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Attitudes, Confidence, and Achievement of High-Ability Fifth Grade Math Students

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Math in the Middle Institute Partnership
Action Research Project Report

in partial fulfillment of the MA Degree
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Attitudes, Confidence, and Achievement of High-Ability Fifth Grade Math Students

ABSTRACT

In this action research study of my fifth grade high-ability mathematics class, I investigated student attitudes of mathematics and their confidence in mathematics. Student achievement was compared to two different confidence scales to identify a relationship between confidence and achievement. Six boys and eleven girls gave their consent to the study. I discovered there seems to be a connection between confidence and achievement and that boys are generally more confident than girls. Most students liked math and were comfortable sharing answers and methods of solving problems with other students. As a result of this study I plan to use my survey and interview questions at the beginning of the school year with my new class in order to assess their attitudes and confidence in math. I can use this information to identify potential struggles and better plan for student instruction.

INTRODUCTION

Growing up, math was probably my favorite class (next to P.E., of course). I was able to get pretty good grades throughout middle school and high school without expending too much energy. That all changed my first semester in college when I came face to face with a class called Elementary Functions. For me, there was nothing elementary about this class. As a result, Math went from being one of my favorite subjects to something I decided to avoid. With the exception of a methods course I was required to take as part of my Education degree, I did not take another math course. My confidence in higher-level math absolutely disappeared, and I was satisfied with my understanding of basic computation and survival math skills. After all, I was just going to be an elementary teacher, and I was sure I could do the math that a 10-year old would be expected to do.

With thirteen years of teaching experience under my belt, I was feeling pretty good about my ability to teach young children. However, I was not feeling so good about my students' attitudes towards their own abilities as learners of mathematics. Many days I found myself complaining about their apathy toward the content I was presenting in class. Oftentimes I heard students telling me, "I'm no good at math." During parent-teacher conferences I would hear parents telling me how they were never good at math. This really frustrated me. I feared parents were giving my students an excuse for their lack of success. I believed that as long as students would put forth effort they would be successful.

While I do not discount the importance of effort, I believe there are more factors that contribute to achievement than effort alone. Two years ago I became involved in the Math in the Middle Institute Partnership at the University of Nebraska - Lincoln. By the time I had completed my first three weeks and three courses, my attitude toward teaching math changed

dramatically. I became increasingly aware of what it really means to learn math. For me, success in math had always come from memorizing facts, rules, and efficient procedures for computation. I was never taught how and why certain procedures produced the correct results. I did not think I needed to know. I was just given the "best" method and asked to show that I knew how to use the method over and over and over again. I believe this is how a large number of people were taught mathematics, and moreover, are teaching mathematics today.

I do not exclude myself in this criticism of a teaching style that diminishes thinking and robs students of the opportunity to discover things for themselves. If teachers continue to tell students precisely what we want them to know and give them endless opportunities to demonstrate that they can reproduce what we showed them, we end up creating a society without the ability to think for itself. If this style of teaching continues, our students will become no different than a computer; doing only what it has been programmed to do. This, I believe, is setting students up for struggles in math at some point down the road. Ever since I was 13 or 14 years old, I could easily recall various mathematical formulas such as the area of a circle. It was not until an activity in the Math in the Middle Institute that I really understood how and why the formula is used. I remember being asked to imagine cutting a circle into pieces like a pizza and laying them side by side in order to create a rectangle. Then I was asked to think about what the parts of that "rectangle" represented. We talked in groups about how the curved part gets increasingly straight as you cut the pieces smaller and smaller until there are actually no more curves on the top and bottom and one is left with a rectangle. We ended up using the formula for the area of a rectangle to show and prove why the formula for a circle works. These are the types of connections that I was missing in my own education, and I suspect are missing in most of

today's classrooms as well. Imagine the impact on attitudes and confidence if students begin to really understand the math they are learning.

There is a difference between procedural understanding and conceptual understanding of mathematics, and I was most certainly missing the latter. Math in the Middle's emphasis on the how's and why's of mathematics has brought me to a completely different level of understanding. This, in turn, has given me more confidence and a whole new perspective on teaching mathematics as well.

As I continued to struggle with my students' negative attitudes toward math, I began to wonder… by the time children are in fifth grade, have they already decided that math is something that they either get or do not get? Have they already determined that learning math is out of their locus of control? I have felt that many of my students have developed a learned helplessness toward mathematics. For me, it happened during my freshman year of college, but for many children the point at which math becomes too difficult happens much sooner.

Not only did the courses in Math in the Middle focus on the how's and why's of mathematical procedures, but they did so by encouraging us to derive our own solutions to problems. We were given opportunities to explain, demonstrate, and even defend our solution. This was done both in small groups as well as in front of the entire class. It was through this discourse that I began to really understand the concepts behind even the most basic mathematical processes. The classroom environment created by the instructors and participants was very safe and comfortable. It was safe to try a problem without assurance of success. It was safe to make mistakes without fear of ridicule. I learned about math because I talked about math. When I worked to solve a problem I explained the steps and process I went through to arrive at my

solution. The confidence I gained as a result of my Math in the Middle experience has given me a new found confidence and appreciation for mathematics.

In this project, I wanted to see if there was a relationship among students' perceptions and attitudes about what math is, their confidence in math, and their level of achievement. Specifically, in what areas of mathematics are students most confident and does this confidence translate into higher achievement?

PROBLEM STATEMENT

It is human nature for people to spend more time doing the things they enjoy. People embrace things that they are good at. Likewise, people avoid those things that cause them angst. If students begin to feel they do not understand mathematics, they will begin to lose confidence and avoid math whenever and however possible. Those students who struggle with math in their early elementary years begin to develop an, "I'm no good at math" attitude. This attitude perpetuates as math becomes more and more complicated.

There are students who are successful in math and get good scores on tests. The majority of successful math students claim to enjoy math. They are confident in their mathematical abilities. However, I have found that many of these same students are unable to explain how or why mathematical operations work. When doing basic subtraction, they know how to borrow from the number to the left and make it a 13 rather than a 3. While they have likely been shown by a teacher using manipulatives how one can borrow to subtract, they most likely have never had to explain that to someone else. All they needed to know is how to do it so they can get the right answer on a test. Eventually this confidence can begin to diminish. Students who have enjoyed much success by memorizing rules and procedures with little to no conceptual understanding of the math involved will likely "hit a wall" at some point in their education.

When students get to fifth grade, they are expected to subtract mixed numbers. It is extremely difficult to get students to understand why one-third is not eleven-thirds after borrowing a "one." This is an example of the "crack" that children fall through when the focus of instruction is procedural. Time constraints often force teachers to teach and students to learn math in the most efficient way in order to pass tests. This can become problematic for students who are not good at memorizing math procedures in a short period of time. The result becomes poor attitudes and a loss of confidence that can stick with students for the rest of their lives.

In the area of reading, teachers expect their students not only to be able to read the words they see, but to understand what those words mean when they are put together into sentences, paragraphs, and complete stories. I think teachers should expect the same from their math students. I think students should spend time talking about the math they are doing just like they share their thoughts about the stories they are reading. Students should be able to use correct vocabulary during those explanations. For example, in math, students work addition problems, not "plus" problems. Likewise, fractions have a numerator and denominator, not a "top" and "bottom" number. I believe that if students begin to develop this conceptual understanding of mathematics, their attitudes about math, their confidence in understanding math, and their subsequent achievement will improve.

If students engage in discourse with their teacher, as well as with their classmates, maybe math will be seen as a dynamic, multi-dimensional system which, while being multi-faceted, is very much interconnected. If math becomes something to be understood rather than memorized and conquered, maybe negative attitudes toward it will diminish and confidence will grow. I want those students who come into my classroom and tell me they are "no good at math" to leave my classroom with a confidence that they can be successful math students.

