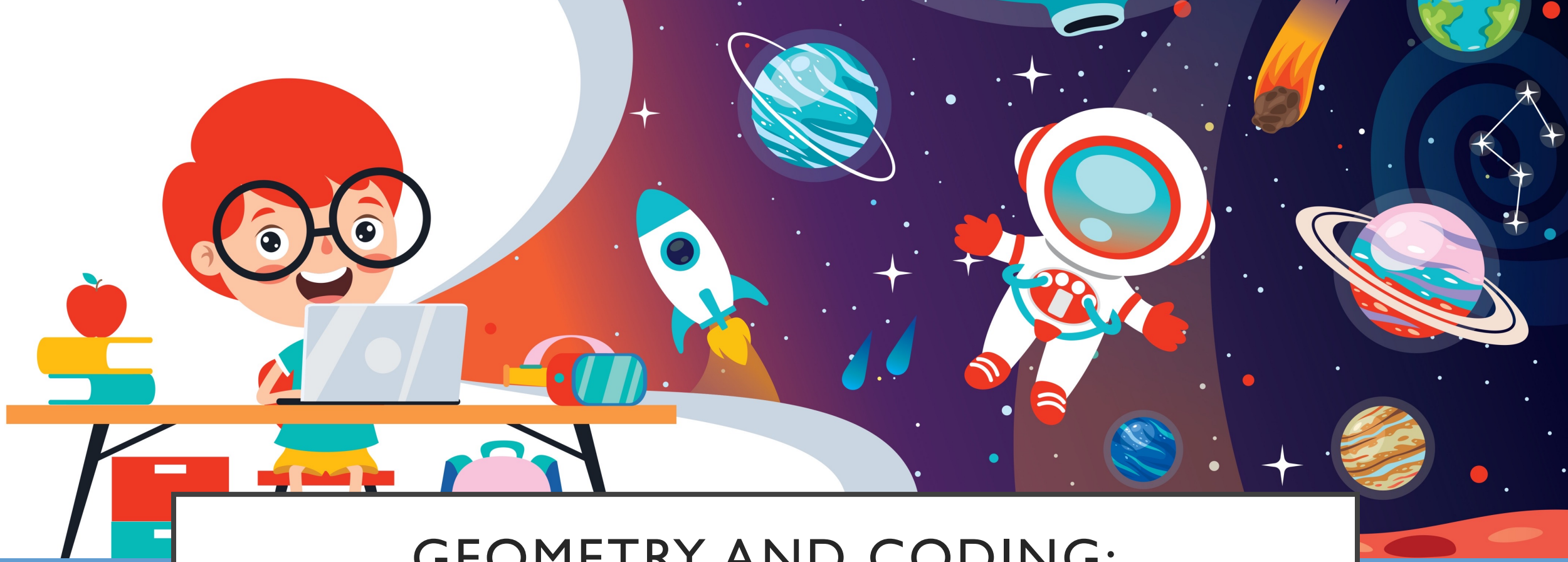
4-2023

Geometry and Coding: Introducing an Interactive and Integrated Mathematics-Computer Science Unit

Kimberly Beck
Utah State University, kimberly.beck@usu.edu

Jessica F. Shumway
Utah State University, jessica.shumway@usu.edu



GEOMETRY AND CODING:
INTRODUCING AN INTERACTIVE AND INTEGRATED MATHEMATICS-COMPUTER SCIENCE UNIT

Kimberly Beck
School of Teacher Education
Utah State University

Jessica Shumway
School of Teacher Education
Utah State University

SESSION OVERVIEW

1. Cache Code Math Project
2. What is Coding in Elementary School?
3. Expansive Framing
4. Expansively Framing Geometry and Coding
5. Other Areas for Integration and Expansive Framing: Exponents and Fractions
6. Discussion and Q&A

