Math Interventions

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Core Math Curriculum

- Common design flaws that create barriers for success are: 1) a spiraling curriculum, 2) the rapid introduction of new concepts before previously introduced concepts are mastered, 3) insufficient examples and explanations to support new learning, and 4) insufficient practice (Hardy, S. 2005).
- Three keys of mathematics curriculum:
  - **Conceptual Knowledge,** often referred to as "mathematical sense," is the knowledge of mathematical concepts and ideas that transcend the boundaries of a specific problem.
  - **Procedural Knowledge** is the knowledge of basic skills or the steps needed to solve a problem.
  - **Procedural Flexibility** is the knowledge of the many ways to solve a problem and the ability to select an appropriate strategy.

Key Questions to Evaluate the Core Curriculum

- Are the objectives observable and focused on “big ideas”?
- Does the program use a strand instead of a spiral design?
- Is there a balance between computation and problem-solving?
- Is strategy instruction taught explicitly, strategically and sequentially?
- Are appropriate strategies selected that are generalizable?
- Are adequate examples provided for practice and review?
- Are there opportunities for discrimination practice?
- Is scaffolding used, including modeling and the gradual fading of teacher support?
- Are assessments linked to and aligned with instruction?
- Are placement assessments provided?
- Are there recommendations for content acceleration and remediation?

  – (Engelmann & Carnine, 1991; Harniss, Carnine, Silbert & Dixon, 2002; Montague & Jitendra, 2006)

Considerations for Curricular Content for Supplemental Instruction

- The National Council for Teachers of Mathematics (www.nctm.org) has developed a set of “Focal Points” for each grade level that represent the key concepts required for developmental success in mathematics.
- In a tiered system of support, with limited time and resources, it is proposed to narrow the focus of the interventions to standards that are critical in the sequence of learning mathematics.

Focus Points

- The following chart depicts the predictive concepts and skills that students must know and be able to perform for success at the next grade level

(Gersten, Beckmann, Clarke, Foegen, Marsh, Star & Witzel, 2009)

Grade	Focus Points
Kdg.	• Represents, compares, and orders whole numbers and joins and separates sets. (Num.) • Describes shapes and space. (Geo.) • Orders objects by measurable attributes. (Geo.)
1st Grade	• Develops understandings of addition and subtraction and strategies for basic addition facts and related subtraction facts. (Num.) • Develops an understanding of whole number relationships, including grouping in tens and ones. (Num.) • Composes and decomposes geometric shapes. (Geo.)
2nd Grade	• Develops an understanding of the base-ten numeration system and place-value concepts. (Num) • Develops quick recall of addition facts and related subtraction facts and is fluent with multi-digit addition and subtraction. (Num) & (Alg.) • Develops an understanding of linear measurement and facility in measuring lengths. (Geo.)
3rd Grade	• Develops understandings of multiplication and division strategies for basic multiplication facts and related division facts. (Num. & Alg.) • Develops an understanding of fractions and fraction equivalence. (Num.) • Describes and analyzes properties of two-dimensional shapes. (Geo.)
4th Grade	• Develops quick recall of multiplication facts and related division facts and fluency with whole number multiplication. (Num. & Alg.) • Develops an understanding of decimals, including the connections between fractions and decimals. (Num.) • Develops an understanding of area and determining the areas of two-dimensional shapes. (Geo.)
5th Grade	• Develops an understanding of and is fluent with division of whole numbers. (Num. & Alg.) • Develops an understanding of and is fluent with addition and subtraction of fractions and decimals. (Num.) • Describes three-dimensional shapes and analyzes their properties, including volume and surface area. (Alg. & Geo.)
6th Grade	• Develops an understanding of and is fluent with multiplication and division of fractions and decimals. (Num.) • Connects ratio and rate to multiplication and division. (Num.) • Writes, interprets, and uses mathematical expressions and equations. (Alg.)

Principles for Selection of Supplemental Curriculum Materials

1. Instructional explicitness.
2. Instructional design that eases the learning challenge.
3. A strong conceptual basis for procedures that are taught.
4. An emphasis on drill and practice.
5. Cumulative review as part of drill and practice.
6. Motivators to help students regulate their attention and behavior and to work hard.

(Fuchs, 2009)

Resources for the Selection of Supplemental Curriculum Materials

- *Washington State Program Review Report: K-12 Mathematics Diagnostic-Intervention Programs*
  - www.k12.wa.us/CurriculumInstruct/Mathematics/default.aspx
- *Considerations for Selecting a K-12 Supplemental Mathematics Diagnostic Intervention Program*
  - www.kentuckymathematics.org
- Ideas That Work, USDE, Office of Special Education, or What Works Clearinghouse, USDE, Institute of Education Sciences, can be found at www.ed.gov.
- Curriculum Chart Handout

Considerations for Supplemental Curriculum for Intensive Instruction

- Use of same materials as for supplemental instruction that are matched to the needs of the students and the content.
- Computer based programs are supported by research.
- Number Worlds and Ramp Up are examples of programs supported by research.
- Regardless of the materials used, spend 10 minutes each day to build automaticity of math facts (Gersten, Beckmann, Clarke, Foegen, Marsh, Star & Witzel, 2009).

Instructional Elements

- Alignment to state standards.
- Questioning and discussion strategies.
- Link experience and background knowledge to the abstract.
- Provide for interactions and considerations of various problem solving models with varied student groupings.
- Strategic use of manipulatives, calculators and computers.
- Formative assessments to plan for adjustments/modifications.
- Provide differentiated instruction to respond to student needs.

(National Research Council, 2001; National Mathematics Advisory Panel, 2008)

Recommendations for Instruction

- Teach students using explicit instruction on a regular basis.
- Teach students using multiple instructional examples.
- Have students verbalize decisions and solutions to a math problem.
- Teach students to visually represent the information in the math problem.
- Teach students to solve problems using multiple/heuristic strategies.
- Provide ongoing formative assessment data and feedback.
- Provide peer-assisted instruction to students.

