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ABSTRACT

A teacher in a large suburban elementary school in East Tennessee found that her fourth grade students had poor number sense and relied almost solely upon algorithmic procedure to solve math problems. Therefore, mental math was difficult for these students, so the daily number talks method was employed to strengthen number sense. However, no research could be found to validate the efficacy of daily number talks. The purpose of this study was to determine if daily number talks would increase the number of methods a student could produce to solve a given mental math problem or the number of addition problems a child could correctly answer in two minutes, and if there was any relationship between the two. A two-fold pretest was individually administered to a class of twenty-two fourth graders. Students were first shown a two-digit addition problem and asked to solve it. Next, the researcher asked each child to explain how he/she solved the problem, and this was recorded as one strategy. The researcher then asked, "Can you think of another way to solve this problem?" and recorded each additional strategy until no more could be produced. Next, the student was given a set of flash cards containing two-digit addition problems, and the researcher recorded how many problems each child could correctly answer in two minutes. After the pretests were administered, there treatment period began. Before the math lesson each day, the teacher put a two-digit addition problem on the board. Students were given time to mentally compute the answers and then the children shared their strategies with the class. The treatment took about ten minutes each day over a period of six weeks. At the conclusion of the six-week treatment period, a posttest identical to the pre-test was given. A paired t-test was conducted on the data collected from the pretests and posttest. Statistically significant gains were found in both the number of strategies a child could produce and the number of problem a child could answer correctly. Tests were then performed to determine the correlation coefficient between the number of strategies a child could produce and the number of problems he could correctly answer in two minutes during both the pretest and the posttest. These tests produced no statistically significant difference. This research concluded that daily number talks effectively increase both the number of strategies available to a child and the speed with which that child can mentally calculate two-digit addition problems. However, the study concluded that there was no correlation between the number of strategies a student knew and the number of problems he could correctly answer on a timed test. (Author)

ABSTRACT

DAILY NUMBER TALKS AND THE DEVELOPMENT OF COMPUTATIONAL STRATEGIES IN FOURTH GRADERS

An Action Research Project

Presented to

the Department of Teacher Education

of Johnson Bible College

In Partial Fulfillment

of the Requirement for the Degree

Master of Arts in

Holistic Education

By

Mindy O'Nan

July 2003

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with the class. The treatment took about ten minutes each day over a period of six weeks. At the conclusion of the six-week treatment period, a posttest identical to the pre-test was given.

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APPROVAL PAGE

This action research project by Mindy Alaine O'Nan is accepted in its present form by the Department of Teacher Education at Johnson Bible College as satisfying the action research project requirements for the degree of Master of Arts in Holistic Education.

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Date

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Chapter 1

INTRODUCTION

Concern and Purpose of the Study

Trends are exceedingly influential in the field of education. As a new approach gains popularity, classroom teachers often join the bandwagon without examining the statistical data to substantiate the use of the technique. Without such research, negative trends may be perpetuated despite their ineffectiveness, and positive trends may be abandoned when a more novel approach gains popularity.

In recent years, the development of number sense in students has become a major goal of the National Council of Teachers of Mathematics. The Mathematical Perspectives organization also recognizes this same goal and has developed a number of techniques to achieve it. One such technique is the use of daily number talks. Daily number talks strive to create an understanding of number through the use of various mental computation strategies. Proponents of Mathematical Perspectives believe that students who are equipped with a greater variety of mental computation strategies will solve problems more quickly and accurately because they can choose the strategy that will be most effective for the given problem. Daily number talks are intended to improve accuracy and speed through the development of number sense and alternative computational strategies. Much anecdotal information has been published regarding the use of daily number talks, but little to no research exists to substantiate the use of daily number talks. Therefore, a study was needed to determine the effectiveness of daily number talks in the classroom setting.

Statement of the Problem

This study sought to determine if the use of daily number talks increases the number of computational strategies available to children and if such an increase leads to greater achievement in mathematical problem solving. After participating in daily number talks, did students achieve an increase in the number of methods they produce to solve a given problem? Furthermore, if such an increase did occur, did it produce greater achievement in mental mathematics?

Definition of Terms

Daily Number Talks Daily number talks provide students with an opportunity to construct and deconstruct numbers in meaningful ways. In a daily number talk, the teacher presents the class with a problem such as "35+98=?". Students are then given a few minutes to mentally compute the answer without using pencil and paper. The teacher then asks students to share their answers and lists each answer on the board without comment. Students then share the processes they used to determine their solutions. Students talk through their various strategies as the teacher visually represents the solutions on the board. These talks take place at the beginning of a lesson and are approximately ten minutes in length.