CACHE COUNTY
SCHOOL DISTRICT

UtahState University

Stanford

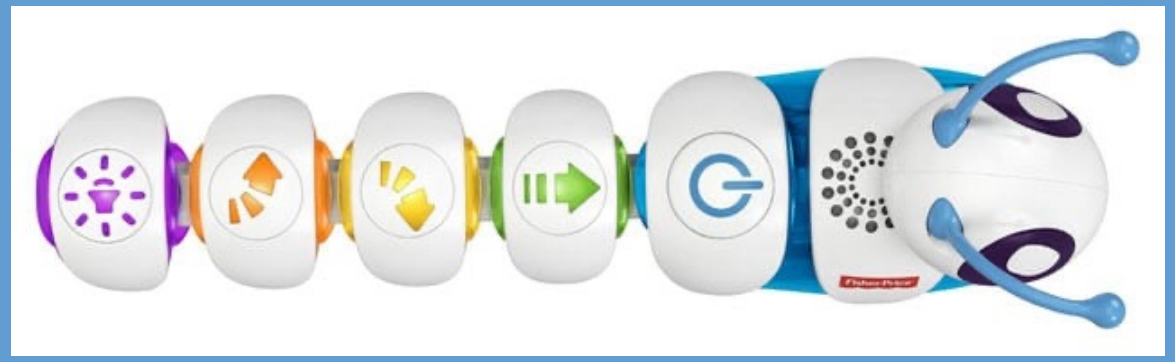
CACHE CODE MATH

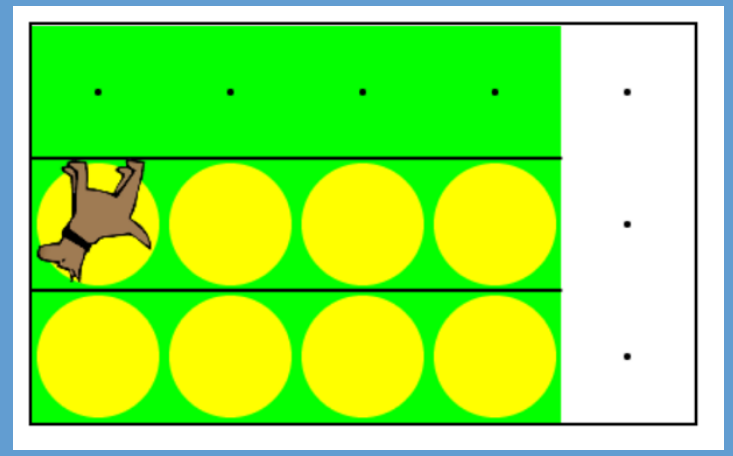
CSFORALL GRANT
#2031382 &
#2031404

PIs: Mimi Recker, Jody Clarke-Midura,
Jessica Shumway, & Victor Lee

CODING IN ELEMENTARY SCHOOL

SCRATCH





WHAT IS SCRATCH?

"Scratch is the world's largest coding community for children and a coding language with a simple visual interface that allows young people to create digital stories, games, and animations."

scratch.mit.edu/about

Let's Explore!

1. Go to scratch.mit.edu
2. Click on "Start Creating"

SCAN ME

Make a letter turn when you click it.

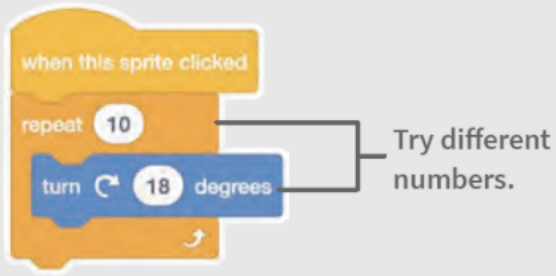
GET READY

Go to the Sprite Library.

Click the **Letters** category.

Choose a letter sprite.

ADD THIS CODE



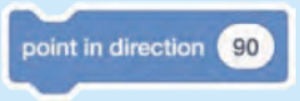
Try different numbers.

TRY IT

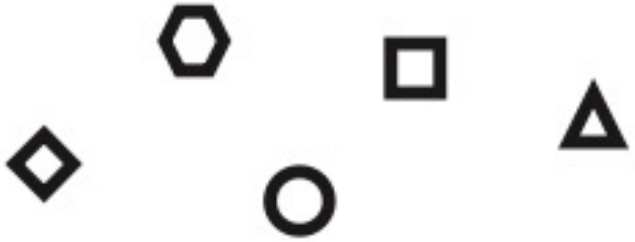
Click your letter.

TIP

Click this block to reset the sprite's direction.

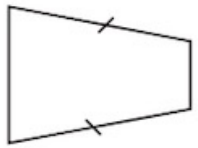


Bounded Framing



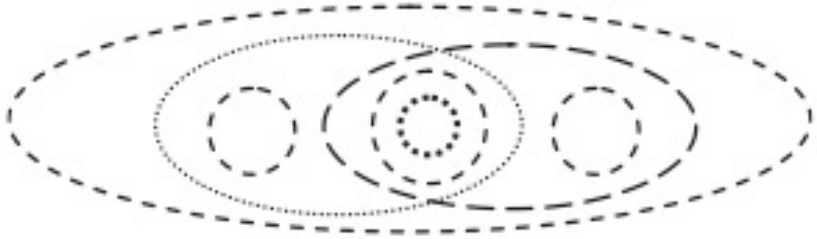
Classify the quadrilateral in as many ways as possible.
Write *quadrilateral, trapezoid, parallelogram, rectangle, rhombus,* or *square*.

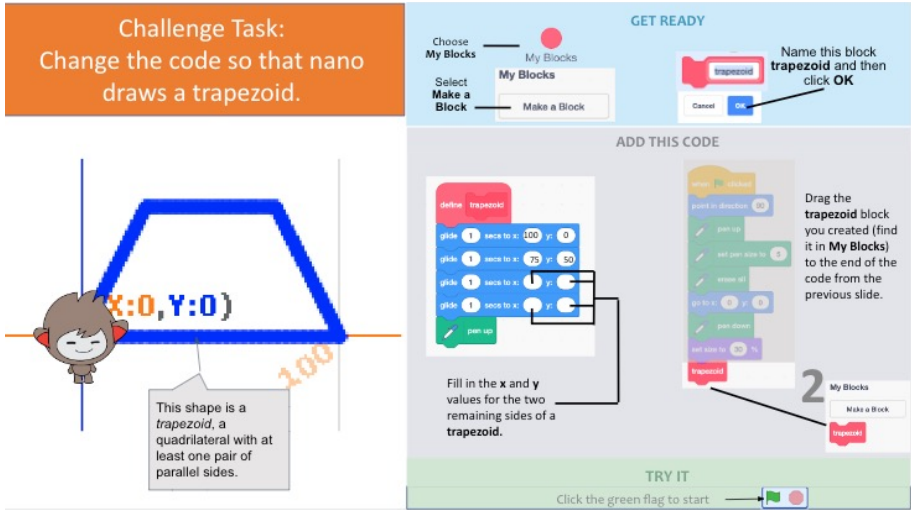
5.



quadrilateral, trapezoid

Expansive Framing





EXPANSIVE FRAMING

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

MATH & COMPUTER SCIENCE STANDARDS

FCR Focus:

Common Core State Standards

5.G.B.3 Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category.

5.G.B.4 Classify two-dimensional figures in a hierarchy based on properties.

