# MATHEMATICS INSTRUCTION FOR STUDENTS WITH LEARNING DISABILITIES OR DIFFICULTY LEARNING MATHEMATICS

## *A Guide for Teachers*

CENTER ON INSTRUCTION

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## *A Guide for Teachers*

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# CONTENTS

# INTRODUCTION

Historically, mathematics instruction for students with learning disabilities and at-risk learners has not received the same level of consideration and scrutiny from the research community, policy makers, and school administrators as the field of reading. A recent review of the ERIC literature base (Gersten, Clarke, & Mazzocco, 2007) found that the ratio of studies on reading disabilities to mathematics disabilities and difficulties was 5:1 for the years 1996–2005. This was a dramatic improvement over the ratio of 16:1 in the prior decade. Even though this is far from a large body of research, sufficient studies exist to dictate a course of action.

Recently, the Center on Instruction conducted a meta-analysis on the topic of teaching mathematics to students with learning disabilities (Gersten, Chard, Jayanthi, Baker, Morphy, & Flojo, 2008). A meta-analysis is a statistical method by which research studies on a particular method of instruction are summarized to determine the effectiveness of that instructional method. A meta-analysis helps combine findings from disparate studies to determine the effectiveness of a particular method of instruction.

In the meta-analysis on teaching mathematics to students with learning disabilities (LD), only studies with randomized control trials (RCTs) and high quality quasi-experimental designs (QEDs) were included. In an RCT, the study participants (or other units such as classrooms or schools) are randomly assigned to the experimental and control groups, whereas in a QED, there is no random assignment of participants to the groups.

## *Seven Effective Instructional Practices*

Based on the findings of the meta-analysis report, seven effective instructional practices were identified for teaching mathematics to K–12 students with learning disabilities. In describing these practices, we have incorporated recommendations from *The Final Report of the National Mathematics Advisory Panel* (National Mathematics Advisory Panel, 2008) as well. This report specified recommendations for students with learning disabilities *and* for students who were experiencing difficulties in learning mathematics but were not identified as having a math learning disability (i.e., at-risk). The seven effective instructional practices in this document are supported by current research findings. Other instructional practices may be effective, but there is, at present, not enough high quality research to recommend their use at this time.

Some of the recommendations listed later in this document (e.g., teach explicitly and use visuals) are age-old teaching practices. While there is nothing new about these practices, research continues to validate them as effective instructional practices for students with learning disabilities and at-risk students, and continued use is warranted. Other instructional methods recommended here, such as using multiple instructional examples and teaching multiple strategies, have also been endorsed in studies that focused on reform-oriented mathematics instruction in general education classes (e.g., Silver, Ghousseini, Gosen, Charalambous, & Strawhun, 2005; Rittle-Johnson & Star, 2007). This alignment of teaching methods between special education and general education enables students with learning disabilities to learn meaningfully from general education curricula in inclusive classrooms.

## *Mathematical Knowledge*

Current mathematics researchers emphasize three areas of mathematical abilities (e.g., Kilpatrick, Swafford, & Findell, 2001; Rittle-Johnson & Star, 2007; Bottge, Rueda, LaRoque, Serlin, & Kwon, 2007). They are:

- procedural knowledge,
- procedural flexibility, and
- conceptual knowledge.

*Procedural knowledge* refers to knowledge of basic skills or the sequence of steps needed to solve a math problem. Procedural knowledge enables a student to execute the necessary action sequences to solve problems (Rittle-Johnson & Star, 2007).

*Procedural flexibility* refers to knowing the many different ways in which a particular problem can be solved. Students with a good sense of procedural flexibility know that a given problem can be solved in more than one way, and can solve an unknown problem by figuring out a possible solution for that problem.

*Conceptual knowledge* is a grasp of the mathematical concepts and ideas that are not problem-specific and therefore can be applied to any problem-solving situation. Conceptual understanding is the over-arching understanding of mathematical concepts and ideas that one often refers to as a "good mathematical sense."