(*National Mathematics Advisory Panel, 2008)*

Instructional Design Principal for Students with Learning Difficulties

1) Big ideas
2) Conspicuous strategies
3) Efficient use of time
4) Explicit instruction of strategies
5) Adequate practice and review

(*Carmine, 1997)*

Instructional Strategies: Adapting Materials

- Adapted Texts
  - Highlight key concepts.
  - Rewrite in more simple terms.
  - Allow for language differences.
- Structured Worksheets
  - Use vertical lines or graph paper to help the student keep math problems in correct order.
  - Highlight symbols, different colors.
  - Use different colors for rules, relationships.

Interventions for mathematics at the supplemental level

- Instructional explicitness
- Instructional design that eases the learning challenge
- A strong conceptual basis for procedures that are taught
- An emphasis on drill and practice
- Cumulative review as part of drill and practice
- Motivators to help students regulate their attention and behavior and to work hard

(Fuchs, 2009)

Tier 2 Supplemental Instruction

- Research advocates implementing Tier 2 within the regular classroom structure by extending core mathematics time and using grouping techniques.
- Extending core time and using student groupings along with other research-based instructional strategies, has shown to be effective in improving students' math skills.

(Fuchs & Fuchs, 2001)

Tier 2 Structure

- It is recommended that the optimal teacher to student ratio for supplemental instruction be 1:3 to 1:5, based on MTSS Reading recommendations.
- Peer assisted learning structures can accommodate a higher teacher to pupil ratio.

Tier 3: Intensive Instruction

- Intensive instruction may use many of the same instructional strategies as Tier 2.
- Intensive instruction requires significantly more time; though can be delivered within the regular classroom or in a pull-out format.
- The optimal teacher to student ratio is 1:1 to 1:3; however larger ratios may be effective if using peer assisted learning strategies.

Tier 3: Intensive Instruction

- More important than time or size of groups, the following characteristics describe the intensive level, which respond to individual student need:

1. High rates of active responding.
2. Careful matching of instruction with the individual student's skill levels.
3. Instructional cues, prompts and fading that support approximation to correct responses.
4. Detailed task-focused feedback.

Fuchs & Fuchs, 2001

Recommendation for Scheduling

Master Schedule

- 45 - 60 minutes for core curriculum
- 15 - 30 minutes for supplemental instruction time at least three times a week beyond the core
- 30 - 40 minutes of intense mathematics instruction time beyond the core

✓ *More research is needed regarding time and group size.*

Instructional Design Comparison Study

- A meta-analysis reviewed interventions for students with math learning difficulties for learning numeracy, basic skills and problem solving. **Self-instruction** was found to be the most effective for problem-solving and **direct instruction** for basic skills. **Computer-assisted instruction** was most effective for practice, building automaticity and providing immediate feedback. **Peer teaching** was not as effective as teacher instruction for students with learning disabilities.
- The study noted that more traditional approaches were found to be more effective; however limited research has been conducted for reform math models.

(Kroesberger & Van Luit, 2003)

Instructional Strategies for Computer Assisted Instruction (CAI)

- Effective for building automaticity and fluency of basic facts.
- Employs virtual “manipulatives” and “think-alouds” for improving number sense.
- Supports problem-solving through visual and symbolic expressions.
- May alleviate issues with scheduling but does not alleviate the involvement of a highly skilled teacher.
- It is most effective when combined with hands-on experiences and concepts previously taught.

Concrete, Representational (Semi-concrete), and Abstract Sequences of Mathematics Instruction (CRA or CSA)

- Students perform better and have a more positive attitude toward math when provided with concrete materials by teachers knowledgeable about their use (Sowell, 1989).
- Maccini & Gagnon (2000), set forth the following guidelines for using manipulatives as an intervention:
  - Manipulatives are connected to the concept and to students’ developmental level.
  - Use a variety of manipulatives for concept exploration and attainment.
  - Provide verbal explanations and questions with demonstrations.
  - Provide opportunities for student interaction and explanation.
  - Encourage manipulatives and strategies across settings.
  - Program for transition from concrete to symbolic representation.

Instructional Strategies: Cognitive Strategy Instruction

- Montague (1997), cognitive strategy instruction provides
  - scaffolding with systematic modeling of active thinking,
  - interactive dialog among peers,
  - schedule of practice with transfer tasks, and
  - routines for students to verbalize their rationale for selecting a particular strategy.

Examples of Cognitive Strategy Instruction

- Schema-Based Strategy Instruction
- Multiplication Attack Strategy
- Subtraction Strategies
- Cover, Copy and Compare
- Rules to Lower the Amount of Memorization in Math

Instructional Strategies: Mnemonics

- Draw and Fast Draw
- Slobs and lamps
- STAR
- 4Bs
- SASH
- MAMA

Instructional Strategies: Meta-Cognitive Strategies

- Thinking about the thought processes involved in solving problems is the basis of meta-cognitive strategies. Examples include:
  - Self-Monitoring (Self-Regulating) Strategies
  - Self-Checking
  - Structured Organizers

Instructional Strategies: Peer Assisted Learning Strategies

- The most important ingredient for success in using peer assisted learning is that teachers must teach parameters and processes, as well as the roles each student plays in the process.
  - The teacher trains students on the process of peer tutoring and role of tutor or tutee.
  - The teacher assigns partners.
  - Students retrieve tutoring materials prepared by the teacher.
  - Students follow a highly structured tutoring procedure; tutors present material previously covered by the teacher and provide feedback to the tutee.
  - Students switch roles after the teacher's signal. The tutee becomes the tutor.
  - The teacher circulates around the room, monitoring and providing feedback.

Taken from www.k8accesscenter.org.

Examples of Peer Assisted Learning

- Peer Assisted Learning Strategies (PALS)
  - A highly structured format, using PALS combined with Curriculum Based Measurement (CBM) assessment strategies is designated as an "effective practice" by the Program Effectiveness Panel for the US Department of Education (Fuchs & Fuchs, 2001).
- Reciprocal Peer Tutoring - Math (RPT-M)
  - Designed to assist students working in small groups (Fantuzzo, King & Heller, 1992)

Instructional Strategies: Problem Solving Strategies

- George Pólya's 4-step process (Van de Walle, 1998):
  1. Understanding the problem
  2. Developing a plan to solve the problem
  3. Carrying out the plan
  4. Looking back to be sure the answer solves the problem
- FOPS – (Jitendra & Star, 2008) is a schema-based strategy. A diagram and self-monitoring checklist is provided:
  1. Find the problem type
  2. Organize the information using diagrams
  3. Plan to solve the problem
  4. Solve the problem

Problem Solving Strategies, cont.

