Strategies and Interventions to Support Students with Mathematics Disabilities

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In the absence of intensive instruction and intervention, students with mathematics difficulties and disabilities lag significantly behind their peers (Jitendra et al., 2013; Sayeski & Paulsen, 2010). Conservative estimates indicate that 25% to 35% of students struggle with mathematics knowledge and application skills in general education classrooms, indicating the presence of mathematics difficulty (Mazzocco, 2007). Additionally, 5% to 8% of all school-age students have such significant deficits that impact their ability to solve computation and/or application problems that they require special education services (Geary, 2004). This InfoSheet provides an overview of strategies and resources to support students with, or at-risk for, mathematics learning disabilities.

Common Core Mathematics Standards

With the current emphasis on the Common Core State Standards (CCSS; National Governors Association Center for Best Practices [NGA Center], 2010, 2014), it is essential that students with math difficulties and disabilities be prepared to meet with success on these newly articulated grade level expectations in mathematics. Special education teachers and general education teachers need to have strategies to help students who struggle with mathematics to gain access to the general education curriculum and to meet with success in all areas of math including math literacy and conceptual knowledge (Gargiulo & Metcalf, 2013; Powell, Fuchs, & Fuchs, 2013).

Although the CCSS do not provide a curriculum, they do specify the topics within standards that should be addressed by grade level. CCSS included two major components: Standards for Mathematics Practice and Standards for Mathematics Content. These standards indicate that students should be able to (1) make sense of problems and persevere in solving them, (2) reason abstractly and quantitatively, (3) construct viable arguments and critique the reasoning of others, (4) model with mathematics, (5) use appropriate tools strategically, (6) attend to precision, (7) look for and make use of

structure, and (8) look for and express regularity in repeated practices. During the elementary years, focus is placed on mathematics fundamentals with the goal of moving from counting skills to multiplying and dividing fractions. By middle school, students are expected to understand geometry, ratios and proportions, and pre-algebra skills. During high school, the focus is on more advanced algebra, functions, modeling, advanced geometry, statistics, and probability content. For a complete listing of grade level standards download the complete set of grade specific standards (www.corestandards.org/the-standards/mathematics).

The Early Learning in Mathematics program (Davis & Jungjohann, 2009) is an example of a core mathematics program that embodies the current thinking on effective instruction in math (Doabler et al., 2012). Both systematic and explicit instruction and detailed coverage of significant areas of content in mathematics are addressed in this program. The successful elements of explicit and systematic instruction incorporated in this program that can also be utilized in other core mathematics instruction include the following:

1. Specific and clear teacher models
2. Examples that are sequenced in level of difficulty
3. Scaffolding
4. Consistent feedback
5. Frequent opportunity for cumulative review (NCEERA, 2009)

Fuchs and Fuchs (2008) identified seven principals of effective practice for primary students with math disabilities. In their article, the authors stated that third grade is a time when mathematical disabilities tend to be identified, and used the seven interventions to illustrate the principles. The seven principles include (1) instructional explicitness, (2) instructional design to minimize the learning challenge, (3) provide strong conceptual knowledge for procedures taught, (4) drill and practice, (5) cumulative review, (6) motivation to help students regulate their attention and behavior and to work hard, and (7) on-going progress monitoring.

Strategies for Teaching Problem Solving Skills

Strategy training has been helpful to students with LD when learning mathematical concepts and procedures. The following are a few examples of strategies that are useful to teachers when instructing students with LD in problem solving.

RIDE (Mercer, Mercer, & Pullen, 2011)

RIDE is a strategy used to assist students with solving word problems. Students who experience difficulty with abstract reasoning, attention, memory, and/or visual spatial skills may benefit from the strategy. Ensure that steps are taught through demonstration and plenty of opportunities for practice are provided before asking students to independently use the strategy. Visually display the strategy on a chart or class website as a reminder.

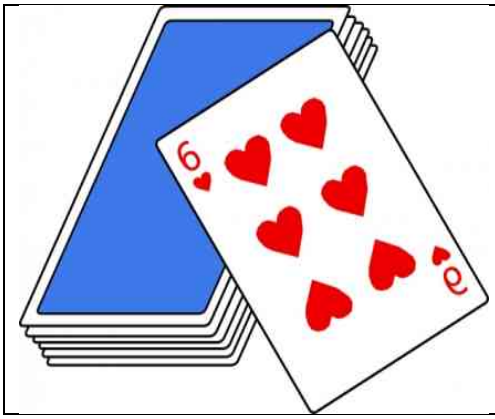
***R**-- Remember* the problem correctly

***I**-- Identify* the relevant information

***D**-- Determine* the operations and unit for expressing the answer

***E**-- Enter* the correct numbers, calculate and check the answer

FAST DRAW (Mercer & Miller, 1992)
Like RIDE, FAST DRAW is another strategy used to solve word problems. Teach each step in the sequence allowing sufficient time for guided practice prior to asking students to independently implement the strategy. Create a visual display and post in the classroom or student notebooks to assist students.



