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Writing in math and distributive learning in math problem solving

Mary Jo Metz
University of Northern Iowa

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Writing in math and distributive learning in math problem solving

Abstract
Many teachers, parents and students have questions about single sex classrooms. Are there gender based strategies that can be used in single sex classrooms and coed classrooms?

The purpose of this study was to investigate a possible difference in the perceptions of boys and girls in their math problem solving ability, and to determine if writing in math and distribution of curriculum would be effective strategies in math problem solving. The researcher conducted a classroom study to determine the effects of writing in math and compare the impact on males and females. In addition, another study investigated the distribution of curriculum to determine if this has an impact on students' achievement.
WRITING IN MATH AND DISTRIBUTIVE LEARNING
IN MATH PROBLEM SOLVING

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Mary Jo Metz
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John E. Henning
Director of Paper

Victoria L. Robinson
Reader of Paper

Reader of Paper

John E. Henning

Advisor

John K. Smith
Department Head

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Date Approved
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INTRODUCTION

Purpose

There is much discussion in today's school concerning student achievement. Our national goal is ensuring that each student receives an equitable, high quality education and that no child is left behind. The new mandates are putting pressures on schools, teachers and districts. Are we achieving that goal in mathematics education? In order to increase student achievement, a task force led by Robert Smith of University of Northern Iowa Center for Urban Education (UNICUE) introduced gender based classroom to three schools in the Waterloo District.

Dr. Walter Cunningham School for Excellence initiated three gender-based classrooms the 2004/2005 school year. Two of the three second grade classrooms, are gender-based, and one first grade classroom is all boys. This classroom will loop with the same teacher for the next five years. Many teachers, parents and students have questions about single sex classrooms. The gender based teachers and other teachers are wondering if there are gender based strategies that can be used in single sex classrooms and coed classrooms.

The purpose of this study was to investigate a possible difference in the perceptions of boys and girls in their math problem solving ability and determine if writing in math and distribution of curriculum would be effective strategies in math problem solving? The researcher conducted a classroom study to determine the effects of writing in math and compare the impact on males and females. In addition, another study investigated the distribution of curriculum to determine if this has an impact on students' achievement.
Significance

Cunningham’s school improvement plan is focusing on math problem solving. Looking at the fourth grade Iowa Test of Basic Skills (ITBS) data we are seeing small growth in the area of proficiency; however, we have a long way to go. After analyzing our subgroups, especially boys and girls, we noticed differences in growth in math problem solving. As teachers we wondered why there was a difference and what strategies could be used to narrow the achievement gap. Research shows that boys and girls in gender-based classrooms are more focused on the task at hand without the distractions that come from the opposite sex. Single sex classrooms are more than just separating girls and boys, the challenge is to create a culture and a learning environment that reflects how girls and boys learn and process information.

Finding from this study may suggest more effective ways to discover what students don’t know, to help students organize their thinking, to help them use higher level thinking skills, to look at the way they process information and to investigating preference of learning styles.

Distributive curriculum allows teachers to expose students to background knowledge before formally introducing the concept. The survey of the students in second grade verified that girls self-efficacy in math problem solving was lower than boys. The author feels that the strategies addressed in this paper will benefit teachers and students in the area of math problem solving.

Limitations

There are limitations to this research. Each investigation was conducted with different groups of students. The study of writing in math, was to determine if students were better problem solvers when required to write about the problem. The students seemed more confident and increased their posttest scores during this research. However, was that due to writing in math or
cooperative group discussion? A student stated that "Writing helps me know what I'm thinking," another one said, "Writing about math was boring and hard."

Each of the studies was conducted at one school at different times with different students. It would be beneficial to track these students and see how their math problem solving evolves. It would also be interesting to see if these strategies work with other students. Discussing these strategies with staff and teams may be helpful to our students. The author will continue to utilize these strategies to determine if they are beneficial to different students.

We also need to consider when reading this study that this is the first year of gender-based classrooms in this school and district and we do not have enough data to formulate whether gender-based is advantageous to closing the achievement gap. Keeping an eye on these classrooms, continuing to collect data and utilizing different strategies will only help our students and teachers.

**LITERATURE REVIEW**

**Introduction**

Interest in gender-based classroom began for this researcher's when her school implemented three such classrooms. Lacking information about single-sex classrooms, the researcher wanted to know if there were gender specific strategies and learning styles. She also wondered how these strategies could be beneficial not only for gender specific classrooms but also coed classrooms. This interest eventually extended to the area of math problem solving, one of our foci in our school improvement plan. The following literature review will focus on three specific areas: gender-based classrooms, writing in math and distribution of curriculum in the area of math.

The literature review will begin with a variety of viewpoints on gender-based classrooms. Next, the focus will shift to differences and strategies that benefit boys and girls. Strategies of
writing in math and the distribution of math curriculum will also be investigated as a strategy. This review will attempt to give the reader a broader view of the potential strategies in order to utilize them in a gender based classroom or a coed room.

