

DMT INSIGHTS

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NUMBER LINES OR 100S CHARTS? IT DEPENDS ON THE MATHEMATICS

What does each representation make visible?

Introduction

A 100s chart and a number line can include many of the same numbers, but they represent those numbers differently. A 100s chart organizes numbers in rows and columns, making counting patterns and base-ten regularities visible. A number line represents numbers as positions and quantities as distances from zero, making magnitude, order, units, iteration, and partitioning visible.

The instructional question is not simply which tool to use. It is what mathematical relationship students need to see. As students move from counting to reasoning about magnitude, operations, fractions, and later proportional relationships, the number line becomes an increasingly important representation because its structure carries across number systems (Gravemeijer, 2020; Siegler & Braithwaite, 2017).

Research supports the number line in specific ways. Number-line estimation is associated with broader mathematical competence, and researchers have studied the number line in fraction instruction and in embodied training of number concepts. The studies cited here do not compare number lines with 100s charts directly, so this Insight does not claim that one representation produces better learning than the other. It asks what each representation makes visible.

Key Idea • A representation earns its place when it makes the mathematical relationship students need to reason about visible. The question is not which representation is universally better, but what each one allows students to see and reason about.

Magnitude, Position, and Distance

On a number line, a number is represented by a position, and its magnitude can be interpreted through its distance from zero. Equal intervals represent equal units. Students can compare quantities, locate numbers relative to benchmarks, and reason about how far apart two numbers are.

The unit matters. Before locating 7, 37, or three-fourths, students must determine what interval represents one unit and how that unit is iterated or partitioned along the line.

The accuracy with which students place numbers on a number line is associated with their broader mathematical competence. A meta-analysis of 263 effect sizes from 10,576 participants aged 4 to 14 found a moderate association

between number-line estimation and mathematical competence, and the association was stronger for fraction number lines than for whole-number lines (Schneider et al., 2018). In a professional development study linking numerical cognition research to Kindergarten through Grade 3 classrooms, students made first-year gains in number-line estimation, arithmetic, and numeration relative to comparison classrooms, with more mixed results in the second year (Hawes et al., 2021). An association is not a cause, and neither study compares the number line with another representation.

Key Idea • On a number line, position shows magnitude, and equal intervals show equal units. Students identify the unit before they locate a number.

Place Value: Structure and Magnitude Are Not the Same Thing

A number line is particularly useful for showing magnitude—where a number lies relative to other numbers and benchmarks. It is less direct for showing that 37 is composed of 3 units of ten and 7 units of one. Those are related but different ideas.

A 100s chart can make base-ten patterns visible: moving one space changes the number by one; moving one row changes it by ten. However, students should reason about why those patterns occur rather than learn “right means +1” and “down means +10” as visual rules.

A chart's layout can change what students do without changing what they understand. In one experiment, kindergarten and first-grade children solved arithmetic problems on virtual hundreds charts that differed in orientation. Children who used a chart with numbers increasing from top to bottom were more likely to count by tens than children who used a bottom-up chart. However, orientation produced no measurable difference in place-value understanding (Osana et al., 2023).

Key Idea • Structure and magnitude are related but different. A 100s chart can make base-ten patterns visible, and a number line makes magnitude visible. Neither replaces reasoning about why a pattern occurs.

Addition and Subtraction: A Starting Quantity, a Change, and a Result

For addition and subtraction, the number line can represent a starting quantity, a change, and the resulting quantity while preserving unit size. Students can decompose a change into useful parts, for example, representing $38 + 27$ as $+20$, $+2$, and $+5$, and connect that reasoning to equations and mental strategies.

The goal is not to teach students to draw jumps. The goal is to use the line to make quantities, distance, and the structure of the operation visible. A Dutch consultation study in which students commented on the empty number line, together with comparable findings from an Australian study, documents the pitfalls of applying the number line too mechanically (van den Heuvel-Panhuizen, 2008).

Physical experience with a number line has also been studied. First graders who walked to estimated positions on a number line on the floor showed stronger training gains than children who received comparable number-line training without whole-body movement, and the gains partially transferred to untrained numerical skills (Link et al., 2013). The study compared two forms of number-line training: not a number line and a 100s chart.

Key Idea • The number line is not a procedure for drawing jumps. It represents a starting quantity, a change, and a result while the unit stays the same size.

