2005

A distributed strategies approach to teaching multiplication and problem solving

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Abstract

Multiplication and problem solving are two fundamental math topics in third grade. The expectation is that students will enter fourth grade with a strong foundation in multiplication and problem solving, which was established in third grade. This research project implements a variety of multiplication and problem solving strategies, in conjunction with a "distributed" or "spaced" curriculum style. Distributed teaching means multiplication is introduced and practiced on a regular basis. This project addresses the question; . Does a distributed curriculum in multiplication and problem solving improve students' understanding of multiplication and problem solving and improve students' assessment results?

A DISTRIBUTED STRATEGIES APPROACH TO TEACHING MULTIPLICATION AND PROBLEM SOLVING

Submitted for the Requirements for the Degree

Master of Arts in Teacher Leadership

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This Research Paper by: Holly K. Ritter

Entitled: A Distributed Strategies Approach to Teaching Multiplication and Problem Solving

Has been approved as meeting the
research paper requirement for the degree of

Master of Arts in Education
Educational Psychology: Professional Development for Teachers

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5/13/05
Date Approved

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INTRODUCTION

Purpose

Multiplication and problem solving are two fundamental math topics in third grade. The expectation is that students will enter fourth grade with a strong foundation in multiplication and problem solving, which was established in third grade. This research project implements a variety of multiplication and problem solving strategies, in conjunction with a "distributed" or "spaced" curriculum style. Distributed teaching means multiplication is introduced and practiced on a regular basis. This project addresses the question: Does a distributed curriculum in multiplication and problem solving improve students' understanding of multiplication and problem solving and improve students' assessment results?

The need for this study was driven by the data. Our school continues to score in the low percentile range (40 or below) on the Iowa Test of Basic Skills standardized tests in math computation, problem solving, and math total. With scores remaining near this level for more than one year and without a 10% decrease in the overall low percentile scores, our school awaits confirmation on whether we will be included on the "School in Need of Assistance" list, as required by No Child Left Behind (NCLB) standards.

Significance

The topics of multiplication, problem solving, and efficient, successful teaching methods are important to classroom teachers. As teachers find themselves with more and more to teach, in less and less time, the best teaching methods must be used in the classroom. Research has been conducted on classrooms combining math instruction with written, oral, and language skills. Also, research has found that students process and retain information better in smaller, extended chunks. Therefore, these strategies are worth sharing with colleagues.

As a community of collaborative teachers, our school will be able to implement some of the successful strategies used in this project. Our teachers are no different than other educators. We feel the pressure to ensure all students learn and we are continually searching for the best practices to reach each one. The problem solving strategies can be implemented at all levels because writing and discussion already take place daily in a classroom. Multiplication strategies can be introduced in the lower grade levels, and the same strategies can again be reemphasized in the upper elementary as a review. By providing evidence that combining classroom skills and reviewing previous math skills continuously, teachers and students will benefit from these teaching methods.

Limitations

The study does not examine the benefits of a distributed curriculum over an entire school year. Due to the time frame of the research project, the use of a distributed curriculum was only implemented over a two month segment. The implementation of the strategies was completed four months prior to the unit on multiplication in the classroom, so the students had no prior experience with multiplication yet this year. The study will not be able to show the students' attitudes towards multiplication before, during, and after the curriculum multiplication unit, which was to be taught during the second half of the school year. In addition, the study only included 23 students who were taught the specific strategies. After the implementation of the various strategies and distributed curriculum format, it would be beneficial to see the three classroom's Iowa Test of Basic Skills scores in the spring of 2005. Also, due to the limited research completed on distributed curriculum in the mathematical field, specifics on the ideal amount of time and frequency for a distributed curriculum are unavailable.

LITERATURE REVIEW

Introduction

Does a distributed curriculum in multiplication and problem solving improve students' understanding of multiplication and problem solving and improve students' assessment results? In the following sections, the use of multiplication and problem solving strategies will be addressed, along with an explanation of the implementation and benefits of a distributed curriculum. The multiplication strategies addressed are games and discussion. The problem solving strategies are "real life" writing, combining classroom writing with problem solving, and again discussion. Finally, the delivery method of a distributed curriculum will be discussed.

Multiplication Strategies

Teaching multiplication requires more than having students memorize basic facts. Students need to think about, relate to, and analyze multiplication problems. Not only should students know their basic facts, but students should also know what multiplication is, how it relates to addition, and how to make reasonable estimates both mentally and on paper (Burns, 2001). Two strategies that can be implemented to support teaching multiplication are games and discussion.