Findings from the literature also indicate that there are some biological and neurological differences between the sexes that can impact math skills. The literature will show that a single sex classroom builds self-esteem, gives opportunities for girls to excel in math and allows both sexes to try non-traditional skills. The literature will also examine teaching strategies that will benefit boys and girls. It is not sufficient just to put girls in one classroom and boys in another. In order to improve academic performance, teachers need to understand how boys and girls learn differently.

**Gender-Based Classrooms**

The National Foundation for Educational Research was commissioned to study the effect of school size and school type (single-sex vs. coed) on academic performance. The Foundation studied 2,954 high schools throughout England, where single-sex public high schools are widely available. They released their report on July 8, 2002. They found that both girls and boys did significantly better in single-sex schools than in coed schools. In this age group (senior high school), the benefits were larger and more consistent across the board for girls than for boys. Specifically, girls at all levels of academic ability did better in single-sex schools than in coed schools; whereas, for boys the beneficial effect of single-sex schools was significant only for boys at the lower end of the ability scale. (NASSPE, N.D.).

A large Australian study in 2001 compared performance of students at single-sex and coeducational schools. Their analysis, based on six years of study of over 270,000 students in 53 academic subjects, demonstrated that both boys and girls who were educated in single-sex classrooms scored on average 15 to 22 percentile ranks higher than did boys and girls in
coeducational settings. The report also documented that "boys and girls in single-sex schools were more likely to be better behaved and to find learning more enjoyable and the curriculum more relevant." The report concludes: "Evidence suggests that coeducational settings are limited by their capacity to accommodate the large differences in cognitive, social and development growth rates of boys and girls aged between 12 and 18. (NASSPE, N.D.).

Eight years ago, just four public schools in the United States offered single-sex classrooms, according to the National Association for Single-Sex Public Education. This year, 156 schools are offering single-sex classes in some form. The surge occurred after No Child Left Behind, the federal education law that took effect in 2002, demanded that federal regulations be changed to allow single-sex schools and classrooms. The rule change caught the eye of low-income schools eager for anything that could help them meet the yearly academic requirements of No Child Left Behind. Many factors influence the changes in classrooms; the "No Child Left Behind Act" has made teachers look at different strategies to reach all the students. The National Council of Teachers in Mathematics suggest six principles for equity.

- High expectations for all students: no longer can we leave children behind and just "spray and pray" for success;
- A coherent curriculum of important mathematics, articulated across grade levels;
- Teachers who understand what students need to learn and then challenge and support them;
- Instruction that builds new knowledge from experience and prior knowledge;
- Assessment that supports learning and provides useful information to both teachers and students; and parents;
- Technology that influences the mathematics taught and enhances students' learning.
Researchers suggest that when these principles are applied to practice, they can improve equity (Halloway, 2004).

It is important to evaluate single-sex class arrangements using multiple outcome measures to assess their impact. A study by Singh & Vaugh (1998) compared two single-sex and two coeducational classes of African American fifth-grade boys and girls in two inner-city schools. Data from students' daily work, final grades and attendance were collected and compared. The measures of achievement examined were from the ITBS scores. No differences were noted between single-sex and coed classes in reading scores. However, boys in the single-sex grade earned higher grades in all subject matters. Girls did better than boys in all measures except reading and science grades in the coed class. The largest difference was in attendance. There were no significant differences in attendance in the female students in coeducational and single-sex classes, but there was a notable finding related to male attendance. Males in the coeducational class missed the highest number of days annually (13.39), while males in the same-sex class missed only 5.77 days. (Singh & Vaugh, 1998). If single-sex classes promoted better school attendance, as in the present case, then this trend represents a positive outcome. Attendance is strongly related to school learning.

Leonard Sax (2005), family physician and Executive Director of the National Association for Single Sex Public Education and author of *Why Gender Matters*, says that sex differences are real, biologically programmed and important to how children are raised, disciplined, and educated. For example, girls are born with more sensitive hearing than boys, and those differences increase as children grow up. The boy’s failure to pay attention in class may be because the female teacher is not talking loud enough, or when a male teacher is speaking in a normal voice, a female student may be thinking he is yelling. Sax states if he can make teachers more aware of the differences in
learning styles, they can incorporate them into their own teaching styles. The students can benefit and there will be an increase in their academic performances.

Another difference involves fine motor skills and language. Girls were about 4 years ahead in language and boys are four years ahead in gross motor skill, spatial memory and visual targeting (Hanlon, Thatcher & Cline, 1999). These researchers suggest that parents and teachers should be aware that each sex has an advantage in preschool and kindergarten that they bring to learning to read. Boys favor vocabulary skills needed for comprehension while girls favor fluency and phonic sub-skills needed for reading. Emotions are another difference that Sax sites. Girls' emotions are processed in the same area of the brain that processes language. In boys, the regions are separate. Therefore, many boys find it hard to answer a question such as, "How would you feel if you were in that situation?" A better question might be "What would you do if you were in that situation?" Boys generally do better in high-stress environments compared to girls (Sax, 2005).

