

# Research: Multiplication Facts 0 to 81

## Study 1 – Overview

The Multiplication Facts 0 to 81 program is used to teach students the multiplication facts. In this study, 123 second graders participated. Thirteen of them had a disability (a learning disability or an emotional disability), 11 were low achievers, and the rest were normal achievers. Their six teachers were trained to teach the Multiplication Facts 0 to 81 program, and they implemented the program in classes containing heterogeneous groupings of 25 to 27 students. The point of the study was to compare the effects of the program with regard to the performance of the three groups of students: students with disabilities, low achievers, and normal achievers. First, the performances of the students with disabilities and low achievers were compared. Then, the performance of the normal achievers was compared to the performance of the combined group of low achievers and students with disabilities. Two types of measures were gathered: student performance on an acquisition test (number of correct responses to problems; and student performance on a proficiency/fluency test (number of correct responses per minute).

## Results

MANOVA results revealed no statistically significant differences between the performances of the students with disabilities and the low achievers on six dependent measures including untimed tests of multiplication acquisition and timed tests of multiplication proficiency. A statistically significant difference was found between the students' pretest and posttest scores [acquisition,  $F(1, 22) = 187.42, p < .01$ ; proficiency,  $F(1, 21) = 17.59, p < .01$ ].

When the performances of the students with disabilities and the low achievers were combined and compared to the performances of the normal achievers, no statistically significant differences were found on four of the six dependent measures. Differences were found on the students' performance after abstract lessons and their performance on the untimed test of acquisition. Again, a statistically significant difference was found between the students' pretest and posttest scores [acquisition,  $F(1, 120) = 875.66, p < .01$ ; proficiency,  $F(1, 119) = 59.23, p < .01$ ].

Both teachers and students indicated that they were satisfied with the program. All six teachers indicated they would use the program again and rated the program as "excellent." Student surveys indicated that 97% of the normal achievers, 100% of the students with disabilities, and 100% of the low achievers liked learning multiplication.

## Conclusions

These results suggest that different groups of students can experience statistically significant gains with regard to learning multiplication facts when taught together in inclusive classes using this program.

## Reference

Miller, S. P., Harris, C. A., Strawser, S., Jones, W. P., & Mercer, M. M. (1988). Teaching multiplication to second graders in inclusive settings. Focus on Learning Problems in Mathematics, 20(4), 50 - 70.

# Research: Multiplication Facts 0 to 81

## Study 2 - Overview

Three seventh-grade students with mental retardation were taught multiplication facts and how to solve multiplication word problems using the Multiplication Facts 0 to 81 program. One of the students was visually impaired, and another had a physical disability. A special education teacher taught the lessons after receiving training in one session. A multiple-baseline across-students design was used.

## Results

All three students' scores on multiplication tests improved from baseline to after instruction. Student 1 earned a mean score of 73.3% in baseline and 90.5% after instruction began. Student 2 earned a mean score of 67.5% in baseline and 93.5% after instruction began. Student 3 earned a mean score of 58% in baseline and 91.5% after instruction began. The multiple-baseline design showed that the improvement did not occur until after the intervention had begun. When the students began to learn to solve advanced problem-solving skills, their performance dropped slightly. The mean scores for the students during these lessons were 83%, 87%, and 90%.

When the performances of the students with disabilities and the low achievers were combined and compared to the performances of the normal achievers, no statistically significant differences were found on four of the six dependent measures. Differences were found on the students' performance after abstract lessons and their performance on the untimed test of acquisition. Again, a statistically significant difference was found between the students' pretest and posttest scores [acquisition,  $F(1, 120) = 875.66$ ,  $p < .01$ ; proficiency,  $F(1, 119) = 59.23$ ,  $p < .01$ ].

## Conclusions

The results showed that students with mental retardation can learn multiplication facts through the use of the Multiplication Facts 0 to 81 program, and they can learn to solve the more advanced multiplication problems at a socially significant level, with mean scores above the 80% level in all cases.

## Reference

Morin, V. A., & Miller, S. P. (1998). Teaching multiplication to middle-school students with mental retardation. *Education and Treatment of Children*, 21(1), 22 - 36.

# Research: Multiplication Facts 0 to 81

## Study 3 - Overview

The purpose of this study was to determine the effects of teaching multiplication skills to diverse groups of students in inclusive general education classes. The students were second graders and included 99 normal achievers, 12 students with learning disabilities (LD), and one student with an emotional disability. Six general education teachers were trained to teach the Multiplication Facts 0 to 81 program to the diverse groups of students regularly enrolled in their classes. A multiple- baseline across-classes design was used.

