# Mapping What Works in Math

## *Thinking Maps Alignment to What Works Clearinghouse Evidence-based Practice Guides for Math*

How do you develop mathematical thinking? Thinking Maps supports the development of cognitive skills that are fundamental for numeracy, mathematical logic and problem solving. Students learn to use the Maps to define and compare mathematical terms, deconstruct problem-solving processes, decompose mathematical and algebraic expressions, explore mathematical relationships, and visualize abstract mathematical concepts.

Thinking Maps is aligned with evidence-based practices for math reviewed by What Works Clearinghouse (WWC) and included in their Evidence-based Practice Guides. WWC's practice guides provide specific recommendations based on reviews of available research, experiences of practitioners, and the expert opinions of a panel of nationally recognized experts.

### *Practice Guide: Teaching Math to Young Children*

#### Recommendation #1: Teaching numbers and operations using a developmental progression.

Students use Thinking Maps to explore numbers and operations in a variety of ways. For example, they may use a Circle Map to show all the ways a number could be represented (words, numerals, pictures, etc.), a Flow Map to sequence numbers and their representations, a Brace Map to show whole/part relationships within numbers, or a Double Bubble Map to compare number characteristics (odd vs. even, number of digits, etc.). The Maps can also be used to break down operations and problem-solving processes. Flow Maps, Multi-Flow Maps, Brace Maps, and Bridge Maps can be used to explore operations and visualize problem-solving processes in different ways. The Maps are applied in increasingly sophisticated ways across the grades to support a developmental progression in mathematical instruction. Younger children can benefit from creating simple physical Maps using manipulatives, while older students may use multiple Maps to analyze and visualize complex problem-solving processes. Teachers can scaffold the use of the Maps based on the developmental needs of their students.

#### Recommendation #2: Teach geometry, patterns, measurement and data analysis using a developmental progression.

Thinking Maps are ideal for exploring patterns, geometric relationships, measurement and data analysis. The Maps are used to make patterns and relationships visual and help students explore mathematical concepts. For example, the Tree Map can be used to classify shapes, while the Flow Map and Bridge Map can be used to analyze patterns. Data can be analyzed in a variety of ways using multiple Maps, such as the Tree Map (for classifying), the Brace Map (for part/whole

relationships), and the Bridge Map (to explore relationships). The Maps are applied in increasingly sophisticated ways across the grades to support a developmental progression in mathematical instruction.

### Recommendation #4: Teach children to view and describe their world mathematically.

The Maps are ideal for helping young children view and describe their world mathematically. Thinking Maps make abstract mathematical concepts concrete and visible. The Maps tap into the foundational cognitive skills that underlie mathematical thinking, such as seeing relationships, classifying, comparing and contrasting, sequencing, and part/whole relationships. They also help students clarify their understanding of mathematical concepts and terms.

## *Practice Guide: Improving Mathematical Problem Solving in Grades 4 – 8*

### Recommendation #1: Prepare problems and use them in whole-class instruction.

Thinking Maps are a valuable tool for whole-class instruction. Teachers can use Maps to deconstruct problems and then plan and execute their solution pathways. Maps can also be used collaboratively, providing a way for students to demonstrate their problem-solving methods visually to the class. The Maps then become a guide that students can use to move from whole-class to independent problem solving.

### Recommendation #2: Assist students in monitoring and reflecting on the problem-solving process.

Each of the eight Thinking Maps is correlated with a different cognitive process, including defining, describing, comparing/contrasting, classifying, part/whole relationships, sequencing, cause/effect, and relationships. Students learn to use and combine the Maps in a variety of ways to explore different methods of problem solving, clarify and show their thinking, and demonstrate their understanding. The Frame of Reference around the Maps activates metacognitive processes and provides an opportunity for students to think about what they know and reflect on their different problem-solving methods. Students also learn how to use guiding questions for the Frame of Reference to think about their problem-solving approach systematically. Students identify the knowledge and strategies they used to solve the problem, explain the reasons they chose the strategies, and think about what they might do differently next time.

### Recommendation #3: Teach students how to use visual representations.

The Maps are visual representations that can be used to visualize and clarify a broad range of mathematical terms, concepts, processes and methods. They are ideal for making abstract mathematical concepts visual. For example, the Brace Map is used to help students visualize part/whole relationships or deconstruct a problem into its component parts, Flow Maps to visualize the steps of a problem-solving process, and Bridge Maps to visualize relationships.