Zero Gives the Number Line an Anchor

Zero is more than an empty quantity. On a number line, zero establishes an origin from which you can interpret magnitude and direction. The distance from zero gives meaning to the magnitude of a positive number and later supports reasoning about negative numbers. Zero is a reference point, not necessarily the place where a number line starts. A number line can show 40 to 60, or -5 to 5 , and each position still takes its meaning from zero. Many 100s charts begin at 1, so zero does not appear on them.

Key Idea • Zero is an origin. Distance from zero gives a number its magnitude, and direction from zero later gives it a sign.

Fractions: Partition the Unit, Then Iterate It

The number line becomes especially powerful when students move beyond whole numbers. Begin with the unit interval from 0 to 1. Partition that unit into equal-sized parts, name the size of one part, and iterate that fractional unit to locate other quantities.

For example, partition 0 to 1 into four equal intervals. Each interval has magnitude one-fourth. Iterating that unit three times locates three-fourths. The denominator describes how the unit was partitioned; the numerator tells how many of those units have been iterated from zero.

Fraction instruction that uses the number line consistently, alongside concrete representations, has been piloted with struggling fifth graders, and preliminary findings are reported (Schumacher et al., 2018). A formative pilot describes a direction for instruction, not a settled result. The meta-analysis cited earlier found that the association between number-line estimation and mathematical competence was stronger for fractions than for whole numbers (Schneider et al., 2018).

Key Idea • The denominator describes how the unit was partitioned. The numerator tells how many of those units have been iterated from zero.

One Representation Across Number Systems

The same representation can represent whole numbers, fractions, decimals, integers, and irrational numbers. What changes is the unit and how it is partitioned; the underlying spatial relationships remain. Siegler and Braithwaite (2017) describe numerical magnitude development as gaining increasingly precise knowledge of increasing ranges and types of numbers, from smaller to larger whole numbers and from whole numbers to rational numbers.

That continuity matters. Students do not need a new representation every time the number system expands. They can return to the same questions: What is the unit? Where is zero? How has the unit been partitioned? Where is the quantity relative to benchmarks? What distance separates two quantities?

This continuity is the number line's long-term advantage. It is an advantage of range, not a verdict on the 100s chart, which is designed for the whole numbers to 100.

Key Idea • The unit and its partitioning change as the number system expands. The questions students ask of the number line remain the same.

When the Representation Becomes the Rule

Any representation can become limiting when students learn its visual patterns without understanding the mathematics behind them. On a 100s chart, “move down one row to add 10” may work as a procedure without students reasoning about ten more. On a number line, students can similarly learn to “make jumps” without attending to the unit or the quantities represented.

The issue is not the representation itself. The issue is whether students are reasoning about the mathematical relationship the representation is intended to reveal.

Key Idea • The issue is not the representation. The issue is whether students are reasoning about the relationship it is intended to reveal.

What Each Representation Makes Visible

Representation	Especially useful for making visible	Watch for
100s chart	Counting patterns, +1 and -1, +10 and -10, and base-ten regularities	Students memorizing movements rather than reasoning about quantities
Number line	Magnitude, order, distance, benchmarks, iteration, and partitioning	Students treating “jumps” as a procedure without attending to the unit
Both	Relationships among numbers and operations	The representation replacing reasoning rather than supporting it

Conclusion: Choose the Representation for the Mathematics

The goal is not to choose one representation and discard the other. The goal is to choose a representation because of the mathematics it makes visible.

A 100s chart can make counting and base-ten patterns visible. A number line makes magnitude, distance, units, iteration, and partitioning visible, and those relationships continue as students move from whole numbers into fractions, decimals, integers, and beyond.

As the mathematics changes, keep asking the same question: What relationship do I want students to see and reason about? A model earns its place when it makes that relationship visible.

Key Idea • A model earns its place when it makes visible the relationship students need to see and reason about.

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Social Media

A 100s chart and a number line can show the same numbers. Do they show the same mathematics?

On a 100s chart, moving down one row adds ten. On a number line, 37 is a position, and its distance from zero is its magnitude. Each representation makes a different relationship visible. The question is what students need to see and reason about.

Our new DMT Insight examines what each representation makes visible.

- What a 100s chart makes visible, and what a number line makes visible
- Why students identify the unit before they locate a number
- How partitioning and iterating a unit locates fractions on the same number line
- What happens when a representation becomes a rule to follow

Read the full Insight at mathsuccess.io/dmtinsights

When your students use a 100s chart or a number line, what relationship are they reasoning about?



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