As teachers integrate new instructional methods into their basic facts teaching, classrooms are incorporating other approaches such as games, literature, charts, discussion, and manipulatives. As a teacher in a low-performing NCLB school, Kami and colleague Anderson (2003) have found that games help students develop fluency, speed, and identification of relationships between numbers. Games can incorporate the use of one or several time tables, factors, or speed. The following first four games are practiced by Kami and Anderson (2003):

- Rio - a game focusing on factors which uses a game board with specific factors and a numbered cube.
- Salute - a game focusing on factor and fact families which uses a deck of cards. Two cards are pulled by a dealer and the other players try to guess the factors.
- Around the World – a game focusing on speed where students compete to respond to the multiplication problem the fastest.
- Multiplication War – a game focusing on number sentences where students find the product using a deck of cards and discuss their strategies to solving the problem.
- Circles and Stars – a game focusing on grouping. The game uses dice and students roll a number for the circles and another number for the stars to go inside the circles. Students must then calculate the total number of stars. (Burns, 2001).

Games are also used as a form of assessment and a way to understand students' thinking. A student's thinking can be further investigated through a conversation during a game rather than on a piece of paper. According to Dominick and Clark, through the use of games, students conduct discussions in which new ideas are formed and challenged (Steffe & Killion, 1989) and games are where learning takes place when thinking is modified.

Discussion is also a way for teachers to discover which students are fluent in multiplication. Discussion as a multiplication strategy allows students to share thoughts and work with each other. Wickett (2003), a classroom teacher and coauthor of a math text book, found the use of discussion enables students to generalize and apply previous knowledge to solve more difficult problems. Discussion is as important for word problems as it is for computation problems.

Problem Solving Strategies

In addition to being computationally fluent in multiplication, students must fluently solve word problems. Problem solving is a student's ability to navigate their way through words and numbers to discover the correct answer. Teaching problem solving is time consuming and often difficult. When faced with teaching problem solving, Bushman (2004) found that teachers often fall into the "blame game." Teachers either blame themselves, the word problems, the students, or other people for the unsuccessful problem solving occurring in their classrooms. However, several strategies have been implemented successfully in classrooms. Two strategies that have been used are real life writing and classroom writing combined with problem solving.

Teaching students to be efficient and capable problem solvers takes time, which teachers do not have in abundance. Several research projects have been conducted in third grade classrooms that incorporate problem solving into the classroom. One strategy is real life writing. This work parallels the work done by Marilyn Burns. In her text, students create and discuss several of the multiplication activities. For example, in the activity – "things that come in groups", students create a classroom chart of items they know come in groups. From the chart, story problems are written from information supplied by the students, so the problems are real to them because they are student created. Again, Ford (1990) finds that students show excitement about problem solving when they use everyday, real life materials, like menus and catalogs to develop their problems.

Teachers are distributing problem solving throughout the day into other curricular areas to allow for more learning in a small amount of teaching time. Hildebrand, Ludeman and Mullin (1999) use writing in combination with creating and solving story problems. In their action research, they state students were able to use prior knowledge and incorporate the prior

knowledge into their mathematical learning. This strategy combines two key concepts. First, students write their own story problems and use their writing and editing skills, and secondly, the students create real life problems that they can solve mathematically.

Another form of writing done in many classrooms is DOL (daily oral language). Ponce and Garrision (2004) share research completed on combining the DOL writing activity with the development of word problems. With this strategy, the teacher taught students to carefully look at a word problem as first a piece of writing and secondly, as a mathematical problem to be solved.

By using multiplication and problem solving strategies together, teachers are able to reach students in many different ways. A final strategy investigated in the research project was the teaching delivery method of a distributed curriculum. By using a distributed curriculum, multiplication and problem solving would be taught intermittently distributed over a school year, not as a single unit. Therefore, previously taught material would be reviewed and built on continuously throughout a school year.

Distributed Curriculum

A distributed curriculum or spaced learning is a structure that provides students with many opportunities to practice mathematical skills. Rathmell states "a distributed curriculum is an opportunity where mathematical topics are presented repeatedly throughout the academic year, rather than in a single unit of instruction" (Renick, Lesgold, & Leer, 1991). According to the Saxon mathematics curriculum, another definition of a distributed curriculum is "the tendency, given an amount of time, for spaced presentations of a unit of information to yield much better learning than massed presentations." (Dempster & Farris, 1990). Students are continually assessed both formally and informally throughout a school year. But most of the

standardized testing used to report to the district, state, or nation are completed at the beginning and end of a school year. By using a distributed practice, it would help students maintain the information necessary to prove their success.

The benefits of a distributed curriculum are that teachers can scaffold students to a certain point and then continually return to previous concepts to practice, discuss, and discover new ideas. Math expert Marilyn Burns states "time is required for children to absorb concepts, when students return to ideas after a break, they bring not only the learning they've done in other areas but also a fresh look that some distance can provide." A distributed curriculum can be easily implemented into the classroom. Instead of spending weeks on a particular unit of instruction, a concept is taught and then revisited over the school year. A brief ten minute practice on a weekly basis can provide extended and effective learning. Several experiences over a school year should be more beneficial than a two-three week unit (Rathmell, 2003). Research studies have been conducted to find the implications of the distributed effect of teaching. Research conducted by the Saxon Publishers found that a distributed curriculum leads to greater math achievement than mass practice (Dempster, 1988; Dhaliwal, 1987).

