

DMT INSIGHTS

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BEYOND THE CORE CURRICULUM: WHY MATHEMATICAL INTERVENTION MATTERS

Research on mathematical understanding, procedural fluency, and flexibility

Introduction

A high-quality core mathematics curriculum is essential for providing students with coherent, grade-level instruction. However, even with effective core instruction, some students struggle to develop the mathematical understanding needed to work accurately, efficiently, and flexibly.

When students struggle, they often need additional instruction. Repeating an explanation or providing more practice may help, but some students need opportunities to examine the mathematical relationships underlying the concepts and procedures they are learning.

This DMT Insight examines the role of core and intervention curricula, the research on conceptual understanding and procedural fluency, and the importance of mathematical representations, student reasoning, and teacher knowledge in designing effective intervention.

Core Mathematics Curriculum: Coherent Grade-Level Instruction

A high-quality core mathematics curriculum is a comprehensive, grade-level program that addresses state standards and provides all students with coherent mathematics instruction (Achieve the Core, n.d.; CCSSO, 2022). Its main components include:

- **Content Standards:** Clearly defined learning goals for each grade, such as those in state standards, covering domains like number operations, algebra, geometry, measurement, and data.
- **Instructional Sequences:** Lessons and units that build knowledge progressively, ensuring coherence across grades and topics.
- **Practice Standards:** Emphasis on mathematical models, reasoning, problem solving, and communication, connecting conceptual understanding with procedural fluency.
- **Assessment Tools:** Formative and summative assessments to monitor student progress and guide instruction.
- **Differentiation:** Strategies and materials to address diverse learning needs within the classroom.

- **Purposeful Practice and Review:** Regular opportunities to revisit and practice previously learned concepts and procedures.
- **Application Tasks:** Problems that ask students to apply mathematics in new situations.

A core curriculum's effectiveness depends in part on teachers' mathematical knowledge and the instructional decisions they make. Teaching mathematics draws on specialized knowledge: recognizing the mathematics in student strategies, interpreting errors, choosing representations, and explaining why procedures work (Ball et al., 2008). Hill et al. (2005) found that teachers' mathematical knowledge for teaching was positively related to students' achievement gains. Ongoing, content-focused professional development can help teachers develop this knowledge.

Core curricula are designed to develop grade-level mathematics, but students enter each lesson with different prior knowledge and understandings of mathematical relationships. When students struggle, additional practice with the same procedures may not address the underlying mathematics. Intervention should provide opportunities to examine those relationships through different tasks, representations, and explanations.

Supplemental Mathematics Materials: Practice, Review, and Enrichment

Core mathematics curricula provide the primary sequence of grade-level instruction. Supplemental mathematics materials serve as flexible resources to support, enrich, or remediate learning. These materials are not designed to replace the core program, but rather to address specific needs that arise in the course of instruction:

- **Targeted Practice:** Focused on particular concepts and skills where students need extra help or challenge.
- **Flexible Formats:** Instead of a full course structure, short units, worksheets, games, videos, or online tools may be used.
- **Just-in-Time Support:** Used to provide immediate help when students struggle with specific topics, often in small groups or one-on-one settings.
- **Customization:** Tailored to individual or small group needs, rather than following a set sequence for an entire class.

Supplemental materials provide additional opportunities for practice, review, and enrichment. Some materials reinforce the instruction students have already received, while others offer different representations or tasks. However, when students struggle to understand the mathematics, additional practice alone may not be enough. Intervention materials may also supplement the core curriculum, but their purpose is to address identified mathematical learning needs through targeted instruction.

Why Mathematical Understanding Matters in Intervention

Research on conceptual and procedural knowledge shows that the two support one another during mathematical learning. Rittle-Johnson et al. (2001) found that children's conceptual understanding of decimals predicted gains in their procedural knowledge, and that gains in procedural knowledge also supported conceptual understanding. A later review described the relationship as bidirectional (Rittle-Johnson et al., 2015). Practice and understanding are not competing goals.

Adding It Up defines procedural fluency as the ability to carry out procedures flexibly, accurately, efficiently, and appropriately. It treats it as one of five intertwined strands of mathematical proficiency alongside conceptual understanding (National Research Council, 2001). Star (2005) argues that procedural knowledge can be deep, including knowing when a procedure applies and which strategy is most appropriate among several. In this sense, flexibility means recognizing mathematical relationships, selecting appropriate strategies, and using procedures accurately and efficiently.

Mathematical understanding involves recognizing the quantities, units, and relationships that numbers, operations, and procedures represent. Students who multiply two-digit numbers need to understand how numbers can be composed and decomposed into tens and ones and how multiplication operates on those quantities. A student who writes $23 \times 4 = 812$ may be multiplying the digits separately and recording the partial results side by side. The response alone does not establish the student's reasoning. Asking the student to explain or represent the calculation can help determine whether the student needs further development in place value and the distributive property. Representing 23 as 20 and 3 shows that 23×4 is $80 + 12$, or 92. When students understand these relationships, they can connect procedures to the mathematics they represent rather than learn them as disconnected steps.