LITERATURE REVIEW

In this section of my paper I review the existing literature on the topics of students' attitudes, confidence, and achievement in mathematics. I begin by talking about what students think about math as a content area. I also discuss factors that influence attitudes and confidence. Finally, I explore what previous studies have found concerning how attitudes and confidence impact student learning.

Attitudes and Confidence about Mathematics

One problem I encountered in my 14 years of teaching was the preconceived notions students have about what mathematics is and whether or not they can be successful in mathematics. In a study about student views of learning math, Stodolsky, Salk, and Glaessner (1991)interviewed 60 students from 11 classrooms. Questions pertained to general ideas about what math is and how it is taught. Reasons for liking and disliking math were also explored. Most students identified math in a very traditional sense in that math was seen as being about numbers and doing stuff (computations) with those numbers. Math was generally characterized by worksheets, using textbooks, and doing problems on the board (Stodolsky, Salk, & Glaessner, 1991). This was especially true in elementary grades. Most students in this study reported little to no interactions with the other students in the class indicating that learning was expected through teacher-student interaction.

In a three-year study of elementary students' attitudes and beliefs about mathematics, Kloosterman, Raymond, and Emenaker (1991) found that students reported working in groups as "useful because students could help each other when they were stuck" (p. 50). However, this belief seemed to change in sixth grade when she indicated that solving problems needed to be done independently. This change in attitude toward doing problems as a group seemed to be a

reflection of the difference in teacher attitudes, as the authors reported five other students whose attitude about group work changed with a change of teacher (Kloosterman, Raymond, & Emenaker).

A student's attitude toward mathematics may be formed from a number of sources. One powerful influence on student attitudes is the classroom teacher. In a study of fourth, seventh, and ninth graders from both rural and urban schools, Haladyna, Shaughnessy, and Shaughnessy (1996) identified a strong relationship between teacher quality (enthusiasm, respect, willingness to help, fairness, etc.) and positive attitudes toward math. The authors also noted that this relationship may be more significant for grade four than grades seven and nine. Studying two teachers with different communication styles, Turner, Meyer, Midgley, and Patrick (2003) found that students reported a lower negative affect and self-handicapping attitudes when the teacher used more supportive comments when interacting with students than did students with a teacher using more critical comments during interactions. They concluded that it was important for the teacher to recognize how they are interacting with students because a teacher was sending messages constantly, both verbally and non-verbally, and those messages had an impact on student confidence and attitudes toward math.

Student attitudes were also found to be shaped by a student's level of success. In a study of college-aged men and women, Ross and Broah (2000) investigated factors that influence achievement. Specifically, they looked at self-esteem and personal control (attribution of success and failure). One of their findings suggested that, "By far the strongest predictor of academic achievement in the 12th grade is earlier academic achievement" (p. 277). The more success a student had in mathematics, the more positive their attitude toward it (Stodolsky, Salk, & Glaessner, 1991). While this seemed to make sense on a logical level, it also implied that

teachers needed to find ways for students to feel success. This was especially true for those students that had had a relatively small amount of success in the past. A student's attitude and confidence could be difficult to change. This could be good if a student had a good attitude, but could be very problematic when a student's attitude and confidence are negative. In a three-year study of students' attitudes and beliefs about mathematics, Kloosterman, Raymond, and Emenaker found that nearly 66 % of student attitudes and confidence remained constant from year to year. Those students who reported a change in their level of confidence changed only from one level to the next; a student with low confidence never moved to high confidence and vice versa.

Kloosterman, Raymond, and Emenaker (1996) also found the relationship between confidence and achievement varied with age. While there was seemingly no relationship between these two variables in first grade students, by third grade and beyond there existed a strong positive correlation between a student’s confidence in their mathematical ability and their achievement. Hackett and Betz (1989), who studied college aged men and women, found a "moderately strong positive relationship" (p. 265) between student self-efficacy and performance.

It was not clear whether confidence promotes achievement or vice versa. Lloyd, Walsh, and Yailagh (2005) suggested that confidence did not directly affect achievement but rather what students attributed their success and failure to. In their study of fourth and seventh grade boys and girls in Canada, Lloyd, Walsh and Yailagh found that both boys and girls were more likely to attribute their success to internal factors such as ability and effort and less likely to attribute success to external factors such as the teacher. They made the connection between how students attributed success and failure to self-efficacy by stating that "ability attributions for success have

been linked with higher academic achievement and enhanced perceptions of self-efficacy (p. 401). Ross and Broh (2000) suggested that while academic achievement enhanced student self-efficacy, the extent to which students felt a sense of personal control over their success is actually what impacted achievement. The implication was that understanding how students thought of their success and failure in math might have been more important than their confidence level as teachers plan how to increase student achievement.

How students attributed success and failure in school and their confidence levels may have had an impact on students as they progressed from elementary to middle school and from middle school to high school and beyond. It was not that surprising that students would bring old feelings with them to a new class. Those feelings might have been positive and rooted in a history of success, or could have been negative stemming from a lack of academic success. In a study of upper elementary students in a metropolitan area of the Western United States, Mason and Stipek (1989) found that, "…students carry with them a certain amount of baggage to new classrooms that may undermine teachers' efforts to increase student's skills"(p. 65). Therefore, it became important for a teacher to make efforts to assess students' attitudes and confidence early in a school year in order to address "hidden" issues that might have been impacting student achievement.

I think teachers too quickly assume that students struggle because they just have not been exposed to the right teaching method. If a student struggled in the classroom as a result of how he or she attributed success and failures in class, then the "right" teaching method might very well have been one that addressed how the student felt about his or her own ability rather than a particular teaching tool. As Mason and Stipek (1989) stated, "Once teachers ascertain which students possess these negative self-perceptions and emotions, they much develop strategies to

assist students in overcoming the cognitive and emotional obstacles that may interfere with successful performance" (p. 66). Age and grade level might also affect how a student attributed success and failure. Because of their more direct role in student learning, younger students might be more likely to attribute their success and failure to their teacher rather than their own efforts or abilities (Lloyd, Walsh, & Yailagh, 2005). Lloyd, Walsh, and Yailagh found that seventh graders were more likely to attribute success and failures to internal factors than were younger students.

As much of the previously mentioned literature suggests, student's attitudes and beliefs are shaped by a number of factors. Some a teacher can control, such as the amount of supportive comments during discourse, and others a teacher may have less control over, such as preconceived notions of ability to do math a student brings with them. Prior to my experience with Math in the Middle, I never considered the role attitude and confidence might be playing in my students' learning. This led me to the following action research project.

PURPOSE STATEMENT

The purpose of my study is to identify student attitudes and perceptions of mathematics in addition to finding possible connections between student confidence in mathematics and their mathematical achievement. Is it possible for students who lack confidence in math to have high achievement? Conversely, are there students who had a lot of confidence in their abilities, but still fell behind in their level of achievement? I wanted to see how students felt about math and the learning of mathematics. Were students willing to persevere through difficult problems or did students want to simply be told how to solve the problem with the least amount of effort necessary? During this project, I investigated the following questions:

1. What is the level of student confidence when the teacher focuses on the implementation of mathematical discourse?

2. What are my students' attitudes about the teaching and learning of mathematics?

3. What connections are there between student confidence in mathematics and their actual achievement?

METHOD

The math class that was the subject of this action research project consisted of 22 students (11 male and 11 female) who were identified as gifted or high-ability learners from a large elementary school in the Midwest. The school is a Title 1 school as over 60% of its students qualify for the free or reduced lunch. Data for this project was collected between January 3rd and April 15th of 2008.