However, according to Findell, B., Kilpatrick, J., & Swafford, J.(2001), there are several teaching issues that are under researched. One of those issues is instruction over time. The report indicates that too many of the current studies "provide little understanding of how the interactions of teachers, students, and content emerge over time, and how earlier interactions shape later ones." Therefore, with the combination of multiplication and problem solving strategies being taught in distributed curriculum, the results will show greater student understanding and improved assessment results.

METHODS

Introduction

Does a distributed curriculum in multiplication and problem solving improve students' understanding of multiplication and problem solving and improve students' assessment results? Several methods were used to gather data and answer the question about distributing a student's learning in the area of multiplication and problem solving. The Iowa Test of Basic Skills standardized achievement test was used to assess students' needs in math and problem solving. During the data collection, student interviews and surveys were conducted. Through interviews and surveys, students shared their thoughts, feelings, and background knowledge about math and multiplication and the strategies used to solve problems. A pre and post test were also given during data collection. The test was used to assess students' understanding of multiplication and problem solving, and also to see if students show work when solving problems. Throughout the research project, teacher observations were made to assess the amount of work shown on student papers.

Context

Three classrooms were used in the research project; one classroom was the implementation group and the other two classrooms were control groups. The implementation classroom consisted of 23 third grade students at McKinstry Elementary. Students at this level enjoy sharing their work and taking ownership of the problems created in the classroom. Over the last five years, math had consistently been a low achievement area for McKinstry Elementary. From the ITBS taken at the beginning of the school year, 68% of the students scored in the low range, 14% scored in the middle range, and 18% scored in the high range.

McKinstry Elementary is a school on the verge of the "School in Need of Assistance" list. Multiplication is one of the main concepts introduced in third grade. By the end of third grade, students are to complete 90 out of 100 multiplication problems in five minutes. Students are also expected to possess several math problem solving strategies that can be easily accessed in future grade levels.

Participants

In this study, there were three sets of participants. The participants were students from three different third grade classrooms. The classrooms consisted of 23 students, 21 students, and 20 students. The different classrooms are identified in the project by their room numbers: 201, 204, 205. The classroom teachers plan together and teach the same units in math simultaneously. Room 201 would have the multiplication and problem solving strategies distributed into the other math curriculum and Room 204 and 206 would have no strategies deliberately taught in addition to the regular math curriculum. All students participated in the survey, the classroom pre and post assessments, and the Iowa Test of Basic Skills. The student interview was given to twelve third grade students at McKinstry Elementary. Four students from each third grade section were interviewed. The students interviewed had varied math ability levels. Teacher observations were made daily in Room 201 and work observation was accounted for in all classrooms on the pre and post assessment.

Measures

Five different measures were used in this study, including the Iowa Test of Basic Skills, student interviews, student surveys, pre and post classroom assessments, and teacher observations.

Iowa Test of Basic Skills

The Iowa Test of Basic Skills is a standardized achievement test. The ITBS consists of three different math sections. The sections are: math concepts and estimation, problem solving and data interpretation, and math computation. A total math score is also calculated by combining the scores of the three previous tests. Using the classroom results from this assessment, significant low areas in math were identified. The math computation, problem solving, and math total scores were used in the research project.

Interview

The student interviews provided information on the students' feelings and perceptions about math and multiplication. During the interview, I was able to identify use of math vocabulary terms by the students. I could clarify, question, or probe students further for more information. I could also provide encouragement during the individual problem solving time. The interviews varied in length from 5-10 minutes; this included work time to complete a multiplication story problem. The interview included 8 questions that were answered orally and one story problem that was solved on paper.

Survey

The survey questions were given to discover students' background knowledge on multiplication, problem solving, and to recognize the strategies used to solve problems in math. The survey asked for students' input about their feeling towards math, multiplication, classroom work environment, and strategies used. Six questions were included on the survey.

Test

An eleven question written pre and post test was given to determine what strategies students used when solving multiplication and word problems. The test provided space for

students to show their work and thoughts. Unlike the survey, the assessment was not multiple choice. The assessment gave students the opportunity to work individually to show what they knew about problem solving strategies on their paper. The test may have been limiting because if a student did not ask for a question to be clarified, the student may have not answered the question. The test consisted of one explanation question, four multiplication story problems, and six basic fact multiplication problems. Example story problem: Question 4 – There is a new soccer team at McKinstry. There are 7 people on the team and each player needs 3 balls to practice with. How many soccer balls are needed for practice? Example basic fact problem: Question 5 – 4 x 3 = ?. The same test was given for both the pre and post assessment.

