The impact of math teaching strategies on math achievement

Patty Jenkins
University of Northern Iowa

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The impact of math teaching strategies on math achievement

Abstract
The following study will highlight student achievement analysis of selected portions of the Iowa Test of Basic Skills of fourth grade students at Lincoln Elementary School. Teacher interviews about planning for teaching math, teaching strategies used, and outcomes are the second part of this research. A student survey about strategies teachers use and attitudes toward math is included along with the results of classroom action research. These data will be utilized to answer the question: Has the implementation of math teaching strategies had a positive impact on student math achievement at Lincoln Elementary School?
THE IMPACT OF MATH TEACHING STRATEGIES
ON MATH ACHIEVEMENT

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Patty Jenkins

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Patty Jenkins

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John E. Henning
Director of Paper

Reader of Paper

Reader of Paper

John E. Henning
Advisor

John K. Smith
Department Head

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INTRODUCTION

Purpose of the Study

For at least ten years Lincoln School has been involved in excellent grant projects to secure materials and teacher training to improve student achievement in reading, and is finally seeing some results. It is time to broaden the focus to include math instruction. For years, math instruction has been uncoordinated and under funded. This is changing. New math curriculum is being implemented with a coordinated effort by the district and some special training for first and second grade teachers through the University of Northern Iowa.

Data collected from Iowa Test of Basic Skills indicate that Lincoln Elementary School fourth graders show need of improvement in math. Research has shown that students must receive the right training in math in elementary school because by the time they reach high school it is too late. The prekindergarten through fifth grade teachers should all be included in sharing information about planning lessons, the various strategies used to teach math concepts and skills, and the outcomes of their work. There would be a better understanding of where the school is in math achievement and where it needs to go if a coordinated effort was implemented. Involving students in the process by continually seeking their input could strengthen the interventions being implemented. When individual teachers share strategies that have proven successful in
their own classrooms, other teachers may be encouraged to try them also.

The following study will highlight student achievement analysis of selected portions of the Iowa Test of Basic Skills of fourth grade students at Lincoln Elementary School. Teacher interviews about planning for teaching math, teaching strategies used, and outcomes are the second part of this research. A student survey about strategies teachers use and attitudes toward math is included along with the results of classroom action research. These data will be utilized to answer the question: Has the implementation of math teaching strategies had a positive impact on student math achievement at Lincoln Elementary School?

Significance of the Study

This study may provide information on how to improve math achievement. Teachers may be convinced that planning and the use of multiple teaching strategies does affect student achievement positively. This study may have some important findings on teachers' attitudes towards the strategies they use to teach math concepts and skills to influence student achievement. This study attempts to demonstrate that the combined efforts of all teachers from prekindergarten through grade five will result in higher student achievement in math at Lincoln Elementary School.
This research may give momentum to other studies of data generated by the various assessments teachers use at Lincoln Elementary. The continued search for "best practice" can encourage educators to monitor their teaching through student achievement, interviews and discussions with colleagues, surveys of student attitudes, and further classroom action research.

Limitations of the Study

The validity of this study could be improved by including more grade levels in the student achievement analysis. It would also be helpful to have ITBS math scores from more than two years. The length of the study and limited number of participants could also possibly be limitations.

REVIEW OF THE LITERATURE

Introduction

The following review of research will look at the special needs of low achievers to determine how the impact of math instruction affects their future performance in math in high school and their pursuit of college beyond high school. Secondly, the consequences of teaching strategies on student learning will be considered. The current research indicates that most teachers use a limited number of strategies when teaching math concepts and skills. Some strategies promote active student involvement and participation in learning math concepts. There are strategies that limit
student involvement. Small group teaching and using a distributed curriculum are two additional strategies used in teaching math.

Finally, professional development and staff training that could be developed to help teachers improve instruction in math will be discussed. A brief look will be taken at what one school district is doing to retrain teachers for teaching math and science.