In January, students were given a survey with 56 items regarding their attitude and confidence in math (Appendix A). On the survey students identified to what extent they agreed or disagreed with each statement using a five-point Likert Scale. Responses of four or five meant students agreed or strongly agreed with the statement. Responses of two or one meant students disagreed or strongly disagreed with the statement. A response of three meant "unsure" or "no feelings one way or the other." Some of the statements were taken from the *Fennema-Sherman Mathematics Attitude Scale* as well as statements that I created to help me give a good picture of my students' attitudes and confidence levels in mathematics. I decided to reword some of the statements from the Fennama-Sherman scale to make them a little easier to understand. I also had to add the items addressing specific mathematical computation as this was not on the Fennama-Sherman Scale. Some statements were designed to assess the students' overall confidence in mathematics; some were to assess specific types of math problems, while others were to assess the students' general attitude toward Math as a subject. If a student's response was

not indicated or more than one response was recorded for any particular item, the item was discarded for that student.

Students were asked to put only their birthday on their survey and not their name. This helped protect the anonymity of the students throughout the data collection process, and I hoped that it would encourage students to be more open and honest when answering the questions and completing the survey based on how they really felt without being worried that I would look at a survey and know who they were. This was also stated in the directions that I read aloud to the students prior to completing the survey. The other reason for the birthday was because I knew I could easily get access to student birthdays. When I needed to use them at the completion of the research process, I knew identifying students by birthdays would enable me to compare the results of the survey to achievement data for each student.

Each item on the survey was read aloud in order to limit the chance that a student would read the question incorrectly, thus making their response invalid. Students were encouraged to not answer a question before I read it to them. In giving their response, students were asked to think not just about their experiences this school year, but also to consider their past experiences in math. It was not my goal to determine how they felt about me as their teacher but about how they feel about the subject of Mathematics. In April, the students were given the same survey under the same conditions as the pre-survey. The original intent of this action research project was to determine how a discourse oriented approach to teaching would impact student confidence in Mathematics. However, it became evident that the short period of time that data was collected would make it difficult to accurately identify changes in attitude and confidence in mathematics. For this reason, only post-surveys were used to assess students' attitude and confidence levels.

I reorganized the statements from the survey into two separate categories - confidence and attitude. Fifteen items were identified as "attitude" questions. These statements addressed general attitudes regarding what math is and to what extent they liked or disliked math. The rest of the items on the survey addressed students' confidence in mathematics. I split the confidence statements into two subgroups. Confidence A consisted of nine survey items assessing students' general confidence in mathematics. Five of these nine items were coded so that higher responses would indicate a higher level of confidence. The other four statements were reverse coded whereas a lower response indicated higher confidence in mathematics. Means for the five positive statements and the four negative statements were calculated separately. I then found the difference between these two means. This difference was used to determine each student's general confidence level. The difference in scores could range from four (very high confidence) to negative four (very low confidence). A score of zero on the Confidence A scale would indicate the student had no tendency toward a positive or negative general math confidence.

The second confidence scale I named Confidence B. This confidence scale identified the students' level of confidence on specific math computations and concepts. Students ranked their level of confidence with addition, subtraction, multiplication, division of whole numbers, decimals, and fractions. Confidence levels were also given for geometry, reading charts and graphs, and problem solving activities. Means for each student were calculated and also broken down by gender as well as the whole class. For this section of confidence, mean scores had a positive correlation to confidence levels. That is, higher means indicated higher confidence levels. Mean scores could range from one to five with a mean of three indicating no feelings one way or the other.

The primary tool I used to assess student achievement was district-created chapter tests. At the completion of each chapter, students were required to take a test created by the school district. The test was actually created by a small group of teachers in the district, and the tests are required of all fifth graders. The tests consisted of four to six questions for each objective, and students were given a score ranging from one to four for each objective. A score of four was given when the student had answered each question for the objective correctly based on the scoring guide provided by the district. A score of three was given when the student had correctly answered 75-99 percent of the questions correctly. Scores of two were given for 50% accuracy, and one was anything less than 50 percent. In general, scores of three to four were considered passing and scores of one to two were not passing. Each student's score for each objective was placed in a spreadsheet and categorized by the six NCTM content strands of Numeration, Computation, Problem Solving, Data Analysis and Probability, Algebra, and Geometry. Most chapter tests contained four to six objectives. Students were then put into three achievement groups: high, average, and low. To place students into each group I looked at the results of their chapter test scores during the time that data was collected.

Other achievement data came from a problem solving activity (Appendix B) that students completed independently. When scoring this activity, I was concerned mostly with the students understanding of the problem and what needed to be done to solve the problem. I did not concern myself with right or wrong answers, but with correct or incorrect methods of solving the problem. Students' work was given a score ranging from one to four with one being little to no correct work and four being completely correct methods and solution. This activity was given to students in early April and was used solely as achievement data from this project and did not factor into students' grades for the course.

Some students were asked to work in small groups on a problem solving activity (Appendix C), and their work and conversations were tape-recorded. This provided some valuable information about how students communicated during group work and to what extent they were understanding the math involved in solving the problem. While six students participated in this activity, only five of them provided parental consent and only their work and comments were included.

A third type of data collection was students' responses to six interview questions (Appendix D). During the interview students were asked to comment on how they felt about working in small groups and whether or not they felt that it helped them to learn and understand mathematics. In addition, students were asked to identify the negative aspects of working together in groups. Finally, students were asked about their readiness for middle school and if discussing mathematics using specific mathematical vocabulary terms was important. Responses were recorded in a notebook.

Throughout the data collection process I kept a journal of observations and accounts of classroom activities (Appendix E). My intentions were to create two to three journal entries per week, but many other obligations, such as dealing with discipline and meetings, prevented me from accomplishing journaling to that extent. I was able to complete 12 journal entries during the time period that data was collected that recounted my observations and thoughts of how students were communicating mathematically. Situations I believed may have affected communication were also recorded in addition to general ideas or beliefs regarding student actions or comments.

FINDINGS

In this section I describe what a typical day in my math classroom was like. Also I report on my students' attitudes about math, their confidence in mathematics, and the relationship I

found between confidence and achievement. Finally, I discuss the impact that this action research project has had on my teaching.

Typical Day

A typical day in my math classroom during the time which data was collected began with a set of problems on the overhead that students were to begin working on independently as they entered the classroom. The problems were usually a review of lessons we had already completed in the current chapter of study. After about 10-15 minutes of working on these problems, students were called on or volunteered to come to the overhead and share their solutions.

After a solution was presented, I would ask if there were any questions or comments about the way the student solved the problem. I would also ask if anyone solved the problem a different way. When appropriate, we would discuss the different solutions and students would be asked to comment on them. When I was satisfied with the discussion, I would then introduce the day's lesson. Sometimes, because of time constraints and the students' relative high ability we would combine a couple of lessons into one class period. The lessons were from Houghton Mifflin Mathematics and we primarily followed the scope and sequence suggested by the district.

In most cases, students were given 15 - 30 minutes of work time at the end of the period. Most of the time students were able to work with other classmates in order to discuss their solutions and compare answers. While some students favored working with just one other student, some of the students formed groups of three or four. When it appeared that students were more off task than on, they were reminded that the purpose of working in groups was to help each other understand the math they were working on and to have someone they could compare their answers with to see if they were finding the correct solutions. When students' solutions differed, they were told to convince the other student that his or her solution was

correct. On occasion I had to remind students that the person who argued the loudest was not necessarily the one with the correct response. I also reminded students that it was possible both solutions were incorrect and that both students should be willing to double check their own work and listen carefully to their group's or partner's ideas.

Homework was given about three times per week. On days students were expected to bring their homework back, we would go over their work after the initial review on the overhead. Sometimes going over their work consisted of simply having students give their answers (on basic computation problems). Other times we selected a few of the questions and I asked for volunteers to come to the overhead and share how they got their solutions. Once again, I encouraged discussion here by asking students to explain the how's and why's of the problem and asked the rest of the class for comments, questions, or concerns. Any student with a different solution was encouraged to come to the overhead and share their solutions.