Computational Strategies Computational strategies are the various methods by which a mathematical equation can be solved. These include traditional algorithmic procedures, adding-on, the decomposition of tens and ones in each of the numbers, counting up or down by tens from a base number that has not been split, anticipation, and mental retrieval.

Traditional Algorithmic Procedures For the purpose of this study, a traditional algorithmic procedure is defined as the pencil-and-paper method of addition and subtraction taught by most schools that includes borrowing, carrying, and regrouping numbers.

Adding-On This involves adding-on in small increments to create tens units and then adding the units again, as shown in the following solution for 92-79: 79+1=80, 80+10=90, 90+2+92, 1+10+3= answer 13 (Beishuizen, Van Putten, Van Mulken, 1997).

1010 This term refers to the decomposition of tens and ones in each of the numbers, named (1010) by researchers (Beishuizen, Van Putten, Van Mulken, 1997). An example of this is shown in the following solution for 21+32: 21-1=20, 32-2=30, 30+20=50, 1+2=3, 50+3= answer 53.

N10 This term refers to the strategy of counting up or down by tens from a base number that has not been split, which is assigned the abbreviation N10 by researchers (Beishuizen, Van Putten, Van Mulken, 1997). An example of this is shown in the following solution for 21+32: 21+30=51, 51+2= answer 53.

Mental Retrieval As students deal with numbers more frequently, certain mathematical facts are memorized, and they must merely access this answer from a mental network. Thus, it is an automatic process which is commonly referred to by researchers as retrieval.

Construction of Number For the purpose of this study, construction of number is the process of combining various quantities to form a new number. For example, 20+19+1=40.

Deconstruction of Number For the purpose of this study, deconstruction of number refers to breaking larger numbers into their smaller parts. For example, 23= 20+3.

Limitations of the Study

This study did not reflect the entire population of fourth grade students. It was limited to students in one fourth grade classroom in a suburban elementary school.

The researcher was also the instructor, which may or may not have affected the results of this experiment.

The researcher used a limited sample size of only twenty-two students.

There was no control group to determine if additional computational strategies developed due to the standard math curriculum.

Due to time constraints, the study was performed over a period of only six weeks.

Assumptions

The researcher assumed that students within the school were randomly assigned to each classroom, and thus, the sample classroom is reflective of all the fourth grade students within the school.

Hypothesis

Students participating in daily number talks will show no correlation, at the .05 level of significance, between the number of heuristic methods they develop and their achievement on an oral math test.

Students participating in daily number talks will show no difference between the number of problems they correctly answer on the two-minute pre-test and the number they correctly answer on the two-minute posttest, at the .05 level of significance.

Students participating in daily number talks will show no difference between the number of computational strategies they produce on the pre-test and on the posttest, at the .05 level of significance.

Chapter 2

REVIEW OF RELATED LITERATURE

Introduction

Recent trends in mathematics education have advocated the development of number sense and conceptual understanding before the development of procedural and algorithmic techniques (Rittle-Johnson, Siegler, and Alibali, 2001). Several mathematical philosophies have arisen from this trend. Mathematical Perspectives, developed by Kathy Richardson, is one of these. It advocates the use of daily number talks to increase number sense among children. Number talks encourage the use of non-algorithmic strategies that promote thinking among students and emphasize conceptual understanding (Young, 2001).

Number sense is defined as an understanding of numbers and the concepts behind them as well as an ability to use them in everyday life with efficiency and facility (Yang, 2002). The National Council of Teachers of Mathematics has emphasized number sense in recent years, and its development has become a driving goal in mathematics education (Yang, 2002).

Number talks are proposed to equip students with the necessary mathematical skills to perform in real world situations, such as comparing prices in the grocery store. Hecht (1999) cites research showing, "The efficiency of solving math facts is closely associated with individual differences in the speed with which adults can accurately calculate multidigit computation problems." It is also surmised that adults who consistently select the most efficient retrieval strategy are also the most likely to achieve higher mathematical performance (Hecht, 1999). Therefore, it is important to equip students with a variety of computational strategies from which to choose.