**Special Needs for Low Achievers**

The gap between the academic performance of low and high achievers increases each day (Lumpkins, Parker & Hall, 1991). Math is now being called “the gatekeeper” in American society, but few black and Hispanic children get the right training in elementary school (McAuliffe & Liepke, 1993). By the time they reach high school, it’s too late: These students have already been “tracked” into vocational or remedial math programs and excluded from the academic path that leads to college (McAuliffe & Liepke, 1993). Disadvantaged students who are required to take higher level mathematics classes in high school are more likely to go on to college than those disadvantaged students who do not study higher level mathematics (Pitsch, 1991). As one educational researcher sums up the situation: The mathematics classroom is one of the most segregated places in American Society (McAuliffe & Liepke, 1993).
**Strategies**

The main means of math instruction implemented by math teachers is teacher explanation followed by student practice (Stodolsky, 1985). Many teachers teach students math concepts and skills the same way they were taught as students. McAuliffe & Liepke (1993) found that “most teachers are used to just standing at the board and imparting facts to their students...” (p. 64).

Stodolsky’s (1985) studies found that teachers do not use a variety of teaching strategies to instruct their students in math. Her research established that math instruction is the same from day to day within a given math class and across classes of different instructors in different schools and districts. The results of her studies combined with the research of others illustrate that elementary school math instruction generally relies on a recitation and seatwork pattern of instruction. Teacher’s oral presentation of new concepts or procedures relies on text-book oriented instruction along few manipulatives and little small group work.

Students perceive their role in learning math to be primarily passive listening and watching. The whole-class approach is the dominant approach to teaching math in the elementary schools. Text books are the center of math instruction. Teachers may eliminate teaching some of the material in the text, but rarely go beyond what is in the books. Most math instructors agree on the usefulness of manipulatives in teaching
math concepts, but the paper and pencil world dominates the elementary math classes (Stodolsky, 1985).

In the same study, Stodolsky found that less than 5% of student time was spent in small group work. Stodolsky claims that the limited structure in which math is taught causes students to become dependent on the teacher as their only learning resource. If students don’t understand the explanation of math by their teacher, they are stumped. Data collected reveals that the students in small co-operative groups participated more often, opportunities for exchanging information increased among students, and positive attitudes increased (Utsumi & Mendes, 2000).

Teachers need to use multiple strategies to help students understand math concepts. Students who have difficulty learning in math need even more experiences to use math concepts. A distributed curriculum approach, where mathematical concepts and skills are taught in smaller doses throughout the school year, rather than in one large unit, is another strategy that has worked to improve student understanding (Rahtmell & Gabriele, 2003).

**Staff Development/Training**

Among the several aspects of staff development to consider are allowing adequate time for staff to study and understand any innovation to be implemented, providing ongoing support with materials, and providing further training and time to collaborative planning and teaching.
Lumpkins, Parker and Hall state that administrators must be willing to provide time, fiscal resources and moral support for teachers willing to develop a program based on research. Even if teachers understand the need to change their classroom practices in mathematics instruction, for many it is unclear how they can undertake such change (Wimer, Ridenour, Thomas, & Place, 2001). It is important that teachers who want to monitor or change their classroom practices have access to the support and resources necessary to do so (Wimer, Ridenour, Thomas, & Place, 2001).

Leon Lederman, a Nobel laureate in physics, is spearheading an effort to change the way math and science is taught in inner-city schools (McAuliffe & Liepke, 1993). Teachers in Chicago receive intensive retraining in teaching science and math. The premise of the retraining is to:

Show teachers how to let children work together in small groups rather than passively listen, to use simple everyday materials like soap bubbles and beads to illustrate basic principles, to move from textbooks and rote memorization to hands-on, activity-based learning. In short, to take the drudgery out of math and science and relate these subjects to children's lives (McAuliffe & Liepke, 1993, p. 63).
METHODS

Introduction

With the inception of the No Child Left Behind legislation all public schools must show proficiency in the core curriculum areas of reading, math, science and social studies. Fourth grade students at Lincoln Elementary School need improvement in math. Lincoln fourth grade students rank ninth from the top among the thirteen elementary schools in the Waterloo District. The following studies conducted within the Lincoln learning community in the areas of ITBS student achievement analysis, teacher interviews, student surveys, and classroom action research attempt to answer the question: Has the implementation of math teaching strategies had a positive impact on student achievement in math at Lincoln Elementary School?