Student Attitudes

The first question I sought answers for was, "What are my students' attitudes about the teaching and learning of mathematics?" I wanted to know to what extent students were comfortable with a classroom structure that promoted discourse in math. Furthermore, I wanted to know how much students enjoyed math class and how hard they were willing to work to learn math concepts. The students in this class had very positive attitudes regarding math. Most students liked math and saw mathematics as more than the memorization of facts and rules. Students were willing to share and discuss their solutions with their classmates, but there was conflicting evidence of their willingness to persevere through challenging problems. While it was not the original intent of my inquiry, I was surprised to find that gender differences existed in most areas of attitude toward mathematics.

In general, the students in this class liked math. The average class response for the first item on the Attitude and Confidence Survey, "I like Math," was 3.65 indicating a more positive than negative response. The average score for males on this item was 4.5 while the average score for females was 3.18. Furthermore, on survey item number 24, "Math is probably my least favorite subject", the males tended to disagree with this item as their average score was 1.67. The females, however, tended to agree with this item as their average score was 3.18. Complaints about math class were rare and usually were directed at the idea of not wanting homework and wishing we would play more games in class. Unlike many classes I have had in the past, I did not recall hearing any of these students say, "I hate math," or, "I don't like math."

Males were also more likely to agree with statements that demonstrated a willingness to work hard in math and persevere through challenging problems. Males were more likely to agree with survey item number 5, "I like learning new things in math" than females with average responses of 4.17 and 3.27, respectively. Similarly, survey item number 10, "I like learning new things in math even if it's challenging," showed again that the males tended to agree with this statement more than girls did: 4.5 and 3.18, respectively. However, both boys and girls agreed that they would have more success in math if they tried harder. This was indicated by item number 14 on the survey, "I would probably get better scores in math if I tried harder." While both boys and girls agreed, the girls tended to agree slightly more than the boys did. Boys also tended to agree while girls disagreed with item number 25, "I like challenging math problems." The female response to this item was not consistent with responses to the previously mentioned item 10 where girls tended to agree they liked learning new math problems even if it is challenging. However, the average female response to both questions showed no strong feelings one way or the other regarding their attitude toward taking on challenging problems. On item 16,

"If I don't understand a word problem I usually read the problem again," boys reported a greater willingness to reread the problem.

On item number 26, boys continued to demonstrate a willingness to work harder as they disagreed with the statement, "I would rather have a teacher show me how to do a problem rather than work on figuring it out myself." The average boy's score was 2.5 while the girl's average score was 3.27. This item also began to address how students felt about a traditional fact/procedural based approach compared to a more exploratory, experimental and conjecture approach (reform) to math education.

On the six survey items used to assess students' attitudes toward traditional approaches to learning mathematics versus a reform approach, students tended to favor a more reform approach to learning mathematics. That is to say, students agreed with statements that promoted discussion of mathematics and how students solved problems. They disagreed with statements that characterized math as the memorization of rules and procedures and that different math topics are often connected which are more characteristic of traditional fact-based approaches to teaching mathematics. This was also indicated by student comments in an interview. In response to how math class this year was different than in previous years, Kacey[1] said, "This year we try to understand why the answer is the way it is." Jason noted that it was beneficial to, "see how to solve a problem in many different ways." On one of the six items, students showed no feelings one way or the other about their conceptual understanding of mathematics. For this item, number 34, students responded to the statement, "I don't understand why certain ways of doing math works, but I still can get the right answer." Students overwhelmingly favored working with other students to solve math problems. Twelve students were interviewed and all twelve voiced positive comments about working with other classmates. Below are some of the responses of

[1] All names are pseudonyms

students to the interview question, "Does solving problems with other students help you understand the problems better, worse, or about the same? Explain."

- *"A lot! Friends help you understand better."*
- *"Better. They do problems different ways and if it's easier than you can do it easier. That happened this year."*
- *"Better. Classmates explain problems to help me understand better."*

While preferring to work with others, students also recognized problems associated with working in small groups and with partners. During student interviews, many students mentioned classmates being off task, talking, and just giving out answers as problems with working with other students. I also indicated this problem in my teacher journal. Below are two excerpts from my journal that illustrated some of the difficulty in getting my students to work together on their math problems.

> *This activity was an attempt to get my students working together and helping each other understand how to do problems. Most groups did not work together as a group and there were several students who simply relied on group members for how to solve the problem.* (Teacher Journal, February 25, 2008)

> *I have several students working independently in spite of my directions that all students need to understand. Some students came to me with questions prior to asking their group members what they thought. Group work isn't happening the way I had hoped for all students, but some students are using the group work as I intended.* (Teacher Journal, March 4, 2008)

In most cases students were allowed to select the classmate(s) they wanted to work with and almost always they segregated themselves by gender. Girls primarily worked with girls and boys primarily worked with boys. Connie gave her reasoning for this in my interview with her. When explaining problems she encountered working with other classmates, Connie said, "I don't like working with boys. They talk too fast and don't explain things" (Student Interview, April 11).

Overall, students in this class had positive attitudes toward math, working on challenging problems in math, and working with other students on math problems. The data obtained in this action research project suggested that most students were very comfortable with a classroom atmosphere that promoted the sharing and discussion of mathematical ideas and solutions. As indicated by the survey, boys tended to like math more and were more willing to take on challenging problems than were girls. Both boys and girls tended to agree that working harder would produce better results.

Student Confidence

My second research question addressed student confidence. I originally wanted to find out if a teaching style that encouraged mathematical communication in small groups as well as during whole class discussion would affect the level of student confidence in math. Students had a fairly high level of confidence in their mathematical abilities, which did not significantly change during this study. As indicated by my first journal entry in my teaching journal, this class was not typical of the students I generally have in math.

> *This class is very different than what I have experienced in most of my years of teaching math. I have not heard any students claiming to hate math, be no good at math, or any of the other negative comments that are typical of a class with a greater mix of abilities. Their body language suggests they are ready to work. I am not suggesting they are anxiously waiting for a bunch of work, they are more alert and give off a very confident energy. They appear to be very sure of their abilities. This is a refreshing change.*
>
> (Teacher Journal, February 20, 2008)

Results of pre and post survey data indicated no significant change in levels of confidence. Because this class consisted of students identified as differentiated (gifted) or high-

ability learners, I was not surprised to find that students had a high level of confidence. The results of the Confidence A scale showed that most of the students were confident in their mathematical knowledge. In Table 1 below, notice that the highest level of confidence was reported by Jason. Jason's mean difference of four indicated that he was extremely confident in his general confidence in math. For Jason, this confidence was also demonstrated in his responses to the items that were specific to various concepts and computation problems (Confidence B). Jason responded with a five (highest level of confidence) for all items except for one. His response of four to the items about measuring sizes of shapes indicated confidence, but slightly less confidence than other areas of math. This response could have been due to the fact that this concept had not been taught at this point in the year. Including Jason, thirteen of the seventeen students indicated positive confidence levels in mathematics. While Jason's response showed extreme confidence, the other twelve students' responses were likely more typical, indicating that they have experienced some struggles with mathematics or question their own abilities with some mathematical concepts. For example, item #21 of the survey was, "I don't usually worry about being able to solve math problems." The average response for this item was 3.24 with 11 out of 17 students responding with scores of three or lower for this item. This showed that most of the students were either unsure or tend to worry about their ability to solve math problems.

