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See, Anchor, and Frame Math With Coding

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CACHE CODE MATH

CACHE COUNTY SCHOOL DISTRICT

Stanford

NSF

See, Anchor, and Frame Math with Coding

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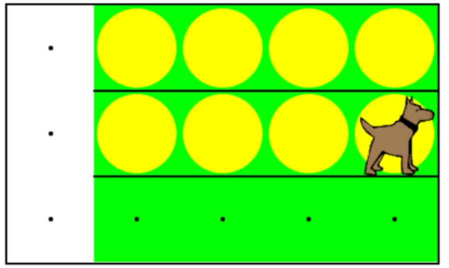
Session Overview

- What is coding? Why integrate with math?
- Lesson: See, Anchor, and Frame in Action
- Unpacking "See, Anchor, and Frame”
- Discussion and Questions



What is Coding in Elementary School?

What does CT have to do with Computer Programming and Coding?

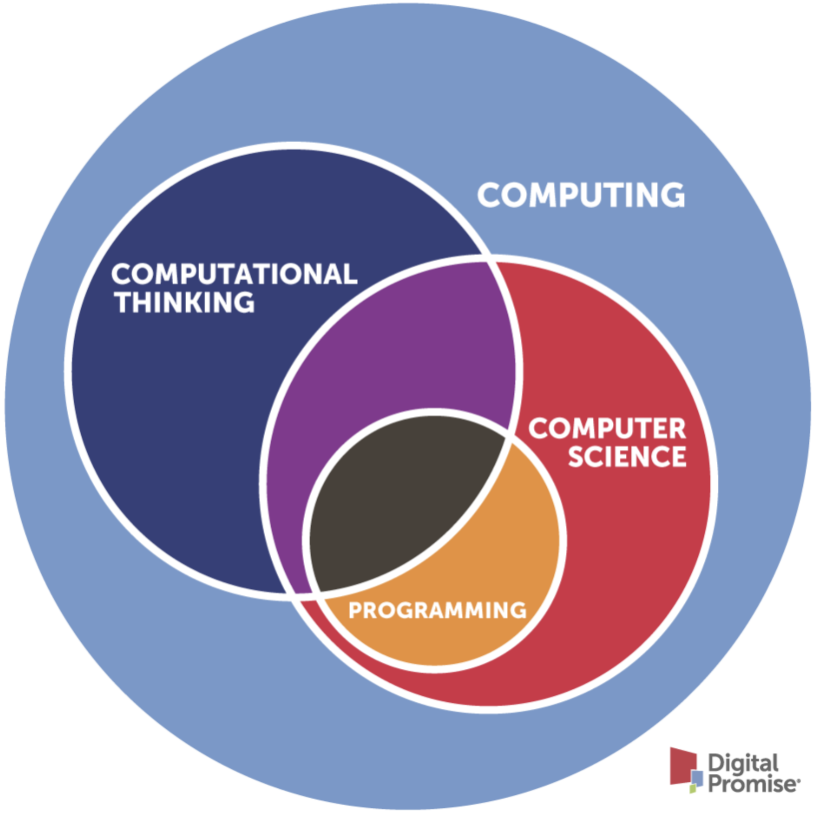
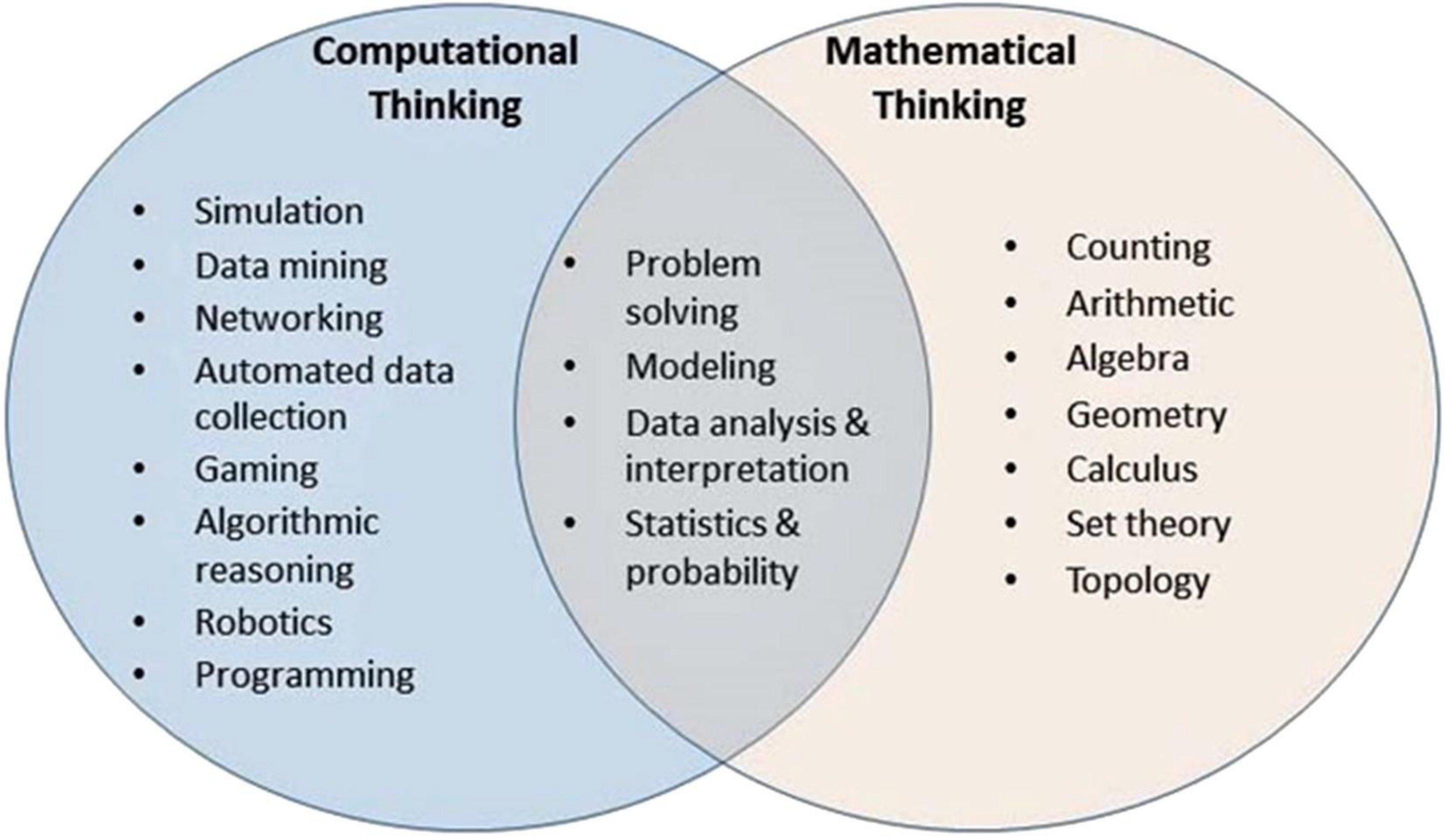