MATHEMATICAL PRACTICES (See *Mathematical Practices in GO Math!* in the *Planning Guide* for full text.)
MP1 Make sense of problems and persevere in solving them. **MP7** Look for and make use of structure. **MP8** Look for and express regularity in repeated reasoning.

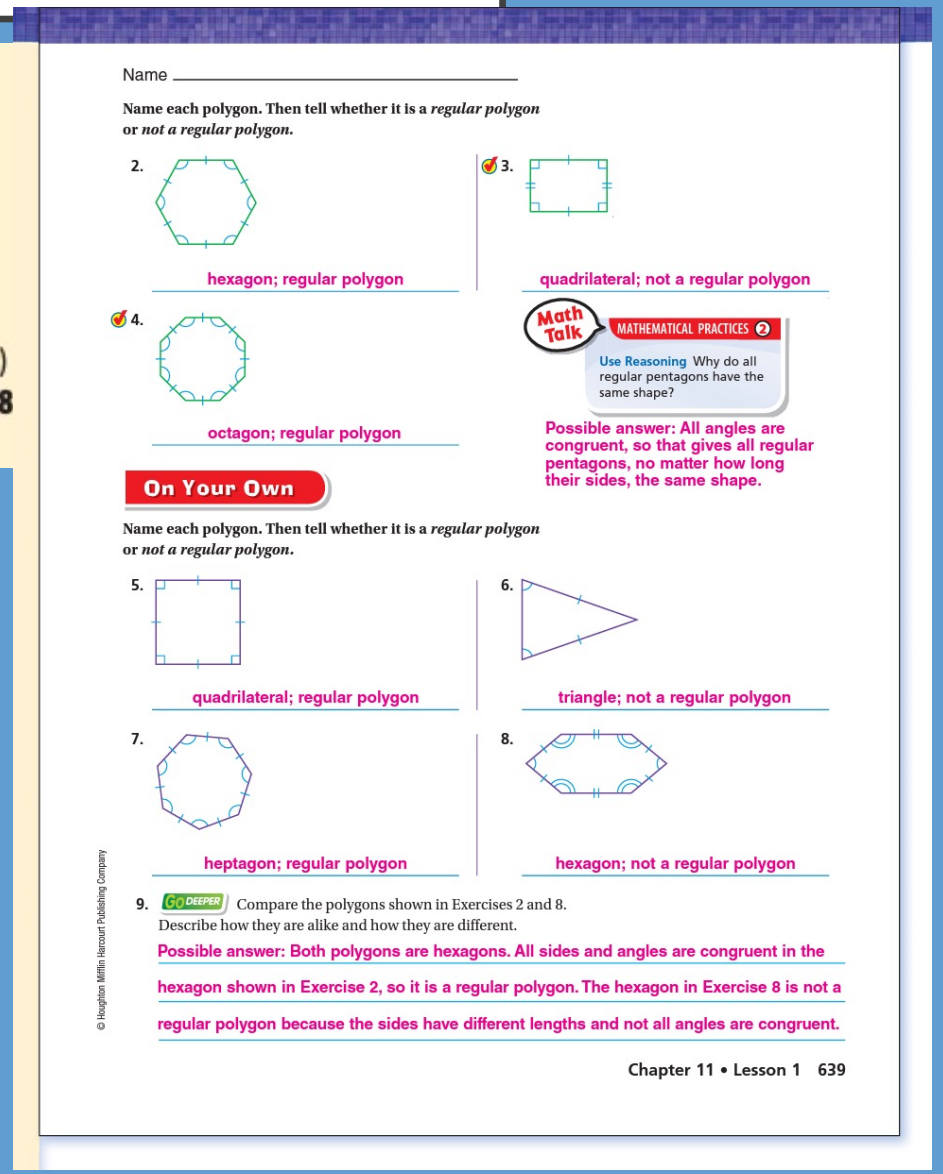
Algorithms and Programming (AP):

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 efficien it, breaking analyzing d

Utah K-5 Computer Science Standards — Writing Draft: March 15, 2019

Standard 4.AP.2 - Create **programs** that include **events**, **loops**, and **conditionals**. *(Practice 5: Creating Computational Artifacts)*

Students will develop a set of instructions (a program) that include events, loops, and conditionals to facilitate and manage tasks. Event examples include mouse clicks, typing on the keyboard, and collisions between objects. Conditional statements are sets of commands that are tied to specific actions based on whether the condition evaluates to TRUE or FALSE. Other terms that can be used to specify the appropriate groups of instructions to execute under various conditions include AND, OR, and NOT.



Name _____

Name each polygon. Then tell whether it is a *regular polygon* or *not a regular polygon*.

2. hexagon; regular polygon

3. quadrilateral; not a regular polygon

4. octagon; regular polygon

Math Talk — MATHEMATICAL PRACTICES 2
Use Reasoning Why do all regular pentagons have the same shape?
Possible answer: All angles are congruent, so that gives all regular pentagons, no matter how long their sides, the same shape.

On Your Own

Name each polygon. Then tell whether it is a *regular polygon* or *not a regular polygon*.

5. quadrilateral; regular polygon

6. triangle; not a regular polygon

7. heptagon; regular polygon

8. hexagon; not a regular polygon

9. GO DEEPER Compare the polygons shown in Exercises 2 and 8. Describe how they are alike and how they are different.
Possible answer: Both polygons are hexagons. All sides and angles are congruent in the hexagon shown in Exercise 2, so it is a regular polygon. The hexagon in Exercise 8 is not a regular polygon because the sides have different lengths and not all angles are congruent.