Benjamin Wright, outgoing principal of Thurgood Marshall Elementary School in Seattle stated that his students improved significantly when he began offering single-sex classrooms. The average boys' score in reading went from the 10th percentile to the 66th percentile after single-sex classrooms were implemented. Other benefits include an improvement in student's morale, less referrals and more students going to college. (Washington Times, 2003).

Motor skills are other differences that should be examined. Girls are about 4 years ahead in fine motor skills while boys were about 4 years ahead in gross motor skills, spatial memory and visual targeting (Hanlon, Thatcher & Cline, 1999). This has an impact on writing, reading and math especially math problem solving. Dr. Jawanza (2005) at a teacher conference at Cunningham, suggested that teachers of an all boy classroom should shorten their lessons due to
their shorter attention span, increase opportunities for physical activities and encourage teaching styles that involves active games (2005).

The National Association for Single Sex Public Education (NASSPE ND) states that thirty years ago, single-sex programs were incredibly sexist. But times have changed and today’s single sex classrooms are helping break down gender stereotypes by giving students greater freedom in taking a wider variety of classes. Sax says that girls who attend single sex schools are more likely to take course in computer science and physics, while boys are more than likely to study subjects such as foreign languages, art, music and drama (Sax, 2005).

Advocates for single-gender schools say that removing the distractions of the opposite sex, especially during puberty, can boost student learning. Some studies contend that girls in single-sex schools display greater self-esteem, increased preference for stereotypical “masculine” topics such as mathematics and science and higher educational aspirations. Gavin and Reis’s (2003) research indicates that girls tend to thrive in small group work, especially all female groups. In a coed group boys may dominate, becoming the leaders and monopolizing the discussion, while girls become the recorder of the discussion (2003). When it is an all female group the girls are more willing to take risk and try new strategies. Other studies show that it is natural for boys to play with boys and girls to play with girls. At a school where teachers are encouraged to promote gender equity by de-emphasizing gender, they discovered that over 80% of the children showed clear same–sex play partner preferences, and many boys and girls played almost exclusively with same-sex partners. They also found that the style of play was very different. The play style of the boys was forceful, active and rough whereas the girls were calmer and less physical. Although play among boys is rough and dominance oriented, boys appear to find this active type of play increasingly interesting and compelling (Martin & Fabes, 2001).
The interaction dynamics between teachers and students are complex and played out in subtle ways in the classroom. The results suggest that teachers initiate more overall interactions and more negative interactions but not more positive interactions with male students than with female students (Jones & Dindia, 2004). High achieving students prefer learning alone in an informal classroom. They prefer self-select objectives and self-paced objectives. Low achieving groups indicate they preferred a more traditional classroom (Collinson, 2000).

Girls preferred the all girl classes because girls were supportive of each other. Everyone could contribute to a task and there were opportunities to be both a leader and follower. Girls reported losing some of the feeling of leadership when boys were present. Girls described boys as noisy, distracting and mean. (Baker & Jacobs, 1999). Some of the reasons for girls’ lower confidence and interest in mathematics are because they are discouraged from risk taking, and due to a biased curriculum. Gender-inclusive curriculum encourages students to share their mathematical thinking, work together in cooperative groups, take responsibility for their own learning, and go more in depth with problem solving. Advocates say separating the sexes can improve learning by easing the peer pressure that can lead to misbehavior as well as low self-esteem among girls (Austin, 2004).

The concept of single sex classrooms remains controversial, however, because there are few definitive studies about the effectiveness of teaching boys and girls separately. Critics contend it is based on stereotypes about how boys and girls behave. Some women’s rights organizations oppose the concept, saying it undermines laws designed to make sure girls and boys receive equal instruction. Supporters point to studies showing girls are more assertive without boys and respond better to more collaborative teaching methods. For boys, single-sex schools may be more likely to provide male role models and reduce some of the drop out rates. Critics point to studies that suggest
single-gender classrooms can lead to increased gender stereotyping and that teachers should focus on learning styles and their own practices. Boys called out more and were encouraged to solve problems on their own. Girls are called on less frequently than boys and receive significantly less teacher attention than boys. Evidence suggest that attending single-sex schools improves girls' academic performance and attitude toward less traditional school subject for girls encourages them to assume non-traditional career paths (NASPE, 2004).

There are many studies on the difference in learning styles between boys and girls in math problem solving. One of the main reasons that girls do not succeed in mathematics may not be due to any lack of ability or effort. It may be that they are not expected to excel in this area by some of their parents, teachers, or peers. Parent's attitudes and beliefs may be transmitted through instruction or comments to children (Carr, Jessup & Fuller, 1999). Stereotypes influence perceptions and performance. Math anxiety among females in single sex class decreases while math anxiety among females in a coed class increased (Campbell & Evans, 1997). Some strategies to encourage girls in mathematics include teachers' consideration of their own bias about math and how these feelings might affect their teaching and students (Garvin & Reis, 2003).

