like playing bingo				
** I am good at shapes and stuff but that's all.				

APPENDIX I: FINAL STUDENT QUESTIONAIRE

Answer the following questions. Please use complete honesty.

How did you like working in your groups in mathematics?

1. How do you feel about YOUR ability to work with decimals and fractions?

2. What did you like least about the "communication" used in the classroom?

3. What did you like most about the "communication" used in the classroom?

4. What are your feelings about math in general?

5. What are your feelings about your class mates' abilities to work with decimals and fractions?

6. Is there anything else you would like to tell me about ***anything?***

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