***F**— **F**ind* what you're solving for.
***A**— **A**sk* yourself, "What are the parts of the problem?"
***S**— **S**et* up the numbers.
***T**— **T**ie* down the sign.

***D** — **D**iscover* the sign.
***R** — **R**ead* the problem.
***A** — **A**nswer,* or draw and check.
***W**— **W**rite* the answer.

TINS Strategy (Owen, 2003) The TINS strategy allows students to use different steps to analyze and solve word problems.

***T**—**T**hought*	Think about what you need to do to solve this problem and circle the key words.
***I**— **I**nformation*	Circle and write the information needed to solve this problem; draw a picture; cross out unneeded information.
***N**— **N**umber Sentence*	Write a number sentence to represent the problem.
***S**-- **S**olution Sentence*	Write a solution sentence that explains your answer.

Strategies to Support Vocabulary Development

Strategies that can help students improve their mathematic vocabulary include (a) pre-teach vocabulary, (b) mnemonic techniques, and (c) key word approaches. These strategies are only a few strategies available to help enhance students' mathematics vocabulary comprehension.

Pre-teach Vocabulary

- Use representations, both pictorial and concrete, to emphasize the meaning of math vocabulary (Sliva, 2004).
- Pretest students' knowledge of glossary terms in their math textbook and teach vocabulary that is unknown or incorrect.

Mnemonic Techniques

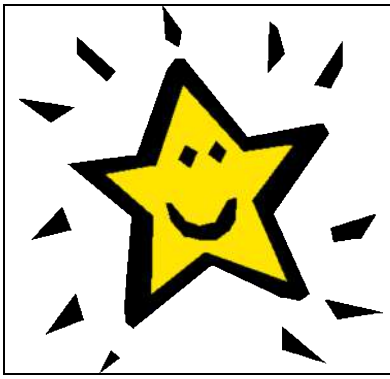
- Teach mnemonic techniques to help remember word meanings.
- Use mnemonic instruction to help students improve their memory of new information (The Access Center, 2006).

Key Word Approach

- Use the keyword approach (e.g., visualize a visor as the keyword for divisor; visualize quotation marks as the keyword for quotient (Mastropieri & Scruggs, 2002).

Strategies to Assist with Teaching Algebraic Concepts

Algebra is introduced in elementary school as students learn algebraic reasoning involving patterns, symbolism, and representations. Students experience difficulty with algebra for various reasons including difficulty understanding the vocabulary required for algebraic reasoning, difficulties with problem solving, and difficulties understanding patterns and functions necessary for algebraic reasoning. Possible strategies to assist with teaching algebraic concepts include, but are not limited to, (a) teaching key vocabulary needed for algebra, (b) providing models for identifying and extending patterns, (c) modeling "think aloud" procedures for students to serve as examples for solving equations and word problems, (d) incorporating technology usage (e.g., graphing calculators) (Bryant, 2008), and (e) implementing Star Strategy described below (Gagnon & Maccini, 2001).



S— ***S****earch* the word problem.

T— ***T****ranslate* the words into an equation in picture form

A— ***A****nswer* the problem

R— ***R****eview* the problem.

CRA and CSA Instructional Methods

Maccini and Gagnon (2005) stated that the STAR strategy incorporates the concrete-Semiconcrete-Abstract (CSA) instructional sequence, which gradually advances to abstract ideas using the following progression: (a) concrete stage, (b) semiconcrete stage, and (c) abstract stage. By using the CSA framework teachers can incorporate effective teaching components to teach students effectively and efficiently. Students progressively move through each stage to achieve mastery in a mathematic concept.

Using multiple representations, beginning with the concrete level and moving to the abstract level, is an effective technique in helping struggling learners solve calculation problems. The Concrete-Representational-Abstract (CRA) teaching sequence has been found to help students with LD learn procedures and concepts (Flores, Hinton, & Strozier, 2014). During the concrete stage students are in the "doing" stage, during the representational stage students are in the "seeing" stage, and during the abstract phase students are in the "applying" stage. Students move through the phases fluidly.