It is reasonable to extrapolate from this small but important body of research that such an emphasis would also benefit students with disabilities and at-risk students. Recent studies have attempted to address reform-oriented math instruction in special education settings. Researchers such as Woodward (e.g., Woodward, Monroe, & Baxter, 2001) and Van Luit (Van Luit & Naglieri, 1999) have endeavored to address the issue of procedural flexibility in their research by focusing on multiple strategy instruction—a recommendation in this document, as mentioned earlier. Bottge (e.g., Bottge, Heinrichs, Mehta, & Hung, 2002) has addressed the issue of procedural knowledge and conceptual understanding by means of engaging, real-life, meaningful problem-solving contexts; however the limited number of studies precludes any recommendations at this time.

## *Effective Instruction at Each Tier*

The current focus on Response to Intervention (RTI) as a tiered prevention and intervention model for struggling mathematics learners also calls for evidence-based instructional methods (Bryant & Bryant, 2008). While RTI models can have three or more tiers (the most common being three tiers), they all share the same objectives. For example, Tier 1 instruction, with an emphasis on primary prevention, requires teachers to provide evidence-based instruction to all students. Tier 2 focuses on supplemental instruction that provides differentiated instruction to meet the learning needs of students. Tier 3 emphasizes individualized intensive instruction. The ultimate goal of the RTI model is to reduce the number of students in successive tiers and the number of students receiving intensive instruction. The groundwork for the success of this model is the effectiveness of the instruction provided in Tier 1.The evidence-based instructional strategies identified in this document need to be part of the teaching repertoire of Tier 1 teachers. These validated techniques, when implemented soundly, can effectively bring about student gains in mathematics.

Our document guides K–12 teachers of students with disabilities and at-risk students in their selection and use of effective mathematics instructional methods. For each of the seven recommendations, we explain what works, describe how the practice should be done, and summarize the evidence supporting the recommendation.

## Recommendation 1:
## Teach students using *explicit instruction* on a regular basis.

Explicit instruction, a mainstay feature in many special education programs, includes teaching components such as:

- clear modeling of the solution specific to the problem,
- thinking the specific steps aloud during modeling,
- presenting multiple examples of the problem and applying the solution to the problems, and
- providing immediate corrective feedback to the students on their accuracy.

When teaching a new procedure or concept, teachers should begin by modeling and/or thinking aloud and working through several examples. The teacher emphasizes student problem solving using the modeled method, or by using a model that is consonant with solid mathematical reasoning. While modeling the steps in the problem (on a board or overhead), the teacher should verbalize the procedures, note the symbols used and what they mean, and explain any decision making and thinking processes (for example, "That is a plus sign. That means I should…").

Teachers should model several problems with different characteristics (Rittle-Johnson & Star, 2007; Silbert, Carnine, & Stein, 1989). A critical technique is assisted learning where students work in pairs or small groups and receive guidance from the teacher. During initial learning and practice, the teacher provides immediate feedback to prevent mistakes in learning and allows students to ask questions for clarification.

According to *The Final Report of the National Mathematics Advisory Panel* (National Mathematics Advisory Panel, 2008), explicit systematic instruction improves the performance of students with learning disabilities and students with learning difficulties in computation, word problems, and transferring known skills to novel situations. However, the panel noted that while explicit instruction has consistently shown better results, no evidence supports its *exclusive* use for teaching students with learning disabilities and difficulties. The panel recommends that all teachers of students with learning disabilities and difficulties teach explicitly and systematically on a regular basis to some extent and not necessarily all the time.

### Summary of Evidence to Support Recommendation 1

***Meta-analysis of Mathematics Intervention Research for Students with LD***

COI examined 11 studies in the area of explicit instruction (10 RCTs and 1 QED). The mean effect size of 1.22 was statistically significant ($p<.001$; 95% CI = 0.78 to 1.67).

***National Mathematics Advisory Panel***

The panel reviewed 26 high quality studies (mostly RCTs) on effective instructional approaches for students with learning disabilities and low-achieving students. Explicit Systematic Instruction is identified in *The Final Report of the National Mathematics Advisory Panel* as one of the defining features of effective instruction for students with learning disabilities (National Mathematics Advisory Panel, 2008).

RCT = Randomized control trial. QED = Quasi-experimental design. CI= Confidence interval.