Figure 1. The relationship between computer science (CS), computational thinking (CT), programming and computing.

https://digitalpromise.org/initiative/computational-thinking/about/

Computational Thinking & Math



Shute, V. J., Sun, C., & Asbell-Clarke, J. (2017). Demystifying computational thinking. *Educational research review*, *22*, 142-158.

Why Integrate Coding with Mathematics?

FCR Focus:

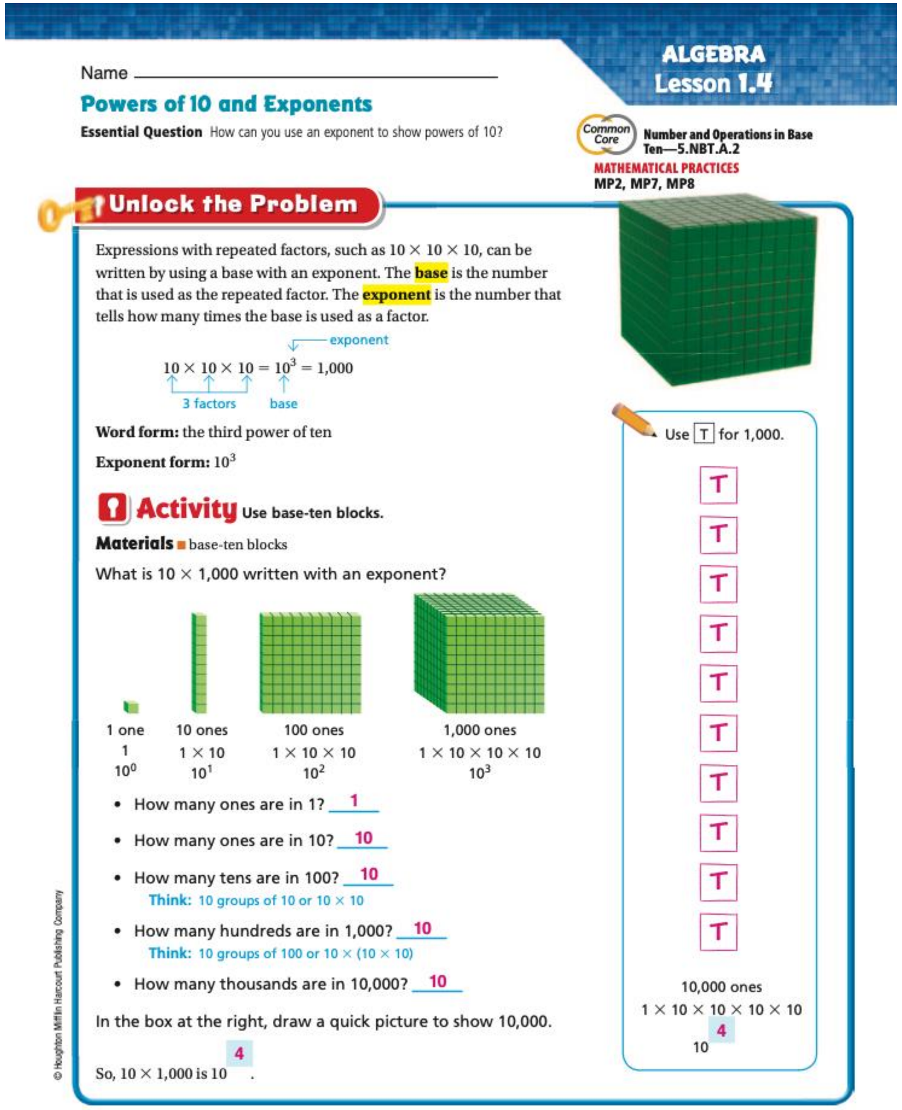
Common Core State Standards

5.NBT.A.2 Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10.

MATHEMATICAL PRACTICES (See *Mathematical Practices in GO Math!* in the *Planning Guide* for full text.) **MP2** Reason abstractly and quantitatively. **MP7** Look for and make use of structure. **MP8** Look for and express regularity in repeated reasoning.

Algorithms and Programming (AP):

An algorithm is a sequence of steps designed to accomplish a specific task. Algorithms are translated into programs, or code, to provide instructions for computing devices. Algorithms and programming control all computing systems, empowering people to communicate with the world in new ways and solve compelling problems. The development process to create meaningful and efficient programs involves choosing which information to use and how to process and store it, breaking apart large problems into smaller ones, recombining existing solutions, and analyzing different solutions.


