



# A SYNOPSIS OF A SYNTHESIS OF EMPIRICAL RESEARCH ON TEACHING MATHEMATICS TO LOW-ACHIEVING STUDENTS

## INTRODUCTION

*As states and districts expand Response to Intervention (RTI) models across the curriculum and beyond the primary grades, a need has arisen for guidance in implementing effective interventions for students who are struggling in mathematics. As in literacy, core instruction and interventions in math must be research-based. Although the existing research on effective math interventions is limited, that which does exist is sufficient as a foundation for beginning to implement effective instructional strategies for students who are struggling in math.*

*Research syntheses are particularly helpful in making connections between research and practice. By examining findings that are robust across studies, syntheses offer guidance in implementing research-based instructional practices. Baker, Gersten, and Lee (2002) synthesized findings from 28 years of research on interventions for students who are struggling in learning math. The present synopsis highlights the key findings from this synthesis and outlines recommendations for practice that follow from the findings.*

**Baker, S., Gersten, R., & Lee, D. (2002). A synthesis of empirical research on teaching mathematics to low-achieving students. *The Elementary School Journal*, 103, 51-73.**

## METHOD

Baker et al. applied rigorous criteria in selecting studies for their synthesis. Only experimental or high-quality quasi-experimental designs (with a control group and with an analysis that accounted for any significant differences between groups in pretest performance) that measured results using reliable and valid math assessments were included. Further, the intervention's total duration had to be at least 90 minutes, and participants had to have been or be at risk for low achievement in mathematics. From a pool of 194 studies, 17 satisfied these conditions. Two of these were eliminated because the intervention relied on an outdated software program, leaving 15 studies in the final synthesis.

All studies were conducted in school settings. Participants' grade levels ranged from 2nd-11th; most studies focused on primary or middle school students ( $n=11$ ). The scope of most studies was limited, focusing on a very specific area of intervention. Students were selected for intervention based on teacher identification of their low achievement or at-risk status in math and their scores on a measure of math achievement. Most studies did not include students with learning disabilities. In the studies that did include students with LD ( $n=5$ ), these students were a small segment of the total sample of participants. When results were presented

separately for the sub-sample of students with LD, these results were excluded from Baker et al.'s calculation of effect sizes. As a result, their findings mainly apply to students who are struggling in math but have not been identified as having a learning disability.

The researchers calculated a measure of the strength of the effect of each intervention (effect size). Studies were coded descriptively (participant characteristics, length of intervention, research design, grade level, etc.) and grouped into one or more of four broad categories of interventions that served as the focus of Baker et al.'s analysis. These broad categories were:

- providing data or recommendations to teachers and students;
- peer-assisted learning;
- explicit teacher-led and contextualized teacher-facilitated approaches; and
- providing parents with information about student successes.

Through meta-analysis, the researchers sought to determine the overall effectiveness of each intervention category.



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### PROVIDING DATA OR RECOMMENDATIONS TO TEACHERS AND STUDENTS

**Key Finding:** *Differences in the strength of the effect among the studies in this category suggest that to be effective, these types of interventions must include both progress monitoring data on students and instructional recommendations for teachers based on the student data.*

The overall effect for the four studies that provided this type of intervention was moderately strong, 0.57, or a gain of just over half a standard deviation for the experimental group over the control group (e.g., about 8 standard score points on a normed measure with a standard deviation of 15). In these interventions, teachers, and in some cases students, were provided with progress monitoring data. In some instances teachers were given instructional recommendations to implement based on each student's results. The control group received either minimal or no data on performance.

### PEER-ASSISTED LEARNING

**Key Finding:** *Peer-assisted learning appears to be an effective strategy for remedying student deficits in computation and may also be effective for other areas of mathematical learning.*

The overall effect for the six studies that implemented peer-assisted learning was moderately strong, with an average effect size of 0.62 (a gain of nearly two-thirds of a standard deviation for the experimental group compared with the control group). In these interventions, students worked in pairs, alternating the roles of tutor and tutee. Computation problems tended to be the focus of the learning activities in these studies, and showed stronger results than did studies where overall math achievement or math problem-solving was the focus.

### EXPLICIT TEACHER-LED AND CONTEXTUALIZED TEACHER-FACILITATED APPROACHES

**Key Finding:** *A direct approach to math instruction for students struggling in mathematics has shown the greatest effectiveness.*

The studies in this category implemented instruction in one of two different ways: through direct, explicit teaching of math concepts and problem solving ( $n=3$ ) or through a less-direct approach that taught math through more contextual, real-world applications ( $n=3$ ). One study compared the two approaches. The average effect size for the direct instruction approach was just over one-half of a standard deviation (0.58), while the average effect size for the conceptual approach was approximately zero (0.01), although positive effects were found in some studies.