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

FCR Focus:

Common Core State Standards

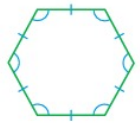
5.G.B.3 Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category.

5.G.B.4 Classify two-dimensional figures in a hierarchy based on properties.

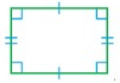
MATHEMATICAL PRACTICES (See *Mathematical Practices in GO Math!* in the *Planning Guide* for full text.) **MP1** Make sense of problems and persevere in solving them. **MP7** Look for and make use of structure. **MP8** Look for and express regularity in repeated reasoning.

Name _____

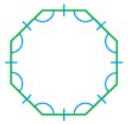
Name each polygon. Then tell whether it is a *regular polygon* or *not a regular polygon*.

2. 

hexagon; regular polygon

3. 

quadrilateral; not a regular polygon

4. 

octagon; regular polygon

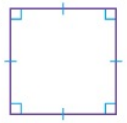
Math Talk MATHEMATICAL PRACTICES 2

Use Reasoning Why do all regular pentagons have the same shape?

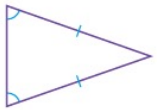
Possible answer: All angles are congruent, so that gives all regular pentagons, no matter how long their sides, the same shape.

On Your Own

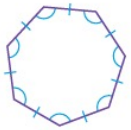
Name each polygon. Then tell whether it is a *regular polygon* or *not a regular polygon*.

5. 

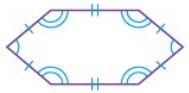
quadrilateral; regular polygon

6. 

triangle; not a regular polygon

7. 

heptagon; regular polygon

8. 

hexagon; not a regular polygon

9. GO DEEPER Compare the polygons shown in Exercises 2 and 8. Describe how they are alike and how they are different.

Possible answer: Both polygons are hexagons. All sides and angles are congruent in the hexagon shown in Exercise 2, so it is a regular polygon. The hexagon in Exercise 8 is not a regular polygon because the sides have different lengths and not all angles are congruent.

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

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.

Standard 4.AP.2 - Create **programs** that include **events**, **loops**, and **conditionals**. *(Practice 5: Creating Computational Artifacts)*

Students will develop a set of instructions (a program) that include events, loops, and conditionals to facilitate and manage tasks. Event examples include mouse clicks, typing on the keyboard, and collisions between objects. Conditional statements are sets of commands that are tied to specific actions based on whether the condition evaluates to TRUE or FALSE. Other terms that can be used to specify the appropriate groups of instructions to execute under various conditions include AND, OR, and NOT.

Cache Code Math: CS-Math Unit on Geometry for March

Chapter 11 (and review Chapter 9, Lesson 9.2) in *Go Math!* + Scratch Cards

Lesson	Computer Lab	Mathematics Class	Notes	Suggested Timing/Pacing
#1 Math Routine		Math Routine: Which One Doesn't Belong? (reasoning about shapes using attributes in Chapter 11 lessons)	Teach **prior to** Computer Lab lessons *Supports a math content and language review. Supports reasoning with attributes.*	7-10 minutes Week of March 14, before or during Lesson 11.1
Computer Lab Scratch Card: Introduction to My Block	The typical Scratch Card (Scratch card 9: Jumping Game Cards) New jumping card (Monkey jump)		Teach **prior to** the Computer Lab Quadrilateral activity. *Supports students' learning of the My Block procedure in Scratch in order to focus on the mathematics in subsequent Computer Lab lessons.*	5-10 minutes Week of March 14 **Exit Ticket**
#2 Math Minilesson		Math Minilesson: Visualizing the Shape – What Shape Will It Be? (extends Lesson 9.2 on order pairs and accesses background knowledge for Lessons 11.1-11.3)	Teach **prior to** Computer Lab Quadrilateral activity in Scratch to explain the use of coordinate grid and ordered pairs in Scratch. *Supports the use of ordered pairs in Scratch.*	10-15 minutes Week of March 14
#3 Math Minilesson		Math Minilesson: Conditionals and Regular/Non-Regular Polygons (goes with Lesson 11.1 on polygons)	Teach **prior to** Computer Lab lesson Scratch Quadrilateral Quiz to explain the use of conditional statements with shapes. *Supports math content for Lesson 11.1. Supports use of conditionals in upcoming Computer Lab lesson.*	10 minutes Week of March 21, extends Lesson 11.1
Computer Lab Scratch Card: Scratch Quadrilaterals Quiz	Scratch Quadrilaterals Quiz card		Teach **after** #4 Math Minilesson on conditionals and quadrilaterals	20-30 minutes Week of March 21 **Exit Ticket**
	Create a shapes quiz on polygons using conditionals and My Blocks		*Supports the math content in Lesson 11.2 and introduces conditionals and procedures (My Blocks).*	
#4 Math Minilesson		Math Minilesson: Conditionals and Quadrilaterals (goes with Lesson 11.3 on quadrilaterals or after Lesson 11.3)	Teach **after** Computer Lab Quadrilateral activity in Scratch *Supports math content for Lesson 11.3 Supports use of conditionals in Computer Lab lessons.*	10 minutes Week of March 21, supports Lesson 11.3 **Exit Ticket**
Computer Lab Scratch Card: Triangle Quiz	Scratch Triangle Quiz card Create a triangle quiz on equilateral, isosceles, and right triangle types using conditionals		Teach **after** students learn lesson 11.2 on triangles and after #2 Math Minilesson on conditionals *Supports the math content in Lesson 11.2 and uses conditionals and procedures (My Blocks).*	20-30 minutes Week of March 28 **Exit Ticket**
		Math Minilesson: Interior/Exterior Angles of	Teach **after** Computer Lab "Triangle Quiz" to explain the interior/exterior angles in My	10 minutes

