

Supporting Research

FOCUS on

Mathematics



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The Supporting Research document for the *Focus on Mathematics* series provides information related to research-proven instructional strategies and features that lead toward mathematics achievement.

The Supporting Research document is based on a literature review of academic monographs, journals, and reports by content-area researchers and experts.

The Supporting Research document covers topics related to the instruction of mathematics, as well as the application of research-based teaching strategies that are beneficial to struggling students.

Introduction to the Series

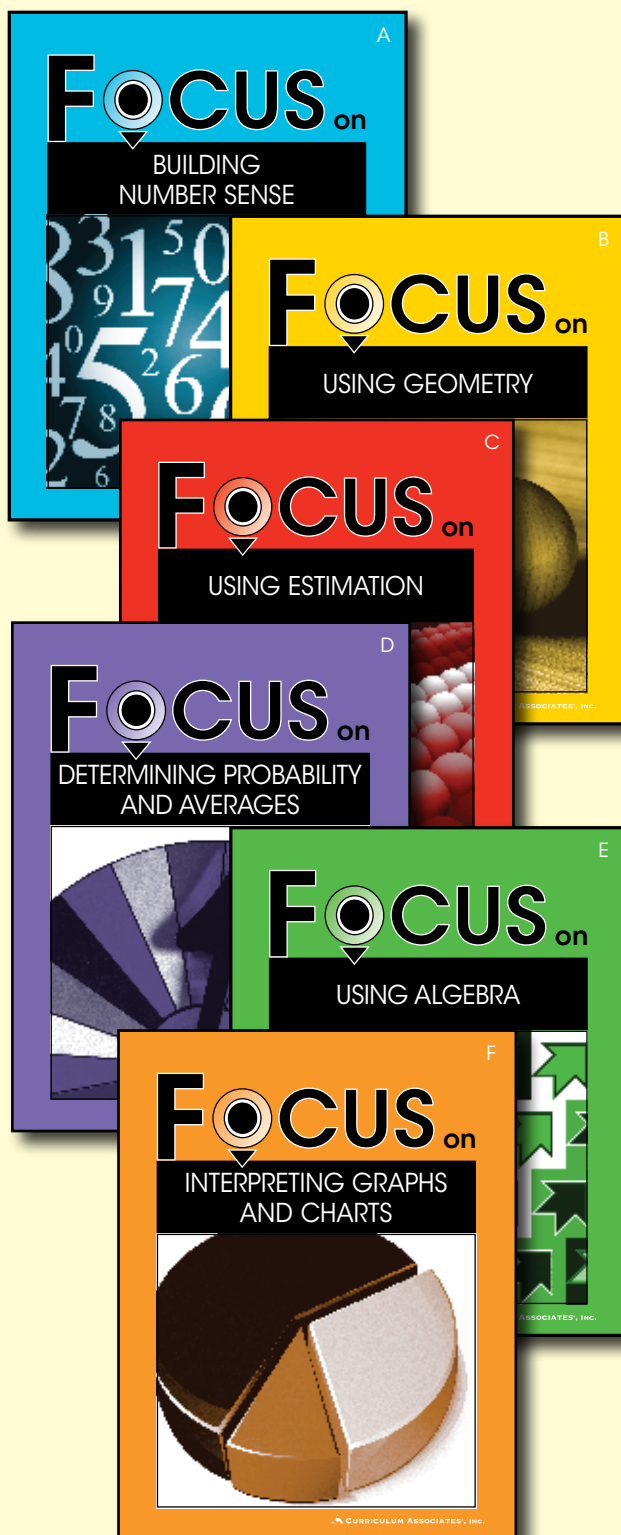
Mathematics has been deemed as the gateway to success in both the classroom and the workplace. The further a student goes in mathematics, the greater chance he or she will have in earning a higher academic degree or earning more money once he/she has left the academic world.

Mastery of algebra has received the most concentrated focus as a signature of achievement. But before a student can master this higher level of mathematics, the student needs to master the foundations of mathematics, the stepping stones to higher-level mathematics. This is the intention of the ***FOCUS on Mathematics*** series.

The ***FOCUS on Mathematics*** series is a concentrated math-strategy practice program geared toward both on-level and off-level math students. ***FOCUS on Mathematics*** is a series designed for on-level and struggling math students needing repeated practice. ***FOCUS on Mathematics*** centers on brief instruction and concentrated targeted math concepts and strategies in the context of word problems.