ALGEBRA Lesson 1.4

Name ______

Powers of 10 and Exponents

Essential Question How can you use an exponent to show powers of 10?

Common Core Number and Operations in Base Ten—5.NBT.A.2

MATHEMATICAL PRACTICES MP2, MP7, MP8

Unlock the Problem

Expressions with repeated factors, such as $10 \times 10 \times 10$, can be written by using a base with an exponent. The **base** is the number that is used as the repeated factor. The **exponent** is the number that tells how many times the base is used as a factor.

$10 \times 10 \times 10 = 10^3 = 1{,}000$ (3 factors; base; exponent)

Word form: the third power of ten

Exponent form: 10^3

Activity Use base-ten blocks.

Materials ■ base-ten blocks

What is $10 \times 1{,}000$ written with an exponent?

1 one, 1, 10^0 — 10 ones, 1×10, 10^1 — 100 ones, $1 \times 10 \times 10$, 10^2 — 1,000 ones, $1 \times 10 \times 10 \times 10$, 10^3

- How many ones are in 1? 1
- How many ones are in 10? 10
- How many tens are in 100? 10
  Think: 10 groups of 10 or 10×10
- How many hundreds are in 1,000? 10
  Think: 10 groups of 100 or $10 \times (10 \times 10)$
- How many thousands are in 10,000? 10

In the box at the right, draw a quick picture to show 10,000.

So, $10 \times 1{,}000$ is 10^4.

Use T for 1,000.

T T T T T T T T T T

10,000 ones, $1 \times 10 \times 10 \times 10 \times 10$, 10^4

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Chapter 1 23

Image credit: Go Math! 5th grade teacher's edition

The Process

- Identify the Team and Compatible Skills
- Collaborative Planning
- Design CS and Math Lessons
- Implementation of Lessons
- Reflect, Revise and Evaluate

Let’s Do a Lesson!

Fraction Unit: Math Routine #3

- Mathematics Classroom:
  - We taught 3 Math Routines prior to their lesson in the Computer Lab. Students learned to interpret and model the fractional part of a group using visuals from CodeHS.
- Computer Lab:
  - Students used CodeHS in the Computer Lab.
  - The coding concepts focused on using **repeat loops**, **creating a function**, and **using abstraction and algorithmic design** with fractions as a context for directing Karel to collect “fiery orbs”:
    - *Karel Cleans Up Program: Karel demonstrates multiplying a fraction by a whole number by cleaning up tennis balls.*
    - *Karel at the Dog Park Program: Karel demonstrates multiplying a fraction by a fraction by placing tennis balls in a fractional portion of the dog park.*

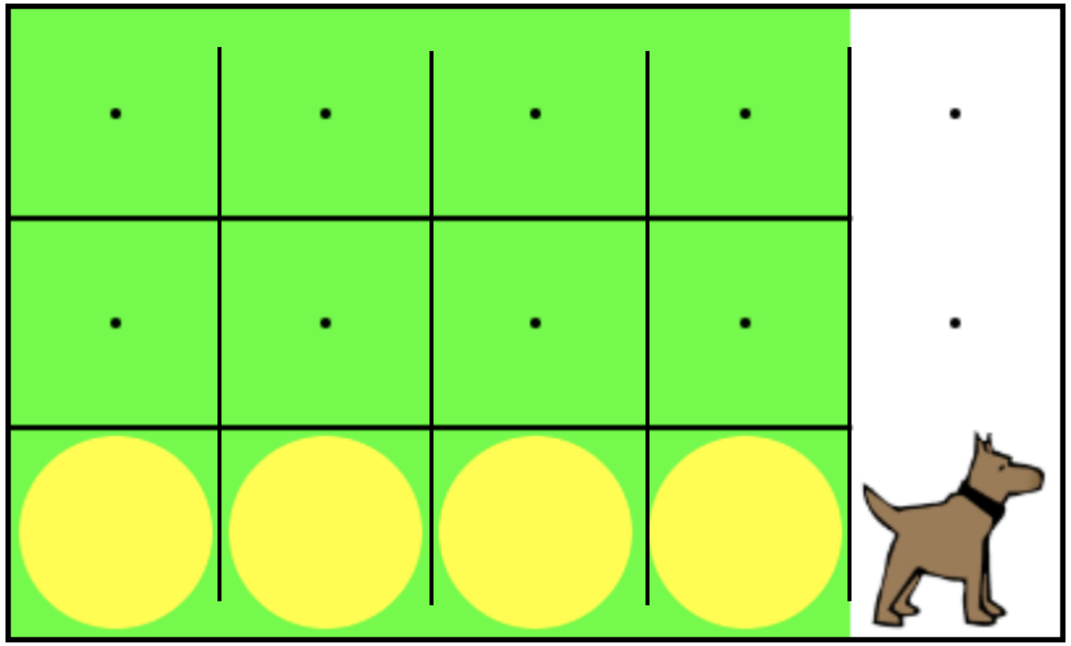
Math Routine 3

Karel Shows the Product! Why is the Product Getting Smaller?

Karel at the Dog Park

Equation #1

Think.



Karel shows the product. The product is 4/15.

What is the equation that Karel modeled for you?

Write.

Write the equation.

Check that it represents what Karel did and results in a product of 4/15.

Pair & Share.

Explain your reasoning.

Run the code.

Check your thinking.

<u>Equation</u>

Discuss.

What does the product mean in this situation?

What does the 4 in 4/15ths represent?

What does the 15 in 4/15ths represent?

How did we get to the product of 4/15?

Compare & Discuss.