## Recommendation 2:
## Teach students using *multiple instructional examples*.

Example selection in teaching new math skills and concepts is a seminal idea that is strongly emphasized in the effective instruction literature (e.g., Ma, 1999; Rittle-Johnson & Star, 2007; Silbert, Carnine, & Stein, 1989). Teachers need to spend some time planning their mathematics instruction, particularly focusing on selecting and sequencing their instructional examples. The goal is to select a range of multiple examples of a problem type. The underlying intent is to expose students to many of the possible variations and at the same time highlight the common but critical features of seemingly disparate problems. For example, while teaching students to divide a given unit into half, a variety of problems can be presented that differ in the way the critical task of half is addressed in the problems (i.e., use the symbol for half; use the word half, use the word one-half; etc.) (Owen & Fuchs, 2002).

Multiple examples can be presented in a specified sequence or pattern such as concrete to abstract, easy to hard, and simple to complex. For example, fractions and algebraic equations can be taught first with concrete examples, then with pictorial representations, and finally in an abstract manner (Butler, Miller, Crehan, Babbitt, & Pierce, 2003; Witzel, Mercer, Miller, 2003). Multiple examples can also be presented by systematically varying the range presented (e.g., initially teaching only proper fractions vs. initially teaching both proper and improper fractions).

Sequencing of examples may be most important during early acquisition of new skills when scaffolding is needed for student mastery and success. The range of examples taught is probably most critical to support transfer of learned skills to new situations and problems. In other words, if the teacher teaches a wide range of examples, it will result in the learner being able to apply a skill to a wider range of problem types. Both of these planning devices (sequence and range) should be considered carefully when teaching students with LD.

### Summary of Evidence to Support Recommendation 2

***Meta-analysis of Mathematics Intervention Research for Students with LD***

COI examined 9 studies on range and sequence of examples (all RCTs). The mean effect size of 0.82 was statistically significant ($p<.001$; 95% CI = 0.42 to 1.21).

***National Mathematics Advisory Panel***

The panel reviewed 26 high quality studies (mostly RCTs) on effective instructional approaches for students with learning disabilities and low-achieving students. The panel recommends that teachers, as part of explicit instruction, carefully sequence problems to highlight the critical features of the problem type (National Mathematics Advisory Panel, 2008).

## Recommendation 3:
## Have students *verbalize decisions and solutions* to a math problem.

Encouraging students to verbalize, or think-aloud, their decisions and solutions to a math problem is an essential aspect of scaffolded instruction (Palincsar, 1986). Student verbalizations can be problem-specific or generic. Students can verbalize the specific steps that lead to the solution of the problem (e.g., I need to divide by two to get half) or they can verbalize generic heuristic steps that are common to problems (e.g., Now I need to check my answer). Students can verbalize the steps in a solution format (First add the numbers in the *units* column. Write down the answer. Then add numbers in the *tens* column…) (Tournaki, 2003) or in a self-questioning/answer format (What should I do first? I should…) (Pavchinski, 1998). Students can verbalize during initial learning or as they are solving, or have solved, the problem.

Many students with learning disabilities are impulsive behaviorally and when faced with multi-step problems frequently attempt to solve the problems by randomly combining numbers rather than implementing a solution strategy step-by-step. Verbalization may help to anchor skills and strategies both behaviorally and mathematically. Verbalizing steps in problem solving may address students' impulsivity directly, thus suggesting that verbalization may facilitate students' self-regulation during problem solving.

### Summary of Evidence to Support Recommendation 3

***Meta-analysis of Mathematics Intervention Research for Students with LD***

COI examined 8 studies in the area of student verbalizations (7 RCTs and 1 QED). The mean effect size of 1.04 was statistically significant ($p<.001$; 95% CI = 0.42 to 1.66).

***National Mathematics Advisory Panel***

The panel reviewed 26 high quality studies (mostly RCTs) on effective instructional approaches for students with learning disabilities and low-achieving students. The panel recommends that teachers, as part of explicit instruction, allow students to think aloud about the decisions they make while solving problems (National Mathematics Advisory Panel, 2008).

## Recommendation 4:
## Teach students to *visually represent the information* in the math problem.

Visual representations (drawings, graphic representations) have been used intuitively by teachers to explain and clarify problems and by students to understand and simplify problems. When used systematically, visuals have positive benefits on students' mathematic performance.