Setting

Waterloo, Iowa with an urban population of nearly 70,000 is the location of Lincoln Elementary School. Lincoln is one of 13 elementary schools in the Waterloo Community School District, a district of approximately 10,450 total students. The Waterloo District is diverse in Socio Economic Status with 55% of its students qualifying for free and reduced lunch. At Lincoln, 70% of the students qualify for free and reduced lunch. Ethnic diversity in the district is 67% white and 33% minorities including Black students (Afro American, Liberian, Ugandan,
South African and others), Native American students, Hispanic, and White (Bosnian included) students. Lincoln's ethnic diversity includes 53% white and 47% Black (Afro American, Liberian, Ugandan, South African and others), Native American, Asian and Hispanic. About 15% of the Waterloo students have special needs. Lincoln reflects that same percentage. The percentage of district fourth graders scoring proficient, on the Iowa Test of Basic Skills, above the 40th percentile, in math for Fall 2002 was 51.2%. The percentile of Lincoln fourth graders proficient was 42.1% for Fall 2002. The average student mobility for the Waterloo elementary schools is 21.6%. Lincoln's student mobility rate is 16.9%. The average attendance for the district elementary schools is 94.9%. Lincoln's average attendance is 95.8%. The percentage of professional staff with Masters Degrees is 36% for the Waterloo district and 26% for Lincoln.

The Waterloo School District strives for improved student achievement through community efforts such as Partners in Education with business and community organizations, community surveys, newsletters, and improved physical facilities. Further endeavors to improve student achievement include: using technology extensively in classrooms, class size reduction in grades K-3, prekindergarten programs in six elementary schools in the 2003-04 school year with more programs planned for the future, professional development to improve teachers'
skills and using the Data-Driven Decision Making model for teachers to assess student achievement and adjust teaching.

**Participants**

**Student ITBS Achievement Analysis**

The participants in the student achievement analysis were the 2002-2003 fourth grade students from Lincoln Elementary School.

**Teacher Interviews**

The three teachers interviewed taught fourth grade math at Lincoln Elementary School during 2003-2004. The first teacher has been teaching six years. She has a reading endorsement and is just eight hours short of her MA in education. The second teacher has been teaching for five years all at the fourth grade level. She is working on a master’s degree in education. The third teacher is a special education resource teacher who has been teaching for four and one half years. She has a reading endorsement, a special education endorsement, and is four hours short of a master’s degree in special education and twelve hours short of a master’s degree in education.

**Student Survey**

157 fifth grade math students at Jewett, Kingsley and Lincoln (JKL) Elementary Schools who were the fourth grade class of 2003-2004 participated in a student survey to determine student attitudes toward math and math teaching strategies.
**Classroom Action Research**

Thirty one prekindergarten students in two sections of Title I prekindergarten were the participants in the classroom action research. Sixteen students were in the morning class and fifteen were in the afternoon class. All of the students in the Title I prekindergarten program must show academic need as determined by the Brigance Four-Year-Old Prescreen a widely used testing instrument to measure overall pre-academic readiness skills in four-year-olds. To qualify for the Lincoln Title I Prekindergarten program students must score 75/100 or below on the Brigance Four-Year-Old Prescreen.

**Instruments**

**Student ITBS Achievement Analysis**

Teachers of fourth grade math use a variety of assessment instruments including timed tests, section review, chapter tests, all from the new Scott Foresman/Addison Wesley math curriculum, teacher created tests, Target Teach which is district curriculum to teach and improve test taking skills in math, and the Iowa Test of Basic Skills. For this study we will compare Iowa Tests of Basic Skills Math Problem Solving, Math Concepts and Estimation, and Math Total without Computation from Fall 2002, Fall 2003 and Spring 2004.

Iowa Tests of Basic Skills, norm referenced standard achievement tests, are administered to all district fourth graders in the content areas of
reading, math, science and social studies in the fall of each school year. Additional ITBS tests in math have been administered since the spring of 2004.