C— *Concrete:* students use three-dimensional objects to represent math problems	**C— *C**oncrete:* students use three-dimensional objects to represent math problems
R— *Representational:* students use pictures to represent math problems	**S— *S**emiconcrete:* students use two-dimensional representation to draw pictures of the math problem
A— *Abstract:* students represent the problem using numerical symbols	**A— *A**bstract:* students represent the problem using numerical symbols

Strategies to Assist with the Use of Metacognitive Skills

Metacognition refers to individuals' awareness of how they think and plan activities. Metacognition also involves strategizing, monitoring success and effort, and knowing when to change directions or to try a different approach to problem solving. Many students with learning difficulties benefit from the use of metacognitive skills to help them focus on what they are doing and to plan for how to employ strategies as needed and change directions when appropriate (Mevarech & Amrany, 2008). A few examples of how to incorporate metacognitive strategies include:

- Demonstrating "think-alouds" so students become aware of how one talks oneself through a learning task.
- Demonstrating the use of graphic organizers, schematics, and visual imagery.
- Explicit, direct instruction accompanied by modeling of self-monitoring, self-talk, and self-checks.

Mathematics Advisory Panels and Their Reports

Developing foundational mathematics skills at the elementary level is essential. Maintaining basic skills acquired during the elementary years is essential as students move toward more advanced computational, place value, and fractional concepts. As

students move from elementary to secondary mathematics, it is important that students maintain skills mastered and that teachers continue to scaffold instruction and provide supports to ensure that foundational skills are addressed while affording access to more advanced mathematics concepts. Below are links to various advisory panel recommendations for effectively teaching mathematics.

Panel	Link
National Commission on Mathematics and Science Teaching for the 21st Century—Before It's Too Late	http://www.ptec.org/items/detail.cfm?ID=4059
*National Research Council—Adding It Up: Helping Children Learn Mathe*matics	http://www.nap.edu/catalog.php?record_id=9822
RAND Mathematics Study Panel—Mathematical Proficiency for All Students	http://www.rand.org/pubs/monograph_reports/MR1643/index.html
Foundations for Success: The Final Report of the National Mathematics Advisory Panel	http://www2.ed.gov/about/bdscomm/list/mathpanel/report/final-report.pdf
The Access Center's *Math Problem Solving for Primary Elementary Students with Disabilities*	http://www.k8accesscenter.org/training_resources/mathprimaryproblemsolving.asp
The Access Center's *Math Problem Solving for Upper Elementary Students with Disabilities*	http://www.k8accesscenter.org/training_resources/MathPrblSlving_upperelem.asp

Resources

There are numerous website and resources available to assist with mathematics instruction. Following are suggested websites with a summary of resources for teaching a variety of mathematics concepts across levels.

Website	Resource
www.cast.org	• expand learning opportunities through universal design
http://www.factmonster.com/math/flashcards.html	• increase math fluency with web-based flashcards
www.aplusmath.com/flashcards	• enhance fluency through the use of web-based flashcards
www.flash-cardmachine.com	• enhance fluency with the use of web-based flashcards
www.academicskillbuilders.com	• support math and vocabulary fluency (Brownell, Smith, Crockett, Griffin, 2012)
www.sunburst.com	• research based achievement solutions; standards based products prescriptive web based instruction K-5, digital classroom
www.intellitools.com	• technology for preK – 8 classrooms, free downloads available.
www.tomsnyder.com	• software for fluency, word problems, graphing, etc.
www.illuminations.nctm.org	• activities, lessons, standards web links for math education; preK-12.
www.internet4classrooms.com	• Common Core State Standards internet sites for teaching mathematics in culturally responsive ways
http://ncisla.wceruw.org/teachers/index.html	• resources related to supporting understanding of science and math

References

The Access Center. (2006). *Using mnemonic instruction to teach math*. Retrieved from http://www.k8accesscenter.org

Brownell, M. T., Smith, S. J., Crockett, J. B., & Griffin, C. C. (2012). Inclusive instruction: Evidence based practices for teaching students with disabilities. New York, NY: The Guilford Press.

Bryant, D. P. (2008). Teaching mathematics. In D. P. Bryant, D. D. Smith, & B. R. Bryant (Eds.), *Teaching students with special needs in inclusive classrooms*. Boston, MA: Allyn & Bacon.