SCAN ME

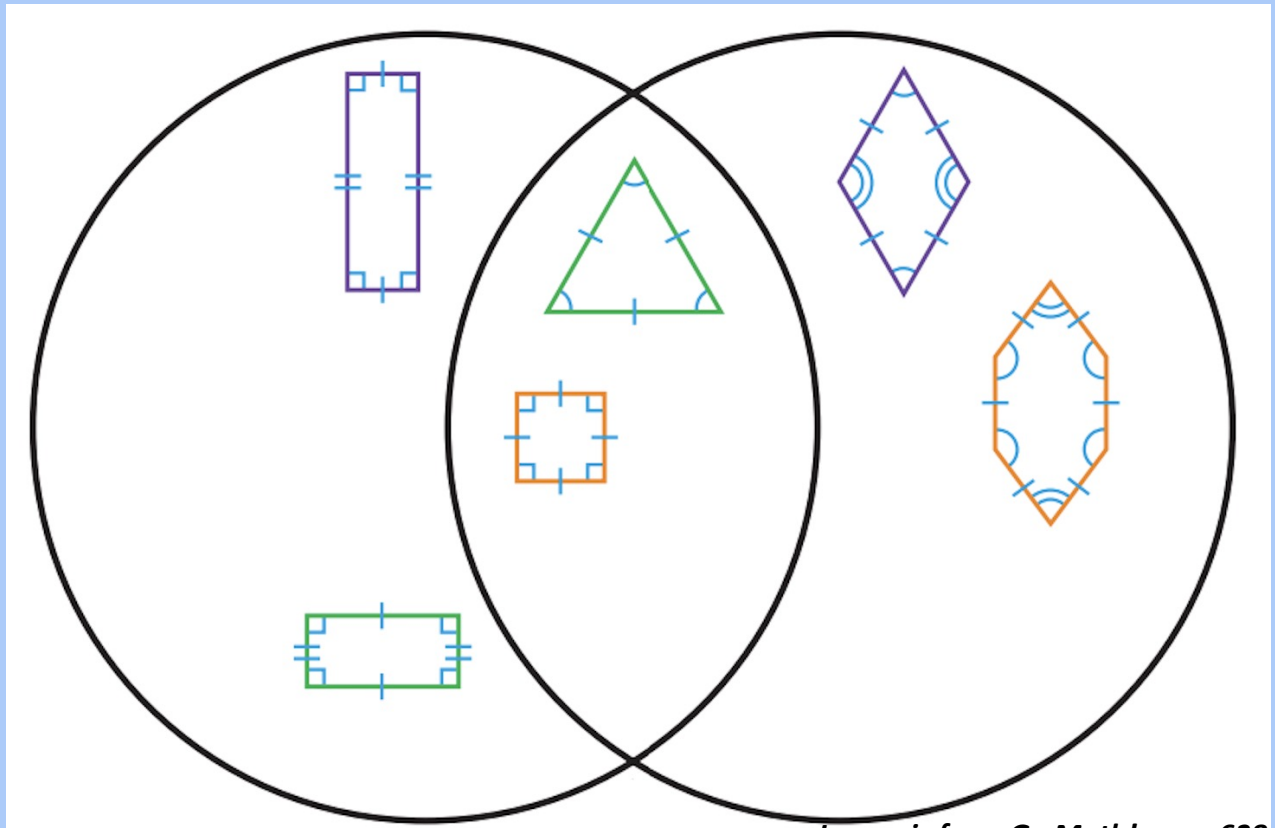


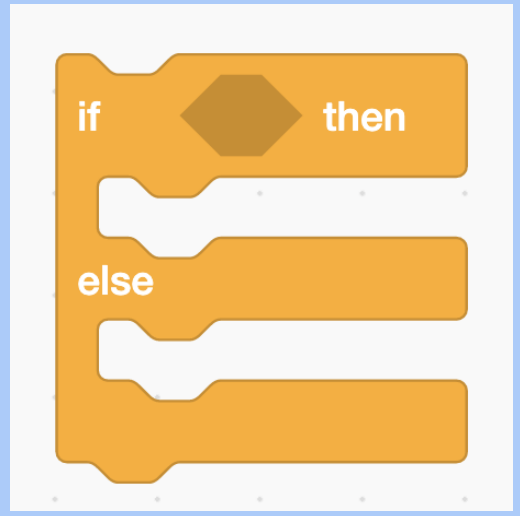
Image is from Go Math! page 638

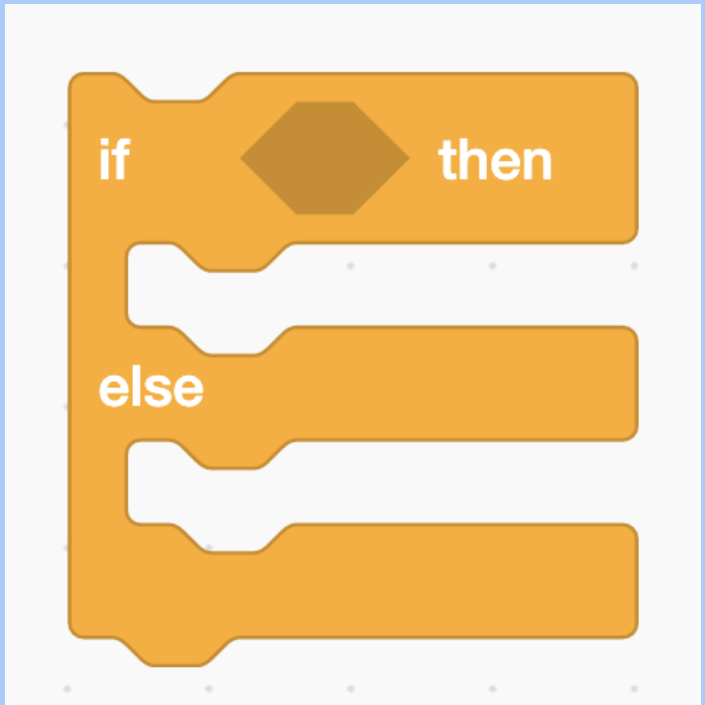
1. What do the polygons in the left circle have in common with each other?
2. What do the polygons in the right circle have in common with each other?
3. What do the polygons in the center section have in common with both groups?