## Results

The students with disabilities began instruction performing at about the same level on the pretests as the normal achievers. During instruction, the median scores of the students with disabilities on learning sheets were about the same as those of the normal achievers. During the phase of instruction where students had to demonstrate conceptual understanding of the multiplication process, the scores of the groups were also very similar. During the phase of instruction where students had to read or write and solve word problems, the students with disabilities earned lower scores than their peers. On the acquisition posttest, the median score for students with disabilities was 70%, which was 15 percentage points lower than the median score for the normal achievers. Nevertheless, the posttest scores of the students with disabilities represented a 65 percentage point mean gain over their pretest scores. On the fluency measures, the mean rate increase for the students with disabilities was 10 correct digits per minute, and the mean rate increase for the normal achievers was 9 correct digits per minute.

## Conclusions

This study shows that students with disabilities can be successfully taught multiplication skills with the Multiplication Facts 0 - 81 program while enrolled in inclusive general education classes. Their scores on learning sheets during instruction were comparable to the scores of normally achieving peers except when asked to read or write and solve word problems. Their rate of solving multiplication problems was higher than the rate of the normal achievers. Their posttest acquisition scores were somewhat lower than those of the normal achievers, which is probably due to their lower performance on the word problems on the test.

## Reference

Harris, C A., Miller, S. P., Mercer, C. D. (1995). Teaching initial multiplication skills to students with disabilities in general education classrooms. *Learning Disabilities Research & Practice*, 10(3), 180-195.

# Research: Multiplication Facts 0 to 81

## Study 4 - Overview

A field test was conducted that involved 22 teachers and 109 elementary students who were experiencing difficulties learning math. This student group included 102 students with learning disabilities (LD), 5 students with emotional disabilities, and 2 students who were at-risk for school failure. The field test took place in seven school districts in both small-group (less than 7 students) and larger group (7 to 18 students) instructional arrangements. The teachers were trained to use programs in the Strategic Math Series. Different groups of students were taught addition facts, subtraction facts, multiplication facts, and division facts, depending on their needs. Three types of measures were gathered: student performance on a math-facts acquisition test (number of correct responses to multiplication problems); student performance on a word-problem test (number of correct responses to word problems); and student performance on a fluency test (number of correct digits per minute).

## Results

The 52 students who received instruction in the Multiplication 0-81 program earned a mean score of 43% on the acquisition pretest and 91% on the posttest. They earned a mean score of 36% on the word-problem pretest and a mean score of 92% on the word-problem posttest. With regard to fluency, the students correctly produced an average of 5 digits per minute during the first abstract lesson and 14 digits per minute at the completion of the program. On the follow-up generalization measure, in which students were asked to apply the DRAW Strategy to multiplication problems that had not been taught in the program (e.g.,  $12 \times 3$ ), students earned a mean score of 96%. The generalization measure was administered 3 to 5 days after instruction ended by examiners unknown to the students in school locations other than their typical classroom. On the follow-up fluency measure, also administered 3 to 5 days after instruction ended in different locations, the students maintained their mean fluency rate of 14 correct digits per minute.

## Conclusions

The results show that students with learning difficulties in math are able to learn basic multiplication facts and associated word problems through use of the Multiplication Facts 0 to 81 program. The students acquire multiplication knowledge and improve their ability to solve multiplication facts with fluency. They also generalize their fluency skills with multiplication facts to new instructors within new settings at levels that exceed initial baseline rates and match mean instructional rates.

## Reference

Mercer, C. D., & Miller, S. P. (1992). Teaching students with learning problems in math to acquire, understand, and apply basic math facts. *Remedial and Special Education, 13*(3), 19-35, 61.

