

DMT INSIGHTS

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DRAWING UNDERSTANDING: WHY LETTING KIDS CREATE NUMBER LINES BUILDS STRONGER MATH MINDS

Introduction: Reframing the Number Line in Classroom Practice

The number line has long been a classroom staple, but its deepest power emerges when students construct it themselves—choosing endpoints, units, spacing, and labels. When students build the model, they engage essential mathematical actions rather than observe them. Research shows that constructing number lines strengthens proportional and spatial–numeric reasoning (Cohen et al., 2014), helping students map numbers onto meaningful distances. These actions connect number to magnitude, rather than leaving numbers as abstract symbols on a page.

Drawing and scaling lines also activate dual coding, linking verbal and visual systems in ways that support understanding and long-term memory (Paivio, 1986). This is why number-line construction becomes a bridge—from discrete counting to continuous reasoning, and from early arithmetic to algebra and graphing. This Insight distills research across mathematics education and cognitive psychology to show why student-constructed number lines deepen structural understanding and how teachers can embed this practice in instruction and professional learning.

Key Idea • When students construct number lines instead of receiving them, they engage the proportional, spatial, and measurement reasoning that pre-made lines quietly remove.

Cognitive Foundations: From Number to Measurement and Scale

Instead of simply placing numbers on pre-made lines, students engage in measurement-based thinking that drives proportional reasoning—a finding supported by research showing that number-line performance depends heavily on scaling, not just numerical magnitude (Barth & Paladino, 2011; Cohen et al., 2014). When constructing lines, students practice unit iteration and equal partitioning, defining a unit length and repeating it across the line. These are the same skills needed for measurement, fractions, and early algebra.

By mapping numbers to space, students learn that numerals correspond to physical, repeatable lengths rather than just positions on a static line—aligning with cognitive studies showing the role of spatial processing in magnitude understanding (Leibovich et al., 2014). Studies also show that many students hold rigid conceptions of the number line—such as the idea that zero must always be centered or that increments must always be one. Constructing lines encourages flexibility and conceptual growth (Ünal et al., 2024), preparing students for later work in algebra and modeling.

Key Idea • Building a line is measurement-based reasoning: students iterate a unit, partition equally, and map number to space, the same actions that underlie magnitude understanding.

Measurement and Fraction Reasoning: Connecting Number to Length

Constructing number lines strengthens understanding of measurement because students connect numeric values directly to physical length. Research shows that coordinating numeric and linear measurement—literally drawing and scaling lines—deepens conceptual understanding (Saxe et al., 2013). As students partition lines into fourths and tenths, they experience fraction values as proportional distances rather than memorized points—an argument supported by work on spatial–numeric integration (Cohen et al., 2014). This work also supports embodied cognition, as drawing and dividing lines engage sensory–motor and spatial networks (Leibovich et al., 2014). This embodied grounding helps students make sense of equivalence, comparison, and scaling across fraction contexts.

Key Idea • Treating a unit as a length lets students experience fractions as proportional distances rather than memorized points, grounding equivalence, comparison, and scaling.

Extending Number-Line Understanding to Data and Graphing

A line plot is essentially a number line with data layered on it, and research shows that students better understand data displays when they construct the axes themselves—selecting the range, tick spacing, and scale (Lehrer & Schauble, 2007). In bar graphs, constructing axes helps students realize that equal spacing represents equal units, reinforcing structural ideas from measurement that do not always transfer when graphs arrive pre-formatted.

Coordinate graphing also becomes more intuitive when students recognize that the x-axis is a scaled number line. Students who have not constructed number lines often struggle with origin placement and scale—a difficulty observed repeatedly in graphing research (Robertson, 2023). These construction experiences develop continuous and proportional thinking, supporting algebraic modeling and early function reasoning.

Key Idea • An axis is a scaled number line; students who build scales themselves carry equal-spacing and origin reasoning directly into line plots, bar graphs, and the coordinate plane.

Instructional Design: Turning Research into Practice

Classroom routines that begin with blank lines help students take ownership of scale and structure, rather than relying on templates. This echoes research showing that student-created tools promote deeper reasoning (Saxe et al., 2013). Tasks with varied endpoints (0–1, 0–50, 2–10) push students to adapt their unit choices and scaling, supporting cognitive flexibility across contexts.

Integrating fraction and measurement contexts ensures that students connect physical measurement to visual and symbolic representations, reinforcing the structural ideas behind units and partitions. Drawing axes for data or coordinate grids builds graphing fluency through scale-making, a key shift emphasized in data-literacy research (Lehrer & Schauble, 2007). Reflection prompts—such as How did you choose your unit?—make students’ structural reasoning visible, which is essential for developing conceptual understanding. Student-created number lines provide rich

assessment evidence because they reveal how students think about spacing, scale, and labeling, not just whether they placed points correctly.

Key Idea • Routines that start with a blank line, vary the endpoints, and ask students to justify their scale make structural reasoning visible and give teachers rich assessment evidence.

Professional Development: Supporting Teachers as Designers of Structural Learning

When teachers construct number lines during PD, they experience firsthand how scaling, spacing, and unit decisions shape reasoning, building pedagogical content knowledge grounded in students' cognitive actions. Using consistent structural language—unit, partition, iterate, compose, decompose, equal—helps teachers anchor classroom discourse in mathematical actions that promote sensemaking (Brendefur & Strother, 2021). Connecting number-line work to measurement, data, and graphing helps teachers see the number line as a unifying model that supports the K–8 trajectory (Robertson, 2023). Analyzing student-created lines enables teachers to identify misconceptions—such as uneven spacing or fixed-zero thinking—and to design follow-up tasks that target structural understanding.

Key Idea • When teachers build and analyze number lines together, using shared structural language, they develop the pedagogical content knowledge to design tasks that target reasoning, not just placement.

Conclusion: Empowering Mathematical Thinking Through Construction

Research across learning sciences and mathematics education shows that constructing number lines leads to stronger, more transferable understanding than using pre-drawn models (Cohen et al., 2014; Saxe et al., 2013). Through drawing, partitioning, and scaling, students internalize mathematical relationships rather than simply perform them. When construction becomes a routine across grades, students learn to design mathematics—not just record it, transforming the number line into a powerful medium for thinking, modeling, and sensemaking.

Key Idea • Constructing number lines produces more transferable understanding than using pre-drawn ones, because students internalize relationships rather than perform them.

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Social Media

How can drawing a line improve mathematical thinking?

In many classrooms, students place numbers on pre-made number lines. But research shows something powerful happens when kids draw the line themselves. When students choose endpoints, create units, and place tick marks, they are not just making a model—they are building measurement sense, fraction understanding, and graphing skills that transfer across K–8. Our new DMT Insight explores why constructing number lines strengthens proportional reasoning, supports flexible thinking, and prepares students for data displays and coordinate graphs.

Inside this Insight, you will learn:

- Why unit, partition, and scale are the hidden engines of number sense
- How construction links number to space, magnitude, and measurement
- Why drawing graphs starts with drawing number lines
- How teachers can use construction routines to build deep understanding