The ***FOCUS on Mathematics*** series covers:

- *Building Number Sense*
- *Using Geometry*
- *Using Estimation*
- *Determining Probability and Averages*
- *Using Algebra*
- *Interpreting Graphs and Charts*



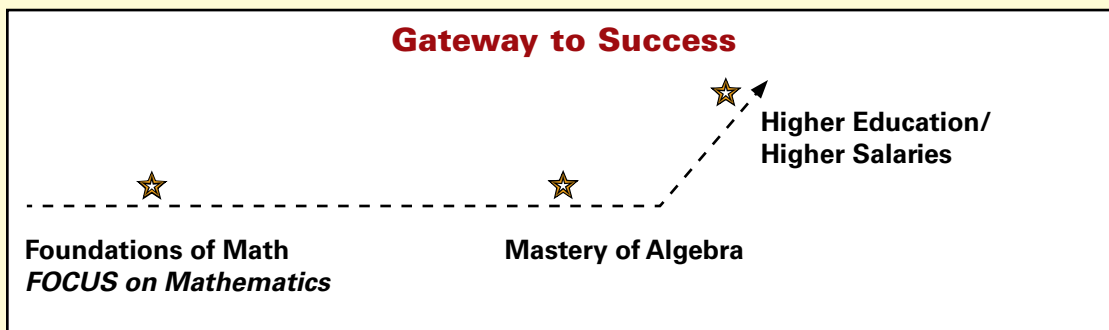
What Is the Need for *FOCUS* on Mathematics?

There is a current drive in mathematics education to meet 21st century skills so that today's students will be competitive in tomorrow's workforce. Several expert panels and mathematical organizations have sounded the alarm bell for improving students' mathematical understanding (National Mathematics Advisory Panel (NMAP), 2008; National Council of Teachers of Mathematics (NCTM), 2006).

Recent tests also show that students' mathematical progress is slowing. The 2007 Trends in International Mathematics and Science Study (TIMSS) showed that 4th-grade and 8th-grade students did improve their math scores from 1995. However, only 10% of tested students scored at or above the advanced mathematics benchmark; only 6% of 8th graders reached the advanced mathematics benchmark (Gonzales et al., 2008).

- The 2007 Education Statistics Digest stated, "Barely a third of American students can be considered proficient today in many basic math skills [on the 2007 National Assessment of Educational Progress (NAEP) mathematics assessment]" (National Center for Education Statistics (NCES), 2007).

- The 2006 PISA (Program for International Student Assessment) is administered every 3 years in reading, math, and science literacy. According to the latest assessment, American teenagers scored 24 points below the international average among the 30 participating industrialized countries (Baldi, Jin, Skemer, Green, & Herget, 2007).
- Congress passed the AMERICA COMPETES Act in 2007 calling for more investments in science, technology, and mathematics education. This action was initiated by the report, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* (Committee on Science, Engineering, and Public Policy, 2005). The push continues as legislators, non-profit organizations, and private investors continue to hold summits and conferences in support of improving math and science education (see National Science and Math Initiative at <http://www.nationalmathandscience.org>).



In answer to these concerns about students' lackluster mathematical performance, math experts and researchers have joined forces to combat the slowing of mathematics progress.

The release of several major reports has named algebra as a "gateway to higher mathematics," which then leads to greater successes in both the academic and working lives of students (NMAP, 2008; NCTM, 2006). In response to this joint effort, these experts have also laid a pathway for students to follow in order to develop the mathematical skills and knowledge to master algebra. The ***FOCUS on Mathematics*** series may be an effective tool to help students along this pathway of proficiency to algebra.

The ***FOCUS on Mathematics*** series provides students with explicit instruction of key mathematical concepts and strategies combined with targeted practice in the context of word problems.

Additionally, the National Mathematics Advisory Panel completed a survey of Algebra I teachers regarding students' readiness for Algebra I. Those surveyed teachers reported that student performance in algebra is negatively affected by students' lack of knowledge and understanding of these topics: rational numbers, word problems, and study habits. ***FOCUS on Mathematics*** addresses the following concerns.

Students Need Help with	<i>FOCUS on Mathematics</i> Helps
Rational Numbers	Using Algebra, Building Number Sense, and Using Estimation
Word Problems	A total of 800 word problems are provided in this series.
Study Habits	Student Self-Assessments in each Student Book promote self-monitoring and goal-setting.