A review of literature on this topic was conducted to discover the research supporting the use of such number talks. However, a review of available sources produced no direct research on daily number talks. Because number talks promote mental mathematics, a survey of research on mental math was then conducted. This search yielded many studies on the topic that give insight into how adults and children work with numbers mentally (Rittle-Johnson, Siegler, and Alibali, 2001; Beishuizen, Van Putten, Van Mulken, 1997; Hecht, 1999; Bisanz, LeFevre, Sadesky, 1996). Research on students' cognitive development in the areas of fractions and multiplication was also examined because an understanding of such processes is key to understanding students' ability to compute mentally (Hecht,1999; Ashcraft and Koshmider, 1991; LeFevre, Bisanz, Daley, Buffone, Greenham, and Sadesky, 1996)

Value of Mental Math

Mental computation ability is popularly recognized as a valuable life skill. However, research in both Japan and the Netherlands has proven that traditional paper-and-pencil strategies are the most commonly used, despite the European emphasis on mental arithmetic (Beishuizen, Van Putten, Van Mulken, 1997). Recent studies, "advocate a greater emphasis on mental computation with two-digit numbers up to 100, to stimulate the development of number sense and insightful flexible number operations" (Beishuizen, Van Putten, Van Mulken, 1997).

Realistic Mathematics Education of the Netherlands encourages the continued development of informal number sense and self-discovered methods of computation which children bring with them to school (Beishuizen, Van Putten, Van Mulken, 1997). In this and other European countries, formal instruction in place value does not begin until at least the third grade to encourage the development of this innate number sense (Beishuizen, Van Putten, Van Mulken, 1997).

Conceptual vs. Procedural Understanding

Before one can determine the effectiveness of mental mathematics, one must first understand the theoretical foundations for how children learn mathematics. To be proficient in mathematics, students need both a conceptual and a procedural understanding of mathematics. Rittle-Johnson, Siegler, and Alibali (2001), define procedural knowledge as, "the ability to execute action sequences to solve problems," while conceptual knowledge is, "implicit or explicit understanding of the principles that govern a domain and of the interrelations between units of knowledge in a domain." Rittle-Johnson, Siegler, and Alibali, (2001) explain two theories in their research. The first theory is a concepts-first approach that says students must first develop conceptual knowledge, which will then lead them to discover or develop procedural skills for solving a problem related to that concept. The procedures-first theory advocates students will develop a conceptual understanding by using a given set of procedures.

Rittle-Johnson, Siegler and Alibali concluded (2001) neither theory is exclusively correct, but rather, that the development of conceptual understanding and procedural skill is an iterative process in which gains in one area lead to gains in the other. The two processes are interdependent, and the acquisition of conceptual knowledge before procedural skill or vice versa has no bearing upon the overall gain in understanding (Rittle-Johnson, Siegler, and Alibali, 2001). However, both are important. Beishuizen, Van Putten, and Van Mulken (1997) say, "Unlike arithmetic under 20, where strategies for memory storage and retrieval of number facts prevail, conceptual and procedural knowledge is more important to addition and subtraction of two-digit numbers up to 100."

Aksu (1997) also researched the connection between conceptual and procedural understanding, with slightly different findings. Aksu's sample population was a group of sixth-graders from a private school in Turkey. He performed three separate tests: a conceptual test, an operations test, and a problem-solving test. Each test contained similar types of fractions with similar levels of difficulty. Aksu found students scored highest on the operations test and lowest on the problem-solving test. He commented,

> students' computational abilities with fractions are better than their ability to solve word problems involving fractions. The source of such difficulty may lie in students' lack of understanding of different ways operations can be embodied in a word problem.

Aksu went on to say, "Many students know and use the procedural rules for carrying out operations, such as multiplying two fractions, but they cannot explain what ¾ x ½ means." In essence, Aksu found it is possible for procedural skill to exist without conceptual understanding.

This becomes a problem because students cannot apply procedural skills to other situations such as word problems. Aksu (1997) cited the work of Saenz-Ludlow, who stated, "For a conventional arithmetical algorithm to become meaningful to a child, it must represent the coordination of mental operations and conventional notations." Thus, number sense is a crucial component of both conceptual and procedural skill.

Computational Strategies

A wide variety of strategies are used to solve mental arithmetic problems, with varying success and accuracy. Among third-graders, the two central strategies for addition and subtraction are the deconstruction of tens and ones in each of the numbers, named (1010) by researchers, and counting up or down by tens from a base number that has not been split, assigned the abbreviation (N10) by researchers (Beishuizen, Van Putten, Van Mulken, 1997).