Confidence A Results												
Student	C2	C13	C18	C21	C22	C28	C30	C31	C32	High scale	Low scale	difference
Jason	5	1	1	5	1	5	1	5	5	5	1	4
Charlie	5	3	2	5	1	5	1	5	5	5	1.75	3.25
Kacey	5	1	3	4	2	4	1	5	4	4.4	1.75	2.65
Fay	4	2	2	4	2	4	2	4	4	4	2	2
Katrina	4	2	3	3	2	4	3	4	4	3.8	2.5	1.3
Jenny	4	3	2	3	2	4	2	4	3	3.6	2.5	1.1
Ramona	4	3	2	3	2	3	3	4	4	3.6	2.5	1.1
Nick	4	2	2	4	4	4	2	4	2	3.6	2.5	1.1
Stacie	4	2	3	2	3	4	3	4	3	3.4	2.75	0.65

Tim	4	3	3	1	1	3	4	5	4	3.4	2.75	0.65
Jeffery	4	4	3	4	4	4	2	4	3	3.8	3.25	0.55
Mary	3	4	3	3	2	3	2	3	3	3	2.75	0.25
Carmen	3	4	3	3	1	3	4	5	2	3.2	3	0.2
Dana	4	5	5	3	4	2	2	5	5	3.8	4	-0.2
Riley	4	4	5	2	3	2	2	4	4	3.2	3.5	-0.3
Dillon	3	5	4	3	2	3	3	4	3	3.2	3.5	-0.3
Kelly	3	4	3	3	3	3	4	3	2	2.8	3.5	-0.7
Class Average	3.94	3.06	2.88	3.24	2.29	3.53	2.41	4.24	3.53			
Female Average	4.27	2.36	2.36	3.45	2.18	4.00	2.18	4.36	3.73			
Male Average	3.33	4.33	3.83	2.83	2.50	2.67	2.83	4.00	3.17			

(Table 1) - Results of students' general confidence levels.

As shown in Table 1 above, four students had negative differences indicating negative confidence levels. These four students lack general confidence when it comes to mathematics. Kelly was the student with the lowest level of confidence. Kelly demonstrated her lack of confidence by agreeing with the statement, "Even If I work really hard, I still have a hard time learning new things in math." Kelly seemed to feel like she had little control over her level of success in math. Carrie and Ted also agreed with this statement. However, their general confidence in math was slightly positive. Carrie and Ted likely realize that while they might struggle in some areas, they also felt they had some strengths as well. This was demonstrated by their agreement with statement #31, "I can usually pick out the important information in a problem and decide what to do to solve it." It was reasonable to expect students to have areas of strengths and weaknesses when it came to their understanding of various math concepts. Assessment of those strengths and weaknesses could help teachers and students identify gaps in conceptual understanding thereby allowing teachers to plan appropriate strategies for teaching those objectives.

In the second part of the confidence survey (Confidence B) students gave responses indicating their level of confidence on specific mathematical concepts and computations. On the

survey, the skills were listed in the order that they are generally given in math books. Questions about their confidence with whole numbers were addressed first and decimals and fractions followed. Next, students indicated their level of confidence with geometry topics, and reading charts and graphs. Finally students gave confidence levels for problem solving activities (word problems). For each type of number (whole numbers, decimals, and fractions), students indicated their confidence levels for addition, subtraction, multiplication and division. Students also gave responses for "mixed applications."

In general, students were very confident in their computation skills as well as other mathematical concepts like shapes, charts and graphs, and word problems. Since this class consisted of gifted and high-ability learners, I would have expected their confidence levels to be high. However, there were some interesting results in which skills students had the most and least confidence. In some cases, it was easy to see where some individual students' confidence levels dropped off.

Scores on the whole number section indicated my students had a very high confidence level when working with whole numbers. Average scores were above 4.00 for all items. As expected, the averages decreased steadily as the skills became progressively more difficult. The category of mixed applications was not clearly defined to the students, and the uncertainty of what mixed application questions were could have led to lower confidence scores. Yet the scores indicated that even if students were not sure what mixed application problems were, they were confident enough in their understanding of whole numbers such that they felt like they could do whatever work was asked of them. While not the focus of my research, it was interesting to note that boys were more confident with whole numbers than girls on all confidence levels except for division. This was only true for division of whole numbers. This pattern did not hold true for

work with other types of numbers. Boys were consistently more confident on computation items for both decimals and fractions.

Confidence in computation of decimals was basically the same as with whole numbers. All ratings were above 4.00, indicating strong confidence in computation of decimals. While the class confidence remained the same, not all students felt as confident working with decimals as with whole numbers. Carmen was very confident in her work with whole numbers (average of 4.8), but her ratings for decimals dropped to 3.8 for decimals. While Carmen was still confident in working with decimals, she seemed to have felt that decimals were at least slightly more challenging.

Students tended to be more confident in their abilities to add and subtract fractions than they were in their abilities to multiply and divide them. This was very interesting to me because, in my opinion, there was more to think about when adding and subtracting fractions than with multiplying them. When adding fractions one must consider common denominators and writing equivalent fractions to calculate sums and differences. When multiplying fractions it was only necessary to multiply and simplify. Since students had already demonstrated high confidence in multiplying and dividing whole numbers, I was slightly puzzled why, although they were still confident with scores over 4.00, they were less confident than they were with whole numbers and decimals. Perhaps they had been indoctrinated that multiplication and division were harder than addition and subtraction and must be true in all cases. This might also indicate a lack in students' abilities to really connect mathematical knowledge in one area to another.

The next two survey items pertained to naming and measuring shapes. While students were confident in their abilities to do both, they were more confident in their abilities to name shapes than to measure them. The mean score for naming shapes was 4.44 while the mean score

for measuring them was 4.04. This decrease in score could have been the result of not defining what measuring shapes meant. The uncertainty could have led to slightly less confidence. In the same section of the survey, students were asked about their confidence in reading charts and graphs as well as doing habits of mind problems. Students indicated a high confidence in reading charts and graphs as well as habits of mind problems. These problems were referred to as "challenging" problems because the method of solution was not immediately recognized.

There was a fairly large difference in the male and female averages for solving challenging problems. While the males indicated a high confidence in their ability to solve these challenging problems (4.83), the females indicated only slight confidence in solving these problems (3.80). The statement was worded as, "Challenging problems Mr. Piper gives you for fun." An example of a challenging problem that I had given my students this year was the locker problem (Appendix F). Students knew these problems were not graded and as their teacher, I likely did not place an appropriate level of importance on their educational value. For this reason, students might have felt less pressure to find solutions to these problems which could have led to higher confidence ratings.

With respect to problem solving skills, fourteen out of the seventeen students indicated that solving "word problems" was both easy and hard. Three of the students showed great confidence in their problem solving skills. Fay was the only female that showed this confidence. Charlie and Jason both demonstrated high confidence in problem solving skills. These three students also responded "very confident" on challenging problems Mr. Piper gives you for fun.

Students also indicated high levels of confidence during interviews that I conducted toward the end of the data collection period. All students, except for one, demonstrated confidence in their response to my question, "Sixth grade math is harder than fifth grade, do you

think you are ready for sixth grade math? Why or why not?" Most students answered this question without much elaboration. Fay's response would be typical of the majority of responses as she simply said, "Yeah." Mary, however demonstrated confidence by first acknowledging an area of weakness saying, "Yeah, except for placing decimals (in multiplication and division of decimals). I think I'll get it." Connie is the only student who questioned her ability to be successful in a future math class admitting she was, "a little concerned. I have trouble with fractions and converting decimals to fractions." I thought recognizing a specific area of weakness versus a general comment such as "I'm not good at math" was still an indication of some level of confidence which would hopefully help her be successful next year.

Correlation Between Confidence and Achievement

With regards to my third research question, I wanted to know what connection, if any, there was between a student's confidence in math and his or her achievement in math. I found that most students had strong correlations between their confidence levels and achievement. However, some students were over or under-confident in their abilities compared to their achievement. Using the two confidence scales, I compared students' confidence scores to the achievement group each student was placed in (Table 2). To place them in achievement groups, I identified which achievement score was most prevalent for each student by looking at the cumulative number of ones, twos, threes, or fours the student earned on their chapter tests. Any student with more threes was only considered for the medium or low group. Mary, Nick, Carmen, and Dillon all had 25% or above non-passing objectives (scores of one or two) and were placed in the low achieving group. One student, Jenny, also had 25% non-passing objectives, but all but one of them were twos and she had a higher number of fours than the rest of the students in the low category. For this reason Jenny was placed in the average achieving group.