- Verbal Rehearsal – A mnemonic devise (Montague, 2006), helps students recall the steps. RPV-HECC stands for:
  - Read for understanding
  - Paraphrase in your own words
  - Visualize by drawing a picture or diagram
  - Hypothesize and make a plan
  - Estimate to predict the answer
  - Compute the problem
  - Check to make sure the steps were followed and the answer is correct.
- Solve It! (Montague, 2007) adds self-monitoring questions for each step SAY, ASK, CHECK.

Problem Solving Strategies, cont.

- MAPS – A schema-based model developed by Judy Burgess for the Shawnee Mission School District. The model provides "anchor" problems of 11 different schema types. The 4-step process:

1. Mark all information
2. Ask what is happening (schema)
3. Problem or process that you use to find the answer
4. Solution with label

(Amthuer, Burgess, Thornton, & Winkler, 2004)

Additional Instructional Strategies

- Analyzing Student Work
  - Error analysis to determine frequency and type.
- Automaticity of Basic Facts
  - Research supports spending 10 minutes daily on automaticity.
- Scaffolding
  - Teacher directed instruction that gradually releases to student directed instruction.
- Visualizing Strategies
  - Requires teacher direction; there is often a mismatch between student drawings and the schematic representation required in the problem.

How to Implement Learning Strategies in the Classroom

Teachers should—

- have a range of strategies from which to choose;
- practice new strategies until they are comfortable with them;
- explain why learning strategies are important;
- match strategies with the material;
- model a variety of strategies in each class;
- consistently encourage students to use learning strategies;
- monitor students' use of learning strategies; and
- encourage generalization to other subject areas.

AND . . . . .

How to Implement Learning Strategies in the Classroom

Administrators should—

- provide professional development about learning strategies and
- monitor teachers to be sure that learning strategies are taught.

(Adapted from Learning Strategies and Mathematics, The Access Center)

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Intervention Curriculum Chart

Source	Resource	Description	Assessment	P-K	K-3	3-6	6-9	9-12	Research Notes
www.gse.buffalo.edu	***Building Blocks Curriculum SRA***	TRIAD 3 components 1.curriculum or goal 2.developmental readiness 3. technology Teacher and student resources. Technology emphasis.	Technology embedded monitoring tool and data management	x	x	x			U. of Buffalo - TRIAD research small scale study. Positive results at Pre-K – ESL, low income. Upper grades used as an intervention. What Works Clearinghouse.
www.sraonline.com	***Connecting Math Concepts 2003***	Direct instruction	Placement and mastery tests	x	x	x	x		Based on direct instruction research. Mixed results
www.sraonline.com	***Corrective Math 2005***	Grades 3-Adult Direct Instruction Seven Modules Computer program to create additional materials.	Pre-skill and Placement			x	x	x	Based on direct instruction research. Mixed results
www.sraonline.com	***DISTAR Arithmetic 1992***	Hard to reach students K-3 Level I and II. Direct instruction. Sub-skills, sequenced, single strategy.	Placement and mastery tests	x	x				Based on direct instruction research. Mixed results
Wright group McGraw Hill	***Everyday Mathematics***	This is a core math curriculum for K-6 grades.			x	x			Meets effectiveness standards for What Works Clearinghouse
www.tomsnyder.com	***FASTT MATH***	Automaticity of basic facts.	Assessment included in program: screening for facts, progress monitoring, diagnostic for facts.		x	x	x	x	Program design is based on over 20 years of research on retrieval and automaticity of facts. Research on using computer based program by Hasselbring in 1986 and 1988. This program developed by Hasselbring and Goin in 2005 (Scholastic Research and Results).

Source	Resource	Description	Assessment	P-K	K-3	3-6	6-9	9-12	Research Notes
Center on Accelerating Student Learning (CASL) http://kc.vanderbilt.edu/casl	***Hot Math***	Helps students understand the underlying structure of the problem type, basic schema.	Unknown		x				Developed and researched by Vanderbilt University, CASL. Positive results.
www.icanlearn.com	***I CAN Learn Algebra and Pre-Algebra***	Interactive, self-paced, mastery-based system software.	Unknown			x			Meets effectiveness standards for What Works Clearinghouse
http://illuminations.nctm.org	***Illuminations NCTM***	Web-based lessons & activities; links to other websites	Embedded monitoring tool	x	x	x	x	x	Sponsored by NCTM
http://www.k12.wa.us/CurriculumInstruct/Mathematics/default.aspx	***K12 Mathematics Intervention Report State of WA***	Comprehensive review of diagnostic and intervention programs also computer-based programs	Part of evaluation of program		x	x	x	x	Group of educators from state of WA evaluated programs. Contains a program evaluation tool that can be adapted by others.
http://fastrabbitsoftware.com/mathflash.htm	***Math Flash***	Improve automatic retrieval of math facts.	Embedded		x				Created by Fuchs, Hamlett and Powell (2003). Research conducted by Vanderbilt University. Positive results.
www.americaschoice.org	***Math Navigator***	Focus on revising student misconceptions of students working at grade level but falling behind. Tier 2. 18 stand alone modules each with 20 sessions. K-6, 30 min. with teacher or para; 7-9, 45 min. with math teacher. On line tutoring option.	Diagnostic screener. Pre and Post tests. Varity of formative assessments for monitoring.		x	x	x	9	Based on National Advisory Panel research of effective instruction. ELL considerations. Results noted for New Mexico, Bethel school district in WA, and other individual schools.