The same structures appear across the grades: identifying the unit and the quantity; composing and decomposing quantities while preserving their value; partitioning the unit of 1 into equal parts and iterating those parts; and recognizing equivalence among representations and expressions. These are mathematical ideas, not a list of skills. Interventions that address them give students a way to reason about the procedures they are learning.

Key Idea • Conceptual understanding, procedural fluency, and flexibility develop together. Intervention should address the relationships that connect them.

Mathematically Focused Intervention: Developing Understanding, Fluency, and Flexibility

Effective mathematics intervention begins by examining what students understand and how they are reasoning. An incorrect answer may indicate difficulty with a mathematical unit, the relationship between quantities, interpreting a representation, or applying a procedure. Such responses often reflect reasonable ideas used beyond their intended scope, and they are evidence to investigate rather than a diagnosis.

Intervention materials should give students opportunities to examine these relationships through carefully selected tasks, representations, and mathematical discussions. Physical materials, diagrams, number lines, equations, and mathematical language can each help students make sense of the mathematics. Students may use several representations together; they do not need to move through them in a fixed sequence.

Research on mathematics intervention identifies several important instructional features, including explicit and systematic instruction, mathematical representations, attention to problem structures, purposeful practice, and ongoing progress monitoring (Gersten et al., 2009; Fuchs et al., 2008). These findings provide a research basis for examining the mathematical design of intervention materials and the instructional decisions teachers make.

The goal is to develop conceptual understanding, procedural fluency, and flexibility together. Students need to understand why procedures work, use them accurately and efficiently, and recognize when different strategies are

appropriate. This requires an approach that goes beyond simply repeating the core lesson. Intervention should support core instruction rather than replace it, so students can continue accessing grade-level mathematics.

Core, Supplemental, and Intervention Materials: Different Purposes

Component	Core curriculum	Supplemental materials	Mathematically focused intervention
Purpose	Develop grade-level mathematics	Provide additional practice, review, or enrichment	Develop mathematical relationships students need to understand
Instruction	Coherent grade-level sequence	Targeted additional activities	Instruction informed by student reasoning
Mathematical emphasis	Concepts, procedures, reasoning, and applications	Specific concepts or skills	Units, quantities, structures, relationships, fluency, and flexibility
Assessment	Grade-level learning and progress	Specific learning needs	Diagnostic evidence and progress monitoring
Connection to core	Primary instruction	Supports core instruction	Develops understanding needed to participate in core mathematics

Intervention differs from core and supplemental materials in its instructional purpose and mathematical design, not only in group size or time.

Why Additional Instruction Does Not Always Develop Mathematical Understanding

Providing additional instructional time does not necessarily address the mathematical difficulties students are experiencing. When intervention focuses primarily on repeated procedures or isolated skills, students may become more proficient at completing familiar problems without understanding the relationships needed to apply those procedures in new situations.

Effective intervention requires teachers to examine student reasoning and identify the mathematical ideas that need further development. Instruction should connect those ideas to mathematical structures and relationships rather than treating them as disconnected skills. Intervention scheduling also matters: when students leave core instruction for intervention, they may lose access to the grade-level mathematics the intervention is meant to support.

Teacher Knowledge and Intervention

Intervention materials can provide carefully designed mathematical tasks and representations, but teachers must understand the relationships those tasks are intended to develop. Mathematical knowledge for teaching includes recognizing the mathematics in student strategies, interpreting errors, selecting representations, and connecting student thinking to increasingly efficient procedures (Ball et al., 2008). Professional development should help teachers build this knowledge so interventions respond to student understanding.

An Example of Mathematically Focused Intervention: Math Success by DMTI

Math Success by DMTI is designed to help students develop mathematical understanding through carefully sequenced tasks and representations. The materials focus on how quantities and units are composed, decomposed, partitioned, and iterated, and how numbers, operations, and equations represent these relationships.

Students examine mathematical relationships, explain their reasoning, and connect that understanding to increasingly accurate, efficient, and flexible procedures. These are the intended instructional features of Math Success; comparative effectiveness requires direct evidence.

Key Idea • Intervention should provide different opportunities to understand the mathematics, not only more time or more practice.

Conclusion

A high-quality core curriculum provides essential grade-level instruction, but some students need a different approach to understanding the mathematics. Effective intervention should examine student reasoning and develop the mathematical relationships underlying concepts and procedures.

Students need opportunities to work with quantities, units, representations, and relationships while developing accurate, efficient, and flexible strategies. Intervention aims to strengthen students' mathematical understanding so they can reason about and use the mathematics they are learning.

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Social Media

Why do some students need more than the core curriculum?

A high-quality core curriculum is essential. Some students still need a different mathematical approach: one that develops the quantities, units, and relationships underlying the procedures they are learning.

In DMT Insight 24, we review research on conceptual understanding, procedural fluency, flexibility, student reasoning, and teacher knowledge, and describe how Math Success by DMTI approaches intervention.

Read the full Insight at mathsuccess.io/dmtinsights.