Davis, K., & Jungjohann, K. (2009). *Early learning in mathematics: Level K.* Unpublished curriculum, Center on Teaching and Learning, University of Oregon, Eugene, OR.

Doabler, C. T., Cary, M. S., Jungjohann, K., Clarke, B., Fien, H., Baker, C., Smolkowski, K., & Chard, D. (2012). Enhancing core mathematics instruction for students at risk for mathematics disabilities. *Teaching Exceptional Children, 44*(4), 48-57.

Flores, M. M., Hinton, V., & Strozier, S. (2014). Teaching subtraction and multiplication with regrouping using Concrete-Representational-Abstract sequence and the Strategic Instruction Model. *Learning Disabilities Research and Practice, 29*(2), 75-88.

Fuchs, L. S., & Fuchs, D. (2008), *Mathematics disabilities in the primary grades: Seven principles of effective practice*. Retrieved from www.TeachingLD.org

Gagnon, J., & Maccini, P. (2001). Preparing students with disabilities for algebra. *Teaching Exceptional Children*, 34(1), 10-17.

Gargiulo, R. M., & Metcalf, D. (2013). *Teaching in today's inclusive classrooms: A universal design for learning approach* (2nd ed.) Independence, KY: Cengage Learning.

Geary, D. C. (2004). Mathematics and learning disabilities*. Journal of Learning Disabilities, 37*, 4-15.

Jitendra, A. K., Rodriguez, M., Kanive, R., Huang, J., Church, C., Conrroy, K. A., & Zaslofsky, A. (2013). Impact of small-group tutoring interventions on the mathematical problem solving and achievement of third-grade students with mathematics difficulties. *Learning Disability Quarterly, 36*, 21-35.

Maccini, P., & Gagnon, J. (2005). Mathematics strategy instruction (SI) for middle school students with learning disabilities. *The Access Center.* Retrieved from http://digilib.gmu.edu/jspui/bitstream/1920/284/1/MathSIforMiddleSchoolStudentswithLD.2.pdf

Mastropieri, M. A., & Scruggs, T. E. (2002). Effective instruction for special education (3rd ed.). Austin, TX: PRO-ED.

Mazzocco, M. (2007). Defining and differentiating mathematical learning disabilities and difficulties. In D. Berch & M. Mazzocco (Eds.), *Why is math so hard for some children? The nature and origins of mathematics learning difficulties and disabilities* (pp. 29-47). Baltimore, MD: Paul H. Brooks.

Mercer, C. D., Mercer, A. R., & Pullen, P. C. (2011). *Teaching students with learning problems* (8th ed.). Upper Saddle River, NJ: Pearson Education.

Mercer, C. D., & Miller, S. P. (1992). *Multiplication facts 0 to 81*. Lawrence, KS: Edge Enterprises.

Mevarech, Z. R., & Amrany, C. (2008). Immediate and delayed effects of meta-cognitive instruction on regulation of cognition and mathematics achievement. *Metacognition and Learning*, *3*(2), 147-157.

National Center for Education Evaluation and Regional Assistance. (2009). *Assisting students struggling with mathematics: Response to intervention (RtI) for elementary and middle schools* (Practice Guide Report No. NCEE 2009-4060). Washington, DC: Institute of Education Sciences. Retrieved from http://ies.ed.gov/ncee/wwc/pdf/practice_guides/rti_math_pg_042109.pdf

National Governors Association Center for Best Practices, Council of Chief State School Officers. (2010). *Common Core State Standards (Mathematics)*. Washington, DC: National Association Center for Best Practices, Council of Chief State School Officers. Retrieved from http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf

National Governors Association. (2014). Trends in state implementation of the common core state standards: Making the shift to better tests. Retrieved from http://www.nga.org/files/live/sites/NGA/files/pdf/2014/1404NGACCSSAssessments.pdf

Owen, M. J. (2003). *It's elementary! 275 math word problems book 3*. Toronto, Canada: Educator Publishing Service.

Powell, S. R., Fuchs, L. S., & Fuchs, D. (2013). Reaching the mountaintop: Addressing the common core standards in mathematics for

students with mathematics difficulties. *Learning Disabilities Research and Practice, 28*, 38-48. doi: 10.1111/ldrp.12001

Sayeski, K. L., & Paulsen, K. J. (2010). Mathematics reform curricula and special education: Identifying intersections and implications for practice. *Intervention in School and Clinic, 46*, 13-21.

Sliva, J. A. (2004). *Teaching inclusive mathematics to special learners, K-6.* Thousand Oaks, CA: Corwin Press.