Writing in Math

Studies on children's problem solving abilities revealed gender differences in strategies used. Girls in the lower grades tend to use modeling or counting strategies, while boys tended to use more abstract strategies such as invented algorithms or derived facts (Fennema, Carpenter & Jacobs, 1998). Casey, Nuttal and Pezaris (2001) agree with Fennama about the strategies that girls use, however, they also stated that boys tend to use more abstract strategies that reflect conceptual understanding.
As educators we try to maximize instructional time. We use a variety of instructional strategies to encourage and promote student achievement. As curriculums become more tightly packed with each new mandate it is important that our students be able to connect the pieces into meaningful whole understanding. Writing can do this. Writing allows students to integrate math concepts into their everyday life. Writing not only captures math thinking but also facilitates learning in powerful ways. We have seen that writing helps students to acquire a rich, functional vocabulary and to use it in the context of understanding math. Journal writing in math teaching has beneficial effects on the feelings and attitudes of students, as well as positive effect on their learning of mathematical concepts and problem solving skills (Jurdak & Zein, 1999).

It is well documented that girls, by the time they reach middle school, become less interested in mathematics and less confident in their math ability (Levi, 2000). Writing helps them develop confidence in their understanding of mathematics and become more thoroughly engaged with mathematics (Powell, 1997). Writing about math is inexpensive and non-intrusive. It allows students and teachers to capture, examine and respond to math thinking. The use of journals and multiple-entry logs prompts learners to communicate, interpret and analysis the text. Writing helps students explore, clarify, confirm and expand their thinking and understanding. It also help the teacher assess student learning (Dusterhoff, 1995).

One of the major components in the National Council of Teachers of Mathematics Standard is the teaching of mathematics concepts that develop spatial sense. Spatial sense involves the ability to think and reason through the transformation of mental pictures. The spatial way of thinking is contrasted with the linear, logical reasoning. Both strategies can be applied to math problem solving (Casey, Nuttal & Pezaris, 2001). Casey, Nuttal, and Pezaris study showed that boys as a group
depend on spatial strategies when solving a mental rotation task, whereas the girls as a group tend to use verb, analytical strategies for solving this task.

Teachers at all levels should become sensitive to gender-based differences and learn to accommodate different styles of problem solving by all children. We need to systematically teach spatial skills, enabling young learner to define their roles as math thinkers by starting to use spatial as well as numerical strategies to solve math problems (Casey, 2000). A good way to do this is to make a transition from manipulatives to symbolic thinking. Writing can help do this. Encouraging girls to apply spatial strategies when solving math problems will benefit them. Writing also allows the think time that girls need. Boys have a tendency to blurt out the answer. Writing allows everyone time to think through the process before responding.

Distribution of Curriculum

Distributive learning and or the spacing effect, is taking a major concept and distributing it over time instead of concentrating it over a short interval. *Everyday Mathematics* is an example and was designed to utilize spacing effects. Scattering information in small doses over a longer period of time will benefit the children in the long run. They will have background knowledge and familiarity to the unit. This may be done 3 to 4 weeks prior to the unit to allow plenty of time for planning learning activities, grouping students and raising anticipation about the new topic. “Emotional hooks” can be used to engage and to capture attention of the students through challenged, novelty and unique experiences.

Children know much about addition, subtraction and other operations before formal instruction begins (Carpenter, Ansell, Franke, Fennema & Weisbeck, 1993). A problem that seems beyond the capabilities of a child working alone with paper and pencil can often be solved when appropriate manipulatives are available. Early learning appears to be greatly enhanced by ongoing
interactions between children and their world. Talking about ideas, with informal error corrections by adults and peers, is often as important. Thinking about ideas and conversations can gradually become internal dialogues that guide the child's progress through a problem (Issac, Carroll & Bell, 2001).

Continuous review and distributed practice is essential to helping children retain what they learn. Long-term retention is best served if assignments on a particular skill are spread out in time rather than concentrated within a short interval. Transfer of a skill or concept is also more likely to occur when it is practiced in a variety of contexts and situations (Anderson, Reder & Simon, 1996). The problem-solving approach and everyday context in *Everyday Mathematics* are similar to lessons in Japanese classrooms and other constructivist classes, but are also based on inquiry-based learning that connects to students' everyday knowledge (Isaacs, Carroll & Bell 2001).

Girls tend to thrive in small group work, especially all female groups. In coed groups boys may dominate, become the leaders and monopolize the discussion while the girls become the recorders (Garvin & Reis, 2003).

Teachers, who create a safe, caring and supportive learning environment, use frequent cooperative learning opportunities and incorporate their knowledge of gender differences and strategies will increase student achievement in math problem solving.

**Methods**

**Introduction**

The purpose of this study is to investigate what teachers can do about gender gaps that produce differences in learning achievement and opportunities for boys and girls in math problem solving. The researcher examined the 4th grade reading and math scores over the past 2 years. Our district considers proficiency to be at the 41st percentile or higher on the Iowa Test of Basic Skills.
The classroom assessment analysis was to see the effects of writing in math and to compare the impact on males and females. In addition another study was on distribution of curriculum to see if this has an impact on students learning. Finally, a survey was completed to determine how second graders viewed gender based classrooms, math problem solving and learning styles. My question was what elementary teachers can do about gender gaps that continue to produce differences in learning achievement and opportunities for boys and girls in math problem solving. I will be discussing writing in math, distributive instruction and single sex classrooms as a strategy for math problem solving.