Source	Resource	Description	Assessment	P-K	K-3	3-6	6-9	9-12	Research Notes
http://mathrecovery.org	***Math Recovery***	Intervention program to work one on one 30 min. a day for a 10 to 15 week period. Teachers trained to deliver instruction.	Diagnostic individual assessment; ongoing monitoring		x				Based on and modified to reflect current research studies. Kentucky Center for Math studies.
www.nctm.org	***Mathematics Assessment Sampler series NCTM***	Multiple choice format with information on adapting to extended response.	Books and resource	x	x	x	x	x	Aligned to NCTM Standards
http://coe.jmu.edu/mathvidsr/Default.htm	***MathVIDS***	Helps teachers with students struggling in math. Research supported strategies, math disabilities and meta-cognition strategies. Lesson plans include scaffolding.	Unknown		x	x	x		Developed by David Allsopp. Provides researched activities.
http://matti.usu.edu/nlvm/nav/index.html	***National Library of Virtual Manipulatives for Interactive Mathematics***	Virtual manipulatives sorted by grade and content aligned to NCTM standards.	Unknown		x	x	x	x	Developed at Utah State University and funded by NSF.
www.nctm.org	***Navigations series NCTM***	Activities books and CDs that support the NCTM Principles and Standards	Unknown	x	x	x	x	x	Based on compiled research on standards based instruction and effective mathematics instruction.
www.sraonline.com	***Number Worlds (for use with Building Blocks software program)***	PreK-1 whole class prevention 30 week course. Grades 2-6 intensive intervention for one or more grade levels behind with six 4-week units per grade. 45 to 60 min. daily.	Placement. Weekly and Unit tests monitor progress. Open response or multiple choice.	x	x	x			Cited research in Kentucky schools Gains in primary grades. One school in CA showed positive gains 1-6 in ELL summer school. Aligned to research practices.

Source	Resource	Description	Assessment	P-K	K-3	3-6	6-9	9-12	Research Notes
http://www.cec.sped.org	***Pirate Math***	Tutoring software program aimed at 2nd and 3rd grades for problem solving strategies.	Unknown		x				Created by Fuchs, Hobbs, Seethaler & Powell). Research conducted by Vanderbilt University, CASL. Positive results.
www.americaschoice.org	***Ramp Up***	Students far below grade level 2 to 3 years behind. Tier 3. 90 min. daily. Two courses - Pre Algebra and Algebra.	Pre and post tests. Progress monitoring assessments and reviews. Summative.				x	x	Based on National Advisory Panel research of effective instruction. ELL considerations. Results noted for school districts in Ohio and New Jersey and individual school districts.
www.sraonline.com	***Real Math SRA***	Complete Curriculum	Component	x	x	x			Research by company. Positive results.
http://saxonpublishers.harcourtachieve.com	***Saxon Middle School Math***	This is a core math curriculum for 6th-9th grades.					x		Found to have positive effects on math achievement in What Works Clearinghouse

Implementing Cognitive Strategy Instruction & Developing Self-Regulated Learners
www.unl.edu/csi/teachingstrategy

Cognitive Strategy Instruction is a very broad subject.

Definition of a Strategy

When discussing strategies it is helpful to dissect the definition. Strategies are: Goals directed and consciously controllable process that facilitates performance.

The key parts are:
- Goals directed - intended to perform a definite function
- Consciously controllable processes

"This how I am doing_____ and this is why_____." This is essential, if the strategy is to be self-regulated. It would not be possible to regulate something that was not conscious.

Facilitate performance - strategies are processes that when matched to task requirements, improve performance. You can do things better, easier, and quicker when you use a strategy.

In essence, a strategy is simply a tool used to accomplish a task. A strategy concentrates and enhances effort. Just as using a lever allows us to move heavy objects more easily, so strategies allow for enhanced performance of academic tasks.

Strategic approaches to tasks separate poor learners from more effective learners. While the use of strategies is common among successful learners the opposite is true for struggling learners and in particular students with learning disabilities. These students may not develop effective strategies, or may use ineffective or inappropriate strategies.

Strategies run the gamut from simple to highly complex. Educators need to look critically at any instructional strategy before they choose to implement it, weighing both pros and cons of the strategy. All this may make strategies sound complicated, but that's not necessarily the case.

Model of Implementation

The implementation model provided follows Harris and Graham's (1996) Self-Regulated Strategy Development model. The goal of SRSD is to make the use of strategies habitual, flexible, and automatic.

Stage 1: Develop and Activate Background Knowledge

Developing background knowledge sometimes seems so obvious that it is often overlooked. Struggling learners may lack essential background knowledge or preskills necessary to successfully complete a task or use a strategy. In many instances, what

knowledge a student does have is often fragmented. Students must have mastered prerequisite skills to effectively use a strategy.

While developing background knowledge it is necessary to initially define the basic skills needed to perform the strategy, and to make certain that the students understand the terms used in the strategy. In order for students to understand the strategy they need to understand its most basic components.

The best way to identify the basic terms and skills necessary for the strategy is to do a task analysis. The task analysis will help teachers to determine whether or not students possess the prerequisite skills necessary perform the strategy.

After the task analysis is complete there are many ways that teachers can check students' skills. These include observing student performance, using curriculum-based measures, or simply asking students. Often, instructors will already possess knowledge of student pre-skills. Skill deficits should be addressed prior to introducing the new strategy.

Stage 2: Discuss the Strategy

Discussion of the strategy is a more involved process than merely going through the steps of a strategy. A major goal of strategy instruction is to bring students to the point where they are self-regulated. In order for this goal to be achieved, students need to be actively involved and allowed ownership in the process.

Teachers will need to "sell" the strategy and get students to "buy in." Having the students believe in what they are learning will enable them to be more actively involved, which is the first step in self-regulation. If a student does not want to use a strategy it is fair to assume that they will not. Teachers need to be excited, committed and energized so that students will be too.

The use of the strategy should be an easy "sell", it will result in improved academic performance. Provide students with examples of how this strategy or other strategies have improved student performance in the past, and even how strategies have helped you in the past. This may not be enough; you will most likely need to find what motivates your particular students. For example: getting work done so that they can go outside for recess, no homework, making parents proud, impressing friends, or making the honor roll.

