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FOR MATHEMATICS

Developing Multiplicative Thinking-

Developing Multiplication Strategies with Bonny Davenport

Welcome!

Your host

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KCM Website

www.kentuckymathematics.org

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Today's Agenda

- Standards
- Let's Do Math!
- Research
- Derived Facts For Multiplication
  - Doubling
  - Break Apart
  - Adding a Group
  - Subtracting a Group
  - Near Squares
- Properties of Multiplication
- Points to Consider

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Standards

Operations and Algebraic Thinking	
Standards for Mathematical Practice	
MP.1. Make sense of problems and persevere in solving them. MP.2. Reason abstractly and quantitatively. MP.3. Construct viable arguments and critique the reasoning of others. MP.4. Model with mathematics.	MP.5. Use appropriate tools strategically. MP.6. Attend to precision. MP.7. Look for and make use of structure. MP.8. Look for and express regularity in repeated reasoning.
Cluster: Multiply and divide within 100.	
Standards	**Clarifications**
KY.3.OA.7 Fluently multiply and divide within 100, using strategies such as the relationship between multiplication and division or properties of operations. **MP.2, MP.8**	Students determine multiplication and division strategies efficiently, accurately, flexibly and appropriately. Being fluent means students choose flexibly among methods and strategies to solve contextual and mathematical problems, they understand and explain their approaches and they produce accurate answers efficiently. Knowing 8 x 5 = 40, one knows 40 ÷ 5 = 8. Note: Reaching fluency is an ongoing process that will take much of the year. Coherence KY.3.OA.7→KY.4.OA.4
Attending to the Standards for Mathematical Practice	
By studying patterns and relationships in multiplication facts, students develop fluency for multiplication facts (**MP.8**). For example, students notice 4 x 6 is equivalent to 2 x 2 x 6 (doubling strategy). They know 9 facts can be found by thinking of the other factor x 10 and subtracting one group. For example, recognizing 9 x 8 is equivalent to 10 x 8 – 8. For each fact, the student thinks, "What reasoning strategy can I use that is more efficient than skip counting?" (**MP.2**).	

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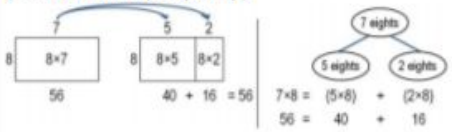
Standards

Operations and Algebraic Thinking	
Standards for Mathematical Practice	
MP.1. Make sense of problems and persevere in solving them. MP.2. Reason abstractly and quantitatively. MP.3. Construct viable arguments and critique the reasoning of others. MP.4. Model with mathematics.	MP.5. Use appropriate tools strategically. MP.6. Attend to precision. MP.7. Look for and make use of structure. MP.8. Look for and express regularity in repeated reasoning.
Cluster: Understand properties of multiplication and the relationship between multiplication and division.	
Standards	**Clarifications**
KY.3.OA.5 Apply properties of operations as strategies to multiply and divide. **MP.3, MP.4**	Students need not use formal terms for these properties. If 6 x 4 is known, then 4 x 6 = 24 is also known (Commutative property of multiplication). 3 x 5 x 2 can be found by 3 x 5 = 15, then 15 x 2 = 30, or by 5 x 2 = 10, then 3 x 10 = 30 (Associative property of multiplication). Knowing that 8 x 5 = 40 and 8 x 2 = 16, one can find 8 x 7 as 8 x (5+2) = (8 x 5) + (8 x 2) = 40 + 16 = 56 (Distributive property).  KY.4.NBT.5 Coherence KY.3.OA.5→KY.4.NBT.6
KY.3.OA.6 Understand division as an unknown-factor problem. **MP.2**	Find 32 ÷ 8 by finding the number that makes 32 when multiplied by 8. Coherence KY.3.OA.6→KY.4.NBT.6
Attending to the Standards for Mathematical Practice	
Students use strategies beyond skip counting to solve multiplication problems. They decide how to use known facts to solve facts like 6 x 9. Students use strategies like Adding a Group, thinking 5 groups of 9 (45) plus one more group (54) and Subtracting a Group, thinking 9 x 6 and reasoning 10 groups of 6 (60) minus one group of 6 (54) (**MP.7**). Students explain their selected reasoning strategy and listen and critique other students' strategies, considering which strategies make sense and are efficient (**MP.3**). Students think about 84 ÷ 4 as, "How many sets of 4 can be made from 84 items?" or "How many in a group, if there 84 items and 4 groups?" and use this relationship to solve the problem (**MP.2**).	

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Let's Do Some Math!