If a triangle is regular, *then* it has three _____ sides and angles, *else* it is not regular.

If a quadrilateral is regular, *then* it has four _____ angles and sides, *else* it is _____.

_____ a pentagon has five congruent angles and sides, _____ it is a regular pentagon, _____ it is not regular.





If a quadrilateral is regular,
then it has four _____ angles and sides,
else it is _____.

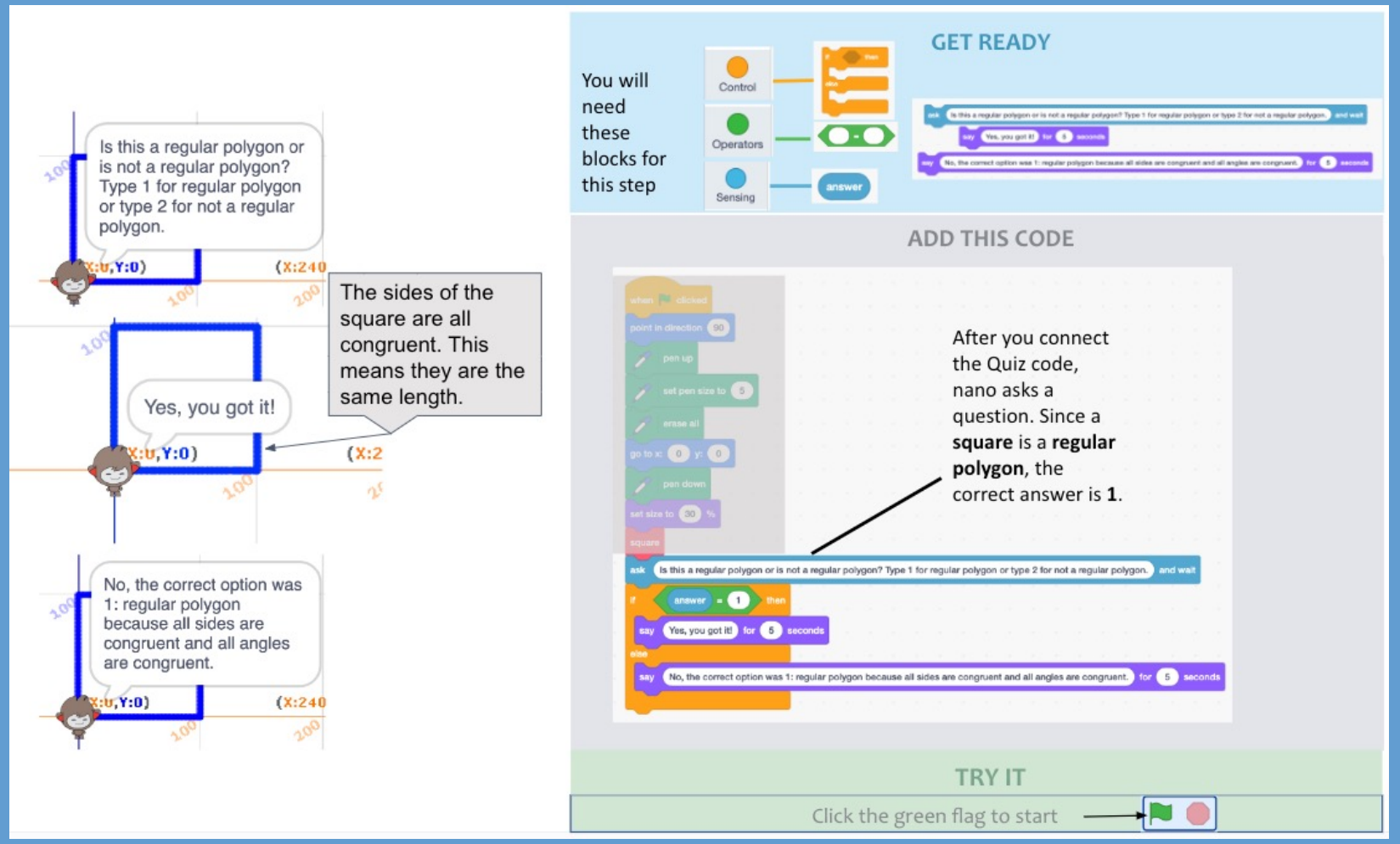
Which quadrilaterals are regular quadrilaterals? How do you know?

Come up with a conditional statement to describe the regular quadrilateral you chose.

GEOMETRY "SCRATCH CARDS"

SCAN ME

shorturl.at/ayMOR



EXPANSIVELY FRAMING MULTIPLICATION OF FRACTIONS AND CODE HS

Unpacking a Fraction Equation: Karel Shows the Product!

C The Carter family has only $\frac{1}{2}$ of a box of cereal at the beginning of the week. They ate $\frac{3}{4}$ of the $\frac{1}{2}$ box of cereal.