**Setting**

Dr. Walter Cunningham School for Excellence is in the Waterloo Community School District in Waterloo, Iowa. Waterloo is a mid-size city with a population of about 68,000 people. It is a diverse community with Caucasians, African American, Native American, Asian, Pacific Islander and other ethnic groups. The Waterloo Community School District’s enrollment for the 2003-2004 is 10,451 students. Thirty- three percent are minority students and fifty five percent receive free and reduce meals at the district level.

Dr. Walter Cunningham School for Excellence opened in August of 2002. The enrollment for Cunningham is 446 students, of which 82% are African American. 87% of our students qualify for free and reduced lunch. Some of the unique innovations at Cunningham are the continuous school year calendar, three gender based classrooms and uniforms for all students and staff. In addition, we have an earlier start time than other elementary schools in our district.
Participates

ITBS Participants

Participates in the ITBS analysis are fourth graders at Cunningham in 2002/2003 and 2003/2004 school year. In 2002, there were 73 students in fourth grade, 39 African American boys, 23 African American girls, 4 Caucasian boys, 5 Caucasian girls and 2 Hispanic boys. In 2003, the fourth graders consisted of 30 African American boys and 28 African American girls, 12 Caucasian boys and 3 Caucasian girls, 2 Hispanic boys, 1 Asian boy and 1 American Indian girl a total of 77 fourth graders. These students are a combination of special needs and regular education students.

Writing in Math Participants

Participants of the writing in math/cooperative learning study were 13 third grade students in Class M. The 5 boys and 8 girls average weekly quiz pretest was 15% and average posttest score was 60%.

Distribution of Curriculum Participants

Participants of the distributive learning study were from two different third grade classrooms. The ten students from Room A consisted of 5 African American boys, 4 African American girls and one Caucasian girl. The six students from Room B were 4 African American boys and 2 African American girls. The average 2002/2003 ITBS score in Math Problem Solving for the 10 students in Room A was 43% and Room B's ITBS scores was 45%. In the category of Math total without computation, Room A's NPR score was 43% and Room B NPR score was 47%. None of the 16 students were proficient on the math pretest given to all third grade students at the beginning of the year. In addition, prior to the chapter on multiplication, two new students joined the class. These girls had not been part of the distributive instruction on multiplication. There was no ITBS data on these two students.
Survey Participants

Participants of the survey were from three second grade classrooms at Dr. Cunningham School for Excellence, two of which, is gender- based. A total of 50 surveys were given to all of the second graders. Total male students were 25 and total female 25. Total male students in one gender-based classroom were 17 and total female students in the other gender-based classroom were 17. Only 17 of the 18 girls in the gender class filled out the survey. Only 17 of the 18 boys in the boy gender classroom filled out the survey, and all 16 students in the combination room filled out the survey. The two surveys not completed were due to the child being out of the room at the time of the survey.

Instruments

Standardized Assessment

Iowa Test of Basic Skills scores are reported in both percentile rank and grade equivalent. There are also scores that examine the national percentile and Iowa percentile in addition to grade equivalent. In these studies we are only looking at the national percentile rank of fourth graders reading and math problem solving, since this is what our district focuses on for the “No Child Left Behind Act.” Our district proficiency for ITBS is 41 percentile or higher. First, I analyzed the reading and math scores to see how many students were proficient and how many were performing below the forth- first percentile. Then, I compared the results between the two years and graphed it too see the progress.

Writing in Math Quiz

The assessment tool that was used during the writing in math was a 24 question weekly quiz that all third grade students take at Cunningham. This quiz has a variety of concepts incorporated in it in addition to 4 to 6 problem-solving questions. I picked this quiz because I would have some
baseline data to compare my research. This quiz was used as a pretest and posttest. The daily learning log that students used for the problem of the day and their writing in math was used as a formative assessment.

**Quiz for Distribution Learning**

The students were given a pre and posttest that consisted of a 5 question questionnaire about multiplication. Then they were give five-multiplication problem solving questions and 100 multiplication fact sheet. Students are considered proficient at 80% or higher on the problem solving and facts. Students at 79-70 are considered developing and those below 70% are at the need improvement stage.

**Survey**

The 15-question survey was administrated to each 2nd grader (see Appendix A.). The questions focused on three main areas; attitude of math and school, learning styles and single sex groupings. Each item had a happy face, neutral face and a sad face attached to the question to symbolize yes, sometimes and no.