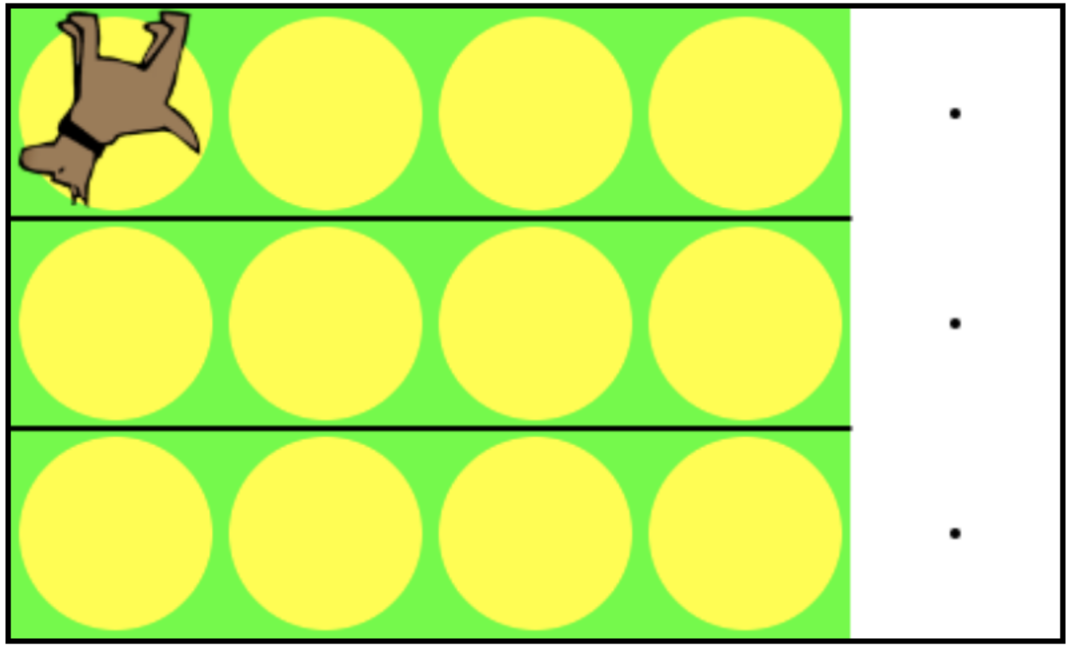
1/3 x 4/5 = 4/15

What do you notice about the product compared to the factors?

Karel at the Dog Park

<u>**Equation #2**</u>

Think.



Karel shows the product. The product is 12/15.

What is the equation that Karel modeled for you?

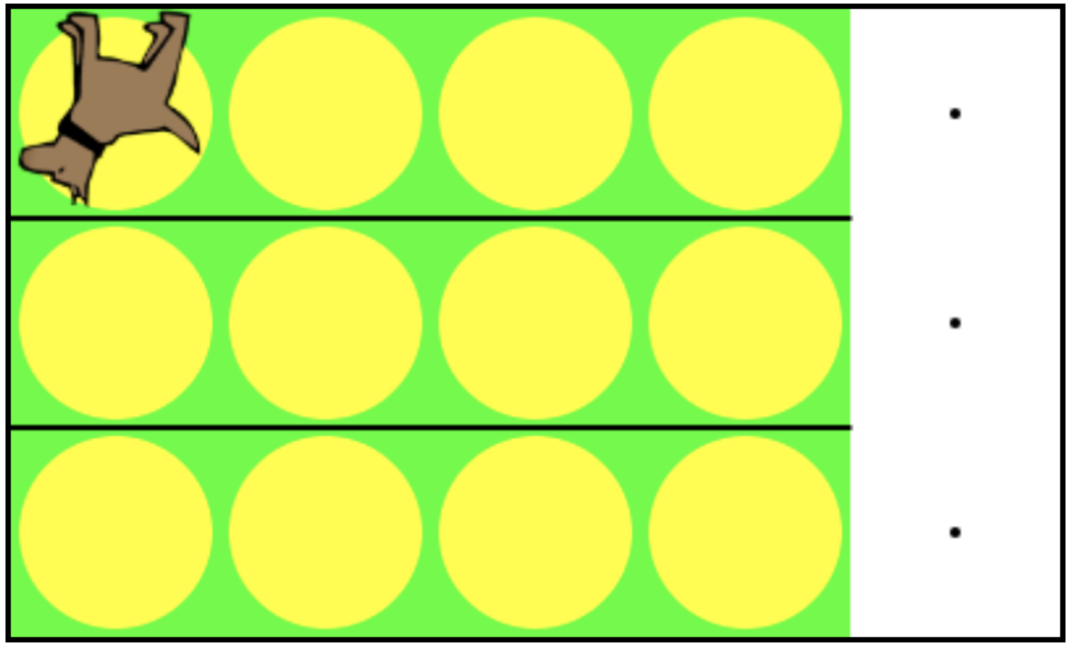
Write.

Write a math equation that represents what Karel did.

Remember, your equation should represent what Karel did and results in a product of 12/15.

Pair & Share.

Explain your reasoning.



Run the code.

Check your thinking.

Discuss.

What does the product mean in this situation?

What does the 12 in 12/15 represent?

What does the 15 in 12/15 represent?

How did we get to the product 12/15?

What did you learn by modeling the fractional parts of groups with Karel and representing the actions with an equation?

- ❑ *Today we learned about creating an equation to represent a fraction being multiplied by another fraction. In computer science, this representation is called abstraction.*
- ❑ *You also saw "for-loops" in today's lesson. In computer science, this is part of algorithm design.*

As we did today, you will practice abstraction in the computer lab to model multiplying fractions. You will use "for-loops" in the computer lab to make the coding more efficient by writing out a sequence of steps for Karel to repeat.

