Building Fact Fluency

A TOOLKIT FOR ADDITION & SUBTRACTION

RESEARCH BASE OVERVIEW

Building Fact Fluency: A Toolkit for Addition & Subtraction offers teachers and their students an engaging approach to building deep conceptual understanding of number facts through classroom-tested practices grounded in research. Here's a quick look at just some of the 35+ works by noted mathematics organizations and educators that supported the program philosophy and lesson structure.

Building Fact Fluency **supports conceptual understanding—not just memorization.**

RESEARCH SUPPORTS

"Psychologists have long known that people more easily learn a body of knowledge by focusing on its structure (i.e., underlying patterns and relationships) than by memorizing individual facts by rote. Furthermore, psychologists have long known that well-connected factual knowledge is easier to retain in memory and to transfer to learning other new but related facts than are isolated facts."

Baroody, Arthur J. 2006. "Why Children Have Difficulties Mastering the Basic Number Combinations and How to Help Them." *Teaching Children Mathematics* 13 (1): 22–31.

"The development of procedural fluency, including the learning of basic number combinations and formulas, must begin with and build from a solid foundation of deep conceptual knowledge. This teaching approach is not only essential for developing positive mathematical identities and strong agency but is a necessary prerequisite. The tendency to rush children to prematurely use procedures or memorize facts and formulas without sufficient understanding robs children of opportunities to grow confidence in themselves as mathematical knowers and doers. Procedural fluency develops gradually over many years and must always keep meaning and sense making at the forefront."

National Council of Teachers of Mathematics, 2020. *Catalyzing Change in Early Childhood and Elementary Mathematics: Initiating Critical Conversations.* Reston, VA: National Council of Teachers of Mathematics.

"Being fluent means that students are able to choose flexibly among methods and strategies to solve contextual and mathematical problems, they understand and are able to explain their approaches, and they are able to produce accurate answers efficiently. Fluency builds from initial exploration and discussion of number concepts to using informal reasoning strategies based on meanings and properties of the operations to the eventual use of general methods as tools in solving problems."

National Council of Teachers of Mathematics. 2014. *Principles to Actions: Ensuring Mathematical Success for All.* Reston, VA: National Council of Teachers of Mathematics.

"The issue here is not whether facts should eventually be memorized but how this memorization is achieved: by drill, practice, and memorization, or by focusing on relationships?"

Fosnot, Catherine Twomey, and Maarten Dolk. 2001. *Young Mathematicians at Work: Constructing Number Sense, Addition, and Subtraction.* Portsmouth, NH: Heinemann.

"Fact fluency requires students both to know facts and to understand them."

Small, Marion. 2019. *Understanding the Math We Teach and How to Teach It*. Portsmouth, NH: Stenhouse.

Building Fact Fluency: A Toolkit for Addition & Subtraction **provides multiple opportunities for students to explore math concepts in different contexts and build connections across ideas.**

RESEARCH SUPPORTS

"What is important is that the contexts of tasks allow all students entry into the situation and allow all students to problematize the situations."

Hiebert, James, Thomas P. Carpenter, Elizabeth Fennema, Karen C. Fuson, Diane Wearne, Hanlie Murray, Alwyn Olivier, and Piet Human. 1997. *Making Sense: Teaching and Learning Mathematics with Understanding.* Portsmouth, NH: Heinemann.

"Combining the use of situations and models . . . is important in helping students construct a deep understanding of addition and subtraction."

Van de Walle, John A., Karen S. Karp, and Jennifer M. Bay-Williams. 2019. *Elementary and Middle School Mathematics: Teaching Developmentally.* 10th ed. London: Pearson.

"Children learn number facts by noticing relations among number facts."

Carpenter, Thomas P., Elizabeth Fennema, Megan Loef Franke, Linda Levi, and Susan B. Empson. 2015. *Children's Mathematics: Cognitively Guided Instruction.* 2nd ed. Portsmouth, NH: Heinemann.

"Our job as teachers is to help students connect procedures, properties of operations, and understanding of place value rather than have them learn these concepts as separate, compartmentalized pieces of knowledge."