Visual representations result in better gains under certain conditions. Visuals are more effective when combined with explicit instruction. For example, teachers can explicitly teach students to use a strategy based on visuals (Owen & Fuchs, 2002). Also, students benefit more when they use a visual representation prescribed by the teacher rather than one that they self-select (D. Baker, 1992). Furthermore, visuals that are designed specifically to address a particular problem type are more effective than those that are not problem specific (Xin, Jitendra, & Deatline-Buchman, 2005). For example, in the study by Xin and her colleagues, students first identified what type of problem they had been given (e.g., proportion, multiplicative) and then used a corresponding diagram (taught to them) to represent essential information and the mathematical procedure necessary to find the unknown. Then they translated the diagram into a math sentence and solved it.

Finally, visual representations are more beneficial if not only the teacher, but both the teacher and the students use the visuals (Manalo, Bunnell, & Stillman, 2000).

### Summary of Evidence to Support Recommendation 4

***Meta-analysis of Mathematics Intervention Research for Students with LD***

COI examined 12 studies on visual representations (11 RCTs and 1 QED). The mean effect size of 0.47 was statistically significant ($p<.001$; 95% CI = 0.25 to 0.70).

***National Mathematics Advisory Panel***

The panel reviewed 26 high quality studies (mostly RCTs) on effective instructional approaches for students with learning disabilities and low-achieving students. According to *The Final Report of the National Mathematics Advisory Panel* visual representations when combined with explicit instruction tended to produce significant positive results (National Mathematics Advisory Panel, 2008).

## Recommendation 5:
## Teach students to solve problems using *multiple/heuristic strategies*.

Instruction in multiple/heuristic strategies is part of a contemporary trend in mathematics education (e.g., Star & Rittle-Johnson, in press). Using heuristics shows some promise with students with learning disabilities. Multiple/heuristic strategy instruction has been used in addressing computational skills, problem solving, and fractions.

A heuristic is a method or strategy that exemplifies a generic approach for solving a problem. For example, a heuristic strategy can include steps such as "Read the problem. Highlight the key words. Solve the problems. Check your work." Instruction in heuristics, unlike direct instruction, is not problem-specific. Heuristics can be used in organizing information and solving a range of math problems. They usually include student discourse and reflection on evaluating the alternate solutions and finally selecting a solution for solving the problem. For example, in the Van Luit and Naglieri (1991) study, the teacher first modeled several strategies for solving a computational problem. However, for most of the lesson, the teacher's task was to lead the discussion in the direction of using strategies and to facilitate the discussion of the solutions provided by the students. Each student was free to select a strategy for use, but the teacher assisted the children in discussion and reflection about the choices made.

Similarly, in the Woodward (2006) study, students were taught multiple fact strategies. Daily lessons consisted of introduction of new strategies or review of old strategies. Students were not required to memorize the strategies. They were, however, encouraged to discuss the strategy and contrast it with previously taught strategies. For example, students were shown that since 9 X 5 has the same value as 5 X 9, they were free to treat the problem as either nine fives or five nines. They also were shown that this was equivalent to 10 fives minus one five, and that this could be a faster way to do this problem mentally. Thus a variety of options were discussed with the students.

### Summary of Evidence to Support Recommendation 5

***Meta-analysis of Mathematics Intervention Research for Students with LD***

COI examined 4 studies in the area of multiple/heuristic strategy instruction (3 RCTs and 1 QED). The mean effect size of 1.56 was statistically significant ($p<.001$; 95% CI = 0.65 to 2.47).

## Recommendation 6:
## Provide *ongoing formative assessment data and feedback* to teachers.

Ongoing formative assessment and evaluation of students' progress in mathematics can help teachers measure the pulse and rhythm of their students' growth and also help them fine-tune their instruction to meet students' needs. Teachers can administer assessments to their group of students and then a computer can provide them with data depicting students' current mathematics abilities.

Providing teachers with information regarding their students' progress in mathematics has beneficial effects on the mathematics performance of those same students. However, greater benefits on student performance will be observed if teachers are provided with not only performance feedback information but also instructional tips and suggestions that can help teachers decide what to teach, when to introduce the next skill, and how to group/pair students. For example, teachers can be given a set of written questions to help them use the formative assessment data for adapting and individualizing instruction. These written questions could include "On what skill(s) has the student improved compared to the previous two-week period?" or "How will I attempt to improve student performance on the targeted skill(s)?"