Let's Unpack What We Mean by "See, Anchor, and Frame"

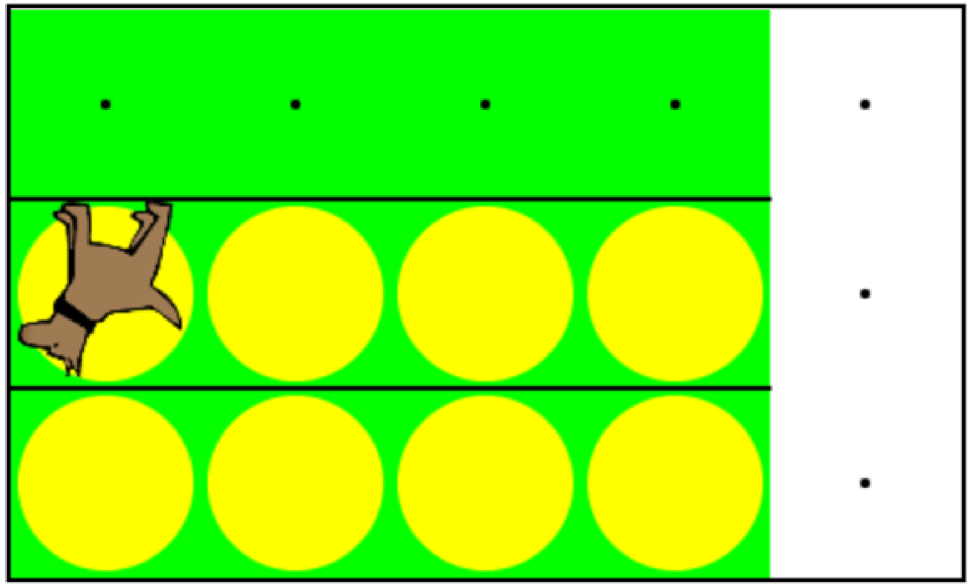
See: visualization of important math concepts

Anchor: big ideas that cross coding and math

Frame: deliberately making connections across content through "framing"

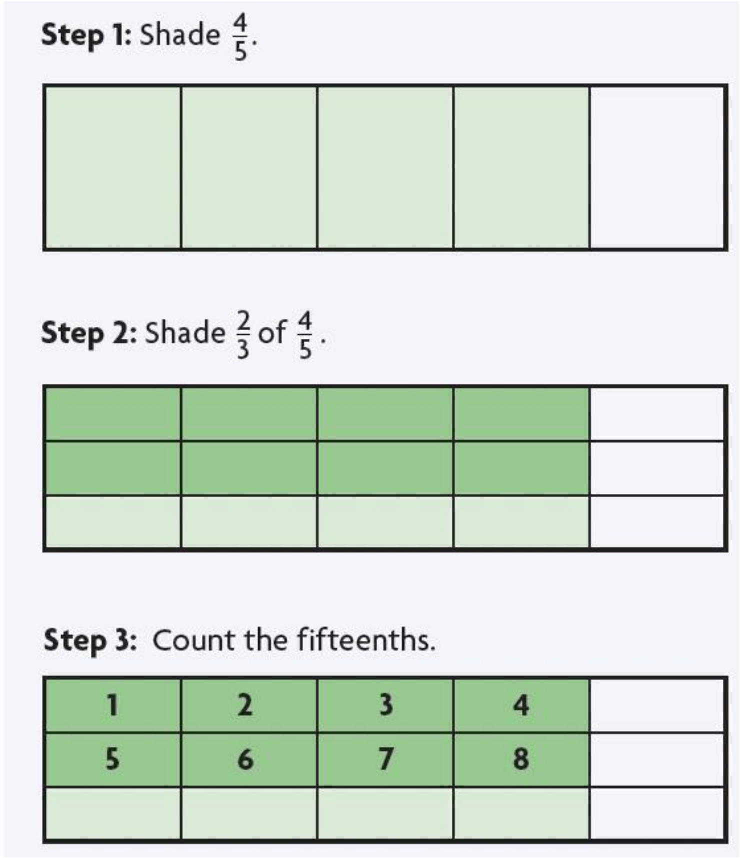
See:
Dynamic Visuals of Fraction Multiplication

The CCM routine uses dynamic area model visuals from CodeHS:



The key goals for the "Karel Shows the Product" routine (#2 and #3) are to help students interpret multiplication as scaling (5.NF.5) and use visual fraction models to represent multiplication of fractions (5.NF.6).

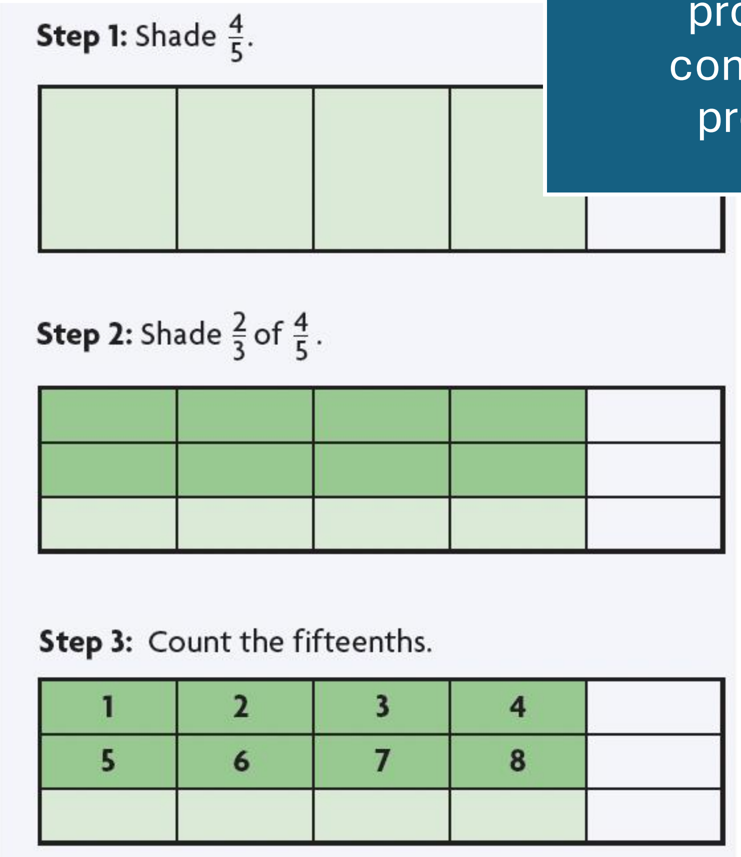
These are the visuals in the teachers' curriculum:

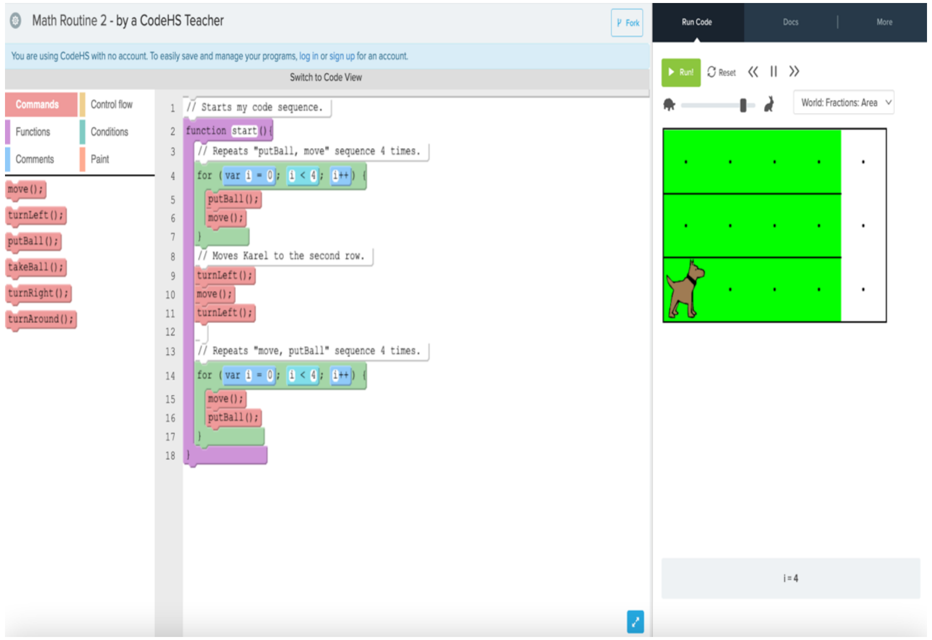


Anchor:
Algorithms and Abstraction

Math: step-by-step process for completing a procedure

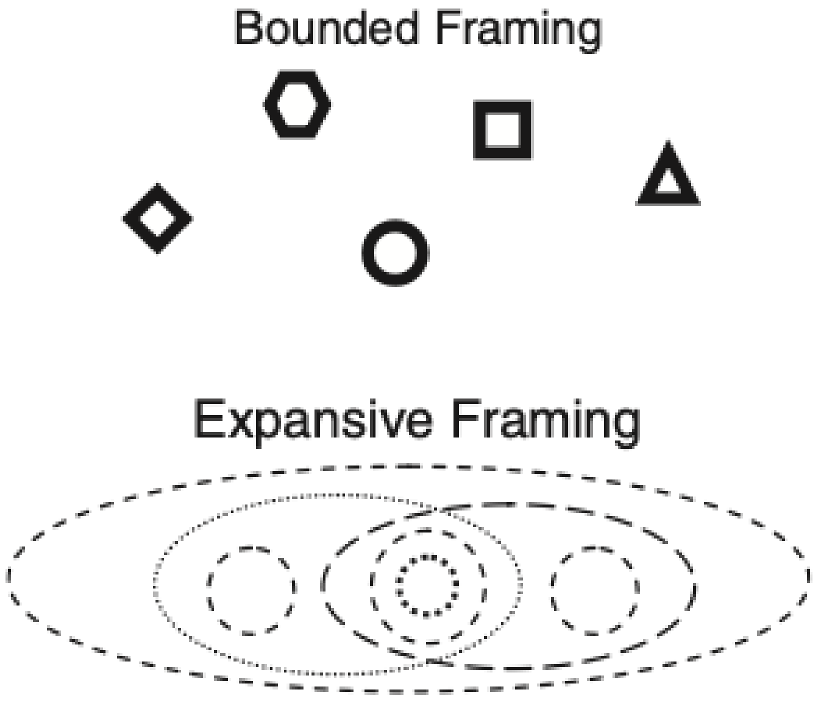
CS: designing a set of commands or instructions for the computer to follow to perform a task





Frame

Explicitly making connections across content through expansive framing:



Today we learned about creating an equation to represent a fraction being multiplied by another fraction. In computer science, this representation is called abstraction. You will practice abstraction in the computer lab to model multiplying fractions.

Image credit: Engle, R. A., Lam, D. P., Meyer, X. S., & Nix, S. E. (2012). How does expansive framing promote transfer? Several proposed explanations and a research agenda for investigating them. Educational Psychologist, 47(3), 215–231. https://doi.org/10.1080/00461520.2012.695678