During this stage it is appropriate for the teachers to explain the benefits of using the strategy; discussing and even providing examples of current performance. Teachers should ask students questions, and ask them how confident they feel in the particular subject or skill being discussed. Then explain how learning the strategy can improve their performance.

The final part of this stage is introducing students to the steps of the strategy. Strategy steps should be explained one-by-one. Typically this is where teachers begin, but the SRSD model has allowed much of the ground work to already be laid at this point.

Throughout this process teachers should be monitoring their students' understanding. Part of this process is to work in cooperation with the students and in doing so you must make sure that they are keeping up and understanding what is being explained.

Stage 3: Model the Strategy

Purpose of modeling is to expose students to the thought processes of a skilled learner. Good modeling goes well beyond merely presenting the steps in a strategy. It provides students with the "why" and "how" of various strategy steps. It also demonstrates that student effort is essential, and shows that strategy use results in better performance.

By modeling, a teacher can show not only what to do, but what to think as well. This process is called a 'think aloud'. A think aloud goes beyond just listing the steps in a strategy. While this is useful, it is insufficient. Students need to see the the metacognitive process involved in understanding and using the strategy. By the teacher expressing their thought process while using the strategy the student is able to see how a successful learner uses the strategy and thinks through it.

The process involved in a think aloud is much more complex than it may initially seem. For expert learners making the covert overt is extremely difficult and requires a significant amount of practice and preparation.

Stage 4: Memorize the Strategy

It is critical that the students commit the strategy steps to memory. Memorizing the steps is crucial, because we want students to be able to focus on the task not on remembering the steps of the strategy. Students have a limited amount of cognitive processing capacity, and if that capacity is consumed with remembering the steps of the strategy it will be difficult or impossible to focus on the task itself.

Memorizing the strategy steps is something that we should not just work on once or twice; we need to be constantly reinforcing the memorization of the strategy steps, and in various contexts so that it becomes second nature to students.

There are many ways to help students memorize the steps of the strategy; the key is repetition and variation. The more practice they get in a variety of settings and situations the more successful they will be at memorizing the strategy.

A teacher could use different activities or games to teach memorization of the strategy: for example, they could use round-robin activities or a ball-toss game.

Memorizing a strategy goes well beyond parroting back the steps of the strategy. Students need to know and understand what is involved with each step in the process.

Stage 5: Support the Strategy

Supporting the strategy is arguably the most important step in the SRSD implementation process. Supporting the strategy is done by using a process called scaffolding. Scaffolding involves teachers initially performing all or most of a task, while increasingly shifting responsibility of performance to the student. This, like the scaffolding used when constructing a building, provides support. Teachers need to provide that support to students when using the strategy. With scaffolding, it is possible for a gradual transfer of strategy performance from teacher to student. Students need to be given adequate time and support to master the strategy.

The process of scaffolding is analogous to teaching a child to ride a bike: When teaching a child to ride a bike, first you put on training wheels, and let them practice with a lot of support from the training wheels. Then, you move the training wheels up, for less support and more practice balancing and riding a little bit more independently. Next, you would take the training wheels off and run behind the child holding the seat. Eventually, you would completely let go and let the child independently with out any support, just your supervision.

In the supporting stage of the SRSD implementation model teachers need to provide whatever support students need to move from current performance to independent use of the strategy. Teachers and students work together to master the performance of a strategy. Teachers need to be aware of the child's capabilities and their needs in order to achieve an improved level of performance.

Supporting the strategy may include:

- Working collaboratively on tasks while gradually fading help
- Putting students into small groups
- Remodeling the strategy
- Prompting the particular use of a step
- Providing corrective feedback

Collaboration between teachers and students is extremely important in the SRSD process. Collaboration gives the teacher an opportunity to check for student understanding and fill in any necessary information the student may be lacking. It also gives the teacher another opportunity to make sure that the students possess the skills necessary to complete the task successfully. If necessary, teachers may need to go back and teach some pre-skills. This is part of the flexibility of the SRSD model.

Stage 6: Independent Performance

It is important to remember, the goal of strategy instruction is not for the student to use the strategy explicitly as taught, but for improved academic performance. Often, students may adapt the strategy to meet their needs. This is an acceptable part of the model as long as the teacher is confident the strategy is still successful in completing the task.

Independent performance does not mean that a teacher's job is done. Teachers must still monitor students' use of the strategy to ensure they are using the strategy properly.

Evaluating instruction should always be part of any curriculum. With current educational initiatives such as state standards and competency tests, accountability is in the forefront of education.

Evaluation and assessment is necessary to know whether or not learning has occurred. CSI facilitates meaningful assessment; the interactive, collaborative nature of the process allows teachers to easily assess changes in students' cognition, affect, and performance.

Considerations When Evaluating Cognitive Strategy Instruction

At a minimum, teachers should know:

- If students are actually using the strategy
- Whether or not its use has had a positive effect on performance
- If students see the strategy as being valuable and manageable

Student Generalizations

It is also important to assess students' use of the strategy over time and in new situations. Do not assume that students will continue to use a particular strategy or successfully adapt it to new situations. Teachers should actively promote the use of the strategy with their students, as well as, with their colleagues. Students will not automatically generalize strategies in different situations; they must be programmed to do so.

When evaluating the strategy instruction process, teachers should collaborate with their colleagues, get feedback, and find out if the students are utilizing the strategy in other content areas in a successful manner. A strategy will not be completely successful if students do not generalize it and use it in various, appropriate, situations. To promote the strategy use, other content area teachers need to be made aware of the strategy steps and how the strategy works. This will enable them to use the same kind of language and prompt the students to use the strategy when appropriate.

Cover, Copy, and Compare: Increasing Math Fluency

Appropriate Grade Level: Elementary and middle school students working on basic math facts.

Brief Description:
Students learn a five-step procedure that gives them increased opportunities to respond to mathematics material and self-evaluate their responses. Cover, Copy, and Compare is an efficient strategy for increasing accuracy and speed in basic math facts, requires little student training or teaching time, and can be used with individuals, small groups, or entire classes.

