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Research-Based Curriculum

Focused Mathematics Booster Pack

Mathematics Instruction

In twenty-first century teaching and learning, mathematical literacy has become more important than ever. The jobs of "tomorrow" don't even exist yet, and those jobs rely heavily on mathematical reasoning skills. This is the age of science, technology, and mathematics. Unfortunately, "innumeracy" has replaced illiteracy as our principal educational gap. To have a mathematically literate society, the population needs to have understanding of, and proficiency with, mathematics concepts and procedures, as well as the ability to apply that knowledge, use it to develop models, and apply those models to new situations.

The goal of mathematics education is to provide all students with the ability to use mathematics to improve their own lives, to help them become aware of their responsibilities as citizens, and to help them prepare for their futures.

To accomplish these goals, state departments of education, school districts, and teachers must set high expectations for all students, and mathematics education needs to be a priority at all levels. *PISA 2012 Assessment and Analytical Framework: Mathematics, Reading, Science, Problem Solving, and Financial Literacy* describes the expectations students are to meet and the experiences they need to achieve them. "This conception of mathematical literacy supports the importance of students developing a strong understanding of concepts of pure mathematics and the benefits of being engaged in explorations in the abstract world of mathematics. The construct of mathematical literacy, as defined for PISA, strongly emphasizes the need to develop students' capacity to use mathematics in context, and it is important that they have rich experiences in their mathematics classrooms to accomplish this" (PISA 2013, 25).

Mathematics education must begin at an early age so students develop number sense and deep conceptual understanding. More intentional instructional time should be dedicated to mathematics instruction, and the curriculum should focus on a depth-versus-breadth approach so that students have sufficient opportunities to achieve and master the content. Cameron (et al.) emphasize the importance of concepts being taught thoroughly and solidly. Students should be solving problems that require higher-level thinking and address grade-level topics (2011). Teachers need research-based curriculum solutions to provide strong instructional support that will develop mathematical proficiency among all students.

The Importance Strong Mathematical Content

Students come to the classroom with different learning styles, variety of languages, and varying mindsets toward learning. To meet these diverse needs, teachers must understand the progression of concepts, strategies, and models that can become powerful forms of representation and tools to develop thinking (Fosnot 2010).

Instructional Shifts: Focus, Coherence, and Rigor

In 2000, the National Council of Teachers of Mathematics (NCTM) released *Principles and Standards for School Mathematics*, which affirmed mathematics as content and process (NCTM 2000). Following its release, a joint project of the National Academy of Sciences, the U.S. Department of Education, and the National Science Foundation resulted in the book *Adding It Up: Helping Children Learn Mathematics* (National Research Council 2001). This publication introduced the five strands of mathematical proficiency conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition. This laid the groundwork for the National Governors Association Center for Best Practices and the Council of Chief State School Officers to collaboratively develop mathematical content and process standards that focus on understandings students must have to develop mathematical proficiency (2010). These documents, and the standards that have evolved from them, are designed to close the education gap and provide all students equal opportunity to achieve mathematical literacy.

Today's mathematics curriculum focuses on helping students develop deeper understanding with fewer topics at each grade level. In fact, "less topic coverage can be associated with higher scores on those topics covered because students have more time to master the content that is taught" (Ginsburg et al. 2005). The takeaway here is to teach less and learn more!

Another shift in today's standards is coherence. Coherent standards connect learning within and across grades to deepen students' understanding of mathematical ideas. Each standard is not a new event but an extension of previous learning.

The third shift—rigor—does not mean "harder." Rather, it relates to the importance of connecting application, conceptual understanding, and skills in learning mathematics (Student Achievement Partners 2013). Conceptual understanding can be thought of as the ability to explain math to someone else, represent it in different ways, apply it to solve simple and complex problems, reverse givens and unknowns, and compare and contrast it to other concepts (NCTM 2014). This shifts away from thinking of mathematics as a group of "tricks," but instead as deep, connected ideas.

Research to Practice

Focus, Coherence, and Rigor

The *Focused Mathematics: Booster Pack* series helps teachers address the instructional shifts of focus, coherence, and rigor with activities that:

- align to college-and-career readiness standards
- build conceptual understanding
- challenge students to use higher-order thinking skills

Real-Life Problem Solving

In mathematics, it is not enough just to be able to compute. Students need to be able to read about situations, make inferences about the types of solutions that might be possible for a given problem, and write about various paths to solutions. Students also need to be able to find solutions to real problems that arise in life. Simply using procedural knowledge to compute arithmetic exercises is not enough to help students reach these goals. They need both procedural and conceptual knowledge to learn and understand mathematics (NCTM 2000).