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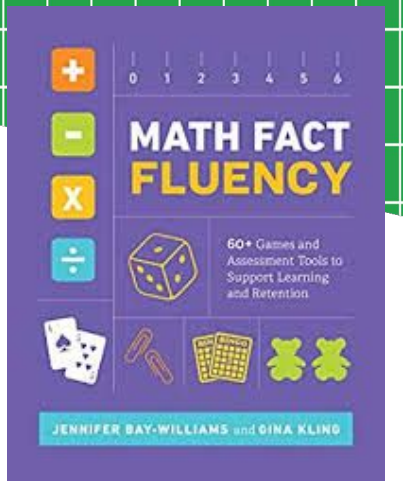
https://www.origoeducation.com/blog/doubling-strategy-for-multiplication/

Five Fundamentals of Fact Fluency



#1: Mastery must focus on fluency!
#2: Fluency develops in three phases.
#3: Knowing foundational facts must precede derived facts.
#4: Timed tests do not assess fluency
#5: Students need substantial and enjoyable practice.

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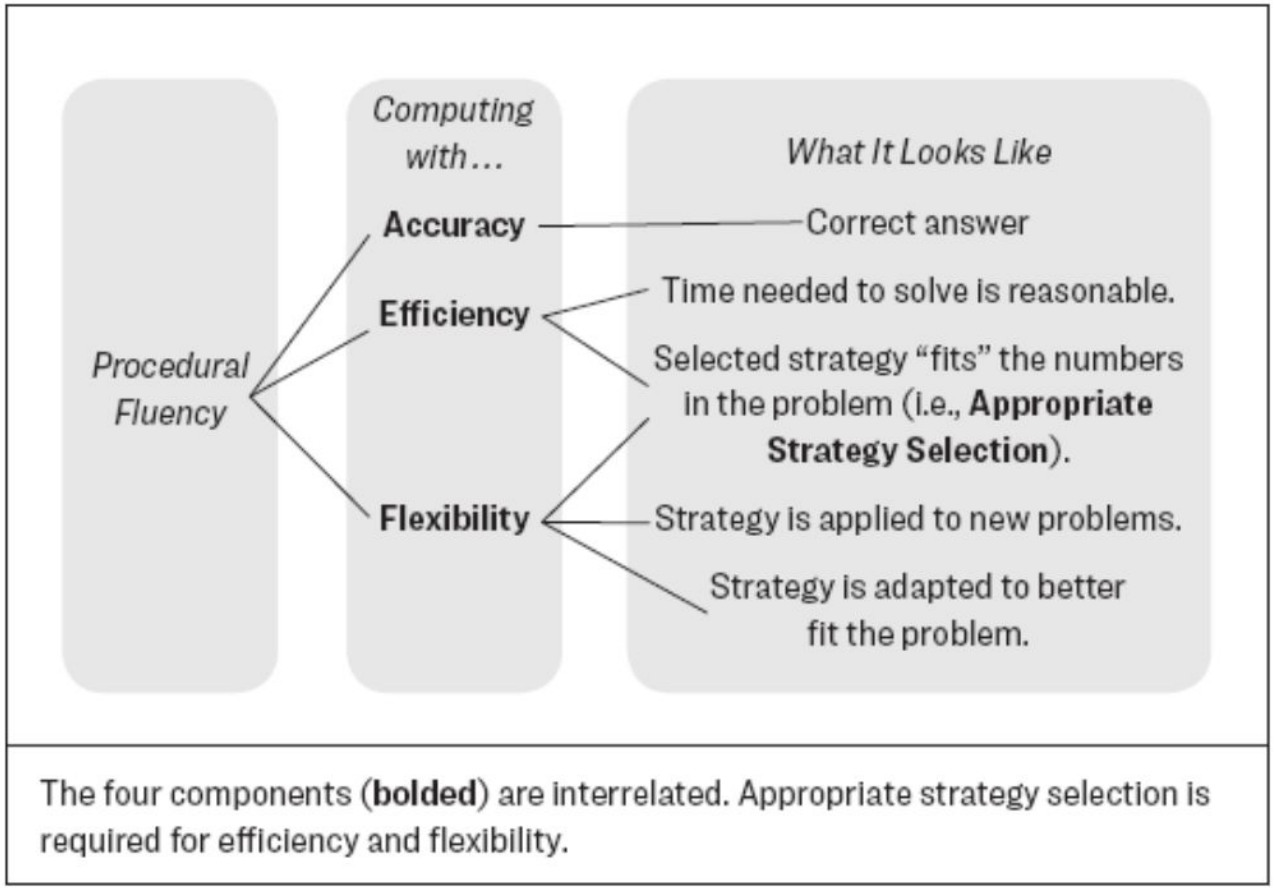
Bay-Williams, J., & Kling, G. (2019). *Math Fact Fluency: 60+ Games and Assessment Tools to Support Learning and Retention*. Alexandria, VA: ASCD.

