NEWSLETTER

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THE BAR MODEL AS A REASONING DEVICE

In today's edition, we explore:

- **The Classroom Reality:** Why students who can compute fluently still freeze on word problems — not because the math is hard, but because they have no way to think about it
- **The Structural Why:** Why a rectangle becomes a reasoning device the moment students use it to think with, not just a drawing they complete
- **The Instructional Shift:** Teaching the bar model as one consistent way of reasoning — from part-whole in kindergarten to algebraic expressions in middle school

Educators

- A student stares at "Maria has 47 stickers. Her brother has 25. How many more does Maria have?" for two minutes. She knows how to subtract. She does not know whether to. There is nothing on her paper but the numbers.
- Another student draws a bar with two equal-sized parts labeled 47 and 25, then asks, "Is this right?" The drawing is a step she has completed; it is not yet something she is thinking with.
- A third draws a perfect bar model for an equal-groups problem, computes the right answer, and then says: "Wait — why did I draw the bar again?" The rectangle helped him solve, but he has not yet seen what it helped him see.

These three students share something important: each has been taught the bar model, but none has been taught to reason with it. The drawing has become a step rather than a structure for thinking. **When the bar model is taught as something to produce rather than as something to think with,** students collect a procedure for drawing it but no method for using it. The rectangle becomes decoration around an answer rather than the path that led to one.

Our latest **DMT Insight — Why Students Struggle with Word Problems and How Bar Models Help** — explains how the bar model becomes a reasoning device when students learn to read its structure, and how that same rectangle carries them from arithmetic into algebra.

The Classroom Reality: A Drawing, Not a Way of Thinking

In most classrooms where the bar model appears, it looks like this:

- The bar model is introduced as a graphic organizer to complete — one template for part-whole problems, another for comparison — with no discussion of how its structure carries the reasoning
- The size of each rectangle is treated as a stylistic choice rather than as the carrier of the relationship — bars for 47 and 25 are drawn the same size, hiding the very idea the model could reveal
- Students are asked to draw the bar and then solve, with no connection made between the drawing and the choice of operation — the model becomes a step in the procedure, not a tool for thinking
- The bar model is introduced once, for one type of problem, in one grade — rather than as a structure that grows with students through fractions, ratio, percent, and into algebraic reasoning

From a student's perspective, the message is clear: the bar model is something you produce, not something you reason with.

So students apply the logic their instruction has given them:

- "I draw the bar because we're supposed to. Then I look for a keyword to tell me what to do."
- "The two parts should be the same size, right? Because they're both parts."
- "The bar model is for younger kids. I don't need it for fractions."

The instruction is consistent — even when it leaves students without the reasoning device the bar model was meant to be.

The Structural Why: What a Reasoning Device Actually Is

Research on representation, cognitive load, and transfer helps explain what changes when the bar model becomes a reasoning device rather than a step.

A reasoning device makes structure visible. Bar models reduce cognitive load by externalizing the relationships students need to reason about: which quantity is the total, which is a quantity, what is known, and what is missing (Sweller, 1988; Hiebert & Carpenter, 1992). When students can see the relationships, they no longer need to hold them in working memory while also choosing an operation.

A reasoning device works across contexts. The bar model is unusual among classroom tools because the same shape adapts to part-whole, comparison, equal-groups, and algebraic situations. Students do not need a new representation for fractions, ratio, or variables — they reuse one they already trust. This is what makes the bar model a structure for transfer rather than a procedure for **"one problem type"** (Fuson, 1992; Nunes & Bryant, 1996). When the rectangle is taught as one tool that grows with the mathematics, students develop a consistent way of thinking that does not get unlearned.