### Recommendation #4: Expose students to multiple problem-solving strategies.

Students learn to use the Maps to think about problems in different ways (e.g., numerically vs. algebraically) and represent their thinking visually. Students may use a multiple-Map process to deconstruct a problem, plan and execute their solution strategy, justify their solution,

and reflect on their process. This allows students to think about their problem-solving strategy systematically and document their thinking for others to see. As students compare the different thinking strategies represented across a class, they develop and extend their own problem-solving repertoire.

### Recommendation #5: Help students recognize and articulate mathematical concepts and notation.

The Maps help students recognize and articulate mathematical concepts more effectively. Each of the Maps invites students to think about mathematical concepts in different ways: defining, describing, comparing/contrasting, classifying, part/whole relationships, sequencing, cause/effect, and relationships. Circle Maps are used to define concepts and notation, while Bridge Maps help students interpret symbols and their uses. By comparing and contrasting concepts in a Double Bubble Map, students clarify their understanding of similar concepts.

## *Practice Guide: Strategies for Improving Algebra Knowledge in Middle and High School Students*

### Recommendation #1: Use solved problems to engage students in analyzing algebraic reasoning and strategies.

Our multiple-Map problem-solving method teaches students to use parallel Flow Maps to outline a solution strategy and then execute the strategy. The application of the Frame of Reference for Thinking Like a Mathematician provides an opportunity to connect prior knowledge to the current problem and discuss a variety of strategies that might be appropriate. By sharing their Maps, students can see a variety of strategies across the classroom and analyze the reasoning behind each application.

### Recommendation #2: Teach students to utilize the structure of algebraic representations.

The Brace Map allows for decomposition of an algebraic representation into its parts. Those parts can then be moved to a Bridge Map to identify the role of each part in the current algebraic context. Multi-Flow Maps are used to analyze the effects of a specific algebraic representation. Double Bubble Maps are used to compare and contrast two different representations of an algebraic situation; for example, the similarities and differences of two function equations or graphs.

### Recommendation #3: Teach students to intentionally choose from alternative algebraic strategies when solving problems.

The different Maps lend themselves to different types of problem solving. Students learn to think about problems in different ways and select different Maps for different kinds of thinking and problem solving. Maps also help students describe their thinking process to teachers and peers so they can easily compare different problem-solving styles. For example, the Brace Map is used for decomposing a problem into the question and the relevant information provided. The application of the Frame of Reference for Thinking Like a Mathematician around the Brace Map provides an opportunity to connect prior knowledge to the current problem and to discuss a variety of strategies that might be appropriate in that problem situation. Depending on the strategy and the type of mathematical thinking involved, an appropriate Thinking Map can then be developed.

## *Practice Guide: Assisting Students Struggling with Mathematics: Response to Intervention (RtI) for Elementary and Middle Schools*

### Recommendation #3: Instruction during intervention should be explicit and systematic.

The application of Thinking Maps provides a structure for student thinking in mathematics that serves as a visual scaffold for processing information and building conceptual understanding. These scaffolds are appropriate across grade levels and can be extended as new information is introduced. The emphasis on different types of thinking allows for differentiation based on student processing styles.

### Recommendation #4: Interventions should include instruction on solving word problems that is based on common underlying structures.

Thinking Maps are ideal for breaking down and solving word problems. Students learn to use the Brace Map to decompose a problem into the question and the relevant information provided. In the Frame of Reference around the Brace Map, students discuss the prior knowledge needed for this situation and look for entry points into the problem—e.g., what clues are there in the language of the problem, what connections they see to prior knowledge and previous problems, and what formulas might apply in this situation. Using our multiple-Map problem-solving method, students use parallel Flow Maps to outline a solution strategy and then execute the strategy.

### Recommendation #5: Intervention materials should include opportunities for students to work with visual representations of mathematical ideas and interventionists should be proficient in the use of visual representations of mathematical ideas.

The Maps are visual representations that can be used to visualize and clarify a broad range of mathematical terms, concepts, processes and methods. They are ideal for making abstract mathematical concepts visual. For example, Brace Maps are used to help students visualize part/whole relationships or deconstruct a problem into its component parts, Flow Maps to visualize the problem-solving process, and Bridge Maps to visualize relationships.

**Contact us for more information!**