How Is *FOCUS on Mathematics* Supported by Research?

The *FOCUS on Mathematics* series is supported by research from mathematical researchers and organizations, including the National Mathematics Advisory Panel (NMAP) and the National Council of Teachers of Mathematics (NCTM). Much of the research on effective instruction for mathematics students parallels the recommendations of the NMAP (2008). Many of these recommendations are integrated into the *FOCUS on Mathematics* series, including: word-problem focus, explicit instruction with modeling, and focused practice.

Word-Problem Focus

Research Says:

Word problems are the proving ground for students to demonstrate their mastery of mathematical fluency and conceptual understanding. Having the ability to transfer what they have learned to new problem-solving situations is one of the major endgoals for mathematical education (NMAP, 2008; NCTM, 2006). “The issue of transfer, that is, the ability to use skills learned to solve one class of problems, such as similar triangles, to solve another class of problems, such as linear algebra, is a vital part of mathematics learning” (NMAP, 2008, p. 30). And yet, students, on average, have the most difficulty solving word problems.


From Research to Application:

The *FOCUS on Mathematics* series provides repeated and focused practice of key math strategies in the context of word problems. With more than 800 word problems in the series, students gain multiple opportunities to practice core math concepts and strategies.

Lesson 2 *Read the passage. Then do Numbers 1–5.*

Dinosaur Data

André went to the local natural history museum to find information about dinosaurs for his science report. He decided to build a papier-mâché dinosaur. For the report presentation, he would make a dinosaur time line on a display board. André had 6 weeks to complete the project. He started by making notes on facts he read about dinosaurs. André focused his research on the Tyrannosaurus or *T. rex*. It was a large meat eater and is André's favorite type of dinosaur.



1. André learned that the Triassic period was when dinosaurs first appeared on Earth. The period started 252,000,000 years ago. Which of the following shows this number rounded to the nearest ten million?

- Ⓐ 300,000,000
- Ⓑ 260,000,000
- Ⓒ 250,000,000
- Ⓓ 200,000,000

2. André read that *T. rex* lived during the Cretaceous period, which lasted until 65.5 million years ago. Which of the following shows this number rounded to the nearest million?

- Ⓐ 60,000,000
- Ⓑ 65,000,000
- Ⓒ 66,000,000
- Ⓓ 70,000,000

Word Problem Practice

Concentrated and repeated word problem practice

Explicit Instruction with Modeling

Research Says:

Explicit instruction is a hallmark for effective instruction for struggling and on-level students. The NMAP recommends explicit instruction as one of the instructional methods that research has proved to be effective.

“By the term *explicit instruction*, the Panel means that **teachers provide clear models for solving a problem type using an array of examples**, that students receive **extensive practice** in use of newly learned strategies and skills, that students are provided with opportunities to **think aloud** (i.e., talk through the decisions they make and the steps they take), and that students are provided with **extensive feedback**” (p. 23).

Each of these features, as defined by the NMAP, can be found in the **FOCUS on Mathematics** series. With explicit instruction and teacher modeling, skill efficiency is nearly guaranteed by students (Hiebert & Grouws, 2008).

From Research to Application:

The **FOCUS on Mathematics** series uses explicit instruction in the teaching of the mathematical strategies. The explicit instruction occurs in the Learn About section and in the Lesson Preview section.

Through the Learn About section, students receive explicit instruction consisting of a definition, semi-concrete and visual representations of the math concepts, and a usage rule for the math strategy. Additionally, the **FOCUS on Mathematics** series is a perfect vehicle for struggling students because it does not overwhelm students with the presentation of information. In the Learn About lesson, students initially experience the math concepts in short presentations, usually three to seven sentences long.

A Remember box text feature is a point of reference for students to use while attending to lessons. The Remember box is consistently placed in each book of the series. Struggling or novice math students usually skip or gloss over text features, which are valuable tools. With repeated exposure and external prompting by the teacher, students learn to pay attention to the text feature.

Learn About
Using Estimation: Rounding Numbers

An estimate is a number that is close to the actual number you are looking for. Numbers can be rounded to the nearest ten, hundred, thousand, ten thousand, and so forth. If the digit one place to the right of the place being rounded to is 5 or greater, round up. If the digit one place to the right of the place being rounded to is 4 or less, round down.