Materials Needed:
- Training sheets of 10 math problems, with problems and answers listed down the left side of the paper, one per student, one to three sets per session
- Assessment sheets with the same math problems listed down the left side, without answers
- 3" by 5" index cards, one per student
- Stopwatch or watch with second hand for teacher (optional)
- Overhead projector and transparency example of training sheet (optional)

Procedure:
1. Evaluate how well students are currently doing by calculating percent correct scores on math worksheets for 5-10 days, counting the number of correct digits on problems, or administering Curriculum Based Mathematics Probes to the entire class or a selected group of students.
2. Give training sheets to students. If desired, use overhead projector displaying a transparency of a training sheet during the introductory session.
3. Conduct a training session:
    a. Silently read the first problem and the answer on the left side of the paper.
    b. Cover that problem and answer with an index card.
    c. Write the problem and answer from memory on the right side of the page.
    d. Uncover the problem and answer on the left side to check the written response.
    e. Evaluate the response.
    f. If the problem and answer are written incorrectly, repeat the procedure with that item before proceeding to the next item.
    g. Repeat this procedure with the rest of the problems on the sheet.
4. After demonstrating these steps on the chalkboard or with the overhead projector, have students complete one or more training sheets and provide corrective feedback as needed.
5. Daily or several times a week, provide students with sets of training sheets and have them follow the Cover, Copy, and Compare procedure.
6. Once or twice a week, administer the assessment sheets that correspond to the training sheets. If desired, time these assessment sessions.

7. When students reach mastery level on one set of problems, provide them with another set. Mastery level is defined as 90% or better accuracy and/or 40 digits correct per minute.
8. Evaluate the effectiveness of the intervention by repeating the first step and comparing the results.

Comments/Tips:
This strategy works best for basic math facts in addition, subtraction, multiplication, and division.

References:
Rathovan, Natalie (1999). *Effective School Interventions*. Guilford Press: New York, NY.

Lee, M.J., & Tingstrom, D.H. (1994). A group math intervention: The modification of cover, copy, and compare for group application. *Psychology in the Schools, 3,1* 133-145.

Skinner, C.H., Turco, T.L., Beatty, K.L., & Rasavage, C. (1989). Cover, copy, and compare: A method for increasing multiplication performance. *School Psychology Review, 18,* 412-420.

Draw & Fast Draw

The draw strategy is used for teaching students with special needs to solve multiplication facts that are not yet committed to memory.

Discover
• Discover the Sign
• The student looks at the sign to figure out what operation to perform
Read
• Read the problem
• The student says the problem aloud or to himself or herself
Answer
• Answer, or draw, and check
• The student thinks of the answer or draws lines to figure out the answer
• The student checks his or her drawing and counting
Write
• Write the answer
• The student writes the answer in the answer space

The FastDraw strategy can help students make the transition from pictures to abstract numbers. First use Fast then use draw.

Find
• Find what you are solving for
• Students look for the question in the problem
Ask
• Ask yourself, "What are the parts of the problem?"
• Students identify the number of groups and the number of objects in each group
Set
• Set up the numbers
• Students write the two numbers in the problem in a vertical format
Tie
• Tie down the sign
• Students add the multiplication sign to the problem

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.

Improving Math Performance with Explicit Timing

Appropriate Grade Level: Elementary and middle school students working on basic math facts.

Brief Description:
In order to increase fluency in basic math facts, math seatwork is timed in 30 minute intervals. Students will become more automatic in math facts and thus become more proficient in solving math problems. The use of explicit timing has been demonstrated to increase the rate of problems worked correctly while simultaneously maintaining very high levels of accuracy.

Materials Needed:
- Stopwatch or watch with second hand
- Kitchen timer with a bell
- Sets of math worksheets with 100 basic problems (addition, subtraction, etc.), with problems on one side only and sheets stapled together, one set per student per session

Procedure:
1. Assess the current math fluency of students by calculating the correct-problems-per-minute rate or accuracy scores on math worksheets for a selected group of students for 5 to 10 days.
2. At the beginning of a mathematics seatwork period, tell students that the work period is 30 minutes long (or the available number of minutes) and that you will be timing the period as a way of helping them improve their math performance.
3. Tell students that you will set the timer for the amount of time in the period, and that you will also be timing them with a stopwatch in 1-minute timings.
4. At the beginning of each timing, say: "Pencils up, ready, begin!" to signal students to begin working.
5. At the end of the 1-minute interval, say "Stop!" and have students draw a line after the last problem answered. Repeat this procedure throughout the 30-minute period until the last timing is completed.
6. When the 30-minute timer rings, announce that the work period is over. Teach students to stop when the timer rings, even if they are in the middle of a 1-minute timed period.
7. Evaluate the intervention by repeating the first step and comparing results.

Comments/Tips:
Because it is not possible to have 30 1-minute timings within a 30-minute period, the actual time available for students to work is always less than 30 minutes.

References:
Rathovan, Natalie (1999). *Effective School Interventions.* Guilford Press: New York, NY.

Van Houten, R., & Thompson, C. (1976). The effects of explicit timing on math performance. *Journal of Applied Behavior Analysis, 9,* 227-230.

Sequence for Teaching Fractional Concepts

Appropriate Grade Level: Elementary and Middle School

Brief Description:
Suggestions for the progression in working with students on fractions and understanding concepts behind fractions.

Materials Needed:
- Fractional Models and Manipulatives
- Graph Paper

Procedure:
The student
1. Manipulates concrete models (e.g., manipulating fractional blocks and pegs)
2. Matches fractional models (e.g., matching halves, thirds, and fourths)
3. Points to fractional model when name is stated by another (e.g., the teacher says "half" and the student selects a model of "half" from several distractors)
4. Names fractional units when selected by another
5. Draws diagrams or uses manipulatives to represent fractional units
6. Writes fraction names when given fractional drawings
7. Uses fractions to solve problems

Reference:
Bos, C.S., & Vaugh, S. (2002). *Strategies for Teaching Students with Learning and Behavior Problems, 5th Edition*. Boston: Allyn and Bacon.