**Procedures**

**ITBS**

Our district looks at proficiency on the Iowa Test of Basic Skills at 41% or higher. The district also focuses on the 4th grade scores. For the purpose of this study we are going to look at the 4th grade NPR scores of reading comprehension and math total without computation, over two year period. Swift Knowledge (a district wide data base) allows us to compare scores to determine if there is a correlation and to desegregate data by percentile, gender, ethnicity or grade level. This allows us to see the correlation between reading and math scores.
Writing in Math

The students were pre-evaluated by a 24 question quiz that included 4 problem solving questions each Monday. The same quiz was given on Friday as a posttest. Every student was given a learning log to write in during math. The first entry was the questionnaire, and the next entry was five story problems, in which they were to write or draw how they would solve the problem. Students were encourage to "Write down their thinking" to solve the problem. Each student was paired and shared with a peer to share their learning logs. After the pair and share students were put in groups of four to share their learning logs.

Distributive Instruction

The pretest was given to 10 students from Class A in September two months after school started. Students were instructed two to three times a week for 5 to 10 minutes on various strategies to understand multiplication. The different strategies that the teacher introduced were skip counting, array and repeated addition. The purpose of these mini lessons was to help the students establish a conceptual understanding of multiplication and to connect the abstract to the concrete. The teacher created a variety of opportunities for students to discover the patterns of multiplication through the use of pictorial representation, cooperative groups, and hands on activities and journaling. Students were also instructed on problem solving strategies (See Appendix B).

Survey

The survey was given to each of the three second classrooms individually. The author modeled how to record on the sheet and informed the students that their teachers would not be seeing the data and to be as honest as possible. She then read each question to the students and gave them sufficient time to answer. The author consistently reminded the students of what each symbol represented.
Results

Introduction

ITBS

Since we are comparing two years of data, we urge caution in identifying “trends” because the cohorts of children in 2002/2003 may be very different. However, major changes up or down are worth close review and analysis. Our proficiency (41% or higher) is indicated by the tables below. The results indicate that Cunningham fourth grade students are performing lower than children nationwide. However, seeing small increases of students moving from the low percentile to the intermediate is promising.

Table 1: Fourth Grade Student Proficient on ITBS

<table>
<thead>
<tr>
<th>Reading Comprehension</th>
<th>Math</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cl 2002-2003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ 2003-2004</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As indicated by Table 1, our reading comprehension had an increase of 12.33 percent and math had a 6.85 percent increase. Analysis the proficiency rate by gender indicates that in 2002/2003 the boys proficient in reading was 42.22% in 2003/04 that increased by 2.22 percent in proficiency. The math scores, boys grew 8.89% proficient from 26.65% in 2002/03 to 35.56% in 2003/04. Girls had a proficiency rate of 25% in reading and 25% in math during the 2002/03 school year. In 2003/04 they had a 28.7% proficiency in reading and a 53.57% in math. The girls’ results show that there was a 3.7 increase in reading comprehension and a 28.7 percent in math. These
results show that boys increase in reading impacted their math scores. On the other hand, when the girls increased in math dramatically there was no significant change in reading.

Writing in Math

Table 3 shows the average pretest scores and posttest scores on the weekly quizzes. Proficiency is 70% on these quizzes. The baseline data showed the average test score was 69%. After three weeks of writing in math the posttest scores average 80% an increase of 11%. Table 4 shows the pre and posttest increase of proficient students.

Table 3

Table 4

Distributive Learning

The average 2002-2003 ITBS scores on math problem solving for the 10 students with distributive learning instruction was 43% and math total without computation was 43%. The six students that joined the class average ITBS math problem solving was 45% and math total was 47%. The students' abilities were very similar.

The result of the 5-question problem solving pretest and questionnaire was that 5 out of 6 students had no familiarity with multiplication. Students left the questions blank or stated they did not know how to do it. On the posttest, girls increase 80% on the problem solving and the boys increased 72 percent. The students that were not exposed to distributive learning had a score of 30%. The students that were exposed to the distributive curriculum all tried solving the problems by
drawing pictures, circles and stars or used manipulative. Eighty percent of the questions were correct. The students that had been exposed to distributive learning left the majority of the questions blank or wrote, "I don’t get it." They had only 30% of the questions correct this was by one student.

The results of the questionnaire were also substantial. The first question stated: What is multiplication? On the pretest all students responded by leaving it blank or wrote, "It’s hard." "I know we have to do it but I don’t know how." Or "I don’t know." On the posttest every student wrote that multiplication was repeated addition and a few stated that it was also like skip counting. The students that had not had distributive learning felt it was hard and confusing.

Survey

The questions in the survey were divided into three areas: questions 9, 11, 12, 13, 14 dealt with learning styles. Questions 4, 5, and 12 dealt with problem solving and questions, 2, 8, 10 was on students self confidence in the area of math. Questions 1, 2, 6, 7 were on self-efficacy. Ninety six percent of the boys said that they would continue to try a problem even if they didn’t fully understand it whereas only 72% of the girls said they would. Fifty six percent of the girls like to figure out problems compared to 92% of the boys. And 82% of the boys said they liked to figure things out by themselves whereas, 50% of the girls said they would. Even though 80% of the girls and 88% of the boys said they like math, 90% of the boys thought they were good at math compared to only 75% of the girls. (See Appendix C).

