Additional Resources

National Center for Progress Monitoring - case studies
RTI Toolkit for MATH CBM Jim Wright - Intervention Central

Difficulties with Mathematics

http://www.pbs.org/wgbh/misunderstoodminds/mathdiffs.html

What Can Stand in the Way of a Student's Mathematical Development?

Math disabilities can arise at nearly any stage of a child's scholastic development. While very little is known about the neurobiological or environmental causes of these problems, many experts attribute them to deficits in one or more of five different skill types. These deficits can exist independently of one another or can occur in combination. All can impact a child's ability to progress in mathematics.

Incomplete Mastery of Number Facts

Number facts are the basic computations (9 + 3 = 12 or 2 x 4 = 8) students are required to memorize in the earliest grades of elementary school. Recalling these facts efficiently is critical because it allows a student to approach more advanced mathematical thinking without being bogged down by simple calculations.

Try it yourself. Experience a problem with basic facts.

Resources for Creating CBM/ Benchmarking Activity

To measure math fact issues but not computational issues - use cloze style assessments that require the student to fill in a missing number, with the answer shown. You can also use flashcards to measure this same skill.

- Printable Math Facts Worksheets - these worksheets designed for grades 1-4 can be printed as flashcards, fill in the answer and fill in the missing number. There are problem set for addition, subtraction, multiplication, division, fractions and decimals(see samples in math tab of binder)
- Create Your Own Math Sheets - multiplication, division, addition,

subtraction, time, money
- Math Magician Game - created by the OSWEGO CITY SCHOOLS, this site is a timed test of basic addition, subtraction, multiplication and division. You can choose the skill - for example, +2, and the students see how many problems of the 20 problems they can complete in 1 minute. You can also picked "mixed level".
- Wild On Math - online game that allows students to solve a set of 20 problems - addition, subtraction, multiplication, division or random - by grade level - gr 1-6 The game keeps track of the total time students took to answer questions and shows total number correct
- Example of Cloze Math Tool

Computational Weakness

Many students, despite a good understanding of mathematical concepts, are inconsistent at computing. They make errors because they misread signs or carry numbers incorrectly, or may not write numerals clearly enough or in the correct column. These students often struggle, especially in primary school, where basic computation and "right answers" are stressed. Often they end up in remedial classes, even though they might have a high level of potential for higher-level mathematical thinking.

Resources for Creating CBM/Benchmarking Activities

To measure computational weakness, use a timed set of problems where the student must find the answer or fill in the appropriate math sign. Assess students math legibility by having them write a set list of numbers. Use a rubric to help measure legibility and precision.

- Create Your Own Math Sheets - multiplication, division, addition, subtraction, time, money
- Math Rubric for Mathematical Work, Notation, Neatness and Organization

Difficulty Transferring Knowledge

One fairly common difficulty experienced by people with math problems is the inability to easily connect the abstract or conceptual aspects of math with reality. Understanding what symbols represent in the physical world is important to how well and how easily a child will remember a concept. Holding and inspecting an equilateral triangle, for example, will be much more meaningful to a child than simply being told that the triangle is equilateral because it has three equal sides. And yet children with this

problem find connections such as these painstaking at best.

Resources for Creating CBM/Benchmarking Activities

To measure how well students are transferring math knowledge, you will need a set of manipulative including shapes, symbols and counting blocks. You will also need shape and number words and number cards to help assess if a child can accurately pair the symbol with the actual object.

- Printable Geometric Shapes
- Printable Math Manipulatives
- Printable Math Tools

Making Connections

Some students have difficulty making meaningful connections within and across mathematical experiences. For instance, a student may not readily comprehend the relation between numbers and the quantities they represent. If this kind of connection is not made, math skills may be not anchored in any meaningful or relevant manner. This makes them harder to recall and apply in new situations.

Resources for Creating CBM/Benchmarking Activities

To measure a student's ability to make connections, counters would be useful to help children construct and deconstruct numbers, model numbers and model counting skills. Number lines, clocks and other tools that require a student to connect a math concept with a real world tool would also be useful.

- Resource Pages to Use for Matching Numbers With Objects
- Printable Math Manipulatives
- City of Chicago Math Assessment Tool - good example problems

Incomplete Understanding of the Language of Math

For some students, a math disability is driven by problems with language. These children may also experience difficulty with reading, writing, and speaking. In math, however, their language problem is confounded by the inherently difficult terminology, some of which they hear nowhere outside of the math classroom. These students have difficulty understanding written or verbal directions or explanations, and find word problems especially difficult to translate.