Teacher Observations

During classroom work time throughout the data collection period , informal observations were made in Room 201. Evidence of students using strategies, like drawing a picture or chart, was noted by the teacher, but not documented. A comparison on amount of work shown on the pre and post test was made in all three classrooms.

PROCEDURES

Data Collection

Iowa Test of Basic Skills

The Iowa Test of Basic Skills was given district wide during the second month of school. The test results were sent to the schools approximately three months later. The previous year's scores were collected from the Swift Knowledge data base. Swift Knowledge is a computer based program used throughout the district to access and share assessment results. The math portion of the test is given again in the spring for improvement analysis only, not for district, state, or national reporting.

Interview

To complete the interview, I meet with each of the twelve students individually. Each student was asked nine questions. They were asked each question one at a time and given time to think about the question and explain their answer. If clarification was needed on the students' answer, I would prompt them with other questions. I recorded all of the students' answers.

Survey

The surveys were given at the beginning of the project during the math period. I distributed and conducted the surveys in each classroom. The survey was six multiple choice questions. A total of 57 surveys were given and collected. In some of the questions, students were able to circle more than one answer; e.g., questions 2 and 3.

Test

The pre and post test were both given in the individual classrooms by the homeroom teacher. A total of 64 students took the pretest and 53 students took the post test. Students were not asked to put their names on either test. I did not want to find out individual scores, but rather improvement as a classroom. I scored the pre and post assessments and calculated the percentage of proficiency for each classroom. From the pre to post test, I calculated percentage of improvement for each classroom on each question.

Teacher Observations

Throughout the project, informal observations were made daily only in Room 201. As students in Room 201 completed various story or basic fact questions, I would make observations as I circulated the room. I was looking for increases in the amount of work shown on their daily work. However, I compared work shown by all classrooms from the pre to post

test. I calculated the percentage of students with work on their paper from the pre to post test by using question one for this analysis.

Teaching procedure

Throughout the research project, various math strategies were used to introduce multiplication to students in a distributed way. Through the use of charts, student-created problems, skip counting, and games, I introduced students to various multiplication strategies. Three different multiplication strategies were introduced and used throughout the quarter. Skip counting was the first strategy used. As a math warm up, together students would skip count aloud. We would skip count aloud from the twos to the tens.

The second strategy taught was "things that come in groups." As a class, we made a chart of items we knew came in groups, e.g., 2's (shoes, earrings, twins), 3's (tricycle wheels, triplets), and 4's (legs on a desk and chair). As the students encountered new groups of things, the ideas were added to the chart. To use the student created chart and to practice our problem solving strategies, students would pick an item from the chart. Then, I would tell them how many groups of the item they had. Students would figure out the total number of items by writing a number sentence, drawing a picture, or using another strategy. For example:

Item: packs of gum with 5 pieces in a pack

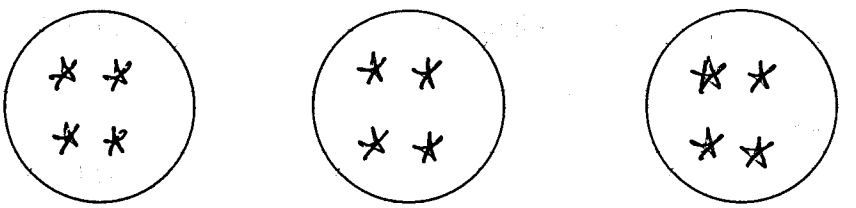
Number of groups of the item: 7

7 groups x packs of gum (5 pieces) = 35 pieces of gum

The third strategy taught was a game called *Circles and Stars.* In the game, students were given a blank game booklet for their drawings. The game was played in pairs with a die. Students took turns rolling the die (2 times each). The first number determined the number of circles and second number determined the number of stars in each circle. First, students drew the

number of circles and then drew number of stars inside each circle. Students wrote a number sentence multiplying the number of circles by the number of starts. The pairs determined which person had the largest product for the page and continued with the same pattern for seven rounds. After seven rounds were played, students calculated the total number of stars to determine the winner of the game. Again, this strategy implemented looking at groups and sets of things.

For example;



3 x 4 = 12 stars

Students were also able to practice writing multiplication number sentences to go with their drawings. All three of the strategies were taken from Marilyn Burns (2001).

RESULTS

Data was gathered from the three classrooms in the form of the Iowa Test of Basic Skills, interviews, surveys, a pre and post test, and teacher observations. Data was gathered only on a regular basis from Room 201 in the form of teacher observations. The results from each method were analyzed for background knowledge, strategies, and improvement. The Iowa Test of Basic Skills indicated that the overall math scores were consistently in the low percentile. The interviews found that overall students felt confident in math and enjoyed math. From the surveys, it found that half of the students felt they already knew multiplication and three fourths wanted to learn multiplication. From the pre to post test, results showed that Room 201 made the largest percentage of growth, improving on seven out of eleven questions. Teacher

observations noted that as students became familiar with multiplication and problem solving strategies, more work appeared on their post test.