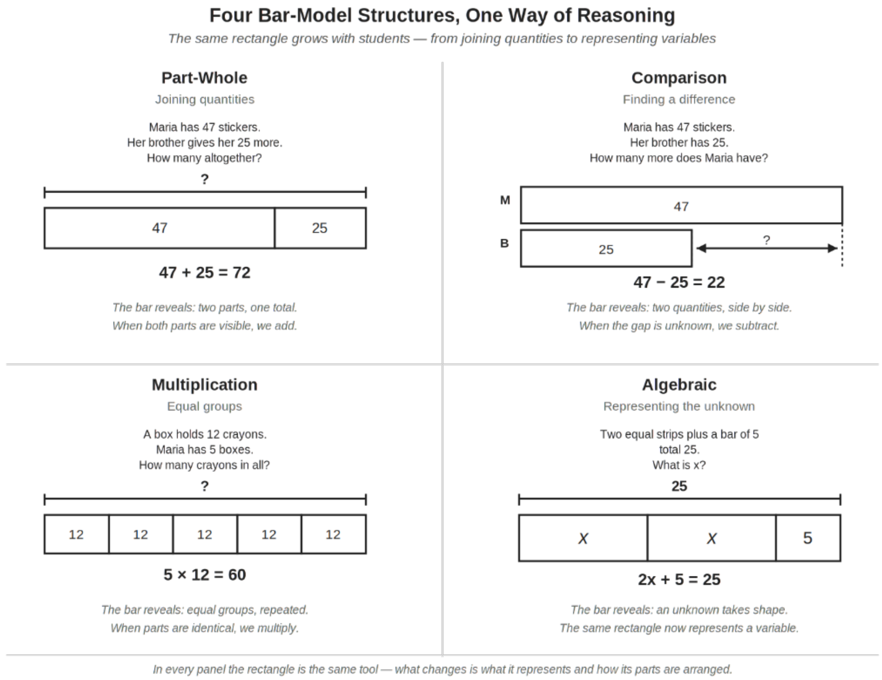

Figure 1. Four bar-model structures — part-whole, comparison, multiplication, and algebraic. The rectangle is the same tool in every panel; what changes is what it represents and how its parts are arranged. This is what makes the bar model a reasoning device rather than a procedure: it grows with the student.

The result, when bar models are taught this way: students don't just draw rectangles. They reason with them.

The Instructional Shift: Reason With the Rectangle

The DMT Insight proposes a foundational reframe: the bar model is not a step in a procedure but a reasoning device students learn to think with. This requires a deliberate instructional shift.

- **Draw before deciding.** Every problem begins with the question: "What does the bar look like?" The drawing comes before the choice of operation, because the structure of the bar is what reveals which operation fits.
- **Let proportions do the reasoning.** A bar for 47 should be visibly bigger than a bar for 25 — without measuring, without rulers. The proportions communicate the relationship before any label is added, and the relationship is what the student is reasoning about.
- **Teach the family of structures together.** Part-whole, comparison, multiplication, and algebraic bars should appear together so students see that the rectangle is one tool that takes different shapes. Each new structure extends a way of reasoning students already trust.
- **Let the model grow.** The same rectangle that shows 47 + 25 in first grade shows 25% of 82 in sixth grade and $x^2 + 2x = 35$ in algebra. Students do not outgrow the bar model — they grow into more of what it can represent. This makes it a way of **seeing** mathematics, not just a way of **solving** a single problem.

When teachers ask **"Model the situation. What do you know? What are you trying to find?"** at every grade level and in every context — the bar model stops being a graphic to complete and becomes a structure students reason with.

Small questions create large shifts:

- “What does the bar model look like? Where is the total? Which quantity is unknown?”
- “Why did you draw it that size? What would change if the bars were equal?”
- “How is this bar model like the one you drew last year? What grew, and what stayed the same?”

These questions move students from drawing the bar model to **reasoning with the bar model.**

Your Turn to Share

We would love to hear from you. **What is one moment when a student’s bar model showed you something about their thinking that the answer alone never could have?**

Share your thoughts at **contact@dmtinstitute.com**. We will compile and elevate your insights to help advocate for stronger teacher support across districts.

Keep inspiring mathematical minds!

MORE INFORMATION

This newsletter is just a preview—there is much more to explore. For the complete **research overview**, visit the **DMT Insights** page at **dmtinstitute.com/research**.

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