Student	4's	3's	2's	1's	Total # of Objectives
Mary	10	21	3	6	40
Ramona	26	13	1	0	40
Kacey	33	5	2	0	40
Jenny	15	15	9	1	40
Carmen	16	8	11	5	40
Riley	23	9	2	2	36
Katrina	28	10	1	1	40
Stacie	18	14	2	0	34
Kelly	12	18	4	6	40
Dana	21	12	4	3	40
Fay	28	10	1	1	40
Dillon	9	12	10	9	40

High	Medium	Low
Charlie	Jeffery	Nick
Kacey	Tim	Dillon
Riley	Jason	Carmen
Katrina	Jenny	Kelly
Fay	Dana	
Ramona	Mary	
	Stacie	

(Table 2) - Achievement groupings based an student chapter test scores

(Table 3) Results of Chapter tests showing student achievement

Students who were placed in the high achieving category all had a significantly higher number of fours than threes. Students that had nearly the same number of fours and threes were placed in the average achieving group. In some cases it was necessary to use my experiences with each student throughout the school year to ensure they were in the appropriate category. Table 3 shows the test results that were used to place the students into appropriate achievement groups.

Jason	20	18	2	0	40
Charlie	27	11	2	0	40
Tim	22	14	2	2	40
Jeffery	23	15	1	1	40
Nick	13	11	11	5	40

Recall that Confidence A was a confidence scale based on students' general attitudes regarding math. Confidence B was based on student responses to specific math concepts and objectives. Based on their scores on the Confidence A scale (refer to Table 1), four of the top five most confident students fell into the highest achievement category. The one student who was actually the most confident was in the average achievement group. This student was one of the hardest workers in class and consistently demonstrated a desire to learn and do well. While his high confidence may not have matched his achievement level, it did very closely match his positive attitude and efforts in learning mathematics.

In looking at the five students with the least amount of confidence, four of them had a negative confidence score, demonstrating a lack of confidence in mathematics. Three of the five students were in the low category for achievement, one of them was in the average achievement group, and most interesting was Riley who was a high achiever with a negative confidence level. Riley was often very quiet in class. While she had a good group of friends, I would say her classroom demeanor was meek. Riley rarely raised her hand to share but would respond when called on directly. Her body language and behavior often resembled someone who lacks self-confidence in spite of her academic success.

Of the seven students who fell in the middle of the Confidence A scale, five of them were also in the middle of the achievement groupings. The two exceptions were Nick and Robbie. While both of them scored exactly the same (1.1) on the Confidence A scale, Robbie was placed in the high achievement group and Nick was placed in the low achievement group. Robbie was more willing to contribute to classroom discussions and to demonstrate her solutions in class.

Nick was much more reluctant to share in class. He often lacked focus and was usually more interested in what his classmates were doing during class than focusing on instruction.

For this reason, he rarely knew what we were discussing in class and was not able to contribute without my prompting him. I did recall one occasion when Nick successfully demonstrated the solution to a problem the students were working on. He was not without the ability to achieve at higher levels, but was typically less willing to put forth the effort needed to succeed at a higher level. My observations of Nick were not consistent with some of his responses on the survey. Nick disagreed with item number 26, "I would rather have a teacher show me how to do a problem rather than figure it out myself." He also agreed with item number 10, "I like learning new things in math even if it's challenging." Many times while working with a group, Nick was found simply copying answers without regard to understanding how to solve them independently. While working with a group on a problem (February 18th), Nick demonstrated a lack of conceptual understanding as I tried to summarize a solution he had on his paper after working with two other students.

> *T: How did you come up with week 11?*
> *N: Week 11? Umm, when we started…um we uh….when we started going on in the problem and we started getting it… we had to add more to get more uh….money*

Nick was really stammering around as he tried to figure out what to say. He was not demonstrating any real understanding of how his group solved this problem. I continued to question him. Eventually he looked down at the math work on his paper.

> *T: Give me some more details about how you were adding and what you were adding.*
> *N: We added 80 plus 2 and that equaled 78.*
> *T: Was that important math then?*
> *N: No.*
> *T: Ok, forget about that then…. What is the important stuff? What actually led you to the answer you got?*
> *N: 80 times 2.*
> *T: Is that 80 times 2?*

N: point 2
T: And what did you get?
N: 16 dollars
T: And what does that 16 dollars represent?
N: How much the bike costs.

At this point Nick was corrected by another student and Nick readily changed his answer.

T: So if you're taking that much money off, what was the price of the bike?
N: Uh….. it would be…..if you would take that much off it would be 20 dollars.
T: The bike would be 20 dollars?
My question causes Nick to doubt his answer and Jason helps Nick out.
J: Remember we did 80 minus 16. Where'd you put that?
N: Oh that? 80 minus 16, its on the back, 80 minus 16 is 64.
T: Ok….so tell me why you did 80 minus 16.
N: 'cause um…. We had to get….to get another….because it sounded reasonable…to get….it wasn't reasonable to add 16 'cause then it would be more.
T: Right, it wouldn't make sense to get an answer that's more? Right? So if you did 80 minus 16, what does the 80 represent?
N: How much the bike was?
T: What does the 16 represent?
N: The 20 percent off.
T: Ok, and so you subtract that and you get an answer of 64. What does that number mean?
N: How much the bicycle is.

Nick was finally able to communicate the math he did and why it made sense. This was after he had worked on the problem with his group. Nick was busy writing down what his group members said, but paid little attention to why it was important. It was after my guidance and more prompting from his group members that he was able to demonstrate some conceptual understanding of the first part of the problem. This was very typical of the way Nick approached math class and group work.

I also compared student achievement to the students' scores on the Confidence B scale. All seventeen students' scores indicated a positive confidence in math concepts and computation. While all students indicated positive confidence levels, some students were more confident than others. Again I looked at the bottom five students and found that only one of those five students

was also in the low achievement range. Two of them were high achievers and two of them were in the average achievement category. Three of the bottom five students had negative confidence levels on the Confidence A scale as well. I found Riley again near the bottom of the confidence scale even though she was in the high achievement group.

I then looked at the top five students on the Confidence B scale. This group also included two high achievers, two average achievers, and one low achiever. The low achiever in this group was Carmen. Carmen had a lower confidence score in the Confidence A scale, but scored much higher on the Confidence B scale. Since the Confidence B scale consisted primarily of computational math problems, most students had fairly high scores.

Finally, looking at the middle seven students on the Confidence B scale, one student stood out. Dillon had a negative confidence score on the Confidence A scale while having relatively high confidence on the confidence B scale. This was a strong indication that Dillon was very comfortable with computation and basic math concepts but was perhaps less confident in sharing that knowledge with his classmates.

In another comparison of student confidence and achievement, I looked at how students completed a problem solving activity in class (Appendix B). The activity proved to be quite challenging for students, as no one was able to use appropriate calculations to arrive at the correct solutions. Since there was no completely correct response, no fours were earned. Students were given a score of one to three based on the extent to which they demonstrated a conceptual understanding of what needed to be done to solve the problem. I compared the confidence levels from the Confidence A and B Scales to each student's score on the problem solving activity. Table 4 shows data sorted by scores on the problem solving activity (Achievement 2). Students that earned a three on the problem solving activity all had very high scores on the Confidence B

scales. While some of the students had lower confidence on the Confidence A scale, all students had positive confidence levels thus supporting the positive correlation between confidence and achievement.