Iowa Test of Basic Skills

The Iowa Test of Basic Skills (ITBS) results for three testing periods show the national percentile rank (NPR) and national grade equivalency (NGE) for the participants in this study. The 2003-2004 scores for the students were from their second grade year and the 2004-2005 fall scores were when the students were participants in this study.

Table 1

ITBS Results of Fall 2003-2004

Test	NPR	NGE
Math Problem Solving	39.30	1.99
Math Computation	37.66	1.87
Math Total Score	33.87	1.82

Table 2

ITBS Results of Spring 2003

Test	NPR	NGE
Math Problem Solving	35.88	2.36
Math Computation	Not taken in spring	Not taken in spring
Math Total Score	32.97	2.27

Table 3

ITBS Results of Fall 2004-005

Test	NPR	NGE
Math Problem Solving	37	3.0
Math Computation	17	2.8
Math Total Score	30	2.92

Interview

The interview found students felt positive about math and confident in their ability to achieve in math. No students refused the interview and all were open with their responses. When asked about favorite math activities, students responded in a variety of way. Addition, subtraction, and writing in math were some of the favorites. Students were asked about the easiest and hardest part of math. Addition was reported to be easiest for 83% of the students and multiplication, division, and working with high numbers was reported to be difficult. For the upcoming school year, students wanted to learn about multiplication and division.

Students' background knowledge on multiplication and vocabulary was varied. Some students indicated it was like counting or adding numbers which would help you to solve a multiplication problem. Some students would ask what I meant by multiplication or ask if I meant "times." Two students did not think they knew anything about multiplication or any strategies to solving a multiplication problem. Also, when asked about objects that come in groups, most students did not know of any objects that came in groups. When asked to solve a multiplication story problem, 25% of the students responded correctly.

Another observation made from the interviews was the students' lack of work shown on the problem solving question of the interview. Only three students solved the problem correctly and there was very little work shown to indicate how they solved the problem. Three students showed a number sentence (one with the right answer and two with the incorrect answer). One student wrote a sentence for his explanation to the problem. Also, none of the students put a label on the answer of their problem. The entire interview and responses can be found in Appendix A.

Survey

The survey provided background knowledge of the students' feelings about math and the strategies used when solving problems. Students were able to circle more than one answer on the multiple choice survey if they felt that more than one answer applied to them. Overall, 94% of the students thought that math was either great or okay. Students indicated that they liked working by themselves or with a partner. Drawing a picture, solving the problem in my head, and writing the problem on my paper were the top three ways students responded to solving problems.

Half of the students believed they knew how to multiply and 77 % were excited to learn about multiplication. From the total number of surveys, only 15% of the surveys showed any type of work indicating how they solved the problems. A few examples of showing work could have been writing out a number sentence or drawing a picture. The entire survey and results can be found in Appendix B.

Test

The assessment showed the overall percentage of improvement in each classroom from the pre to post test.

Table Four

Greatest Percentage of Improvement on Post Test Questions

Classroom	Question with Greatest Percentage Improvement
Room 201	one, two, four, six, nine, ten, eleven
Room 204	eight
Room 206	three, five, seven

Room 201 had an average of 21% increase per question from the pre to post test. Room 204 had an average increase of 12% increase per question from the pre to post test, and Room 206 had an average increase of 5% increase per question from the pre to post test.

The entire pre and post test and results can be found in Appendix C.

Teacher Observations

Throughout the instruction period, differences were recognized in my students when they were trying to solve word problems. One of the differences was the amount of work shown in their daily work. Multiplication and problem solving strategies were modeled in the classroom. Strategies specifically modeled were how to draw pictures, how to write a number sentence or explanation, and how to try several strategies to find the best one. I also observed students offering each other strategies to try, rather than just accepting one shared by myself.

Also through daily observations in Room 201, I noticed that students also self-discovered how to use the multiplication charts on their desk nametags. As we were working on grouping

items and finding the product, students began sharing strategies with each other. Students discovered if they went over to the number of groups in the problem and counted down the number in the group, they would find the product. At the end of the nine weeks and a successful lesson on grouping, students were told what they had been doing was multiplication or times. They were stunned and commented, "I didn't know it was so easy."

On the pre and post tests, teacher observation were conducted looking at the amount of work shown on the tests. Question one was used to make the comparison. Question one stated: Please write a sentence or draw a picture to show what multiplication is. The following table shows the increase of work shown on question one.