Resources for Creating CBM/Benchmarking Activities

To measure this category, the teacher or evaluator will need to create a probe that will help identify fluency in math reading and ability to pull out math concepts from a word problem. Another tool might be a simple set of oral directions to see how accurately a student can follow along. Tally sheets or a rubric would be helpful for this.

- City of Chicago Math Assessment Tool - good example word problems
- Math Vocabulary Matching Tests

Difficulty Comprehending the Visual and Spatial Aspects and Perceptual Difficulties.

A far less common problem -- and probably the most severe -- is the inability to effectively visualize math concepts. Students who have this problem may be unable to judge the relative size among three dissimilar objects. This disorder has obvious disadvantages, as it requires that a student rely almost entirely on rote memorization of verbal or written descriptions of math concepts that most people take for granted. Some mathematical problems also require students to combine higher-order cognition with perceptual skills, for instance, to determine what shape will result when a complex 3-D figure is rotated.

Resources for Creating CBM/Benchmarking Activities

To assess this category, polyomino problems and manipulatives would be helpful.

- Polyomino Page
- Web Based Pentomino Activity
- Printable Assessment Pages for Visualization(requires membership)
- Transformations

 **Try it yourself.** Experience a visualization challenge.

Signs of Math Difficulties

Output Difficulties

A student with problems in output may

- be unable to recall basic math facts, procedures, rules, or formulas
- be very slow to retrieve facts or pursue procedures

- have difficulties maintaining precision during mathematical work
- have difficulties with handwriting that slow down written work or make it hard to read later
- have difficulty remembering previously encountered patterns
- forget what he or she is doing in the middle of a math problem

Organizational Difficulties

A student with problems in organization may

- have difficulties sequencing multiple steps
- become entangled in multiple steps or elements of a problem
- lose appreciation of the final goal and over emphasize individual elements of a problem
- not be able to identify salient aspects of a mathematical situation, particularly in word problems or other problem solving situations where some information is not relevant
- be unable to appreciate the appropriateness or reasonableness of solutions generated

Language Difficulties

A student with language problems in math may

- have difficulty with the vocabulary of math
- be confused by language in word problems
- not know when irrelevant information is included or when information is given out of sequence
- have trouble learning or recalling abstract terms
- have difficulty understanding directions
- have difficulty explaining and communicating about math, including asking and answering questions
- have difficulty reading texts to direct their own learning
- have difficulty remembering assigned values or definitions in specific problems

Attention Difficulties

A student with attention problems in math may

- be distracted or fidgety during math tasks
- lose his or her place while working on a math problem
- appear mentally fatigued or overly tired when doing math

Visual Spatial or Ordering Difficulties

A student with problems in visual, spatial, or sequential aspects of mathematics may

- be confused when learning multi-step procedures
- have trouble ordering the steps used to solve a problem
- feel overloaded when faced with a worksheet full of math exercises
- not be able to copy problems correctly
- may have difficulties reading the hands on an analog clock
- may have difficulties interpreting and manipulating geometric configurations
- may have difficulties appreciating changes in objects as they are moved in space

Difficulties with multiple tasks

A student with problems managing and/or merging different tasks in math may

- find it difficult to switch between multiple demands in a complex math problem
- find it difficult to tell when tasks can be grouped or merged and when they must be separated in a multi-step math problem
- cannot manage all the demands of a complex problem, such as a word problem, even thought he or she may know component facts and procedures

General Suggestions For Helping Students With Math Difficulties

Teach basic concepts using concrete objects. Let children explore number concepts by adding and subtracting objects in the room (for example, add the legs of a chair to find the number four or subtract crayons from a box). Move from concrete materials to pictorial representations to numbers (abstract representations).

Provide specialized materials. To help children organize their calculations, have them use graph paper (or lined paper turned sideways) to keep numbers in columns. Encourage the use of scrap paper to keep work neat, highlighters for underlining key words and numbers, and manipulatives such as Cuisenaire rods, base-ten blocks, or fraction bars.

Make your expectations explicit. Tell children the procedures you would like them to use when solving a problem, and model each procedure for

them. Have a child then tell you what he is expected to do. Some students benefit by having a math notebook filled with examples of completed problems to which they can refer if they become overwhelmed or confused.

Use cooperative math-problem-solving activities. Provide opportunities for children to work in groups when solving math problems. Encourage them to share their thinking aloud as they solve problems. Reinforce efficient strategies using multiple pathways.

Provide time for checking work. Emphasize that completing math assignments is a process. Encourage children to become comfortable reviewing their work, making changes, or asking questions when they are unsure of their answers.

Give children opportunities to connect mathematical concepts to familiar situations. For example, when introducing measurement concepts, have children measure the height of classmates and family members, or the weight of their book bags when empty and when full. Ask children to estimate the measurements (guessing how much taller the refrigerator is than the stove) before solving the problem. Point out how math is used in everyday life, such as when examining bus schedules or filling out catalogue order forms.

