

# Electronic Journal for Inclusive Education

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Volume 1  
Number 7 *Electronic Journal for Inclusive  
Education Vol. 1, No. 7 (Winter 2004)*

Article 3

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Winter 2004

## Mathematical Disabilities in Elementary School Children

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Montani, T. O. (2004). Mathematical Disabilities in Elementary School Children, *Electronic Journal for Inclusive Education*, 1 (7).

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Mathematical disabilities in elementary school children

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March 2003

Abstract

A pilot study was conducted with the lowest performing sixth grade students in two classes in an urban environment. The nine students participating in this pilot study had been performing below grade level for at least two years despite the provision of supplemental services. With direct instruction, slower pace of instruction, mnemonics, math charts, manipulatives, and metacognitive strategies, gains were noted in the students' performance. Pretest and posttest measure were administered and the results revealed modest gains in calculations and basic fraction knowledge with significant improvement noted with math fluency. The strategies used are known to both general and special educators and the reminder of the impact that relatively simple strategy instruction can have on students' overall performance in inclusive environments can be of value to both teachers and students.

Mathematical disabilities in elementary school children

Presently there is a considerable body of research devoted to the identification, assessment, and remediation of reading disabilities. Although many children encounter difficulties with mathematics in elementary school, much less research has been conducted in this area (Ginsburg, 1997). Not only has little research been conducted in the area of mathematical disabilities as compared to reading disabilities, but classroom teachers tend to avoid teaching mathematics at the elementary school level (Ginsburg, 1997). Children who exhibit mathematics difficulties in elementary school frequently continue to exhibit difficulties in mathematics throughout their academic careers. Thus weaknesses in the area of mathematics can impede educational opportunities for students (Rivera-Batiz, 1992).

Children with mathematics difficulties often have problems in several areas of mathematical cognition. These include the ability to solve relatively complex story problems and retrieval of number facts (Jordan & Hanich, 2000; Russell & Ginsburg, 1984). Failure to automatize basic facts can cause persistent difficulties for children throughout elementary school (Ostad, 1997, 1999). In a study of third grade students, Jordan and Montani (1997) found that children identified as having weakness in mathematics, but not in reading, primarily experienced difficulty with rapid fact retrieval and with efficient problem solving. Effective use of strategies to determine the answer to unknown basic facts has been documented as an area of significant weakness for students with mathematical disabilities (Geary, Bow-Thomas and Yao, 1992; Siegler, 1988). Students with mathematics disabilities tend to use less efficient strategies such as

counting all numbers, using fingers, or tally marks rather than more sophisticated strategies such as counting on from the higher number or deriving the unknown fact from known facts. Thus, more opportunities for mechanical errors are present when students have not automatized basic facts. With this in mind, the present study was designed to provide intensive, small group instruction with a focus on strategies and procedures to enhance low performing students' knowledge of mathematics.

### The Present Study

The lowest performing students in two sixth grade classes (n=9) were identified as being participants in this pilot study. The classroom teachers identified these students as being significantly below their peers in all areas of mathematics. Each of the students had been experiencing difficulties in mathematics for at least two years. While some difficulties were present in reading, mathematics was the greatest area of weakness. These students attend a non-public school in an urban setting in New Jersey. Special education services were provided in a trailer in the parking lot of the school property as is the practice for parochial schools in New Jersey. Some of the children also received Title One services for reading, which resulted in being removed from the classroom during mathematics instruction due to scheduling complications. Important to note is the fact that due to scheduling difficulties, the students did not necessarily receive support in mathematics during the time that mathematics was taught in their classrooms.

The present study was designed to address the issue of small group instruction, on functioning level, as a replacement for grade level instruction for which the students are not prepared. It was postulated that given the benefit of consistent small group instruction with the periodic use of manipulatives, strategy instruction, and corrective feedback until mastery, the students would gain skills in areas of deficiency. The question of transference and maintenance of skill is also considered. The aim of this study was to attempt to build the skills of these students to enhance their performance in the classroom setting.

The first group was composed of six students, three male and three female. The second group consisted of two female and one male student. The students were seen twice weekly by this author during the time that mathematics instruction took place in their classrooms. The remediation was conducted for fifteen sessions beginning in October and ending in December.

As a pretest measure, each student was administered the Math Fluency and Calculation Test of The Woodcock-Johnson III Test of Achievement (WJIII). Each was administered a fraction pretest: write the fraction for the shaded amount of the bar (range from  $\frac{1}{2}$  to  $\frac{11}{12}$ ). Fractions had specifically been identified by the classroom teachers as a problematic area for most of the students. The same measures were administered at the conclusion of the study as posttest measures. Please see Table One for pretest/posttest scores for Group One. Please see Table Two for pretest/posttest scores for Group Two.