**Teacher Interviews**

The purpose of the interviews was to determine if teachers at Lincoln used similar teaching strategies and curriculum in their math instruction from October 2003 to April 2004. Three questions were written to help determine what curriculum, strategies, materials, resources, and professional training the three teachers used in the teaching of math. Three more questions were devised to better understand the outcomes of using strategies, math goals, and planning lessons. Two more follow up questions were designed to illuminate current and future teaching strategies. See Appendix A, “JKL Teacher Interview Questions.”

**Student Survey**

The purpose of the survey was to determine student attitudes toward math and math strategies. Prior to determining the survey questions, interviews were done with the fourth grade math teachers who taught math during the 2003-2004 school year at Jewett, Kingsley, and Lincoln. Based on the information gathered through this pilot study, student surveys were developed to discover student attitudes toward math and math teaching strategies.
Of the twenty questions in the survey, nine measure student attitudes toward math and eleven questions measure student attitudes toward the use of particular math strategies. The questions in the survey that measure student attitudes toward math are 1, 4, 5, 6, 8, 9, 14, 19, and 20. The questions 2, 3, 7, 10, 11, 12, 13, 15, 16, 17, and 18 address student attitudes toward the use of particular math strategies. A Likert Scale was used to assign a point value to each answer. See Appendix B, “Survey Instrument.”

Teacher-made Assessments

Rote counting through ten and counting objects through five are both basic screening assessments on the Brigance K & 1 Screen used as a pre and post test for Title I prekindergarten students. For the study in classroom action research, student rote counting and counting of objects math skills were assessed using a teacher-made pretest. Students were asked individually to count to five and then to count as far as they could. Next, each student was asked to give the teacher 5 blocks, 1 block, 3 blocks, 4 blocks, and then 2 blocks. The post test was the same as the pretest.

Procedures

Student ITBS Achievement Analysis

Using data from Swift Knowledge, a district software program, the following scores from Iowa Tests of Basic Skills were analyzed: Math
Problem Solving, Math Concepts & Estimation, and Math Without Computation from Fall 2002, Fall 2003 and Spring 2004. One purpose of the analysis was to look for trends in scoring in these three areas of math. Another purpose was to discover what percentage of students was non-proficient in each area. Also was there a larger decrease in the percentage of students scoring non-proficient from Fall 2003 to Spring 2004 when teachers consciously set goals to improve math scores using different teaching strategies? The main purpose of the study was to determine if the implementation of math teaching strategies had a positive impact on math ITBS scores from Fall 2002 to Spring 2004.

Teacher Interviews

Three fourth grade teachers were interviewed in person during school hours. Each interview lasted about 30 minutes. Part of one interview was finished by telephone during the evening. All three of the teachers taught math at Lincoln during the 2003-04 school year.

Student Survey

The fifth grade teachers at Jewett, Kingsley, and Lincoln Elementary Schools administered the twenty question survey during math instructional time. The students were given directions from their classroom teachers. They were to mark only one answer for each question. 157 surveys were distributed, but only 105 surveys were used to report results. If a survey was taken by a student who did not attend the three schools the previous
year, it was excluded. Surveys were not counted if the student chose over 75% of the same answer.

Using a Likert Scale, each answer was given a point value of 4 for Always, 3 for Most of the Time, 2 for Sometimes, and 1 for Never. The number of students answering each choice for each question was multiplied by the point value to give a numeric value for each question. The questions were ranked from highest points to lowest points in this order 7, 15, 17, 6, 10, 19, 20, 1, 2, 4, 12, 14, 16, 18, 3, 11, 9, 8, 5, 13. The questions with the most positive answers appeared at the top of the ranking and the questions with the most negative answers appeared at the bottom. Question number 7 scored the highest on the Likert Scale with a total of 375 and question 13 scored the lowest with 224 points.

Survey questions were based on information gathered during an interview with the fourth grade math teachers. Student surveys were developed to discover what students' attitudes were toward math and math teaching strategies.