Of the three students who earned a one on the problem solving activity, two of them had negative confidence levels on the confidence A scale and also relatively low Confidence B scores. The one student with low achievement on this activity still had a fairly low score on the Confidence A Scale. It was worth noting that two students who earned a two on the problem solving activity had high confidence on both A and B Scales. Both Kacey and Jason demonstrated a lot of mathematical confidence, but did not score as well as some other students on this activity.

Student	Confidence A	Confidence B	Achievement	Achievement 2
Jenny	1.1	4.56	middle	3
Mary	0.25	3.54	middle	3
Carmen	0.2	4.61	low	3
Charlie	3.25	4.85	high	3
Katrina	1.3	4.26	high	3
Jason	4	4.94	middle	2
Tim	0.65	4.7	middle	2
Dillon	-0.3	4.54	low	2
Nick	1.1	4.5	low	2
Fay	2	5	high	2
Ramona	1.1	4.49	high	2
Kayce	2.65	4.46	high	2
Stacie	.65	4.45	high	2
Jeffery	0.55	4.45	middle	1
Dana	-0.2	3.69	middle	1
Kelly	-0.7	4.01	low	1
Riley	-0.3	3.95	high	NA

(Table 4) A comparison of both confidence scales and both Achievement scales for each student

While the correlation between achievement and confidence on this activity was not as strong, it still loosely followed the findings from students' chapter test data. The chapter test data was a more reliable indicator of student achievement as it was a combination of many different

objectives over a longer period of time compared to this one problem solving activity that was completed during one class period.

As indicated by the strengths of the two separate Confidence Scales, I had found my students to be more confident in straight forward mathematical activities and less confident when a method for solving a problem was not so clear. The problem solving activity just discussed proved to be more challenging. I found this attitude to be pretty consistent with this group of students in that most students were reluctant to begin working on a problem unless they already knew how to solve it. One of my journal entries addressed this reluctance.

> *This week I have given students several problem solving activities that are more challenging than student comfort levels. I got the problems from the More Sideways math from Wayside School by Louis Sachar. Students were asked to replace the letters in the problems boys + boys = Silly with appropriate digits ranging from 0-9. There were many complaints as I heard students saying, "I don't get it!" Very few if any students began trying to solve the problem before I gave in and gave them some clues and suggestions of how to begin.* (Teacher Journal, April 11, 2008)

This journal demonstrated students' hesitation to begin working on a math problem unless they were assured they knew the right thing to do. To me, this was an indication of a lack of confidence, which might have been the result of little experience with problem solving activities outside of basic problem solving activities found in their regular math curriculum. While my students had a lot of confidence with basic math computation, they seemed to lack confidence with challenging problem solving activities.

CONCLUSIONS

With few exceptions, my fifth grade gifted and high achieving class was fairly confident in mathematics. Based on the two confidence scales (A and B) used in this study, students were generally more confident on basic computation problems and understanding graphs and charts (Confidence B). All 17 students had ratings that indicated a positive confidence level even

though some students were less confident than others. Boys were more confident than girls on nearly every item on both confidence scales.

As indicated by the ratings on the Confidence A scale, some students had less confidence when it came to more generalized items about being nervous or worried in class or how their abilities compared to others in the class. Only one survey item elicited an average response greater or equal to 4.00. Responses to Item number 31 showed that most students in my class were confident in their problem solving abilities. My students were confident in their ability to solve problems, and seemed nearly as confident in their abilities to share that knowledge. It appeared that this confidence carried over to whole group discussions as students overwhelmingly believed that working with their peers helped them understand the math they were working on better. They liked showing other students their answers and how they solved a problem. Even though they favored being able to work with partners or in small groups, students identified off-task behavior and that some students just gave answers as problems with this method of instruction. It was important to note that even though survey responses indicated high confidence in problem solving, I did not find this to be true with more challenging problem solving activities. Students were less willing to work on a problem in which the method of solving that problem was immediately known or given to them.

Students' attitudes toward mathematics were generally positive. Most students liked math and liked learning new things in math. The boys showed a greater willingness to accept and work through challenging problems, but both boys and girls agreed that they would do even better if they worked harder. My students seemed to accept a classroom environment that involved discourse about mathematics and working with other students versus a traditional classroom in which students are fed formulas and methods for solving problems. I believed this attitude was

important in order to gain a greater conceptual understanding of mathematical concepts. They saw math as more than rules and procedures and saw much value in discussing problems and solutions with their peers. The boys tended to be more open and willing to share and discuss than did the girls, but average scores for the entire class showed a positive attitude for communicative mathematics.

Finally, there seemed to be a positive correlation between confidence and achievement. With just a couple noted exceptions, students' confidence levels closely matched their achievement levels. However, while boys were typically more confident than girls, five of the six students in the high achieving category were girls. Boys' confidence tended to match or exceed their achievement while girls' achievement tended to match or exceed their confidence. Most students interviewed said they felt confident in their abilities to be successful as they moved on to sixth grade mathematics. Much like the "Chicken and the Egg" debate, it could not be determined whether student confidence came from their general success in math or if their success in math had built up their confidence. Likely it was some combination of the two and may be a subject for further study.

IMPLICATIONS

I learned a lot about my students as I poured over the numerical data as well as the comments that students made during interviews and while working with partners. Unfortunately, by the time I had discovered the value in the data that I collected, it was really to late to use the information to help my students. Teachers and administrators are constantly pouring over achievement data and searching for strategies to improve student achievement. I think there is much to be learned about student achievement by learning more about student attitudes and confidence at the beginning of the school year. The survey I gave my students would be more

valuable if given at the beginning of the school year. I would have early indications of students' confidence prior to assessing the first two or three tests.

Perhaps even more important would be information about students' attitudes toward math instruction and learning. Will a class not made up of gifted and high achieving students be as comfortable with sharing and discussing math problems and solutions? Students who have not had the same level of success that my students this year have enjoyed may come into my room with more negative attitudes. Using this survey and conducting some of these interviews would likely help me address students' needs more efficiently.

I also need to find strategies for improving the peer-to-peer discourse in the classroom. There was too much off-task behavior and off-topic discourse as students were working together. For some, it became a social opportunity, which impeded the learning of some of the students. Also, as suggested by the students, there was some giving of the answers without concern for conceptual understanding. Much of the group work in this class was informal. I need to consider more structure when it comes to having my students work in groups on solving problems. I also need to develop a more systematic way of having students share within their groups as well as in front of the class.

Finally, I need to do more to emphasize problem solving in the classroom. My students were very confident in their abilities to do basic computation, they were less confident in problem solving and mixed application problems that require more thought and analysis. I have not utilized problem solving to the extent I should with my fifth graders and need to do more to ensure it is a major part of my classroom routine. To do this effectively will take planning which I hope to have more time for upon completion of this project.

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APPENDIX A

Mathematics Confidence and Attitude Survey

Please answer each of the following statements and questions about your attitudes and feelings toward math and math problems. Don't just think about this year, but think about all of your experiences with math both in and out of school. Please answer each of the questions honestly. It is very important that your answers reflect your TRUE feelings and not what you think your teacher wants you to say. Your teacher will be looking at overall results and not your individual answers. Circle the number that best matches your attitudes or feelings about math.