Prior to the first session with the students, an error analysis was conducted on the pretest. On the Calculation Test, most students performed calculations involving basic addition, subtraction and multiplication. The majority of the students erroneously responded to the

following types of problems: division with three digits by two digits, division with four digits by two digits, addition of fractions without common denominators and multiplication of decimals. With the exception of one student who performed within the average range, all other students were significantly deficient on the measure of Math Fluency. An error analysis of Math Fluency did not reveal a clear pattern of errors with the exception of the fact that none of the students correctly responded to the following multiplication facts:  $7 \times 9$ ,  $9 \times 9$ ,  $8 \times 5$ , or  $7 \times 6$ . The majority of errors were close to the correct answer indicating that the student understood the process but had not automatized the basic facts. In one instance, a student responded zero, to subtraction problems involving subtracting zero from a given number. In a few instances, students occasionally confused operation signs and multiplied instead of subtracting or added instead of subtracting. However, these errors were not pervasive. An error analysis of the fraction pretest revealed errors in the following areas: correctly identifying zero out of zero shaded in; ten out of twelve, five out of eight, and three out of ten.

Based upon the error analysis, a decision was made to focus on a few selective areas rather than many areas in order to increase the likelihood that the students would fill in the missing gaps and meet with the most success. The following areas were selected for instruction:

1. long division (three digit by two digit and four digit by two digit)
2. addition of fractions with common denominators, fraction equivalency, and finding common denominators in preparation for addition of fractions with unlike denominators
3. multiplication (two digit by two and three digits)

Both sixth grade teachers were interviewed regarding the students' mathematics performance and classroom instruction. Both teachers verified that the concepts selected for instruction were concepts that had been presented but continued to present difficulty for the students. The teachers were presenting higher level division, multiplication, and fractions in the classroom.

### Design of Instruction

The remediation was coordinated so that both groups of students received replacement math instruction during their scheduled math class. Each session last between 45 and 60 minutes and the sessions were conducted in the auditorium. The students were provided with a math notebook, which they used to keep a running record of their math work. They also wrote mnemonics in their notebook, which they referred back to in later sessions.

The instructional strategies used in this pilot study were:

- a. direct instruction
- b. permanent models
- c. frequent repetition
- d. immediate feedback and correction of errors
- e. verbalization of procedures
- f. charts for basic facts
- g. manipulatives – specifically fraction bars

To assist with long division, the mnemonic, “**Does McDonald’s Sell CheeseBurgers?**” was reintroduced to the students. Even though the students were familiar with this mnemonic, they had not gained fluency with its usage. Therefore, writing, reciting, and applying this mnemonic over the course of the fifteen sessions, proved to be helpful with the application and generalization of this aide for solving long division problems.

Of course, this mnemonic alone was not sufficient to improve instruction. The use of permanent models during instruction was a valuable asset for the students. Before each problem was presented, the problem was written on chart paper in large print, posted on the wall, and each step was reviewed. The students then solved similar problems in their notebooks during guided practice and independent practice. Immediate feedback was provided and through discussion, errors were identified and corrected. Each session began with a review of previously introduced material. Gradually more complex division problems were introduced using the same procedure.

As previously mentioned, the need instruction for in multiplication quickly became apparent. As described above, a permanent model, guided and independent practice and review, feedback, and immediate correction were necessary. It was important to move at a slow pace to assure success before moving on to more complex multiplication problems.

Fraction instruction began with the students completing a **Fraction Parade**, in their notebook, which consisted of writing fraction equivalents ( $1/2$ ,  $2/4$ ,  $3/6$ ,  $4/8$ .....). We discussed the relationship of the numeration to the denominator to encourage the students to see the patterns in their Fraction Parade. This visual chart proved useful when the students could not remember equivalent fractions when solving problems. They were encouraged to refer to their notebooks during the learning process to help with problem solving.

Fractions bars were introduced as a concrete means of helping the students see the relationship between the abstract number and a concrete representation of the fraction. Students were encouraged to arrange the fraction bars in increasing and decreasing order and to use the manipulatives as needed when solving problems throughout the sessions.