- Shade the model to show $\frac{3}{4}$ of $\frac{1}{2}$ box of cereal.
- Write an expression to show $\frac{3}{4}$ of $\frac{1}{2}$ box of cereal. $\frac{3}{4} \times \frac{1}{2}$
- Will the product be *equal to, greater than,* or *less than* $\frac{1}{2}$? *than* $\frac{3}{4}$?

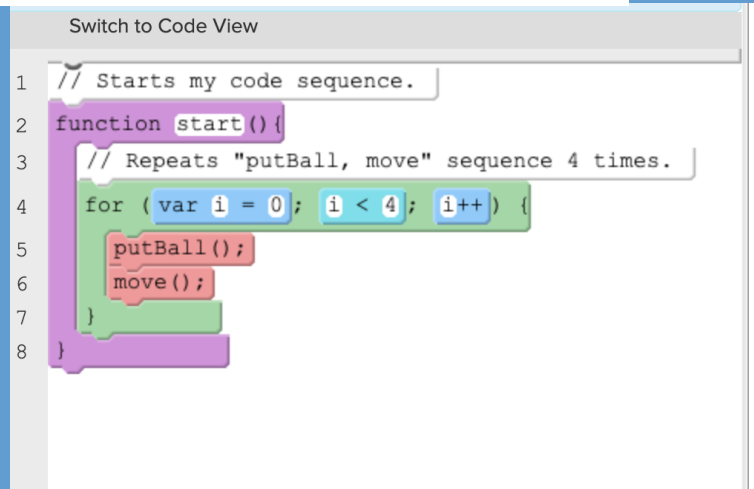
The product will be less than either factor.

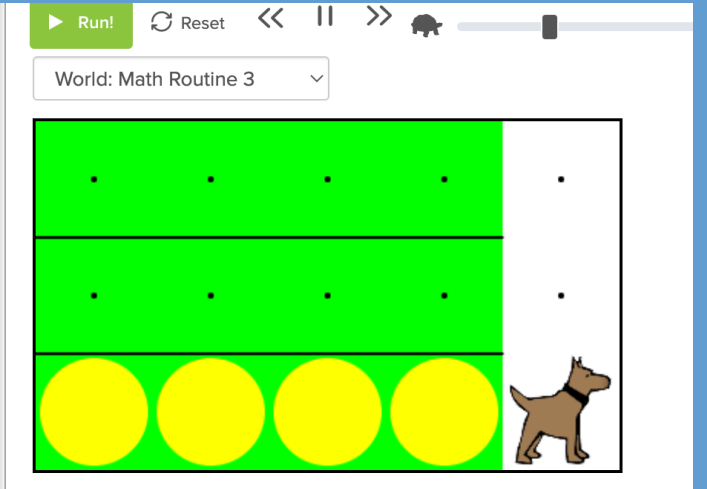
Chapter 7 445

SCAN ME

Why is the Product Getting Smaller?