For learning to be meaningful, students must be able to learn concepts within contexts that are familiar and engaging. Research shows that real-life applied activities and problem-solving activities establish a contextual setting for many lessons, providing motivation and encouraging curiosity (Hiebert and Carpenter 1992). When students are engaged and interested in a topic, they are more likely to retain the information and apply it in the future. "Overall, the challenging and interesting tasks found in application problems help teachers engage students in learning" (Seeley 2004).

Problem solving is an area in which intervention students often struggle. Some have difficulty reading and associating meaning to worded situations. Others do not have a deep grasp of the multiple situations in which an operation can be used. Most lack a repertoire of strategies to help them find a starting point. This is why we often hear students lament, "I don't get what they want us to do."

Providing students with experiences that introduce a concept in a contextual setting moves the lesson away from a focus on arithmetic skill and toward thinking about the meaning of an operation and when to use it. A link between conceptual and procedural understanding begins to take place.

Research to Practice

Problem Solving

In the *Focused Mathematics: Booster Pack* series, students are provided opportunities to **make connections** and build mathematical proficiencies through **real-world scenarios** and problem types. Booster Card activities promote mathematical reasoning and reflect the **multistep**, **higher-order questioning** seen on today's assessments.

Mathematical Discourse

Albert Einstein remarked, "If you can't explain it simply, you don't understand it well enough." Ultimately, this is the goal of mathematical discourse. As students share and listen to others, learning takes place. The value of this interaction "cannot be overemphasized" (Van de Walle et al. 2014). To encourage and develop discourse, mathematics questions must move beyond "What's the answer?" and teachers assessing the rightness (or wrongness!) of the response. Rather, "purposeful questions" requiring deeper thought, explanation, and justification are used to prompt meaningful discourse (NCTM 2014). As students share, reason, and reflect, they are also called upon to listen to the thoughts and approaches of others, ask questions, and try new strategies.

Research to Practice

Math Talk

Each book and Booster Card in this *Booster Pack* includes opportunities for students to **participate in mathematical discourse by explaining their strategies, justifying their reasoning,** and **questioning** themselves and others.

Math and Literacy

It is usually seen as the task of the English or language arts teacher to guide students through the effective use of reading comprehension strategies. However, these strategies best serve students when they are used in the context of actual learning. Dr. Patricia S. Moyer (2000) summarizes the importance of integrating reading across the content areas:

> *When language skills are embedded in meaningful contexts, they are easier and more enjoyable for children to learn. In the same way, numbers and their operations, when embedded in meaningful real-world contexts, give children the opportunity to make sense of mathematics and to gain mathematical power (248–249).*

Mathematics and literacy are naturally linked, especially in the area of problem solving. Students need to be able to determine key details and main ideas, interpret words and phrases, and evaluate content in a variety of formats. Students must have opportunities to grapple with mathematics in context to find success in problem solving.

Research to Practice

Reading and Writing

Each Booster Card in this Booster Pack features writing activities that expect students to engage in mathematical processes include the following:

- arguments
- justifications
- narratives
- observations
- analyses

Today's classrooms are filled with students of varying backgrounds, reading abilities, levels of English proficiency, and learning styles. A teacher's ability to differentiate instruction and respond effectively to the needs of a variety of learners is critical to the success of any program (Henry and Pianta 2011).

Ways to Differentiate

Differentiation encompasses what is taught, how it is taught, and the products students create to show what they have learned. These categories are often referred to as content, process, and product:

- **Differentiating by content**—varying instructional techniques and materials, such as asking leveled questions.
- **Differentiating by process**—offering varying grouping techniques or self-paced assignments.
- **Differentiating by product**—asking students to show their learning in ways that will enhance cognitive development and personal expression.

Differentiating by Specific Need

Below-Level Learners

Below-level learners need concepts to be made more concrete. They may also need extra work with manipulatives and other models, such as visual models, to support conceptual understanding.

Above-Level Learners

All students need a firm foundation in the core knowledge of the curriculum. Even above-level learners may not know much of this information before a lesson begins. However, students performing at or above grade level have the metacognitive ability to apply new concepts and vocabulary to independent work quickly and effectively. To foster students' talents, it is important to provide opportunities for meaningful practice within the learners' control, set high expectations, and provide specific encouragement for effort.

English Language Learners

Students who are English language learners are learning concepts and language simultaneously. They need to have context added to the language. Meeting these needs can be more complex than meeting the needs of native-language struggling learners. Intervention for ELLs should engage students in meaningful activities, as well as cognitively demanding content, while scaffolding the content to ensure that students will learn successfully (Díaz-Rico and Weed 2002).

Research to Practice

Differentiation

Differentiation suggestions on page 12 of this management guide help below-level, above-level, and English language learners access the content in the books and communicate their understanding of the mathematical concepts.

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