“See, Anchor, and Frame” in this Multiplying Fractions Math Routine

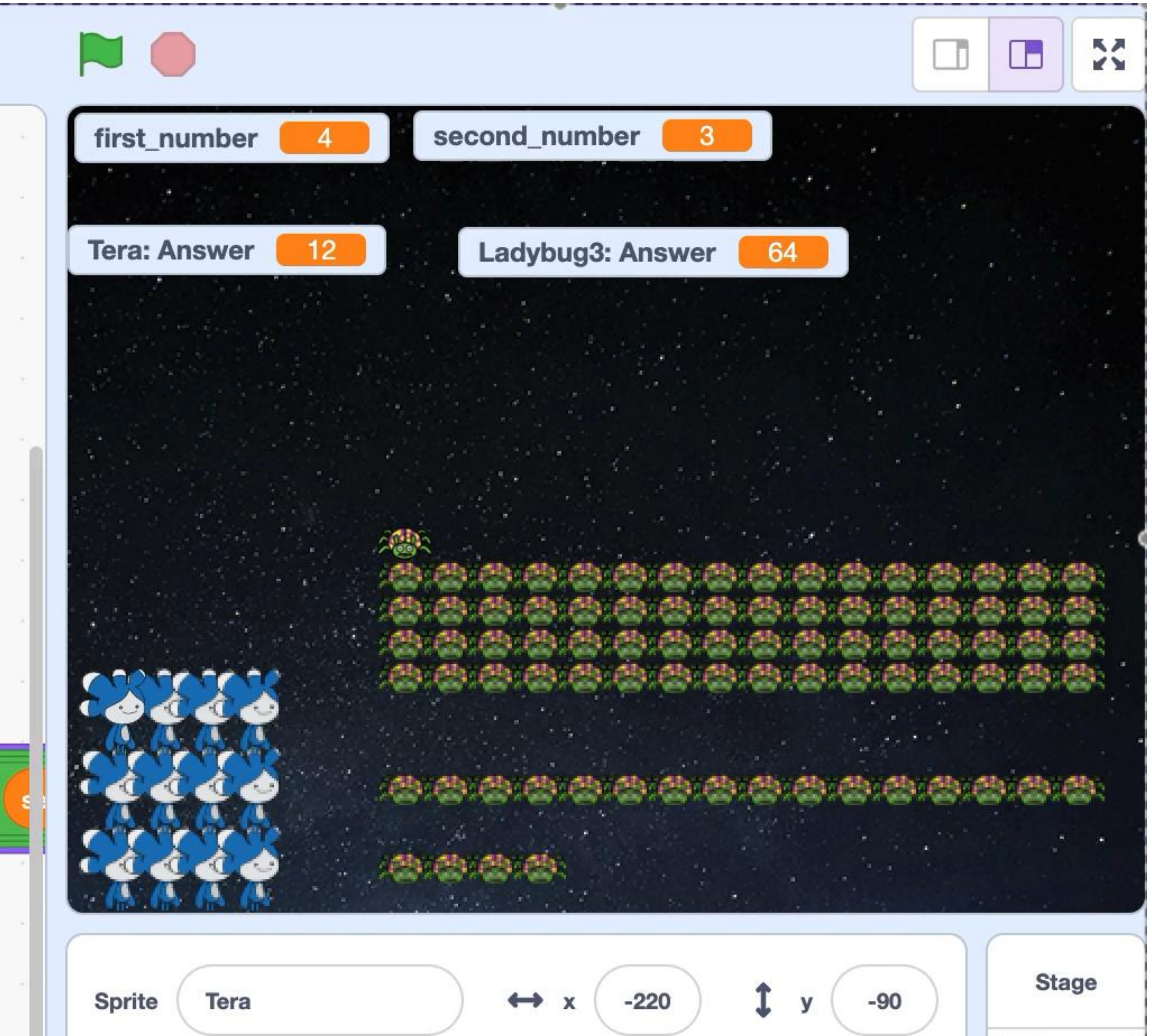
See: used an area model from CodeHS to support students’ understanding of multiplying a fraction by a fraction

Anchors: abstraction and algorithmic design

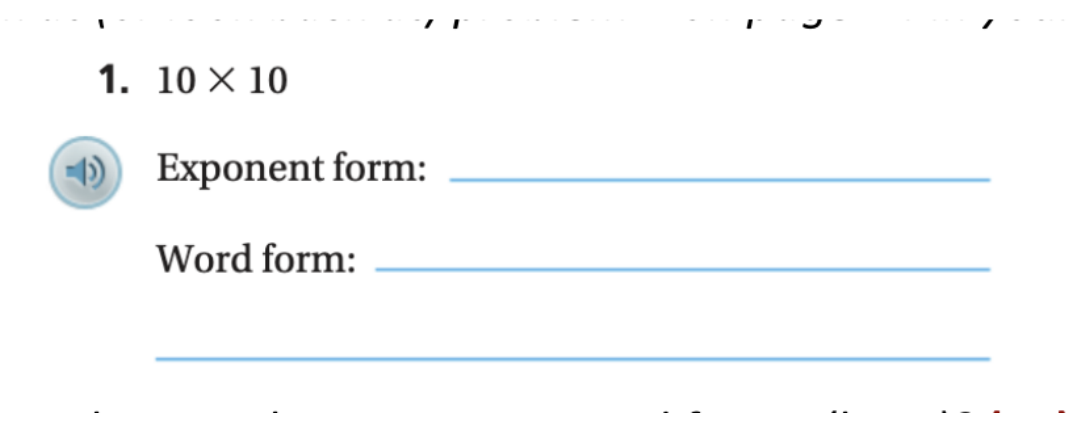
Frame: deliberately making connections across content through “framing”

See:
Dynamic Visual of Exponents

Dynamic visuals in Scratch:



Example task from the teachers' curriculum:


1. 10 × 10

Exponent form: ______

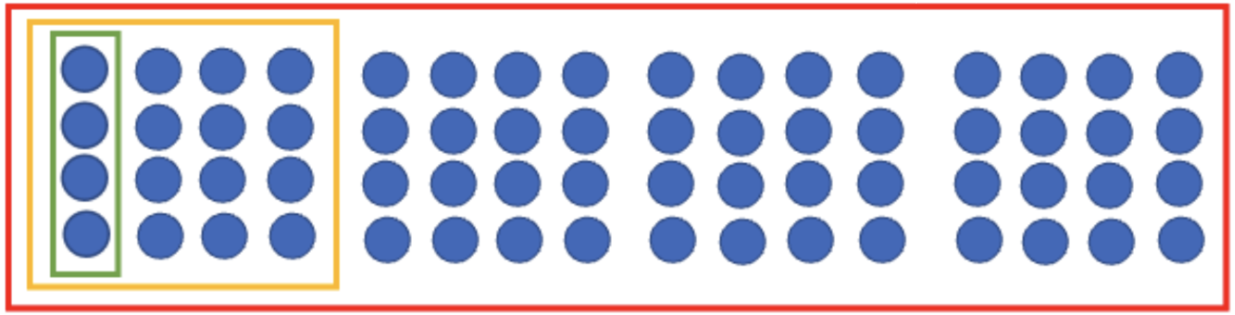
Word form: ______

Anchor: Repeats

Math: repeated factors are exponential and repeated addends are multiplication

CS: the repeat loop repeats a specific piece of code for a set number of times

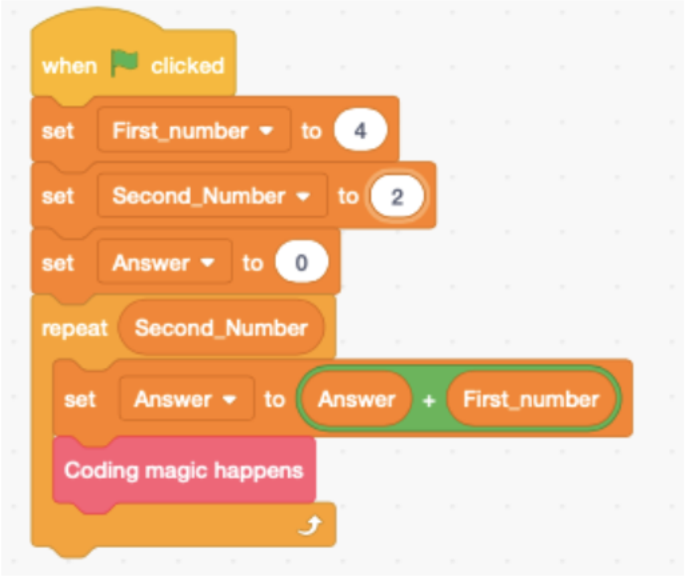
Say: "If we represent 4^3 with dots, what does it look like?"



$4^1 = 4$

$4^2 = 4x4 = 16$

$4^3 = 4x4x4 = 64$



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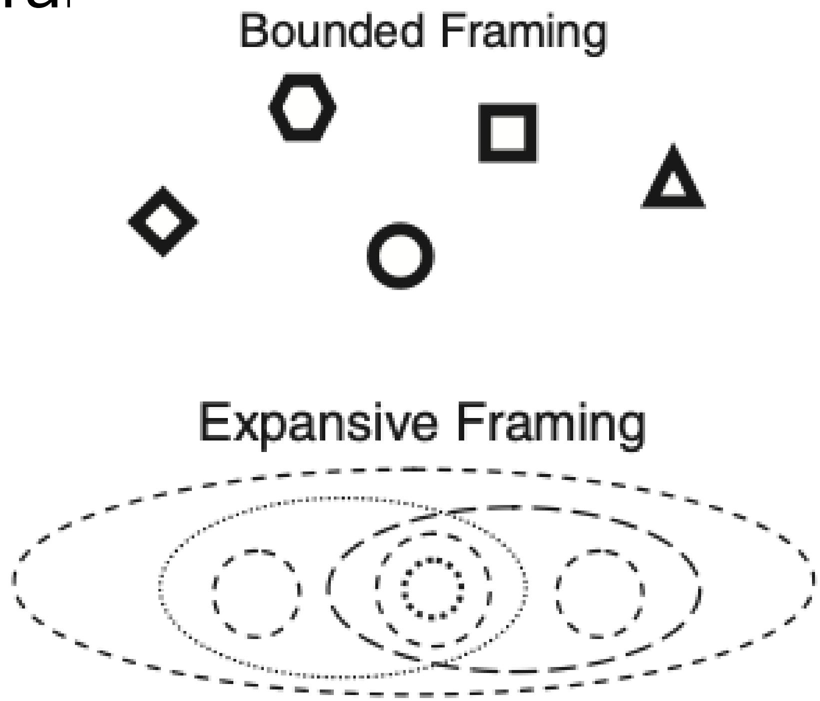

In the computer lab, you'll learn to use the "repeat" blocks to make code easier to write. As you work in math and in the computer lab, be thinking about how we find shortcuts when things repeat.

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Discussion and Questions

- How would you integrate coding in your own classroom mathematics instruction?
- What did you learn from interacting in these math-coding lessons today?
- What connections between mathematics and computer science do you see?
- What “take-aways” do you have from today’s session?

Thank you!

Special thanks to our Cache Code Math research team.

Cache Code Math Website:
https://digitalcommons.usu.edu/eled_support/

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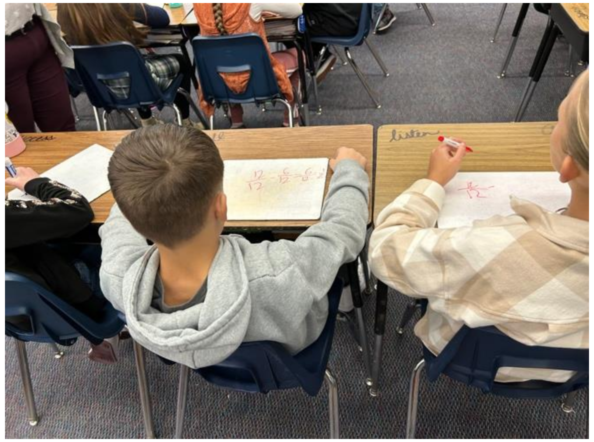

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