Russell, Susan Jo. 2000. "Developing Computational Fluency with Whole Numbers." *Teaching Children Mathematics* 7 (3): 154–158.

Lesson Strings in the ***Building Fact Fluency*** **toolkit offer students opportunities to learn, apply, and practice different strategies over time to build lasting understanding.**

RESEARCH SUPPORTS

"An instructional approach in which students investigate the conceptual understanding of basic facts, explore strategies to support their understanding of numbers, and then engage in strategic practice in order to automatically recall the facts provides students with a strong and balanced foundation."

O'Connell, Susan, and John SanGiovanni. 2011. *Mastering the Basic Math Facts in Addition and Subtraction*. Portsmouth, NH: Heinemann.

"Practice should not be 'meaningless drill' but should occur in a context of making sense of the situation and the number relationships."

Clements, Douglas H., and Julie Sarama. 2014. *Learning and Teaching Early Math: The Learning Trajectories Approach.* 2nd ed. New York: Routledge.

"While practicing is vital to learning and memory, studies have shown that practice is far more effective when it's broken into separate periods of training that are spaced out. The rapid gains produced by massed practice are often evident, but the rapid forgetting that follows is not. Practice that's spaced out, interleaved with other learning, and varied produces better mastery, longer retention, and more versatility."

Brown, Peter C., Henry L. Roediger III, and Mark A. McDaniel. 2014. *Make It Stick: The Science of Successful Learning.* Cambridge, MA: Belknap.

"Students who learn their basic facts through varied practice learn not only the facts but also a way of thinking and working in mathematics that is very useful beyond the context of learning basic facts."

Crespo, Kyriakides, and McGee 2005. "Nothing 'Basic' about Basic Facts: Exploring Addition Facts with Fourth Graders. *Teaching Children Mathematics* 12 (2): 61–67.

"Fluency in each grade involves a mixture of just knowing some answers, knowing some answers from patterns (e.g., 'adding 0 yields the same number'), and knowing some answers from the use of strategies. It is important to push sensitively and encouragingly toward fluency of the designated numbers at each grade level, recognizing that fluency will be a mixture of these kinds of thinking which may differ across students."

Common Core Standards Writing Team, 2011. "K, Counting and Cardinality; K–5, Operations and Algebraic Thinking." *In Progressions for the Common Core State Standards in Mathematics.*

Building Fact Fluency **is designed to disrupt and replace inequitable practices and support shifts toward more equitable mathematics instruction.**

RESEARCH SUPPORTS

"Schools and districts must prioritize meaningful learning of basic number combinations and remove inequitable structures and practices (e.g., timed tests, drills, rote memorization) that have unintended and life-long negative consequences on children. This also demands an understanding of how fluency is developed and positioning the learning of basic number combinations within a broader context of number and operation sense."

National Council of Teachers of Mathematics, 2020. *Catalyzing Change in Early Childhood and Elementary Mathematics: Initiating Critical Conversations.* Reston, VA: National Council of Teachers of Mathematics.

"Each and every child should develop deep mathematical understanding as confident and capable learners; understand and critique the world through mathematics; and experience the wonder, joy, and beauty of mathematics. . . . Early childhood and elementary mathematics should dismantle inequitable structures, including ability grouping and tracking, and challenge spaces of marginality and privilege. . . . Mathematics instruction should be consistent with research-informed and equitable teaching practices that nurture children's positive mathematical identities and strong sense of agency. . . . Early childhood settings and elementary schools should build a strong foundation of deep mathematical understanding, emphasize reasoning and sense making, and ensure the highest-quality mathematics education for each and every child."

National Council of Teachers of Mathematics, 2020. *Catalyzing Change in Early Childhood and Elementary Mathematics: Initiating Critical Conversations.* Reston, VA: National Council of Teachers of Mathematics.

"By 'offering an increased number of pathways and points of entry' to students, we can broaden their conception of what it means to be good at math and position all our students as competent mathematicians."

Aguirre, Julia Maria, Karen Mayfield-Ingram, and Danny Bernard Martin. 2013. *The Impact of Identity in K–8 Mathematics: Rethinking Equity-Based Practices.* Reston, VA: National Council of Teachers of Mathematics.