For example, the number 343,267 rounded to the nearest ten thousand is 340,000 because the thousand place contains the digit 3, which is less than 5. Therefore, 343,267 rounds down to 340,000.

You can also round decimals and mixed numbers. Decimals and mixed numbers can be rounded to different places. For example, the number 23.79, when rounded to the nearest whole number, rounds up to 24 because the digit 7 in the tenths place is greater than 5. When rounding mixed numbers to the nearest whole number, round up if the fraction is $\frac{1}{2}$ or more; round down if the fraction is less than $\frac{1}{2}$. For example, the number $24\frac{1}{4}$ rounds down to 24 because $\frac{1}{4}$ is less than $\frac{1}{2}$.

The area of the state of Idaho is 82,747.21 square miles. Round this number to the nearest thousand.

The digit 7 is in the hundreds place in the number 82,747.21. Seven is greater than 5. The rounded figure is 83,000.

Remember
Numbers can be rounded to the nearest ten, hundred, thousand, ten thousand, and so forth. If the digit one place to the right of the place being rounded to is 5 or greater, round up. If the digit one place to the right of the place being rounded to is 4 or less, round down.

Explicit Instruction
Learn About section

Lesson Preview *Read these sample problems.*

Using Estimation

Koalas are commonly referred to as koala bears even though these animals are not bears at all. They are marsupials, or pouched mammals. The average height of a koala is 28.5 inches. Koalas typically sleep 18 hours a day.

1. What is 28.5 rounded to the nearest whole number?
Ⓐ 27
Ⓑ 28
Ⓒ 29
Ⓓ 30

2. Round the number of hours a koala sleeps each day to the nearest ten. About how many hours does a koala sleep during one week?
Ⓐ about 120 hours
Ⓑ about 140 hours
Ⓒ about 150 hours
Ⓓ about 160 hours

Explicit Instruction
Lesson Preview

Focused Practice

Research Says:


One of the major callings from the National Mathematics Advisory Panel is for deeper learning and practice of mathematical skills and strategies. In fact, the panel states “Few curricula in the United States provide sufficient practice to ensure fast and efficient solving of basic fact combinations and execution of the standard algorithms” (p. 26). This calling is also echoed in NCTM’s *Focal Points*. These two organizations are calling for math instruction that goes beyond being “a mile wide and an inch deep” learning experience for students. Focusing on specific key mathematical topics allows “teachers to commit more time each year to topics receiving special emphasis. At the same time, students would have opportunities to explore these topics in depth, in the context of related content and connected applications, thus developing more robust mathematical understandings” (NCTM, 2006, p. 4).

From Research to Application:

FOCUS on Mathematics is part of a focused curriculum series that allows for deep instruction and practice of specific math concepts. The diagnosis of students’ mastery of math skills and strategies begins with the *Comprehensive Assessment of Math Strategies Series (CAMS® Series)*. Explicit instruction of specific math strategies occurs with the *Strategies to Achieve Mathematics Success Series (STAMS® Series)*. The **FOCUS on Mathematics** series provides repeated practice of math strategies that are directly taught in the *STAMS® Series*. Finally, students are assessed on their mastery of math strategies in the *Comprehensive Assessment of Mathematics Strategies II Series (CAMS® Series II)*.

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Focused Practice
Reteach through
20 Lessons



FOCUS STRATEGIES

Building Number Sense

Using Estimation

Using Algebra

Using Geometry

Determining Probability and Averages

Interpreting Graphs and Charts

Repeated Practice
Reinforce Key
Math Strategies

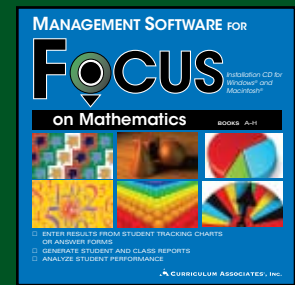
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Progress Monitoring through Formative Assessments

Research Says:

The NMAP recommends that formative assessments, “the ongoing monitoring of student learning to inform instruction” (p. 46), is an effective instructional tool for educators. Formative assessments provide frequent and precise reporting of students’ progress in a subject area. With this information, teachers may adjust or realign their instruction to more precisely fit students’ needs. The **FOCUS on Mathematics** series is a flexible instructional classroom tool to use because of the formative assessments teachers use in the series: student self-assessment and teacher assessment through conferencing, as well as selected and constructed assessments. Research (National Center on Student Progress Monitoring; NMAP, 2008; William, 2008) supports the use of these types of assessments because they are significant in increasing instructional effectiveness, students’ self-efficacy, motivation, and engagement in learning activities. According to Bandura (1986), self-efficacy is “people’s judgement of their abilities to organize and execute courses of action required to attain designated types of performance” (p. 391).