Multiplication Attack Strategy

This Math strategy is designed help to teach multiplication facts. Before using the strategy it is essential that the teacher determine what the learner has to do to implement the strategy and determine whether or not the student possesses the necessary skills; this can be done by using a task analysis (Figure 1).

Steps in Attack Strategy	**Example:**
1. Read the problem	2 x 5 =
2. Point to a number that you can count by:	student points to 2
3. Make the number of marks indicated by the other number.	///// (5 in this example)
4. Begin counting by the number you know how to count by and count up once for each mark, touching each mark.	"2, 4, 6, 8, 10"
5. Stop counting when you've touched the last mark.	
6. Write the last number you said in the answer space.	2 x 5 = 10

Figure 1

Preskills for Multiplication Attack Strategy

1. Say the numbers 0 to 100.
2. Write the numbers 0 to 100.
3. Name x and = signs.
4. Make the number of marks indicated by numerals 0 to 10.
5. Count by numbers 1 to 10.
6. End counting-by sequences in various positions.
7. Coordinate counting-by and touching-marks actions.

Reference:

Cullinan, D., Lloyd, J., & Epstein, M.H. (1981). Strategy training: A structured approach to arithmetic instruction. *Exceptional Education Quarterly, 2*, 41-49.

Reciprocal Peer Tutoring to Improve Math Achievement

Appropriate Grade Level: Elementary and Middle school

Brief Description:
The purpose of this intervention is to improve math performance and behavior during math instruction by means of peer tutoring, group rewards, and self-management procedures.
Students monitor their academic progress in a group context, acting as instructional partners for each other, setting team goals, and managing their own group reward contingencies. Reciprocal peer tutoring has been demonstrated to improve not only math performance but also students' perceptions of their own academic competence and self-control, and earns high satisfaction ratings from both teachers and students. The intervention takes approximately 30 minutes – 20 minutes for peer tutoring and 10 minutes for individual class drills and checking.

Materials Needed:
- Reinforcement Menus with activity rewards, one per student pair
- "Team Score Cards," consisting of 3" by 5" index cards or sheets of paper, one per student pair per week
- Stickers for team score cards
- Flash cards with math problems printed on the front and the problem plus computational steps and answers printed on the back, one problem per card, one set of cards per student pair
- Sheets of paper divided into four sections: "try 1," "try 2," "help," "try 3"
- Instructional prompt cards or sheets with specific instructions related to common mistakes in solving math problems, one per student pair
- Problem drill sheets with 10 or more problems, one per student per session
- Answer sheets for problem drill sheets, one per student per session (optional)

Procedure:
1. Assess students' current level of math performance by calculating percent-correct scores on daily math drill sheets or weekly quizzes, administering Curriculum-Based Math Probes, and/or observing students' behavior during math work periods.
2. Tell the students that they will be learning to work in teams to help each other do well in math.
3. Divide the class into pairs. Provide each pair with a Reinforcement Menu listing activity rewards. Help each pair select a reward for the day.
4. Meet weekly with each team to help the students select their team goal.
5. After each pair has chosen a team goal, have the pairs record their expected individual contribution to the team (individual goals), the sum of the individual goals (team goal), and their choice of a reward on the team score card.
6. Give a set of flash cards to each pair, and tell the students to choose who will act as "teacher" first.

7. Have the "teachers" hold up the flash cards for the students, and tell the students to work the problem on their worksheets in the section marked "try 1" while their teachers observe their work.
8. If the problem is solved correctly, the teachers praise the students and present the next problem. If the solution is incorrect, the teachers give students instructional prompts read from a prompt card and tell them to try again in the worksheet section marked "try 2."
9. If the students do not solve the problem correctly on the second try, teachers help them by computing the problem in the "help" section of the worksheet. As teachers work the problem, they explain what they are doing at each step and answer students' questions. Then the teachers tell the students to work the problem again in the "try 3" section. If teachers have trouble answering students' questions, they can ask the classroom teacher for help.
10. After 10 minutes, signal the pairs to switch roles for a second 10-minute tutoring session.
11. During tutoring sessions, walk around the room supervising and identifying strategies "teachers" can use to help their students.
12. After the second tutoring session, give each student a problem drill sheet and have students work on their own for a fixed period of time, such as 7 to 10 minutes.
13. Have students switch papers with their team partner. Have them use an answer sheet to correct their partner's work or provide the correct answers yourself as students check papers.
14. Have the pairs first determine their team's total score by counting the number correct, and then have them compare their team score with their team goal to see if they have "won" (met their goal).
15. If a team wins, give the students a sticker to put on their score card for that day. After five wins, schedule a time when the team can engage in the previously selected reward activity.
16. Evaluate the intervention by repeating the first step and comparing results.

Comments/Tips:

Rewards can also be provided on a weekly classwide basis rather than on a daily team basis when a pre-determined percentage of teams meet their goals 4 out of 5 days during the week. Deliver the rewards to the entire class on Friday.

References:

Rathovan, Natalie (1999). *Effective School Interventions*. Guilford Press: New York, NY.

Fantuzzo, J.W., King, J.A., & Heller, L.R. (1992). Effects of reciprocal peer tutoring on mathematics and school adjustment: A component analysis. *Journal of Educational Psychology, 8*4, 331-339.

Fantuzzo, J.W., & Rohrbeck, C.A. (1992). Self-managed groups: Fitting self-management approaches into classroom systems. *School Psychology Review, 21,* 255-263.

Rules to Lower the Amount of Memorization in Math

This strategy is designed to help students with some general mathematical rules. Relationships and rules are taught to assist in figuring out challenging problems. Students should be taught to recognize and use math rules and relationships along with concepts being taught.

Addition

- Any number plus zero is the number.
- Any number plus 1 is the next larger number.
- The order of numbers in an addition problem doesn't change the answer.

Subtraction

- Any number take away zero is the number.
- Any number take away the same number is zero.
- Any number take away 1 is the next smaller number.
- In subtraction, when the bottom number in the ones column is bigger than the top number in the ones column, the ten is traded. (Bigger number on Bottom means Break down the ten and trade.)

