Let's **Count On** Math™

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A Counting-Based Instructional Framework

Main ideas:

1. Mathematics is a language of quantities.
2. Before operating on numbers, students need to know what those numbers are quantities of.
3. Reveal analogous structures to reduce cognitive load and create coherence across grades.

Three Instructional Framing Questions (for planning and teaching):

1. ***What are we counting?*** (things, $, time, angle, length, area, volume, tenths, etc.)
   a. Already the same type of thing? Count right away.
   b. Not the same type of thing? Make change if possible, then count.

2. ***How are we counting it?*** (what operation, algorithm, or formula; make change?)

3. ***What previous skill or concept is this analogous to?*** (reduce cognitive load)

Grade 1	2 cats	+	3 cats	=	5 cats
Grade 3	2 squares	+	3 squares	=	5 squares
Grade 5	2 hundreds	+	3 hundreds	=	5 hundreds
Grade 7	2 twelfths	+	3 twelfths	=	5 twelfths
Grade 9	$2x^2$	+	$3x^2$	=	$5x^2$
Grade 12	$2\log x$	+	$3\log x$	=	$5\log x$

Same structure. Different symbols. Related meaning.

Show analogous (prior, current, and/or future) structures side-by-side.

Where is counting hidden or compressed in an algorithm?

Where else in your grade's curriculum are students combining quantities?

What could I try tomorrow? next week? next month?

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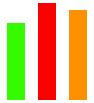

$$ax + by = c$$
$$dx + ey = f$$

A Counting-Based Instructional Framework: Some Grade Level Examples

Grade 1 - Count these things

cat cat cat **dog** **dog** **dog** **dog** cat cat cat ant **dog**

1 cat, 2 cats, 3 cats, 4 cats, 5 cats, 6 cats altogether (3 cats and 3 cats is 6 cats)

1 **dog**, 2 **dogs**, 3 **dogs**, 4 **dogs**, 5 **dogs** altogether (4 **dogs** and 1 **dog** is 5 **dogs**)

1 ant (it's alone)

6 cats + 5 **dogs** + 1 ant (later we teach that we don't need to write "1" in front of ant)

Grade 5 - Adding decimal numbers

Add: 39.4 + 65.2

$$\begin{array}{r} {\scriptstyle 1} \\ 39.4 \\ +\ 65.2 \\ \hline 104.6 \end{array}$$

Instead of saying:	**Say:**
Line up the decimal points	*What are we counting*?
Write down the decimal below	4 tenths + 2 tenths = 6 tenths. Write 6 in tenths place
Start at the right and add down. 4+2, write down the 6	9 ones + 5 ones = 14 ones. 14 is 10 + 4
9 + 5 = 14, write down the 4 and carry the one	Write the 4 in ones place. Write 1 in tens place (there is 1 "ten")
1 + 3 + 6 = 10, write down the 10	1 ten + 3 tens + 6 tens = 10 tens Write 10 (really it's 100)

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Grade 7 - Adding fractions

Add: $\frac{1}{4} + \frac{5}{6}$

$\frac{3 \times 1}{3 \times 4} + \frac{5 \times 2}{6 \times 2}$ LCM = 12

→ $\frac{3}{12} + \frac{10}{12}$

→ $\frac{13}{12}$ or $1\frac{1}{12}$

Instead of saying:	**Say:**
To add fractions we need a common denominator	*What are we counting*?
The LCM for 4 and 6 is 12, so LCD is 12	1 fourth and 5 sixths (fourths and sixths are different)
Rewrite the equivalent fractions with denominator 12	4 and 6 both go into 12 "make change" fractions into twelfths
Add together the numerators	3 twelfths + 10 twelfths = 13 twelfths (still twelfths)
The denominator stays the same	3 ants + 10 ants = 13 ants (still ants)

Grade 9 - Simplifying expressions

Simplify: $3x + x^2 + 5x + 1 + 4x^2 + 6$

Instead of saying:	**Say:**
We group like terms	*What can we count together*?
Remember: add the coefficients, but the bases and exponents stay the same	$3x + 5x = 8x$ (still x) 3cats + 5cats = 8cats (still cats)
$x^2 + 4x^2 = 5x^2$	$x^2 + 4x^2 = 5x^2$ (still x^2)
$3x + 5x = 8x$	1 + 6 = 7 "ones"
1 + 6 = 7 7 is the constant.	Write the term with highest power first, then descend.
$= 5x^2 + 8x + 7$	$= 5x^2 + 8x + 7$

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