Analyzing the survey data, there was a distinct difference in how boys and girls viewed themselves in regards to math. Girls in this survey are not as confident in math, especially the area of problem solving. Girls also felt that they were not as confident in writing about math and explaining math to others. Both boys and girls score comparatively high on liking 2nd grade, liking
math and working with partners. Over 90% of both boys and girls in the gender based classroom and the coed room like being or would like to be in a gender-based classroom.

Discussion

Introduction

Summary of Data

According to our ITBS analysis the boys and girls at Cunningham have improved in proficiency by 8.89% and 3.57% respectively in math problem solving. Cunningham students are performing lower than children nationwide but are making small increases in proficiency. The writing in math analysis showed that this is a very successful strategy with an 11% increase from baseline data. Taking a power objective or skill to be taught in a subject such as math and distributing the information in small dosages over a period of time has a positive impact on students’ achievement. Students increase an average of 80% on math problem solving. And finally, after surveying the students in second grade there was a distinct difference in boys and girls confidence in math problem solving. Even though boys and girls equally like math, girls were lower on each answer and significantly lower than boys on the self confidence questions dealing with problem solving.

The purpose of this study was to determine if there was a difference in the perceptions of boys and girls in their math problem solving ability and if writing in math and distribution of curriculum are effective strategies in math problem solving.

Interpretation

The ITBS analysis indicated that math scores are significantly lower than reading scores at the fourth grade level. Even though the boys growth in proficiency was 8.89% there is still a large percentage of non proficient 64.4%: whereas, the girls are 46.35% non proficient in math. The
large number of non proficient students had an impact in regards to trying different strategies to see if these would be effective in math problem solving.

Writing in math was a strategy that the researcher used after reading about it and discussing it with her peers. Writing in math calls for thinking clearly, organizing and gathering information very similar to math problem solving. The researcher asked her students to do this daily along with cooperative group pair and share. Writing in math was a successful action research. The posttest scores raised 11% from the baseline data. The significant difference came in the amount of students' who were proficient each week. On the weekly pretest only one or two students were proficient. On the posttest 9/10 or all 10 students were proficient. I have come to the conclusion that writing in math made an impact on students thinking through problem solving in a more logical way. Students had to organize the process before writing it down. The use of cooperative groups to share their writing and the use of hands on manipulatives to prove their answers reinforced this higher level of thinking.

Another teaching strategy that was successful was the distribution of curriculum. As part of the strategy the students were engaged in many activities for 5 to 10 minutes daily to understand multiplication. Students were not formally introduced to multiplication, but through games, songs and fun activities they were shown what the concept of multiplication was. Prior to this unit, the research gave each participate a questionnaire and some multiplication problem solving. The question was what is multiplication? Not one student knew what it was. On the posttest every student wrote it was repeated addition. On the pretest not one student was able to do the problem solving activities even though a few boys tried. On the posttest every student tried by drawing pictures, making arrays or doing “circle and stars,” a game that was taught. The posttest scores
raised an average of 80% for girls and 72% for boys. The students that entered the room that had
not been exposed to distributive curriculum had an average score of 30%.

I have come to the conclusion that each of our students comes to us with different abilities and
we are expected to teach a concept in math at a certain time whether that child is developmentally
ready or not. If we take that concept and expose it to the students over a long period of time in 5-10
minute intervals, by the time we get to that unit the child will have background knowledge and
enough confidence to be successful.

Through the results of the students’ surveys the researcher concluded that girls are less
confident in their math problem solving ability as boys. She also concluded that all the students in
gender based and non gender classroom would like to continue with gender based classrooms.

**Recommendations /Future**

Prior to this research I felt that I have treated all my students equally. I do not believe that I
held different expectations for the boys and girls in my class, but after this research and closer
examination of my classroom practices I am aware that there are some gender stereotypes. The boys
are more dominate and vocal in the discussions than the girls. I do think my female students are
insecure in their ability to solve math problems even when they have similar abilities as boys. Even
the literature that I share has gender biases. I recommend that other educators examine their
classrooms closely to see if they have gender stereotypes.

I recommend that we show our students the relevance of math to their lives, and incorporate
real-life problems to solve. I also believe that we need to give both boys and girls the same
experiences and opportunities in math that are gender specific such as allowing girls more think
time, making sure we are calling on girls and boys equally for the high level questions. Teachers
can do this by having in place a system with student’s names on so they don’t overlook anyone.
Teachers need to display a positive attitude and try different strategies to build confidence in the
girl’s math abilities. Many researchers believe that using cooperative learning in math classes can
improve girl’s confidence levels. Teachers can examine the dynamics of coed and single gender
cooperative groups and continue their professional development on learning styles and gender
specific strategies. As teachers and administrators we need to continue dialogue about closing the
achievement gap and look at different strategies and professional development to do this. As
educators, we must get the most from every student, every day, regardless of their gender. We must
have high expectations for all. We must also work to make students feel comfortable and confident
enough to express their thoughts and ideas. Writing in math was a strategy that students felt safe to
express their ideas and thoughts.