Help children apply math concepts to new situations. Show children how to use percentages to understand the price of a jacket on sale at the mall or the amount of their allowance spent on snacks.

Provide tutors. Tutors can assist children with weak math subskills (such as multiplication and division). Arrange for tutors during summer months or after school to boost performance and ensure that the child retains his skills.

Back to Top

Specific Strategies

Strategies for
> Memory
> Language
> Attention
> Production

Strategy Tips: Decide which strategies to try by observing the child and identifying the ways in which he or she learns best.

- It may take several attempts to see positive results from one strategy. Don't give up too soon.
- If the first few strategies you try do not improve the child's skills, try others.
- Most of these strategies can be adapted for use with different age groups.

Back to Top

Memory

Provide the technology tools needed for problem solving. Encourage children to think mathematically, even if they have not mastered basic skills. For example, let them use computer spreadsheet programs and calculators when the goal of the math activity is to develop problem-solving skills as opposed to calculation skills.

Teach basic math facts. Use explicit instruction to promote student mastery. Put a few selected unknown facts on index cards. Put strategies for remembering on the back of the cards. Cards can be put on notebook rings. Add new facts as previous ones are learned. Build practice into lessons. Also, routinely conduct cumulative reviews of skills and knowledge to help children develop automaticity with math facts.

Use rule books. Ask children to keep a notebook in which they write math rules in their own words. Encourage children to use rule books with classroom or home assignments by looking up the rule in the book and talking about it. Rule books could have a math vocabulary section and a strategy section for recording "tricks" that help with the operations.

Teach subvocalization as a strategy. Show children how to quietly repeat sequences (such as numbers and procedures) under their breath while working. Practice the strategy by giving them a sequence of numbers or directions and having them quietly repeat them back to you.

Practice subskills. Help children recall math subskills (like multiplication) more automatically with the use of flashcards and drills. Play a game in which you quiz a child about math facts and record how many he answers correctly. To build motivation, have the child record her own progress each

day. Together, review progress periodically.

Teach math in more than one mode. Children respond well when math is taught in a variety of ways -- visually (such as demonstration), verbally (such as using oral explanations), and experientially (such as setting up a mock store) -- so that children have an opportunity to process and use math information in multiple ways.

Use games. To enhance active working memory, play mental math games. For example, "What two numbers can be multiplied to get 24? How many different combinations can you find?" Gradually build up a child's ability to hold a long problem (How much is 4 + 2 - 1 x 3?) in memory. Make sure the child understands the reason for playing the game.

Review patterns. Use flash cards to review patterns, such as key words that provide clues to the operation of a word problem, or geometric patterns or shapes within complex visual designs.

Back to Top

Language

Focus on the information provided in word problems. Have children separate the necessary information for solving the problem from unnecessary details.

Teach mnemonic strategies for solving word problems. Choose strategies that suit the child's learning style. One strategy is TIPS: **T**hink (read and paraphrase), **I**nformation (what numbers and information do you need in order to solve the problem), **P**roblem (write equation), **S**olve.

Encourage children to put problems into their own words. Teach children to read for meaning when trying to identify the operation to use for solving a math problem. Have them verbalize the problem before trying to solve it.

Teach math vocabulary. Review the meaning of key words and phrases commonly used in mathematics problems, such as "all" or "total" in addition problems ("How much money did they spend in all?" "What was the total amount of the grocery bill?"). To help children identify key terms in problems, ask them whether a problem requires a particular procedure, and

have them underline the word or term that gave the answer away. Include new vocabulary in their rule books (see above).

Back to Top

Attention

Teach children how to preview an assignment. Help them to see the importance of thinking ahead before beginning the task. For example, cue them to ask, "Which math operations will I need next?"

Teach children how to self-monitor. During a task, show children how to stop and assess how well they are progressing. For example, tell them, "Every 10 minutes you will need to stop and check your answers." Teach children to ask themselves questions such as "How is it going?" and, "Do I need to make changes?" "Does my answer make sense?" and "Does my answer match my estimate?"

Help children maintain mental energy. Allow them to take frequent breaks while completing math assignments. Suggest that they get up and walk around during these breaks.

Teach self-checking strategies. Have students change to a different color pen when they have finished their work, becoming a "test checker" instead of a "test taker." This will help them notice their errors. For students who continue to make attentional errors in calculation, despite instruction and practice with self-checking, permit the use of a calculator for checking.

Help children stay focused. Let them choose the best place to do assignments, or allow them to listen to music if that helps their concentration.