Although the (1010) strategy is initially easier to learn, the (N10) strategy is both more efficient and more accurate once it has been mastered (Beishuizen, Van Putten, Van Mulken, 1997). Students using the (1010) method only answered sixty four percent of questions correctly while students using the (N10) method succeeded on ninety four percent of mental arithmetic questions (Beishuizen, Van Putten, Van Mulken, 1997).

While these are the two primary strategies identified by researchers, other secondary methods have been identified. These methods may be variations of or mixes between the two primary methods discussed above. *Anticipation*, or 10s, is one such procedure. In this method, students begin with the tens and then sequentially deal with the ones (Beishuizen, Van Putten, Van Mulken, 1997).

Yet another adaptation is *adding-on*, or A10. A10 involves adding-on in small increments to create tens units and then adding the units again, as shown in the following solution for 92-79: 79+1=80, 80+10=90, 90+2+92, 1+10+2= answer 13 (Beishuizen, Van Putten, Van Mulken, 1997).

Results of a recent study by Beishuizen, Van Putten, and Van Mulken (1997) lead researchers to suggest that students should be introduced to the (N10) method first. When students begin by learning the easier, but less accurate (1010) method, they continue to use this method despite its disadvantages. Although this research is based upon student performance and teaching practices in the Netherlands, the authors feel this also applies to the United States (Beishuizen, Van Putten, Van Mulken, 1997).

When tested on mental multiplication skills, college students were found to use four primary non-retrieval strategies. The first was a "rules" strategy like "anything times 0 equals 0." The second was repeated addition. Next was number series, such as 3x5=5, 10, 15. A final strategy was that of derived facts, a reasoning that says, "six times six equals 36, so six times seven is 36+6 (LeFevre, Bisanz, Daley, Buffone, Greenham, and Sadesky, 1996).

Tabular vs. Associative Network Retrieval Models

Research has also been done in other areas of how learners solve problems. Groen and Parkman's early research (1972), suggested that adults rely on a primary fact retrieval strategy and a backup strategy of counting up for solving simple arithmetic problems. This approach to mental arithmetic is also known as the tabular model (Hecht, 1999). It can be visualized as a sort of "math fact table" by which people mentally access the proper row and column to retrieve the correct answer (Hecht, 1999).

Koshmider and Ashcroft (1991) extended this research to determine the processes by which children and adults solve basic multiplication problems. Their sample population included ninety people from third grade to the college level. Koshmider and Ashcroft (1991) determined students typically do not rely on number sense and the construction and deconstruction of number to solve problems, as is advocated by daily number talks. They found, "even third graders rely heavily on memory retrieval rather than on reconstructive procedures such as counting."

Furthermore, their data showed, "arithmetic processing in simple multiplication is at least partially automatic." As age increases, the dependence on tabular methods of retrieval increases as well (Koshmider and Ashcraft, 1991; Hecht, 1999). Hecht (1999) explains the popularity of the tabular model by saying, "Adults' reliance on retrieval is suggested by studies showing that children increasingly use retrieval to solve math facts as a positive function of age." In fact, a study performed on adults assumed that they used retrieval strategies nearly 100% of the time (Hecht, 1999).

However, more recent findings have shown that this theory may be faulty. Hecht (1999) found, "Contrary to predictions of current solution process models, adults used a variety of procedures other than retrieval to solve addition and multiplication math facts." Manly and Spoehr (1999) discovered simple retrieval is probably not the sole strategy used in mental mathematics.

There is compelling research to support an associative network retrieval model (Hecht, 1999). In a recent set of experiments, adults were asked to choose the correct answer to an addition or multiplication fact from a computer screen. They were then asked to identify the strategy they used to solve the problem. In 30% of addition problems and 12% of multiplication problems, subjects identified a non-retrieval strategy (Hecht, 1999). The tabular model assumes similar mechanisms are used to access the stored math facts in all operations (Hecht, 1999). Therefore, the percentage of non-retrieval strategies should not vary among operations (Hecht, 1999).