### PROVIDING PARENTS WITH INFORMATION ABOUT STUDENT SUCCESSES

**Key Finding:** *Given the ease of implementation and the moderate strength of the effect, using this intervention in combination with other effective intervention strategies appears worthwhile.*

Just two studies included this type of intervention, which involved school-initiated communication with parents on a regular basis to inform them about their child's successes in learning mathematics. Parents were encouraged to support their child's achievement (as part of an intervention that also included peer tutoring). Both studies produced effect sizes of just under half a standard deviation (0.42) for the experimental group over the control group; however, this effect size is not reliably different from 0. Our level of confidence in this finding is also limited by the small number of studies ( $n=2$ ) that contributed to it.

The results of this synthesis of math interventions for struggling students suggest that these instructional strategies are likely to have positive effects on the math achievement of students who struggle with math:

- Providing progress-monitoring data along with specific instructional recommendations;
- Peer tutoring in areas where students need additional practice;
- The use of direct, explicit instruction; and
- Honest, ongoing communication with parents about their child's math gains.

It should be noted that the number of studies included in this synthesis (15) was small. Although all of these studies were high-quality, rigorous investigations of an intervention's efficacy, the findings from such a small research base must be viewed with some caution. Replicating these findings in further research studies is needed to raise our confidence in the instructional recommendations that we have set forth.



## STUDIES INCLUDED IN BAKER ET AL. (2002) RESEARCH SYNTHESIS

- Bass, G., Ries, R., & Sharpe, W. (1986). Teaching basic skills through microcomputer assisted instruction. *Journal of Educational Computing Research*, 2(2), 207-219.
- Bottge, B. & Hasselbring, T. S. (1993). A comparison of two approaches for teaching complex, authentic mathematics problems to adolescents in remedial math classes. *Exceptional Children*, 59, 556-566.
- Cardelle-Elawar, M. (1992). Effects of teaching metacognitive skills to students with low mathematics ability. *Teaching and Teacher Education*, 8(2), 109-121.
- Cardelle-Elawar, M. (1995). Effects of metacognitive instruction on low achievers in mathematics problems. *Teaching and Teacher Education*, 11, 81-95.
- Clairiana, R. B. & Smith, L. J. (1989). *Progress reports improve students' course completion rate and achievement in math computer-assisted instruction*. (ERIC Document Reproduction Service No. ED 317 170).
- Fantuzzo, J. W., Davis, G. Y., & Ginsburg, M. D. (1995). Effects of parent involvement in isolation or in combination with peer tutoring on student self-concept and mathematics achievement. *Journal of Educational Psychology*, 87(2), 272-281.
- Fuchs, L. S., Fuchs, D., Hamlett, C. L., Phillips, N. B., & Bentz, J. (1994). Classwide curriculum-based measurement: Helping general educators meet the challenge of student diversity. *Exceptional Children*, 60, 518-537.
- Fuchs, L. S., Fuchs, D., Karns, K., Hamlett, C. L., Katzaroff, M., & Dutka, S. (1997). Effects of task-focused goals on low-achieving students with and without learning disabilities. *American Educational Research Journal*, 34, 513-543.
- Fuchs, L. S., Fuchs, D., Phillips, N. B., Hamlett, C. L., & Karns, K. (1995). Acquisition and transfer effects of classwide peer-assisted learning strategies in mathematics for students with varying learning histories. *School Psychology Review*, 24, 604-620.
- Ginsburg-Block, M., & Fantuzzo, J. W. (1997). Reciprocal peer tutoring: An analysis of "teacher" and "student" interactions as a function of training and experience. *School Psychology Quarterly*, 12(2), 134-149.
- Heller, L. R., & Fantuzzo, J. W. (1993). Reciprocal peer tutoring and parent partnership: Does parent involvement make a difference? *School Psychology Review*, 22, 517-534.
- Henderson, R. W., & Landesman, E. M. (1995). Effect of thematically integrated mathematics instruction on students of Mexican descent. *Journal of Educational Research*, 88, 290-300.
- Moore, B. M. (1988). Achievement in basic math skills for low-performing students: A study of teachers' affect and CAI. *Journal of Experimental Education*, 57(1), 38-44.
- Moore, L. J., & Carnine, D. W. (1989). A comparison of two approaches to teaching ratio and proportions to remedial and learning disabled students: Active teaching with either basal or empirically validated curriculum design material. *Remedial and Special Education*, 10(4), 28-37.
- Schunk, D. H. (1982). *Efficacy and skill development through social comparison and goal setting*. (ERIC Document Reproduction Service No. ED 222 279).
- Woodward, J., & Baxter, J. (1997). The effects of an innovative approach to mathematics on academically low-achieving students in mainstreamed settings. *Exceptional Children*, 63(3), 373-388.
- Woodward, J., Baxter, J., & Robinson, R. (1999). Rules and reasons: Decimal instruction for academically low achieving students. *Learning Disabilities Research and Practice*, 14, 15-24.



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