Table Five

Percentage of Increase of Work Shown on Test

Classroom	Pretest	Posttest	% Improvement
Room 201	39	63	**24**
Room 204	29	47	18
Room 206	45	41	-4

DISCUSSION

The purpose of the research project was to determine if a distributed curriculum in multiplication and problem solving improved students' understanding of multiplication and problem solving and would improve students' assessment results. Results from the various methods indicated several things.

The Iowa Test of Basic Skills was used to determine specific low achievement areas in math and to determine what percentile most students scored. Math problem solving and computation were the two areas used for the research project. The results showed that for two

years, the overall percentile ranking for the participants in the research project were in the low percentile. Consistently, the scores did not reach over the 39%tile in either problem solving or computation. From the fall of 2003 to the current year's testing, there was actually a decline in the percentile score. Math computation and math problem solving are two areas that are in needed of intervention for our students.

The argument can be made that not all of the same students took the tests both years at our school. Our school has a high mobility rate, so the same exact group of students do not take the tests, so that could have accounted for some of the loss in percentage. However, it also does not take into account new students who may have helped the overall scores by scoring in the middle to high percentile. Also, our school takes the ITBS one month after school has started. It does not give teachers much time to prepare for the tests or time to recover information lost over the summer months. The data gathered from the ITBS has influenced our school's response to the students' needs. This year, the after school program was offered to students scoring in the low to middle range in math on the ITBS. The after school program focused primarily on math computation.

From the interviews and surveys, data showed that most students felt mathematically competent and enjoyed math. Students indicated that they have specific strong areas in math. 90% of the students felt excited to learn multiplication and 50% felt they already knew something about multiplication. The classroom pre and post test indicated that students in Room 201 increased their assessment scores by 21%. On the post assessment, Room 201 had over 50% of the students show work and indicate what multiplication was by either drawing a picture or writing a number sentence. Also, the students in Room 201 were able to use the multiplication

strategies previously taught and use their experience with skip counting, grouping items, and the game of *Circles and Stars*.

Based on these results, there are definite areas in which a teacher could better respond to the students. First of all, from the survey and interviews, it was shown that students do enjoy math and were excited to learn about multiplication. Also, half of the students felt as if they already knew something about multiplication. Teachers need to take the opportunity to build on the students' enthusiasm and excitement about multiplication. I was able to take the students' enthusiasm and build it into the various math strategies. On a distributed basis, I incorporated games and shared learning to keep the interest level high and I continued building on their previous knowledge. By introducing a new strategy every two weeks, the students felt success by reviewing the previous strategy before beginning something new. Another successful problem solving strategy was the use of number sentences and/or pictures. By referring back to the strategies on a weekly basis, the students' background of problem solving strategies continually grew. As new problems were introduced each week, students chose the strategy they wanted to use to show their work and were able to share the strategy with the class.

Although there was growth in the post test scores, Room 201 did not improve by the greatest percentage on every problem. I do not think there was enough time allotted for the basic or "easy" multiplication facts, like 0, 1, 2, 5, and 10. Those particular facts should be automatic and were still missed on the post test. Also, I do not think enough time was contributed to the teaching method of distributed curriculum. The time frame for the research needed to be much longer, like an entire school year. I think by introducing the strategies and teaching into weekly or daily chunks throughout the year, different results may have been seen.

When reflecting over the project, there are changes I would make for the future implementation of a similar project. I would conduct another student survey to see if the students' feelings or assumptions about multiplication or problem solving changed after working on the strategies. As another form of assessment, I would also conduct a pre and post test on the 100 problem 5 minute time test that is required in third grade. We are required by our district to complete the time tests, so it could easily be added to the project. As for individual students who were truly succeeding at multiplication, they needed to be challenged in a different way. These students could have created problems for the rest of the class and lead the discussion of a previously taught strategy.

With the teacher observations, I would have also made some changes. There needed to be a more deliberate and systematic way to record what I was seeing in the classroom. Teacher observations are made continually throughout the day, so again it could be easily implemented. I would want to look for specifics, like pictures, arrays, numbers, or written explanations.

Bringing the distributed curriculum idea into the students' homes would be another change I would suggest. Students could have an activity to share with someone at home explaining the multiplication or problem solving strategy that was being practiced in the classroom and incorporate it into the homework. As the project continued, I found that there were limited resources and research on distributed curriculum. Therefore, future projects on distributed curriculum may be structured with a specific time table and frequency for teaching and reviewing the strategies.

Another area I would like more information on is teacher modeling of problem solving. What has been the students' experience when watching a teacher solve a problem? Did the teacher erase the work as soon as the problem was solved? Did the teacher only show one way?

Do students not feel as smart when they are showing their work on their paper? Also, are students programmed to keep their papers clean because of standardized tests and the inability to write on them?