It is believed that people integrate mathematical facts into a larger network of related information (Manly and Spoehr, 1999). This theory is also known as an associative network retrieval model (Hecht, 1999). This model proposes that a network of candidate answers are built based upon past experience with such facts. An answer is then chosen based upon this network of facts (Hecht, 1999). Various studies such as the one performed by Koshmider and Ashcraft (1991) have tested simple retrieval of mathematical facts and their relationship to backup strategies. However, Manly and Spoehr (1999) did not believe that these studies were testing actual mathematical content. They hypothesized that mathematical facts are integrated with other conceptually related information to make them accessible for retrieval.

Manly and Spoehr (1999) proposed several associative network retrieval models that illustrate the integrated nature of factual storage and retrieval processes. Operand multiples are one such model. In this model, people retrieve mathematical facts based upon their mental connections to multiples of a given number. For example, in the problem "4x8=?", students would be more likely to incorrectly retrieve 28 than 30 because 4 is a multiple of 28. If this model is primarily used, then operand lures related to the problem should evoke either more incorrect responses or a slower reaction time (Manly and Spoehr, 1999).

A second theory involves analog code. In this model, those numbers surrounding the actual answer can be lures because the mind seeks to make connections to the answer through similar problems. For example, if a student practices the problem "6x4=?" repeatedly, problems with similar answers (such as "5x5") should become easier and quicker to retrieve (Manly and Spoehr, 1999).

Number talks seek to show students the flexibility of numbers and help them discover how numbers can be constructed and deconstructed. Manly and Spoehr (1999) show adults have mastered this concept and have a well-developed number sense due to integration. They write, "This study provides evidence that adults' multiplication representation is not just a set of facts. Multiplication knowledge includes a well-integrated set of flexibly accessible structures for use in a variety of tasks."

Finally, it is important to note the effectiveness of the various strategies. Adults who use retrieval strategies have higher mathematical achievement, answer more problems correctly, and have faster reaction times than those who depend on non-retrieval strategies (Hecht, 1999). Therefore, retrieval strategies related to either a tabular model or associative network retrieval model are more effective than non-retrieval strategies such as counting up.

Problem Size

The size of the numbers in a problem is one factor that has been researched in relation to its effect on mental mathematics. Koshmider and Ashcraft (1991) and Groen and Parkman (1972) both found that reaction time increases as the problem size increases. Larger answers are retrieved less quickly than smaller ones. This finding is of interest in relation to number talks because it shows that students have a greater difficulty storing larger facts and must therefore either think longer or rely on a backup strategy. The development of number sense becomes crucial as numbers grow larger and rote facts become more difficult to memorize.

LeFevre, Sadesky, and Bisanz (1996) examined the problem size effect in mental addition among adults. They concluded the problem size effect is a result of greater reliance upon non-retrieval strategies. LeFevre, Bisanz, Daley, Buffone, Greenham, and Sadesky performed another study (1996) that found college students had slower reaction times for problems less likely to be solved using non-retrieval strategies than for those easily solved using retrieval.

Manly and Spoehr (1999) reached a different conclusion. They stated, "Our results suggest that it may be difficult to settle the relative effect of different contributions to the problem-size effect." Manly and Spoehr (1999) go on to say that task-specific factors such as the analog bias or the frequency with which students had studied a specific problem make it nearly impossible to distinguish which factor leads to such a result.

Other research has proposed an interesting hypothesis regarding problem-size in relation to incorrect retrieval. It is proposed that incorrect retrieval occurs more often during larger problems because more errors were made during the initial counting-up phase of multiplication development during childhood. Consequently, a greater number of incorrect answers are associated with the problem in the associative network of retrieval (Hecht, 1999). This would also explain slower retrieval times due to a greater number of associated answer choices.

Reinforcement

Each time a problem is studied, that math fact is reinforced (Koshmider and Ashcraft, 1991; Hecht, 1999). However, individual performance may vary despite similar exposure because of innate differences between people. For example, retrieval processes in a person with a poor working memory may not be strengthened as much by exposure to a problem as in those with a good working memory (Hecht, 1999).

Operand Lures

Operand lures have been shown to influence problem-solving ability. An operand lure is an answer that is related to one of the factors in some way. For example, study subjects rejected "4x7=32" more slowly than they rejected "4x7=30". The explanation of this phenomenon is that people delve into a network of connected material to determine the answer. Because 32 is connected to 4 as one of its factors, this leads to momentary confusion when retrieving the answer (Manly and Spoehr, 1999). When students of all ages were asked to determine whether a solution to an arithmetic problem was true or false, responses were consistently slower when an operand lure was present (Koshmider and Ashcraft, 1991). When more than one possible solution is strongly connected to the problem, people may switch to more time-consuming non-retrieval processes (Hecht, 1999). This phenomenon is important in relation to number talks because it shows that people build connections between numbers based upon their integration of those numbers.