Given that boys and girls have very different ways of thinking and learning, it is important
that we know as much as possible about those differences to be able to provide appropriate gender
based educational situations. Teachers need to be aware of gender bias and how they might
negatively impact the learner’s process. Teachers need to look at their own practices, curriculum
and literature for stereotypes. Professional development, workshops and in-services on gender
issues would help in the awareness process. Further research will tell us whether single-sex
education is more appropriate than coed. One recommendation is to survey the second graders again
and see if there is a significant differences in the confidence level of girls in the gender based
classroom and the coed classrooms after one year of gender based classrooms and to see if there
was an impact on girls self confidence in math problem solving. Next year the gender classrooms
will continue at our school as the teachers will loop with the students. It will be valuable for us
again to give the survey to see if the girls gain confidence or not. It will also be valuable to look
closely at the data of the gender based and coed classrooms to see if we want to continue with
gender based classroom and to see what differences we see in all areas of academics.

I am more convinced than ever that we need to use our best problem-solving strategies to
work toward gender equity. We must define the problem, reflect on the decisions that we make and
examine the influences of these decisions on the children in our classes. We need to work with
others and have an ongoing dialogue of gender, reexamine our practices and continue to revise.
Doing so will have an impact on student achievement and will make a difference in learning
achievement and opportunities for boys and girls in math problem solving.
References


Appendix A: Circles and Stars

Circles and Stars is a two-person game that gives children a visual interpretation of multiplication as repeated addition. To play, children take turns rolling a die to find out how many circles to draw and then rolling the die again to find out how many stars to draw in each circle. The winner is the child who draws the most stars after 5 rounds. After playing the game, students learn to use the standard notation of multiplication to describe each round. In this way, they connect their drawings of circles and stars to the correct mathematical representations.

Materials:

Dice, 1 per group of students (2-3 players)

Paper booklet 3-5 pages

On the front cover have students write the title Circles and Stars and their names.

Model how to play on the board.

Student 1 begins by rolling a die and drawing that many circles roll the die again and draw that many stars in each circle. Student 2 repeats the procedure.

Continue for 5 rounds. If a student rolled a 3 and a 2 they would fill out their page in the following way.

3 circles and 2 stars

3 sets of 2

3 times 2 = 6 stars
Appendix B: Math Problem Solving Strategies

Show what you know

- Draw a picture
- Make an organized list
- Make a table
- Make a graph
- Act it out or use objects

Look for a pattern

Try, Check, and Revise

Write a number sentence

Use logical Reasoning

Solve a simpler Problem

Work backwards
Appendix C: 2004 Survey Question

1. I like 2\textsuperscript{nd} grade

88\% total girls said yes  \quad 92\% gender based girls said yes
88\% total boys said yes  \quad 100\% gender based boys said yes

2. I like math

80\% total girls said yes  \quad 75\% gender based girls said yes
88\% total boys said yes  \quad 88\% gender based boys said yes

3. I like to take time test in math

72\% total girls said yes  \quad 64\% gender based girls said yes
80\% total boys said yes  \quad 83\% gender based boys said yes

4. I like to keep trying even when I don’t understand something.

72\% total girls said yes  \quad 68\% gender based girls said yes
96\% total boys said yes  \quad 88\% gender based boys said yes

5. I like to figure out problems in math.

56\% total girls said yes  \quad 48\% gender based girls said yes
92\% total boys said yes  \quad 89\% gender based boys said yes

6. It’s ok to make mistakes

88\% total girls said yes  \quad 82\% gender based girls said yes
80\% total boys said yes  \quad 95\% gender based boys said yes
7. My teacher makes math fun
   72% total girls said yes  80% gender based girls said yes
   92% total boys said yes  94% gender based boys said yes
8. I am good at math
   75% total girls said yes  55% gender based girls said yes
   90% total boys said yes  92% gender based boys said yes
9. I like to work with a partner in math
   92% total girls said yes  98% gender based girls said yes
   98% total boys said yes  94% gender based boys said yes
10. Math is easy for me
    88% total girls said yes  72% gender based girls said yes
    90% total boys said yes  92% gender based boys said yes
11. I like to figure things out by myself
    50% total girls said yes  42% gender based girls said yes
    82% total boys said yes  88% gender based boys said yes
12. I can explain math to others
    60% total girls said yes  48% gender based girls said yes
    96% total boys said yes  94% gender based boys said yes
13. I like being in a class with all boys or girls
    92% total girls said yes  88% gender based girls said yes
    92% total boys said yes  94% gender based boys said yes
14. When I have a question in math I feel I can ask my teacher and she will help me.

72% total girls said yes  
70% gender based girls said yes

70% total boys said yes  
98% gender based boys said yes

15. When I have a question in math I feel I can ask my teacher and she will help me.

72% total girls said yes  
72% gender based girls said yes

95% total boys said yes  
98% gender based boys said yes