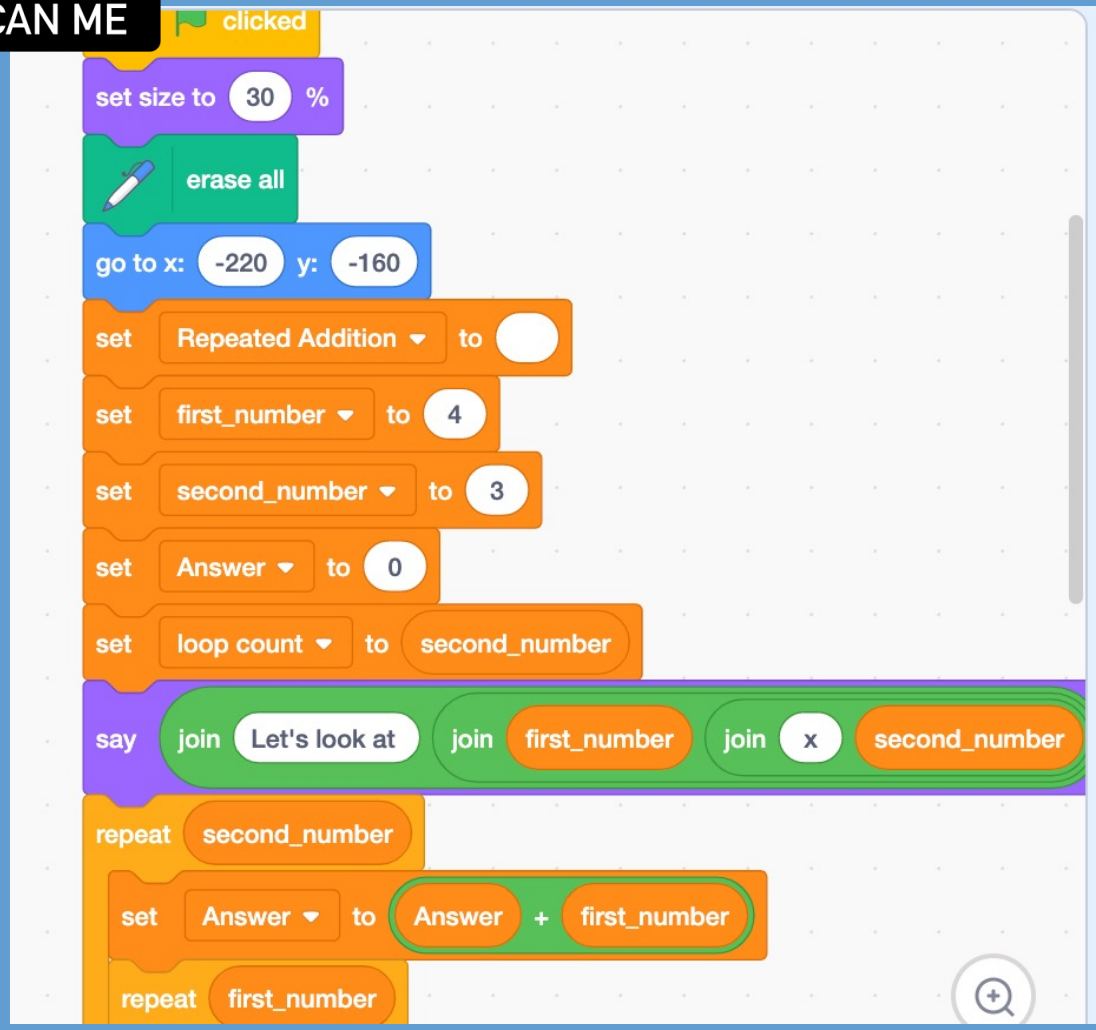
1/3 x 4/5 = 4/15

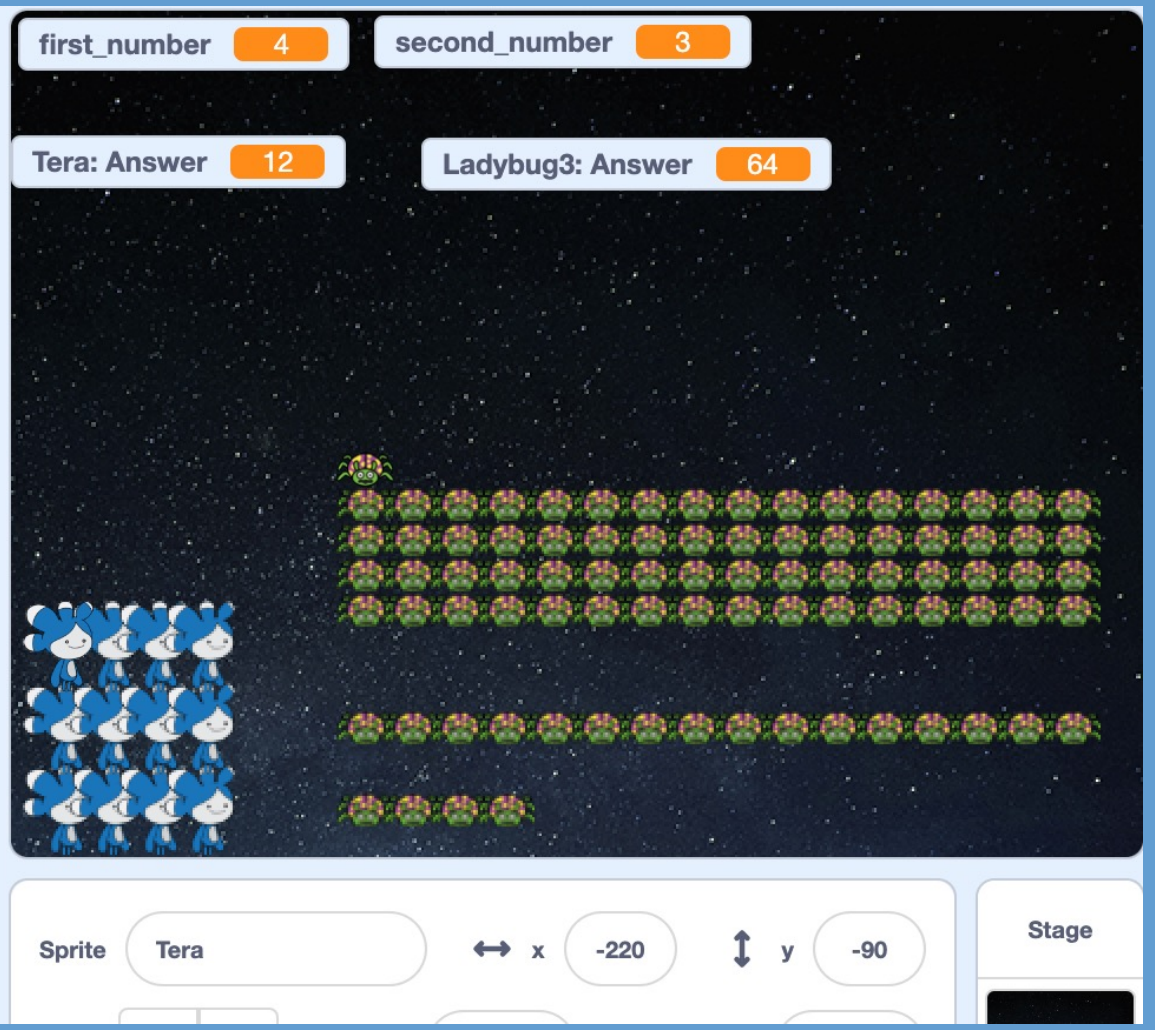




LEARNING EXPONENTS AND SCRATCH CODING

SCAN ME





NSF Grant
#2031382
#2031404

Contact Information:
kimberly.beck@usu.edu
jessica.shumway@usu.edu
digitalcommons.usu.edu/eled_support

Instructional Resources

SCAN ME

These Slides

SCAN ME

Q&A

Acknowledgment

This work was supported by National Science Foundation Grant no. 2031382. Opinions, findings, or recommendations expressed in this paper are those of the authors and do not necessarily reflect the views of the funding agency. We thank the participating teachers and students.