Teachers can respond to these questions and address them again when new assessment data becomes available (Allinder, Bolling, Oats, & Gagnon, 2000). Teachers can also be provided with a specific set of recommendations to address instructional planning issues such as which mathematical skills require additional instructional time for the entire class, which students require additional help via some sort of small group instruction or tutoring, and which topics should be included in small group instruction (Fuchs, Fuchs, Hamlett, Phillips, & Bentz, 1994).

### Summary of Evidence to Support Recommendation 6

***Meta-analysis of Mathematics Intervention Research for Students with LD***

COI examined 10 studies on formative assessment (all RCTs). The mean effect size of 0.23 was statistically significant ($p<.01$; 95% CI = 0.05 to 0.41).

***National Mathematics Advisory Panel***

The panel reviewed high quality studies on formative assessment and noted that formative assessment use by teachers results in marginal gains for students of all abilities. When teachers are provided with special enhancements (suggestions on how to tailor instruction based on data), significant gains in mathematics are observed (National Mathematics Advisory Panel, 2008).

## Recommendation 7:
## Provide *peer-assisted instruction* to students.

Students with LD sometimes receive some type of peer assistance or one-on-one tutoring in areas in which they need help. The more traditional type of peer-assisted instruction is cross-age, where a student in a higher grade functions primarily as the tutor for a student in a lower grade. In the newer within-classroom approach, two students in the same grade tutor each other. In many cases, a higher performing student is strategically placed with a lower performing student but typically both students work in both roles: tutor (provides the tutoring) and tutee (receives the tutoring).

Cross-age peer tutoring appears to be more beneficial than within-class peer-assisted learning for students with LD. It could be hypothesized that students with LD are too far below grade level to benefit from feedback from a peer at the same grade level. It seems likely that within-class peer tutoring efforts may fall short of the level of explicitness necessary to effectively help students with LD progress, whereas older students (in cross-age peer tutoring settings) could be taught how to explain concepts to a student with LD who is several years younger. Interestingly, within-class peer-assisted instruction does appear to help low-achieving students who have learning difficulties in mathematics (Baker, Gersten, & Lee, 2002). One possible explanation seems to be that there is too much of a gap in the content knowledge between students with learning disabilities compared to low-achieving students with learning difficulties, thus enabling peer tutoring to be more beneficial to students at risk than to students with LD.

### Summary of Evidence to Support Recommendation 7

***Meta-analysis of Mathematics Intervention Research for Students with LD***

COI examined 2 studies in the area of cross age peer tutoring (both RCTs).
The mean effect size of 1.02 was statistically significant ($p<.001$; 95% CI = 0.57 to 1.47).

## LIST OF RECOMMENDATIONS

**1: Teach students using *explicit instruction* on a regular basis.**

**2: Teach students using *multiple instructional examples.***

**3: Have students *verbalize decisions and solutions* to a math problem.**

**4: Teach students to *visually represent the information* in the math problem.**

**5: Teach students to solve problems using *multiple/ heuristic strategies.***

**6: Provide *ongoing formative assessment data and feedback* to teachers.**

**7: Provide *peer-assisted instruction* to students.**

## REFERENCES


Allinder, R. M., Bolling, R., Oats, R., & Gagnon, W. A. (2000). Effects of teacher self-monitoring on implementation of curriculum-based measurement and mathematics computation achievement of students with disabilities. *Remedial and Special Education, 21*(4), 219-226.

Baker, D. E. (1992). *The effect of self-generated drawings on the ability of students with learning disabilities to solve mathematical word problems.* Unpublished doctoral dissertation, Texas Tech University.

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

Bottge, B. A., Heinrichs, M., Mehta Z. D., & Hung, Y. (2002). Weighing the benefits of anchored math instruction for students with disabilities in general education classes. *The Journal of Special Education, 35,* 186–200.

Bottge, B. A., Rueda, E., LaRoque P. T., Serlin, R. C., & Kwon, J. (2007). Integrating reform-oriented math instruction in special education settings. *Learning Disabilities Research and Practice, 22*(2), 96–109.