A distributed approach to introducing and practicing new math strategies is a purposeful way for teachers to continually teach and assess their students. In their own way, many teachers probably already instruct in the distributed format. Teaching students in new and creative ways, like collaborative learning, games, and a distributed curriculum will continue to make learning fun and keep students invested in their education.

References

Burns, M. (2001). *Lesson for Introducing Multiplication.* United States: Math Solution Publication.

Buschman, L. (2004) Teaching Problem Solving in Mathematics. *Teaching Children Mathematics,* 10 (6), 302-309.

Dominick, A, & Clark, F. (1996). Using Games to Understand Children's Understanding. *Childhood Education* ,72, 286-288.

Findell, B., Kilpatrick, J., & Swafford, J. (2001) *Adding It Up.* Washington, DC: National Academy of Sciences.

Ford, M. I. (1990) The Writing Process: A Strategy for Problem Solvers. *Arithmetic Teacher,* 1 (4), 35-38.

Gregorio, P., & Garrison, L. (2004-2005) Overcoming the "Walls" Surrounding Word Problems. *Teaching Children Mathematics,* 11 (5), 256-262.

Hildebrand, C., Ludeman C., & Mullin, J. (1999) Integrating Mathematics with Problem Solving Using the Mathematician's Chair. *Teaching Children Mathematics,* 5 (7), 434-441.

Kamii, C., & Anderson, C. (2003). Multiplication Games: how we made and used them. *Teaching Children Mathematics,* 10 (3), 135-142.

Rathmel, E. (2003). Developing Computational Fluency Number and Operations. Unpublished manuscript, University of Northern Iowa.

Saxon Publishers. (2004-2005). *Scientific Research for Saxon Math K-12.* Retrieved February 24, 2005 from http://www.saxonpublishers.com/pdf/research/saxon_math_research.pdf

Schettino, C. Transition to a Problem-Solving Curriculum. *Mathematics Teacher*, (96), 534-537.

Wickett, M. S. (2003). Discussion as a Vehicle for Demonstrating Computational Fluency in Multiplication. *Teaching Children Mathematics,* 9 (6), 318-321.

Appendix A

Student Interview

1. What kind of math student do you feel you are?
2. What do you like doing in math?
3. What is easy for you in math?
4. What is hard for you in math?
5. What would you like to learn in math this year?
6. Tell me what you know about multiplication.
7. How would you solve a multiplication problem? What strategies would you use?
8. What things do you know that come in groups?
9. Please solve the following problem for me on the paper.

I went to the Pet Emporium this weekend. At the store, I bought four new fish bowls. For each fish bowl, I bought six new fish. How many new fish do I have in all?

Appendix B

Survey Results

The findings will be presented in the following way: Each question will be addressed in order, sharing the responses of the students. Students are numbered 1-12. Students 1-4 are from Room 204, students 5-8 are from Room 201, and students 9-12 are from Room 206.

Question One: All students responded in a positive way when asked how they viewed themselves in math. There were nine "good" responses, one "ok" response, one "great, I feel good about Math, fine" response, and one "a plus student" response.

Question Two: In question two, there were a variety of responses about what they enjoyed doing in Math.
Student one – to subtract
Student two – add and subtract
Student three- times
Student four – helping others
Student five- using objects to help me. Last year we used Hershey bars.
Student six – times
Student seven – write in math, write in sentences
Student eight – greater than, less than, add and subtract
Student nine – plus
Student ten – writing in math
Student eleven – plus and adding
Student twelve – getting the answers right

Question Three:
Students one, two, three, six, seven, eight, twelve - plus
Student four – reading answers
Student five – easy questions, like 2 +3, 2 +4, plus problems
Student nine, ten – plus and take away
Student eleven – plus, take away, and greater than, less than

Question Four:
Student one – I am trying to think of the word, but I can't think of it. To take away if it is a high number like 29.
Student two, eight, nine, ten – multiplication
Student three – high times, I am used to doing times.
Student four – hard questions, when everyone is loud and I can't read.
Student five – subtraction, some addition, worst part is getting things wrong.
Student six, seven – subtraction
Student eleven – division, long division
Student twelve – when there is high letters, trying to get it right

Question Five:
Student one – to learn high numbers in subtraction and high numbers in plus
Student two – how to do times, I already know some, but not that well
Student three – two dots and a line through it – division
Student four, six, eight, nine, ten, twelve – times
Student five – multiplication facts, so I can beat my cousin Brandy
Student seven – more about subtraction, "minus"
Student eleven – division, long division

Question six:
Student one – what is that?
Student two – It means you have to add.
Student three – you have to subtract, it's sort of hard when you have to add tens place.
Student four – It helps you get smarter.
Student five – nothing, using the x
Student six – 4 x 4, count by 4's 4 times
Student seven – it is like counting
Student eight – when you go by 5's or 10"s you count by those and 3's you double.
Student nine – I am quick and know how to do it, no mistakes
Student ten – don't know
Student eleven – anything times zero is zero, anything times one is the number
Student twelve – you add them together