Due to the poor performance on the math fluency measure, each student was encouraged to use the math chart on the back of the notebook. Not all of the students were familiar with the chart and its use. They were instructed to use the math chart only for the facts that they did not know and were discouraged from using the chart for the facts they had committed to memory to avoid over reliance on this chart. Initially some of the students were reluctant to use the chart and reverted to guessing answers instead. As feedback was provided, the students’ errors were identified and they were instructed to find the correct fact using the math chart. Although direct instruction in memorizing basic facts was not the focus on this pilot study, significant improvement was noted in the students’ memorization of basic facts through the consistent use of the math chart during each session, verbalization of math facts while solving problems, and use of the math chart to correct errors in calculations.

**Table One**

**Group One Pretest/Posttest Scores**

<u>Student</u>	<u>Math</u> <u>Fluency</u> <u>Pretest</u>	<u>Math</u> <u>Fluency</u> <u>Posttest</u>	<u>Calculation</u> <u>Pretest</u>	<u>Calculation</u> <u>Posttest</u>	<u>Fraction</u> <u>Pretest</u>	<u>Fraction</u> <u>Posttest</u>
Chris	RS: 49 G.E. 3.7	RS: 78 G.E. 6.4	RS: 18 G.E. 4.9	RS: 23 G.E. 7.3	4/17	15/17
James	RS: 38 G.E. 2.9	RS: 69 G.E. 5.5	RS: 20 G.E. 5.7	RS: 23 G.E. 7.3	9/17	12/17
Kadeem	RS: 44 G.E. 3.3	RS: 79 G.E. 5.3	RS: 19 G.E. 5.3	RS: 20 G.E. 5.7	16/17	16/17
Dominique	RS 36 GE 2.7	RS 61 GE 4.8	RS 19 GE 5.3	RS 19 GE 5.3	17/17	15/17
Chynesa	RS 33 GE 2.5	RS 79 GE 6.5	RS 19 GE 5.3	RS 19 GE 6.7	15/17	17/17
Inayah	RS 33 GE 2.7	RS 78 GE 6.4	RS 20 GE 5.7	RS 23 GE 7.3	15/17	15/17

RS = Raw Score; GE = Grade Equivalency

**Table Two****Group Two Pretest/Posttest Scores**

<u>Student</u>	<u>Math</u> <u>Fluency</u> <u>Pretest</u>	<u>Math</u> <u>Fluency</u> <u>Posttest</u>	<u>Calculation</u> <u>Pretest</u>	<u>Calculation</u> <u>Posttest</u>	<u>Fraction</u> <u>Pretest</u>	<u>Fraction</u> <u>Posttest</u>
Krystal	RS 35 GE 2.6	RS 80 GE 6.6	RS 18 GE 4.9	RS: 21 GE 6.2	8/17	17/17
Almontiff	RS 79 GE 6.5	RS 109 GE 10.4	RS 22 GE 6.7	RS 23 GE 7.3	6/17	17/17
Anis	RS 46 GE 3.5	RS 117 GE 12.1	RS 25 GE 8.8	RS 25 GE 8.8	17/17	17/17

While the focus of this study was limited in terms of instructional content, the students' gains were positive. Gains were noted in the areas of calculations and basic fraction knowledge with significant improvement noted with math fluency. Table 3 contains the pretest and posttest scores for the two groups of sixth grade students. Through the use of direct instruction, slower pace of instruction, mnemonics, math charts, manipulatives, verbal rehearsal, and frequent repetition, gains were noted in the students' performance. An incidental benefit was the significant increase in automaticity of basic facts.

Follow-up measures will be conducted to assess the students' maintenance of skills. Both sixth grade teachers provided anecdotal reports that the students were applying the skills and strategies learned in the small group sessions to their classroom mathematics work. While this study is limited in nature, it does provide some evidence for the benefits of providing mathematics instruction on functioning level, rather than grade level, despite the reduced number of sessions. In addition, the provision of replacement instruction coinciding with math instruction in the classroom probably enhanced the students' overall performance.

The strategies used in this pilot study are strategies known to both general and special educators. However, reminders of the impact that relatively simple strategy instruction can have on students' overall performance can be of value to both teachers and students. Another positive outcome of this pilot study was the students' attitude toward mathematics. Initially, the students' were reluctant to ask or answer questions and they expressed a dislike of math. As they became more successful through direct, incremental instruction, their confidence grew and they were

eager participants in most sessions. I dislike math was replace with “I can do this – give me another one!!”

Table 3

## Sixth Graders Pretest and Posttest Means and Standard Deviations

	<u>Pretest Scores</u>	<u>Posttest Scores</u>
<b>Math Fluency</b>	X= 44.33 (14.05)	X = 88.33 (18.03)
<b>Calculations</b>	X= 20 (2.24)	X = 22.11 (1.83)
<b>Fractions</b>	X = 12 (4.5)	X = 15 (2.15)

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