# Research: Multiplication Facts 0 to 81

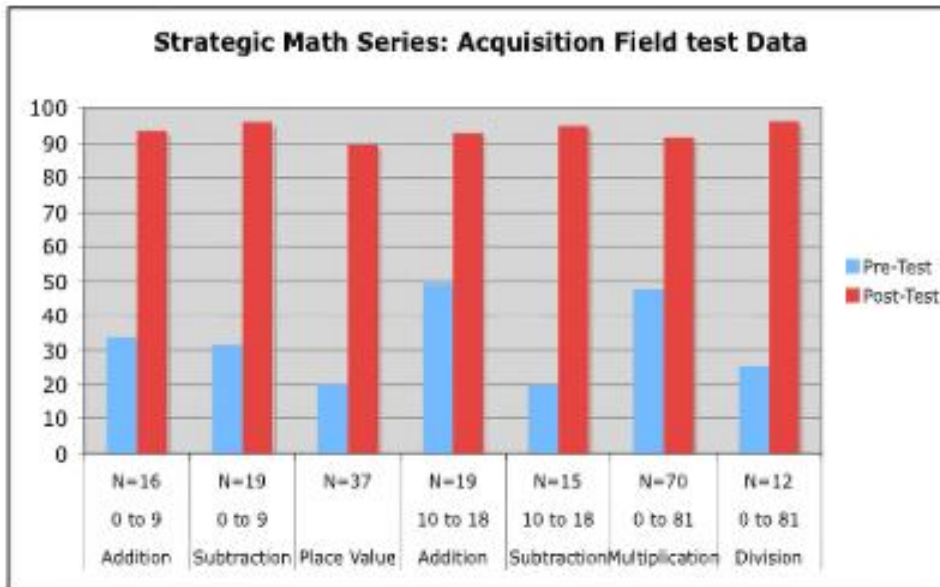
## Study 5 - Overview

Multiple field tests were conducted that involved 56 teachers and 248 elementary students who were experiencing difficulties learning math. These field tests took place in seven school districts in self-contained, resource, and general education classes. The teachers were trained to use programs in the Math Strategies Series. Different groups of students were taught addition facts, subtraction facts, multiplication facts, division facts, and place value concepts and skills, depending on their needs.

## Results

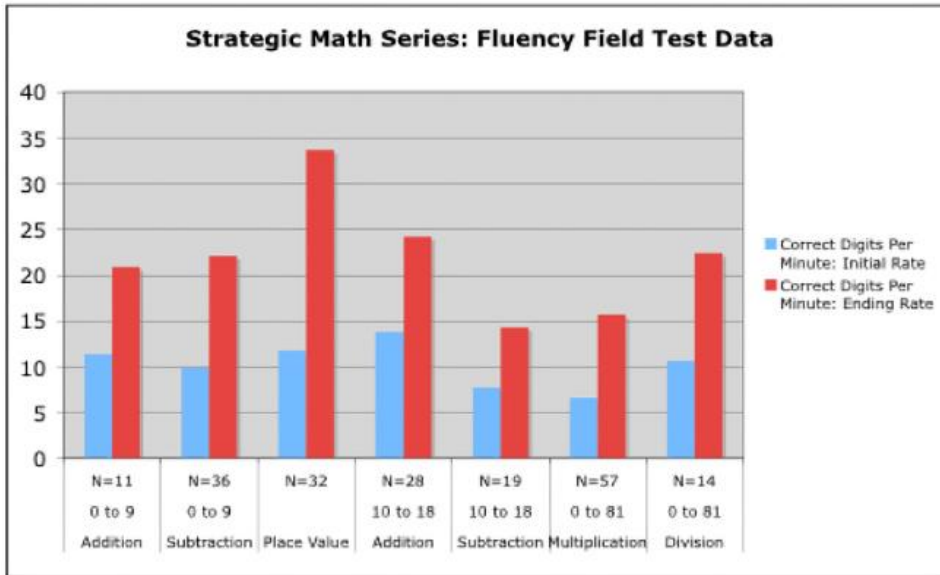
Substantial gains were made by the students in all areas. See the figures below for the results in each math area. Figure 1 shows the results on untimed acquisition tests, and Figure 2 shows the results on timed proficiency tests (i.e., fluency tests). The number of students participating in each field test is shown beneath each pair of bars on the graph.

Figure 1: Percentage of answers correct on untimed acquisition tests



# Research: Multiplication Facts 0 to 81

Figure 2: Percentage of digits correct per minute on timed fluency tests



The results for the Multiplication Facts 0 to 81 program are shown in the sixth pair of bar graphs on the right side in each figure. Students earned a mean score of 48% answers correct on the acquisition pretest and a mean score of 92% correct on the posttest. They produced an average of 7 correct digits per minute in baseline and 16 digits correct per minute after instruction.

## Conclusions

The programs in the Strategic Math Series produce significant gains in student performance on math acquisition and fluency tests across several areas of mathematics. In addition, these programs all produce socially significant final performances with students earning scores around or above the 90% level in all areas.

## Reference

Miller, S. P., & Mercer, C.D. (1998). Strategic Math Series professional developers' guide. Lawrence, KS: Edge Enterprises.