1 = (SD) Strongly Disagree
2 = (D) Just Disagre
3 = (U) Unsure or no feelings one way or the other
4 = (A) Just Agree
5 = (SA) Strongly Agree

I am a boy/girl (circle one)	SD	D	U	A	SA
1. I like Math.	1	2	3	4	5
2. Math is usually easy for me.	1	2	3	4	5
3. 5th grade math is harder than I expected.	1	2	3	4	5
4. Math is mostly about memorizing rules and procedures.	1	2	3	4	5
5. I like learning new things in math.	1	2	3	4	5
6. I like showing other students my answers.	1	2	3	4	5
7. I like showing other students how I solved a problem.	1	2	3	4	5
8. I only like doing math problems I already know how to do.	1	2	3	4	5
9. I don't like explaining or showing how I get my answers.	1	2	3	4	5
10. I like learning new things in math, even if it is challenging.	1	2	3	4	5
11. Things I've learned in one chapter don't usually help me with other chapters.	1	2	3	4	5
12. I usually get good grades in math.	1	2	3	4	5
13. I feel like most of the students in my math class are better at math than me.	1	2	3	4	5
14. I would probably get better scores in math if I tried harder.	1	2	3	4	5
15. The mistakes I make in math class are usually because I don't understand how to do a problem.	1	2	3	4	5
16. If I don't understand a word problem, I usually read the problem again.	1	2	3	4	5
17. When I hear how other students solved a problem it helps me understand the problem better.	1	2	3	4	5
18. I get nervous or worried when a teacher asks me a question in class.	1	2	3	4	5
19. I would like it if the teacher posted the test scores on the wall.	1	2	3	4	5
20. I would like it if I got the highest scores in the class.	1	2	3	4	5

21. I don't usually worry about being able to solve math problems.
1 2 3 4 5
22. I usually get worried during a math test. 1 2 3 4 5
23. Students who are good at math can solve problems very quickly.
1 2 3 4 5
24. Math is probably my least favorite subject. 1 2 3 4 5
25. I like challenging math problems. 1 2 3 4 5
26. I would rather have the teacher show me how to solve a problem than work on figuring it out myself. 1 2 3 4 5
27. I do better in my other subjects than I do in math. 1 2 3 4 5
28. I have a lot of self-confidence when it comes to math. 1 2 3 4 5
29. 5th grade math is easier than I expected. 1 2 3 4 5
30. Even if I work really hard, I still have a hard time learning new things in math.
1 2 3 4 5
31. I can usually pick out the important information in a problem and decide what to do to solve it. 1 2 3 4 5
32. I could teach other students how to solve most of the math we have done in Fifth grade. 1 2 3 4 5
33. I understand math better if someone just tells me what to do.
1 2 3 4 5
34. I don't understand why certain ways of doing math works but I still can get the right answer 1 2 3 4 5

The following statements are about how your confidence in solving particular kinds of math problems.

1 = (VCN) Very not confident
2 = (NC) Not Confident
3 = Unsure or no feelings one way or the other
4 = (C) Confident
5 = (VC) Very Confident

How confident are you in your ability to solve…	VNC	NC	U	C	VC
Addition problems using whole numbers	1	2	3	4	5
Subtraction problems using whole numbers	1	2	3	4	5
Multiplication problems using whole numbers	1	2	3	4	5
Division problems using whole numbers	1	2	3	4	5
Mixed Application problems using whole numbers	1	2	3	4	5

How confident are you in your ability to solve…	VNC	NC	U	C	VC

Addition problems using decimals		1	2	3	4	5
Subtraction problems using decimals	1	2	3	4	5	
Multiplication problems using decimals	1	2	3	4	5	
Division problems using decimals		1	2	3	4	5
Mixed Application problems using decimals	1	2	3	4	5	

How confident are you in your ability to solve…	**VNC**	**NC**	**U**	**C**	**VC**	
Addition problems using fractions		1	2	3	4	5
Subtraction problems using fractions	1	2	3	4	5	
Multiplication problems using fractions	1	2	3	4	5	
Division problems using fractions		1	2	3	4	5
Mixed Application problems using fractions	1	2	3	4	5	

How confident are you in your ability to solve…	**VNC**	**NC**	**U**	**C**	**VC**
Problems about naming different shapes	1	2	3	4	5
Problems about measuring the sizes of shapes	1	2	3	4	5
Problems that require reading charts and graphs	1	2	3	4	5
Challenging problems Mr. Piper gives you for fun		1	2	3	4	5

Word problems on tests and on homework are…

Usually easy for me to solve

Usually hard for me to solve

Some are easy and some are hard

Thank you very much for your participation and your honest responses.

Sincerely,

Mr. Piper

APPENDIX B

Video Game

Michael begged his parents for a new video game. His parents told him it costs too much money. They said if he would pay for half of it, they would get it for him. The video game costs $67.48. Right now, Michael has $11 and he gets $3 each Friday for doing chores around the house. Michael got lucky and found a coupon for 25% off of the regular price. If today is Saturday, how many weeks does Michael have to save before he can get his video game?

APPENDIX C

Achievement Activity

Date of Activity _____

Time interview began _____ Time Interview ended _____

Students participating in the interview:

1.

2.

3.

4.

I am going to give you a problem to work on as a group. I may be asking your questions to see how you communicate your ideas to your classmates. Using precise mathematical language and providing explanations for your thoughts and ideas for solving the problem, find a solution to the following problem. You will be graded according to the Achievement Rubric below.

Problem: Sara wants to purchase a new bicycle that costs $80. She has already saved $15 and gets $5 each week for allowance. If Sara has a coupon for 20% off of the original price of the bicycle, how many weeks will it take for Sara to have enough money to buy the bike? Make sure you show all of the math you need to do to solve the problem. You may use a calculator, but you need to show on your paper what you are calculating.

Possible questions:

- How would you begin to solve this problem?
- Why is that important in solving this problem?
- What does that number mean or represent?
- What do you think about _____'s idea?
- Would you do it a different way?

Scoring Rubric for Mathematical Achievement

4 – Student **completely** explains the solution to the problem using either written or verbally. All necessary math was completed accurately and the solution to the problem was correct.

3 – Student explained or demonstrated most of the components to the solution of the problem. The correct answer was given based on the correct mathematical procedures. The correct procedures with only a slight mistake also is given three as it addresses the Understanding component to problem solving.

2. Little explanation or demonstration of a correct or incorrect solution is provided. Only some of the necessary math is shown. The answer may or may not be correct.

1. No accurate mathematical processes are demonstrated or explained. The answer may or may not be correct. No answer given with no correct work would also result in a score of 1.

APPENDIX D

Interview Questions

1. Would you say math class this year is similar or different to math classes you had in 3rd or 4th grade? In what ways is it different?

2. Do you think that the difference has helped you get better at math, worse, or about the same? Explain.

3. Does solving problems with other students help you understand the problems better, worse, or about the same? Explain.

4. What are some problems with working with other students to solve problems?

5. What are some "Math" words that you've learned this year? When you work with other students on math problems, do you or the other students use any of these math words? Do you think it's important? Why or Why not?

6. Sixth Grade math is harder than 5th grade math. Do you think you are ready for 6th grade math? Why or Why not?

APPENDIX E

Teacher Journal Prompts

Date of Journal Entry _____

Brief description of the lesson:

In what way did you promote discourse in today's class period?

What the discourse whole group, small group, or one-on-one?

Was discourse between students or teacher and students?

Were there any observable benefits to the discourse being used today?

Did students seem comfortable talking about math? Provide details to support your opinion.

What "math" words were used by students during discourse?

Was there any evidence that student learning improved as a result of the discourse?

APPENDIX F

The Locker Problem

An Open and Shut Case. In a certain school there are 100 lockers lining a long hallway. The lockers are numbered 1, 2, 3, …, 99, 100**. All are closed**. Suppose that 100 students walk down the hall in single file, one after another. Suppose the first student (who we will call "Student #1" for obvious reasons) opens every locker. The second student (i.e. Student #2) comes along and closes every 2nd locker beginning with locker #2. (i.e. lockers #2, 4, 6, 8, …, 98, 100). Along comes Student #3 who changes the position of every third locker; if it is open, this student closes it; if it is closed, this student opens it. (i.e. (s)he closes locker #3, opens locker #6, closes locker #9, etc.) Student #4 changes the "open or shut" position of every fourth locker, and so forth, until the 100th student changes the position of locker #100. Which lockers are open at the end of this event?

What pattern do you see in the lockers that are left open? Can you think of a reason why these are the lockers and no others were left open?