When a student’s self-efficacy is raised, so is his or her willingness to engage in that activity. Both struggling and on-level readers benefit from increased self-efficacy.



Progress Monitoring
Provides fast, easy-to-understand reports for individuals and classrooms

From Research to Application:

Students progress through the brief instruction in the Learn About and Lesson Preview sections and then complete the appropriate number of lessons to show progress in the math skill. These brief practice lessons are designed on level so that students may show progress at their instructional level. This series may be used with Tier One and Tier Two students in small groups. Tier Three students may have a meaningful learning experience with one-on-one attention. With a tighter alignment to instruction and deeper student engagement, the **FOCUS on Mathematics** series is a strong mathematical instrument in the quest for conceptual understanding and math fluency. The management software system gives teachers the tools they need to monitor individual and class progress.

Through **FOCUS on Mathematics**, students engage in several types of assessments. Along with teacher interaction and guidance, these assessments foster positive results for students in terms of personal fulfillment and academic success.

Student Self-Assessment

Research Says:

Student self-assessment is not only a motivational tool, but also one that encourages students to take on more responsibility for their learning. Giving students more control over their learning is an empowering instructional tool. Once students are actively engaged in their learning, their self-efficacy is boosted.

Additionally, students with learning disabilities, such as attention-deficit syndrome, benefit from attending to their own progress.

A major obstacle for special-needs students is not being able to focus on the important ideas or concepts in a math problem.

One way to help students focus on what ideas should be learned is through self-monitoring tools, such as the Student Self-Assessments.

“These students benefit from a structured, consistent environment in which clear expectations are communicated for learning and doing mathematics. Communicating clear expectations . . . means the teacher should give students a way to understand what is expected and a way to monitor their progress through a particular task . . . This approach helps students attend to important ideas and promotes independent self-monitoring” (Lovin, Kyger, & Allsopp, 2004, p. 161).

From Research to Application:

The Student Self-Assessments and Tracking Chart are designed to give students immediate feedback on their performance. The Tracking Chart is a visual tool students can use to discuss their progress with the teacher. The Student Self-Assessments bring in self-regulation and monitoring. The Student Self-Assessment questions make students’ thoughts explicit to themselves so that they may make conscious decisions about their learning progress.

Student Self-Assessment
Motivate and Focus Students

Tracking Chart
Showcase Student Progress

Teacher Assessments through Teacher Conferencing

Teachers are encouraged to meet and discuss with students their progress as they proceed through a **FOCUS on Mathematics** book. This action parallels a recommendation from the NMAP in terms of effective use of formative assessments. Teacher conferencing occurs when the teacher meets with students individually to discuss progress toward self-set learning goals, including specific examples of observable increases in math skills and strategies. This conference allows teachers and students to realign assignments and goals for maximum learning. These discussions also make students more aware of individual progress toward their math goals and support a growing belief that with effort they are capable of improving.

Teacher Assessment
Monitor students' progress quickly and accurately.

3. If Maya made \$410 mowing grass in 3 months, estimate to the nearest hundred dollars the amount she would earn in one year.
Ⓐ about \$1,000
Ⓑ about \$1,200
Ⓒ about \$1,600
Ⓓ about \$2,000

4. Maya walked dogs a total of 56 miles. Her friend Gale walked dogs a total of 32 miles, and Zach walked dogs a total of 61 miles. To the nearest ten miles, about how far did Maya, Gale, and Zach walk dogs?
Ⓐ about 160 miles
Ⓑ about 150 miles
Ⓒ about 140 miles
Ⓓ about 130 miles

5. Maya made \$410 mowing, \$13 raking, \$27 painting, and \$75 walking dogs. Round Maya's earnings to the nearest ten dollars to estimate the total amount of money Maya made in three months. Show your work in the space below. Remember to check your solution.

Write your solution.

Explain how you found your solution.