Recommendations for Further Research

The review of current literature produced several recommendations for further research. Koshmider and Ashcraft (1991) recommend more research in the area of the automaticity of mental mathematics. Among other things, they suggest that a study be done to determine the detrimental effects of automatic memory retrieval in place of the meaningful construction of answers.

Manly and Spoehr (1999) recommended further study to determine the role of backup strategies in solving mental multiplication problems. They also suggest that further research should be done to examine how integration structures develop. After proving that mental multiplication in adults involved more than rote retrieval of memorized facts, they still had unanswered questions as to how problems are solved and integration occurs.

Further research has been suggested in the area of how children select procedures for varying tasks. Such research would help develop a model of how children solve both complex and simple tasks (LeFevre, Bisanz, Daley, Buffone, Greenham, and Sadesky, 1996).

While research abounds in the area of mental mathematics, little has been done to substantiate the use of daily number talks, as advocated by Mathematical Perspectives. Furthermore, very little research was found regarding the possibility of increasing the number of mental computation strategies in a student. Therefore, it seems prudent to suggest continued study in this area after a review of the available research.

Conclusion

Number sense is a valuable skill that leads to improved efficiency in solving realistic mathematical equations (Yang, 2002). How can this number sense best be developed? Researchers have attempted to answer this question by exploring several areas of mental mathematics. First, the importance of conceptual understanding has been verified by Rittle-Johnson, Siegler, and Alibali (2001), who found that conceptual understanding and procedural understanding are iterative processes in which gains in one area lead to gains in the other. Research has also been done to determine the various strategies by which students mentally compute mathematical equations. The various strategies vary greatly in their speed and accuracy. Memory retrieval has proved to be a primary strategy among people of all ages (Koshmider and Ashcroft, 1991; Hecht, 1999). Problem size and operand lures have also proved to be vital factors in the accuracy of mental computation (Groen and Parkman, 1972; Koshmider and Ashcroft, 1991; Manly and Spoehr, 1999) While research abounds on this topic, Beishuizen, Van Putten, and Van Mulken (1997) urge an increased emphasis on mental mathematics to improve number sense.

Chapter 3

METHODS AND PROCEDURES

Subjects

The subjects of this study were fourth graders in a large, suburban elementary school in Eastern Tennessee. The students represented varying ability levels; however, the lowest-performing math students in the classroom were pulled out during math time to be targeted for more personalized instruction. These students were not a part of the study. The vast majority of the class was performing on grade level. Eight of the twenty-two students in the class participated in the school's talented and gifted program. Three of the students involved in this study were on free or reduced lunch, and the children ranged in socio-economic status from lower middle-class to affluent. The subjects of this study represented 1/6 of the total population of fourth graders in the school. They ranged in age from nine to ten years old.

Timeline

Subjects participated in this study for a period of six weeks. Because of inevitable breaks in the school calendar, some weeks consisted of only four days. Students participated in the daily number talks for the first ten minutes of their normally scheduled math time.

Tests

Each subject received both a pre-test and a posttest. These tests were individually administered to the children. The pre-test was two-fold. First, the researcher orally presented each child with a two-digit addition problem. The child was asked to solve the problem and explain his or her method. The researcher then asked the child if he could think of an alternate method for solving the problem. The researcher continued with this methodology until the child could produce no more strategies. The researcher then tallied the number of methods each child produced. Next, the researcher presented the child with a series of two-digit addition problems to solve. The researcher then tallied the number of problems that the child solved correctly in a two-minute period of time. The posttest consisted of the same two elements and was conducted in the same fashion.

Experimental Factor

The use of daily number talks was the experimental factor. The pre-test scores served as the control and the same students who participated in the pre-test served as the experimental group.

Statistical Analysis

A paired t-test was performed on the results of the two-minute achievement pre-test and posttest.

A paired t-test was performed on the results of the computational strategy assessment pre-test and posttest.

A test was then be done to determine the paired correlation coefficient between the number of strategies a child produced and his math ability as indicated by his achievement on the two-minute test.