Multiplication

- Any number times 0 equals 0.
- Any number times 1 equals the original number.
- 2 times any number equals the number added to itself.
- Changing the order of the numbers in multiplication does not change the answer.

Division

- 0 divided by any number equals 0.
- Any number divided by 1 equals the number.
- Any number divided by the same number equals 1.

Reference:

Miller, S.P., Strawser, S., & Mercer, C.D. (1996). Promoting strategic math performance among students with learning disabilities. *LD Forum, 21(2), 34-40.*

Slobs & Lamps

These math strategies are designed to help students remember the regrouping process of borrowing and carrying. Slobs is used in subtraction and lamps is used in addition.

Smaller
• *Smaller.* Follow steps.
Larger
• *Larger.* Leap to subtract.
Off
• *Cross Off* the number in the next column.
Borrow
• *Borrow*, by taking one ten and adding to the next column.
Subtract
• *Subtract*.

This is how one would follow these steps with the following problem:

$$\begin{array}{r} 72 \\ -46 \\ \hline \end{array}$$

Look at the top number on the right (2) and see if it is smaller or larger than the lower number (6). If it is larger, the student will leap to subtract. If it is smaller, as in this example, the student must follow the steps. The next step is to cross off the number in the next column, which in this problem is the seven. The "B" of SLOBS stands for borrow, which is the next step. Now borrow one ten from that column by reducing the number by one and adding ten to the other number (12). The last step is to subtract the six from the twelve. Repeat the steps if there are more digits to be subtracted.

Line
• *Line* up the numbers
• This is particularly important with extensive columns of numbers and with numbers with decimal points.
Add
• *Add* the right column of numbers and ask. . .
More
• *More* than nine? If so, do more steps.
Put
• *Put* the ones below the column.
Send
• *Send* the tens to the top of the next column.

Reetz, L., & Rasmussen, T. (1988). Arithmetic mind joggers. *Academic Therapy,* 24(1), 79-82.

STAR
A Number Writing Strategy
A strategy used to assist students in recalling, reciting, and writing numerals.

Step 1: Pretest and Obtain a Commitment to Learn the Strategy
- Observation or formal assessment – the Brigance Diagnostic Inventory of Early Development (Brigance, 1978).
- After the child has written 0-9, the teacher, showing a chart of correctly formed numerals, brings the differences to the child's attention.
- Show numbers as prices to explain how unacceptable it is to make them incorrectly.
- The student can make a commitment to learning a strategy for writing numbers.

Step 2: Describe the Strategy
- Formation of numerals is taught first using multisensory experiences.
- The teacher demonstrates the formation of a selected numeral while reciting its associated saying.
- The child repeats the saying while forming the numeral:
  1. In the air with large motor movements
  2. Using sand, clay, sandpaper, crayon on paper held over a screen, and a marker
  3. Finally, pencil and paper
- Teach the **STAR** strategy for when the student is unable to recall the correct formation.
  S = Stop. Stop and ask myself what I am expected to do (for example, write the number that the teacher is saying).
  T = Think. Think of using a saying to help in forming the number.
  A = Ask. Ask myself which saying should be used for this number.
  R = Recite. Recite the saying while I write the number.
- The teacher should point out various times the STAR strategy can be used, and demonstrate each step.
- *A STAR Strategy Card* can be made with the steps of the strategy on one side and textured numerals with the saying on the other side. If the child is unable to read, a simple drawing of each step can be used instead of writing the words.

Step 3: Model the Strategy
- Demonstrate how the strategy is used, i.e.

  *I have to write a seven. I get mad when I write it backwards. I want to do it right so my mom will be proud of me. I'm going to use my new STAR strategy. The first thing, I have to do is **Stop** and ask myself what I have to do. O.K., I have to write a good seven on this line. Now I have to **Think**. Let's see, to remember which way the seven goes, I'll use one of the Sayings. Now I have to **Ask** myself which Saying to use. Which one is it? I know, seven is the one with the man who made a line at the top. Now I have to **Recite** the saying while I do it. Here's my pencil. The man made a line across the top, and then he slid down the hill to the left. That's a good seven. I know it's facing the right way. I'll check it with the card to make sure.*

The teacher should model other numerals, this time stopping after the varying STAR steps to ask the children, "What should I tell myself to do next?" –thus giving the children practice in self-verbalization.

Step 4: Memorization of the Strategy
• Through verbal rehearsal, students can memorize the sayings and the STAR strategy. The STAR Strategy Card can be used as a cue during rehearsal.

Step 5: Practice with Controlled Materials
• Practice one number at a time: dictate, simple math, or answer a question
• The teacher should provide feedback on the elements of the strategy that are being done correctly and corrective feedback to improve performance.

Step 6: Practice with Grade-Appropriate Tasks
• The child should apply the strategy to classroom materials.
• Frequent opportunities for practice are needed:
  - writing multi-digit numbers, numbering pages or lines, completing math problems, writing the date, or pretending to operate a store

Step 7: Administration of a Posttest
• Require the child to write the numerals and compare the results with the pretest.
• Show the child the results and explain that they need to remember and use the strategy whenever they need to write a number.

Step 8: Generalization
• Monitor the use of the strategy in other situations
• Children can report when they have use the strategy outside the classroom
• Review the steps periodically to encourage generalization

Star: A Number Writing Strategy - *Self-instructions for forming numerals*

To make 0: The woman went around in a circle until she got home.
To make 1: The man went straight down, like a stick.
To make 2: The woman went right and around, slid down he hill to the left, then make a line across the ground.
To make 3: The man went right and around, then around again.
To make 4: The woman went down the street, turned to the right, then back to the top for a straight ride down.
To make 5: The man went down the street, around the corner, and his hat blew off.
To make 6: The woman made a curve and then a circle at the bottom
To make 7: The man made a line across the top, then slid down the hill to the left.
To make 8: The woman made a half circle to the left, another to the right, and then she found her way back up to the top again.
To make 9: The man made a small circle and then a straight line down.

Boom, S.E., & Fine, E. (1995, Winter). Star – A number writing strategy. *Teaching Exceptional Children,* 42-45.