Selected-Response and Constructed-Response Questions
Familiarize students with various test-question formats.

3. Browne Tower Mountain in Alaska is about $\frac{1}{2}$ the height of Mount Everest. Rounded to the nearest hundred feet, about how tall is Browne Tower Mountain?
Ⓐ about 11,000 feet
Ⓑ about 14,500 feet
Ⓒ about 14,000 feet
Ⓓ about 13,500 feet

4. Black Mountain in Kentucky is 4,145 feet tall. Adams Mountain in Washington is about 8 times the height of Black Mountain. Rounded to the nearest thousand, what is the approximate height of Adams Mountain?
Ⓐ about 12,000 feet
Ⓑ about 10,000 feet
Ⓒ about 9,000 feet
Ⓓ about 8,000 feet

5. Mount Kilimanjaro in Tanzania, Africa, is 19,340 feet tall. Round the height of the mountain to the nearest ten thousand. Approximately 5,000 feet equals 1 mile. About how many miles tall is Mount Kilimanjaro? Show your work in the space below. Remember to check your solution.

Write your solution.

Explain how you found your solution.

Selected-Response and Constructed-Response Questioning

Research Says:

By providing practice with test-question formats, the **FOCUS on Mathematics** series may reduce test anxiety in students. "Students of all levels of academic achievement and intellectual abilities can be affected by test anxiety" (Supon, 2004, p. 292). Supon and other researchers suggest that one method of alleviating test anxiety is to provide practice with test-question formats. With practice, students become comfortable with the question formats that are connected with high-stakes testing. This is significant because "cognitive test anxiety exerts a significant stable and negative impact on academic performance measures."

From Research to Application:

FOCUS on Mathematics is a math-practice series that incorporates question formats that reflect those found on national and state standardized tests. The practice of answering questions in a testing format bridges a testing gap students may have.

The selected-response and constructed-response questioning found in each lesson is also a major element of formative assessments. The frequent use of these lessons as assessments enables teachers and students to experience a coherent math curriculum.

Quick-Reference Chart

From Research to Application: Research-based Strategies and Features in *FOCUS on Mathematics*

This Series Uses . . .	Example	Research Says . . .
<p>Annotated Answer Explanations for Students</p> <p>As part of guided instruction, students receive immediate feedback of their answer choices and read the reasoning behind correct and incorrect answers.</p>	<p>Student Book:</p> <p>Lesson Preview</p>	<p>Research (Pashler et al, 2007) has shown that when students receive direct instruction about the reasons why an answer is correct or incorrect, they demonstrate long-term retention and understanding of new learned content.</p>
<p>Balanced Instructional Approach</p> <p>A balanced instructional approach is one that uses both teacher-directed instruction and student-centered instruction.</p>	<p>Student Book:</p> <p>Learn About and Lesson Preview allow for a teacher-directed approach and/or for student-centered learning.</p>	<p>The National Mathematics Advisory Panel (2008) does not support a singular instructional approach for mathematics. An instructional program should neither be solely teacher-directed nor solely student-centered (p. 45).</p>
<p>Differentiated Instruction</p> <p>This is an instructional approach that allows students of varying abilities to learn the same content.</p>	<p>Teacher Guide:</p> <p>Teachers are directed to use individual, paired, or small-group instruction depending on students' abilities.</p>	<p>" 'Multiple paths' does not mean that students are given free rein; it means that teachers must find that sweet spot between structure and choice that makes student learning possible. . . . By allowing options that accommodate different thinking patterns, teachers help all students not only achieve planned learning goals but also own these goals in a way that's all theirs" (Carolan & Guinn, 2007, p. 45).</p>
<p>Explicit Instruction</p> <p>Explicit instruction involves, according to the NMAP,</p> <ul style="list-style-type: none"> • clear models for solving a problem type using several examples • extensive practice in use of newly learned strategies and skills • opportunities to think aloud • extensive feedback 	<p>Student Book:</p> <ul style="list-style-type: none"> • Learn About section • Lesson Preview offers think-aloud opportunities and the annotated answer explanations provide immediate feedback to student's answer choices • Student Self-Assessments <p>Teacher Guide:</p> <ul style="list-style-type: none"> • Teacher Assessments • "How Should I Use the <i>FOCUS on Mathematics</i> Series in the Classroom?" discussion feature 	<p>"Explicit instruction with students who have mathematical difficulties has shown consistently positive effects on performance with word problems and computation" (NMAP, 2008, <i>xxiii</i>).</p>