Chapter 4

RESULTS

A paired t-test was performed to compare the results of the pretest measuring the number of strategies and the results of the posttest measuring the number of strategies. The test results, presented in Table 1, showed that there was a statistically significant difference, at the 0.05 level of significance. The researcher thereby rejects the hypothesis that there is not a difference between the number of strategies a child could produce on pre-test and the number of strategies a child could produce on the posttest, at the 0.05 level of significance.

TABLE 1

Comparison of the Pre-test and Posttest Measuring the Number of Heuristic Methods

Test	n	Mean	Mean Difference	t Stat	t Critical two-tail
Pretest	22	1.45			
			-1.55	-4.93*	2.08
Posttest	22	3			

*sig. > than 0.05

A paired t-test was then performed to compare the results of the pre-test and posttest measuring the number of addition problems a child correctly answered in two minutes. The results of this t-test also showed a statistically significant difference, at the

0.05 level of significance; thereby causing the researcher to reject the null hypothesis that there would be no significant difference between the number of problems a child could correctly answer on the pre-test and the number of problems a child could correctly answer on the posttest. The results of this test are presented in Table 2.

TABLE 2

Comparison of Pre-Test and Posttest Measuring the Number Of Problems Correctly Answered in Two Minutes

Test	n	Mean	Mean Difference	t Stat	t Critical two-tail
Pretest	22	9.17			
			-1.42	-3.38*	2.08
Posttest	22	10.59			

*sig. > than 0.05

Next, two correlation tests were performed to determine the correlation between the number of heuristic methods known and student performance on a two-minute test. One test was performed on the pre-test data while a separate test was performed on the posttest data. The results of the pre-test correlation test are shown in Table 3 while the results of the posttest correlation are presented in Table 4. Neither test produced a significant level of correlation, causing the researcher to retain the null hypothesis.

TABLE 3

Correlation of Number of Heuristic Methods to Number of Problems Correctly Answered in Two Minutes on Pretest

Pretest	n	Correlation	r critical
Number of heuristic methods	22		
		0.32*	0.413
Number of problems correct	22		

*not significant

TABLE 4

Correlation of Number of Heuristic Methods to Number of Problems Correctly Answered in Two Minutes on Posttest

Posttest	n	Correlation	r critical
Number of heuristic methods	22		
		0.13*	0.413
Number of problems correct	22		

*not significant

Chapter 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The development of number sense in children has become a primary concern for the National Council of Teachers of Mathematics. Daily number talks is a strategy designed to move students beyond a procedural understanding to an understanding of number concepts. Each day, students are given a mental math problem to solve. Students then share their methods of solving the problem. However, little research has been done to substantiate the use of daily number talks to improve mental math skills. For this study, the researcher administered a pretest to measure the number of strategies a student could produce and the number of problems that child could correctly answer in two minutes. The researcher then followed the daily number talk routine for a period of six weeks, followed by a post-test identical to the pretest. The results of these test showed that students did make significant gains, at the 0.05 level of significance, in both the number of strategies and the number of problems answered correctly.

Conclusions

The researched showed significant gains in the number of strategies a child could produce to solve a problem. Prior to the implementation of daily number talks, students produced a mean of only 1.45 strategies for solving the addition problem presented in the pre-test. Posttest results, however, showed that students could produce a mean of three strategies for solving the same problem. Some students reported that prior to the treatment, they had never considered using a strategy other than the traditional algorithm to solve an addition problem. In fact, the researcher observed that many students were confused when asked if they knew any other strategies during the pretest. However, daily discussion of various strategies more than doubled the mean number of strategies the children could produce. Furthermore, the researcher noticed increased implementation of newly acquired strategies during the test period. Anecdotal observation during the research period showed that students produced far more strategies for each daily number talk as the six weeks progressed. Furthermore, students excitedly showed the researcher creative ways in which they had mentally solved addition problems during the test period.

Gains in the number of problems a student could correctly answer in two minutes were reflected in the posttest scores. The mean of the pretest was 9.17 correct answers while the posttest mean showed 10.59 correct answers. Some individual students showed dramatic gains in the speed with which they could correctly answer while others showed little to no improvement. These results proved to be statistically significant, at the 0.05 level of significance.

No correlation was found between the number of strategies a child could produce and the number of problems he could correctly answer on a timed test, at the 0.05 level of significance. Therefore, it can be concluded that knowing more mental math strategies does not necessarily improve a student's ability to mentally solve addition problems.