Question seven:
Student one – don't know
Student two – I would look at ones column and borrow, making a four into a three and giving it to the two, like borrowing in subtraction.
Student three – I get mixed up sometimes, I am still thinking, subtract sometimes, minus and plus
Student four – subtract
Student five – objects
Student six – crayons, as counters
Student seven – count the numbers
Student eight – count by 5's, 10's and use my fingers
Student nine – start from the back and go to the front
Student ten – use fingers
Student eleven – 50 x 50, add 50 + 50 till you get to 50 times.
Student twelve – not sure

Question eight:
Student one, three – don't know
Student two – shoes, come in groups of two
Student four – 2 +3 +4
Student five – what does that mean, no
Student six, eleven – no
Student seven – grapes come in a group
Student eight – pencils come in a group of six when you take them out of a case, money
Student nine – (observation, couldn't understand word, asked him three times)
Student ten – times
Student twelve –numbers

Question nine:
Student one, five, ten – 4 + 6 = 10
Student two, eleven - 24
Student three – 24, I was counting by six.
Student four – 12
Student six – 24, 4 x 6 = 24
Student seven – 22
Student eight – 20
Student nine – 10
Student twelve – 6

Appendix C

Classroom Pre and Post Test

1. Please write a sentence or draw a picture to show what multiplication is.

Solve the following problems.

2. At McKinstry, there are two food choices a day. If students go to school for five days, how many food choices are there at the end of the week?

3. John has 14 shoes. How many pairs does he have?

4. There is a new soccer team at McKinstry. There are 7 people on the team and each player needs 3 balls to practice with. How many soccer balls are needed for practice?

5. Yesterday, I got five WOW notes in school. I have gotten five WOW notes for three days in a row. How many WOW notes have I gotten in the last three days.

6. 4 x 3 = 7. 10 x 6 = 8. 20 x 3 = 9. 5 x 5 =
10. 1 x 2 = 11. 8 x 4

Classroom Pre and Post Test Results

The following tables show the overall class average on the pretest and posttest for each classroom. The tables also show the percentage of improvement from pre to post test. The number in bold is the classroom that made the largest gain.

Question 1 – Please write a sentence or draw a picture to show what multiplication is.

Classroom	Pretest Score	Post test Score	Percentage Improved
Room 201	39	63	**24**
Room 204	29	47	18
Room 206	45	41	-4

Question 2- At McKinstry, there are two food choices a day. If students go to school for five days, how many food choices are there at the end of the week?

Classroom	Pretest Score	Post test Score	Percentage Improved
Room 201	30	53	**23**
Room 204	14	35	21
Room 206	65	76	11

Question 3- John has 14 shoes. How many pairs does he have?

Classroom	Pretest Score	Post test Score	Percentage Improved
Room 201	35	53	18
Room 204	38	18	-20
Room 206	40	59	**19**

Question 4 – There is a new soccer team at McKinstry. There are 7 people on the team and each player needs 3 balls to practice with. How many soccer balls are needed for practice?

Classroom	Pretest Score	Post test Score	Percentage Improved
Room 201	22	53	**31**
Room 204	29	35	6
Room 206	40	41	1

Question 5- Yesterday, I got five WOW notes in school. I have gotten five WOW notes for three days in a row. How many WOW notes have I gotten in the last three days?

Classroom	Pretest Score	Post test Score	Percentage Improved
Room 201	48	47	-1
Room 204	38	47	9
Room 206	52	65	**13**

Question 6- 4 x 3 =

Classroom	Pretest Score	Post test Score	Percentage Improved
Room 201	30	59	**29**
Room 204	24	41	17
Room 206	50	41	-9

Question 7- 10 x 6 =

Classroom	Pretest Score	Post test Score	Percentage Improved
Room 201	39	59	20
Room 204	33	53	20
Room 206	50	71	**21**

Question 8 – 20 x 3 =

Classroom	Pretest Score	Post test Score	Percentage Improved
Room 201	30	47	17
Room 204	24	47	**23**
Room 206	25	35	10

Question 9 – 5 x 5 =

Classroom	Pretest Score	Post test Score	Percentage Improved
Room 201	34	53	**19**
Room 204	48	59	11
Room 206	55	59	4

Question 10 – 1 x 2 =

Classroom	Pretest Score	Post test Score	Percentage Improved
Room 201	30	63	**33**
Room 204	38	65	27
Room 206	57	59	2

Question 11 – 8 x 4 =

Classroom	Pretest Score	Post test Score	Percentage Improved
Room 201	22	42	**20**
Room 204	19	24	5
Room 206	45	35	-10