Bryant, B. R., & Bryant, D. P. (2008). Introduction to special series: Mathematics and learning disabilities. *Learning Disability Quarterly, 31*(1), 3–10.

Butler, F. M., Miller, S. P., Crehan, K., Babbitt, B., & Pierce, T. (2003). Fraction instruction for students with mathematics disabilities: Comparing two teaching sequences. *Learning Disabilities Research and Practice, 18,* 99–111.

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.

Gersten, R., Chard. D. J., Jayanthi, M., Baker, S. K., Morphy, P., & Flojo, J.(in press). *Teaching mathematics to students with learning disabilities: A meta-analysis of the intervention research.* Portsmouth, NH: RMC Research Corporation, Center on Instruction.

Gersten, R., Clarke, B., & Mazzocco, M. (2007). Chapter 1: Historical and contemporary perspectives on mathematical learning disabilities. In D.B. Berch & M.M.M. Mazzocco (Eds.). *Why is math so hard for some children? The nature and origins of mathematical learning difficulties and disabilities* (pp. 7–29). Baltimore, MD: Paul H. Brooks Publishing Company.

Kilpatrick, J., Swafford, J. O., & Findell, B. (Eds.). (2001). *Adding it up: Helping children learn mathematics.* Washington, DC: National Academy Press.

Ma, L. (1999). *Knowing and teaching elementary mathematics.* Mahwah: Lawrence Erlbaum Associates, Inc.

Manalo, E., Bunnell, J., & Stillman, J. (2000). The use of process mnemonics in teaching students with mathematics learning disabilities. *Learning Disability Quarterly, 23,* 137–156.

National Mathematics Advisory Panel. (2008). Foundations for Success: The Final Report of the National Mathematics Advisory Panel. Washington, DC: U.S. Department of Education.

Owen, R. L., & Fuchs, L. S. (2002). Mathematical problem-solving strategy instruction for third-grade students with learning disabilities. *Remedial and Special Education, 23,* 268–278.

Palincsar, A. S. (1986). The role of dialogue in providing scaffolded instruction. *Educational Psychologist, 21,* 73–98.

Pavchinski, P. (1988). *The effects of operant procedures and cognitive behavior modification on learning disabled students' math skills.* Unpublished doctoral dissertation, University of Florida.

Rittle-Johnson, B., & Star, J. R. (2007). Does comparing solution methods facilitate conceptual and procedural knowledge? An experimental study on learning to solve equations. *Journal of Educational Psychology, 99*(3), 561–574.

Silbert, J., Carnine, D., & Stein, M. (1989). *Direct instruction mathematics.* Columbus, OH: Merrill.

Silver, E. A., Ghousseini, H., Gosen, D., Charalambous, C., & Strawhun, B. (2005). Moving from rhetoric to praxis: Issues faced by teachers in having students consider multiple solutions for problems in the mathematics classroom. *Journal of Mathematical Behavior, 24,* 287–301.

Star, J. R. & Rittle-Johnson, B. (in press). Flexibility in problem solving: The case of equation solving. *Learning and Instruction.*

Tournaki, N. (2003). The differential effects of teaching addition through strategy instruction versus drill and practice to students with and without disabilities. *Journal of Learning Disabilities, 36*(5), 449–458.

Van Luit, J. E. H., & Naglieri, J. A. (1999). Effectiveness of the MASTER program for teaching special children multiplication and division. *Journal of Learning Disabilities, 32,* 98–107.

Witzel, B. S., Mercer, C. D., & Miller, M. D. (2003). Teaching algebra to students with learning difficulties: An investigation of an explicit instruction model. *Learning Disabilities Research and Practice, 18,* 121–131.

Woodward, J. (2006). Developing Automaticity in multiplication facts: Integrating strategy instruction with timed practice drills. *Learning Disability Quarterly, 29,* 269–289.

Woodward, J., Monroe, K., & Baxter, J. (2001). Enhancing student achievement on performance assessments in mathematics. *Learning Disabilities Quarterly, 24,* 33–46.

Xin, Y. P., Jitendra, A. K., & Deatline-Buchman, A. (2005). Effects of mathematical word problem-solving instruction on middle school students with learning problems. *The Journal of Special Education, 39*(4), 181–192.

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