Test results may have produced more dramatic results if the treatment period had been longer. Daily number talks took place for six weeks; however, many of those weeks consisted of only three or four days due to school holidays or snow days. Such a brief test period may have affected the outcome of the research.

Anecdotal notes during the two-minute posttest showed that students did use methods divergent from the traditional algorithm. Several students indicated that they choose the most efficient method for solving the problem after participating in the daily number talks.

Recommendations for Further Research

Results of the data do not show the increased speed with which students answered questions on the two-minute test. Nearly all students attempted more problems on the posttest, although they were not necessarily more accurate. The researcher believes that a longer treatment period would have resulted in improved accuracy as well; therefore, it is recommended that further research be done with a longer period of daily number talks.

Furthermore, students were not formally asked which strategies they used on the two-minute test. Do students revert to the traditional algorithm when pressed for time, or do they examine each problem and chose the most effective strategy? The researcher suggests that further research be done to determine which strategies students actually employ for such tasks.

Finally, attitudinal research would be beneficial to see if daily number talks affect students' attitudes toward mental mathematics. Such a study would determine if the cooperative and safe environment created by daily number talks is beneficial in improving students' feelings toward the subject.

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APPENDICES

Mindy A. O'Nan
7900 Johnson Drive
Knoxville, TN 37998

Dr. Micheal Winstead
Coordinator of Research and Evaluation
P.O. Box 2188
Knoxville, TN 37901-2188

Dr. Winstead:

I write this letter to you seeking permission to conduct research in the Knox County Schools. My name is Mindy O'Nan and I am a graduate student in the education department at Johnson Bible College. I am currently pursing my Master of Arts in Holistic Education.

I am writing for permission to conduct my research project entitled, "Daily number talks and increased mathematical achievement in fourth graders." Daily number talks is a technique developed by Mathematical Perspectives that seeks to develop number sense in children by teaching them how to effectively compute mental math problems. My study will examine the effect of an increased number of computational strategies on students' performance on mental calculations. I will lead the children through a short number talk each day in which I will share ways to mentally compute a two-digit arithmetic problem.

I have included a letter to the parents of the children involved in the study, seeking permission for the children to participate, as well as to inform parents of the study.

I thank you for your time and look forward to a response.

Sincerely,

Mindy A. O'Nan

KNOX COUNTY SCHOOLS
ANDREW JOHNSON BUILDING

Dr. Charles Q. Lindsey, Superintendent

December 4, 2002

Mindy A. O'Nan
7900 Johnson Drive
Knoxville, TN 37998

Dear Ms. O'Nan:

You are granted permission to contact appropriate building-level administrators concerning the conduct of your proposed research study entitled, "Daily number tasks and increased mathematical achievement in fourth graders." In the Knox County schools final approval of any research study is contingent upon acceptance by the principal(s) at the site(s) where the study will be conducted. Include a copy of this permission form when seeking approval from the principal(s).

In all research studies names of individuals, groups, or schools may not appear in the text of the study unless *specific* permission has been granted through this office. The principal researcher is required to furnish this office with one copy of the completed research document.

Good luck with your study. Do not hesitate to contact me if you need further assistance or clarification.

Yours truly,

Mike S. Winstead, Ph.D.
Coordinator of Research and Evaluation
Phone: (865) 594-1740
Fax: (865) 594-1709

Project No. 124

P.O. Box 2188 • 912 South Gay Street • Knoxville, Tennessee 37901-2188 • Telephone (865) 594-1800

December 10, 2002

Dear Parents,

Our school year is continuing to go well and I am enjoying teaching your children. We are having a great time learning together! As a matter of fact, that is why I am writing. As a part of my coursework for my Master of Arts in Holistic Education, I am performing an action research project on mental math. Several months ago I learned of a new math technique called daily number talks that is designed to develop students' mental math skills. However, little research has been done to determine if daily number talks actually improve children's performance on math tests. For my research project, I will lead students in a ten-minute exercise each day that is designed to improve their mental math skills. However, I need your permission before your child can participate. This will take place during our normally scheduled math time and your child will have complete anonymity. If you consent for your child to participate in this activity, please sign and return the following form. If you have any questions, please call me!

Thank You,
Mindy O'Nan

______ Yes, my child has permission to participate in the research project.

________________	______________________	_________
Child's Name	Parent's Signature	Date

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