This Series Uses . . .	Example	Research Says . . .
<p>Focused Practice</p> <p>Struggling and on-level students benefit from intensive practice of specific math strategies.</p>	<p>Series:</p> <ul style="list-style-type: none"> • Twenty practice lessons per book with both selected-response and constructed-response question formats 	<p>“For all content areas, practice allows students to achieve automaticity of basic skills—the fast, accurate, and effortless processing of content information—which frees up working memory for more complex aspects of problem solving” (NMAP, 2008, p. 30).</p>
<p>Formative Assessments</p> <p>Formative assessments occur during the learning cycle and give students feedback on their progress in learning new content.</p>	<p>Student Book:</p> <ul style="list-style-type: none"> • Student Self-Assessments help set learning goals. <p>Teacher Guide:</p> <ul style="list-style-type: none"> • Teacher Assessments 1–3 help teachers monitor students’ progress. 	<p>“Teachers’ regular use of formative assessment improves their students’ learning, especially if teachers have additional guidance on using the assessment to design and to individualize instruction” (NMAP, 2008, <i>xxiii</i>).</p>
<p>Metacognition</p> <p>Students set learning goals and then self-evaluate for clarity and accuracy of their performance. They think about what skills or strategies need to be activated or improved to achieve their next milestone or final goal.</p>	<p>Student Book:</p> <ul style="list-style-type: none"> • Student Self-Assessments 1–5 	<p>“Merging cognitive and metacognitive strategies and direct instruction has shown promising results among students who have difficulty solving mathematics word problems . . . and can result in improved performance across content areas” (Bottge, 2001, p. 102).</p>
<p>Scaffolded Instruction</p> <p>Scaffolded instruction is the gradual withdrawal of support through modeled, guided, and independent instruction and practice.</p>	<p>Student Book:</p> <ul style="list-style-type: none"> • Learn About: Modeled practice • Lesson Preview: Guided practice • Lessons 1–20: Independent practice 	<p>“Scaffolded instruction provides teachers with the support necessary to ensure that students solve mathematical problems with fewer errors as they become more independent” (Montague & Jitendra, 2006, p. 148).</p>
<p>Test-Taking Practice</p> <p>Selected-response and constructed-response test questions are often used on state and national standardized tests.</p>	<p>Student Book:</p> <ul style="list-style-type: none"> • Twenty independent practice lessons with selected-response and constructed-response question formats 	<p>“Segments of mathematical instruction should target teaching students to generate explanations of math concepts in their own words and to justify the methods they use to solve problems” (Baker, Gersten, & Dae-Sik, 2002, p. 53).</p>

This Series Uses . . .	Example	Research Says . . .
<p>Think-Aloud Strategy</p> <p>This is a strategy that makes thinking visible or audible to students while solving a problem.</p>	<p>Student Book:</p> <ul style="list-style-type: none"> • Learn About section provides modeling. • Lesson Preview provides guided instruction with annotated answer choices. 	<p>“When a teacher “thinks aloud,” particularly during problem solving, his or her verbalizations can be a powerful source of cognitive processing that can be internalized by students” (Martinez, 2006, p. 696).</p>
<p>Word-Problem Focus</p> <p>Students solve word problems based in real-world contexts.</p>	<p>Series:</p> <ul style="list-style-type: none"> • Each book level presents 20 word problems along with 4 selected-response questions and 1 constructed-response question. 	<p>“The three skill areas in which teachers report their students have the poorest preparation are rational numbers, word problems, and study habits” (Hoffer, Venkataraman, Hedberg, & Shagle, 2007).</p>

Summary

FOCUS on Mathematics is a math-strategy practice series that aids all students, including struggling students, to achieve mathematical success. Mastery of core math strategies is a difficult task to fulfill because students must learn to identify and apply abstract math concepts and strategies. The ***FOCUS on Mathematics*** series makes math mastery attainable by providing semi-concrete tools for students to use in identifying more complex math strategies. With repeated practice and exposure, students become automatic in their ability to use the math strategy to solve math problems. The ***FOCUS on Mathematics*** series is grounded in well-researched teaching and learning strategies, which means that teachers will engage their students with an educationally sound mathematics-practice program.

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