Provide a model. Work through the mathematical problem with the child, verbalizing or demonstrating each step. Especially with homework, assist the child by doing the first problem together.

Identify topics of interest to children. Explore mathematical concepts in relation to motivating topics, such as building a skateboard ramp, tracking a satellite's orbit around the earth, discovering how the pyramids were built, or saving money in an interest-bearing account. Ask children to help you identify topics for mathematical problems.

Build a foundation for multi-step problems. Be sure the child understands basic one-step problems (problems requiring only one math operation) before advancing to those that require multiple operations.

Isolate steps. Have children focus on one step at a time. For example, provide mathematical activities in which children identify only (1) what the question is asking them to find, (2) which information is necessary to answer the question, and (3) which operations should be used in solving the problem.

Complete each step. Explain to children that even good problem solvers rarely skip steps when solving problems, though they may appear to.

Reduce the amount of data on a page. Children with spatial problems often become overwhelmed by large amounts of visual data on a page. Reduce the number of math problems or the number of diagrams to interpret per page. Remove unessential visual features.

Have children draw pictures to represent what is going on in a math problem. Suggest they draw representations of objects from the problem (for example, three shirts, a 6-by-12 foot garden plot).

Make auxiliary tools available. Provide calculators, graph paper for aligning numbers, or templates for tracing geometric shapes.

Production

Because math difficulties can affect a child's performance and ability to get work done, the following strategies are designed to help children improve their organization skills, work habits, and overall production.

Use assignment books. Teach children to use assignment books and "To Do" lists to keep track of their short- and long-term assignments, tests, and quizzes. Use peers to help monitor other children's assignment books. Most schools have a "homework hotline" on voicemail or homework posted on the school Web site. These resources provided by the school can help you support a student who does not yet record assignments consistently without reminders.

Provide models of assignments and criteria for success. Give children a clear sense of how a final product might look by showing examples and sharing exemplary products (such as providing a workbook of sample problems completed correctly). You might make work from last year available and draw the children's attention to specific qualities of the work (for example, "Notice how lining up the columns makes the problem easier to understand."). Do not, however, compare children's work with that of peers or siblings.

Build in planning time. Give children five minutes of planning time before beginning an assignment. Provide guidance in effective planning when necessary.

Use stepwise approaches. Require children to break down tasks into parts and write down the steps or stages. Compile steps of frequent tasks into a notebook for easy reference during work assignments. For long-term assignments, provide a due date for each step of the assignment.

Teach proven strategies. Provide children with specific age-appropriate strategies to use in checking work. For example, use TIPS: **T**hink (read and paraphrase), **I**nformation (what numbers and information do you need in order to solve the problem?), **P**roblem (write equation), **S**olve. Children can create a reminder card to keep on their desk or in their assignment book for quick reference to the strategy.

Stress the importance of organization. Have children preview an assignment and collect the materials they will need before starting it. Guide children in keeping their materials and notebooks organized and easily accessible. In middle and high school, conduct intermittent "notebook checks" and grade organization and completion. At the beginning of the school year and a week before each check, give a list of requirements. Emphasize the positive impact that organization and preplanning will have on the completed project or assignment. By grading organization, you will emphasize its value in the learning process.

Let children wait to turn in work. The day before an assignment is due, have children review their work and check it with a parent. This will give the children enough perspective to catch errors or add more details and produce

better results in the end.

Encourage self-evaluation. Set a standard of work quality or criteria for success for children to follow, and allow them to self-assess the quality of their work before turning it in. If the grade matches the child's appraisal, give extra points for good self-assessment. Rubrics are one way for students to assess their own work.

Set goals and record progress. Have children set a short-term goal, such as completing all homework for the week. Record their daily progress toward the goal for children to observe. Graphic recording, such as plotting their own line graphs, may be particularly reinforcing for some children. Reward improvement at home.

Practice estimating. Children may benefit from estimating answers to math problems and science experiments. Stress the real-life benefits of estimating and understanding what the correct answer might look like.

Eliminate incentives for frenetic pacing. Remove any positive reinforcement for finishing first. State the amount of time a task should take. This will slow down children who work too quickly and will speed up children who work too slowly.

Provide consistent feedback. Create a feedback system so children understand which behaviors, actions, or work products are acceptable and which are not. Use specifics to praise good work and recognize when children use strategies effectively. Say, for example, "I like the way you drew a table to help explain the problem," or "Asking to take a break really seemed to help you come back and focus."

Try a mentor. Some children may benefit from a mentor who will work with them to analyze their academic progress, brainstorm alternative strategies, and provide recognition of progress. The mentor must be seen as credible, and may be an individual from either inside or outside the school.