Classroom Action Research Teaching Strategies

A teacher-made pretest in rote counting and counting objects was administered to each student. Following the pretest, the distributed curriculum approach was implemented to help students improve their rote counting and counting of objects. At least three to four times a day, four days a week during large group instruction time, while standing in
line, during snack time and with individual students during center time we counted objects and rote counted. Students clapped and counted, jumped and counted, and closed their eyes and counted. Students rote counted the days of the month every day as we did the calendar, we sang counting songs, we counted dots on ten frame cards, we counted the girls in our class, and we counted the boys in our class, pumpkin seeds, tulip bulbs, crackers on our plates, cars with numbers on them, long blocks, short blocks, and animals in story books. Twice a week small groups met to count objects onto ten frames. After three weeks of the distributed curriculum approach a post test was given.

RESULTS

Introduction

The various aspects of this study pertaining to the impact of teaching strategies on the math achievement of students at Lincoln Elementary School point to generally positive outcomes.

Student Achievement Analysis

Using the data from Swift Knowledge scores were analyzed from Math Problem Solving, Math Concepts & Estimation, and Math Total Without Computation from Fall 2002, Fall 2003 and Spring 2004. For Math Problem Solving, the collected data showed an increase in the percentage of students who scored non-proficient from 48.72% in Fall 2002
to 52% in Fall 2003. It then showed a decrease in percentage of students scoring non-proficient from 52% in Fall 2003 to 44.68% in Spring 2003. For Math Concepts & Estimation the data revealed a constant decrease in the percentage of students scoring non-proficient from 56.41% in Fall 2002 to 52% in Fall 2003 and 51.06% in Spring 2004. For Math Total Without Computation there was a consistent decrease in the percentage of students scoring non-proficient from 58.97% in Fall 2002 to 52% in Fall 2003 and finally 48.94% in Spring 2004.

The largest decreases in percentage of students scoring non-proficient were in Math Problem Solving from Fall 2003 to Spring 2004. During that period students scoring non-proficient decreased 7.32% from 52% to 44.68%. A noted inconsistency was found in Math Problem Solving from Fall 2002 to Fall 2003 where the scores increased in the percentage of students scoring non-proficient from 48.72% to 52%.

Math Total Without Computation scores from Fall 2002 to Fall 2003 fell from 58.97% to 52% non-proficient. These scores represent a 6.97% decrease in students scoring in the non-proficient range.

It is important to note that the number of students scoring non-proficient has gradually declined in Math Concepts & Estimation from 56.41% in Fall 2002 to 52% in Fall 2003 to 51.06% in Spring 2004. Math Total Without Computation scores reflect a similar decline from 58.97% in Fall
2002 to 52% in Fall 2003 to 48.94% in Spring 2004. See Figure 1. Lincoln Fourth Graders Non-Proficient.

**Figure 1. Lincoln Fourth Graders Non-Proficient**

![Lincoln 4th Graders Non-Proficient](image)

**Teacher Interviews**

The results of the teacher interviews highlight lesson planning and strategies teachers used to improve student achievement along with outcomes each teacher observed in her classroom.

**Planning**

In planning math lessons, two teachers collaborated by teaching the same skill each week. One of these teachers stated that there wasn’t enough time to collaborate. These same teachers also chose the goal of mastering basics facts for the focus of their instruction. In addition, one
teacher based her lesson planning on problem solving, multiple step instructions and working backwards. The special needs teacher followed her students' Individual Education Plans (IEPs); therefore, she did not collaborate with the regular education teachers.

Curriculum used in planning and teaching lessons varied with each teacher. One used the district packet, *Thinking With Math* and other resource books. Another teacher used a textbook and her own teaching resources including Carson Delosa and Scholastic materials. The fourth grade special needs resource teacher used a different direct instruction program called Connecting Math with her students with special needs.

In response to the interview question about being given enough support through materials, resources and training, one regular education fourth grade math teacher said yes, if requested, but she felt that professional development in math was way behind where it should be. The second regular education teacher replied that she was not given support with materials. She purchased everything on her own. In contrast, the fourth grade special education resource teacher felt very well prepared and said the Connecting Math program was easy to use and came with everything she needed.

**Strategies**

The regular education math teachers interviewed used multiple teaching strategies to meet the needs of each learner when teaching