Mastery Must Focus on Fluency

Figure 1.1. What Procedural Fluency Is and What It Looks Like



The four components (**bolded**) are interrelated. Appropriate strategy selection is required for efficiency and flexibility.

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Bay-Williams, J., & Kling, G. (2019). *Math Fact Fluency: 60+ Games and Assessment Tools to Support Learning and Retention*. Alexandria, VA: ASCD.

Fluency Develops in Three Phases

Phase 1: Counting

Student counts with objects or mentally.
Example: Solving 6x4 by drawing 6 groups of 4 dots and counting the dots.

Phase 2: Deriving

Uses reasoning strategies based on known facts.
Example: Solving 6x4 by thinking 5x4=20 and adding one more group of 4.

Phase 3: Mastery

Efficiently produces answers.
Example: Knows 6x4=24

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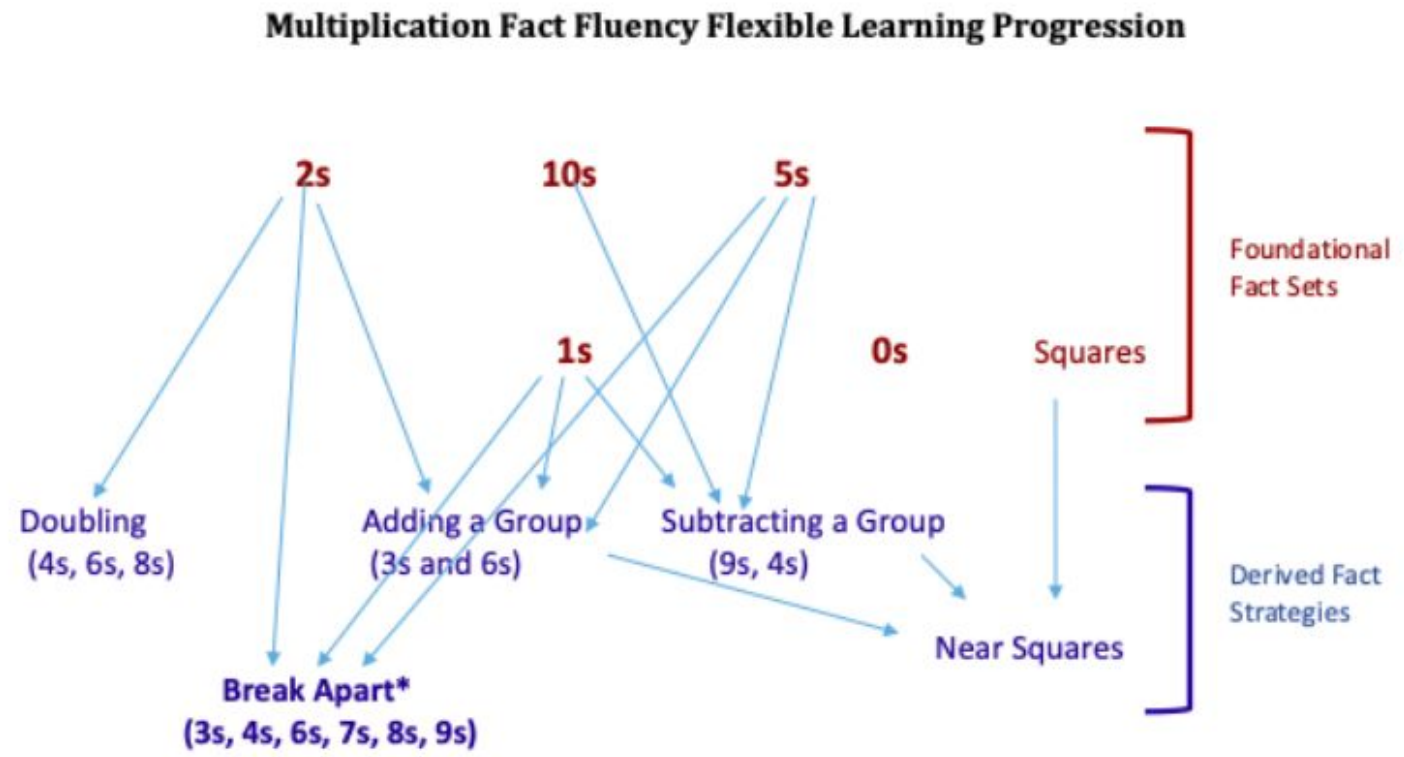
Baroody, Arthur J. 2006. "Why Children Have Difficulties Mastering the Basic Number Combinations and How to Help Them," *Teaching Children Mathematics* 13 (August): 22-31

Foundational Facts Must Precede Derived Fact Strategies



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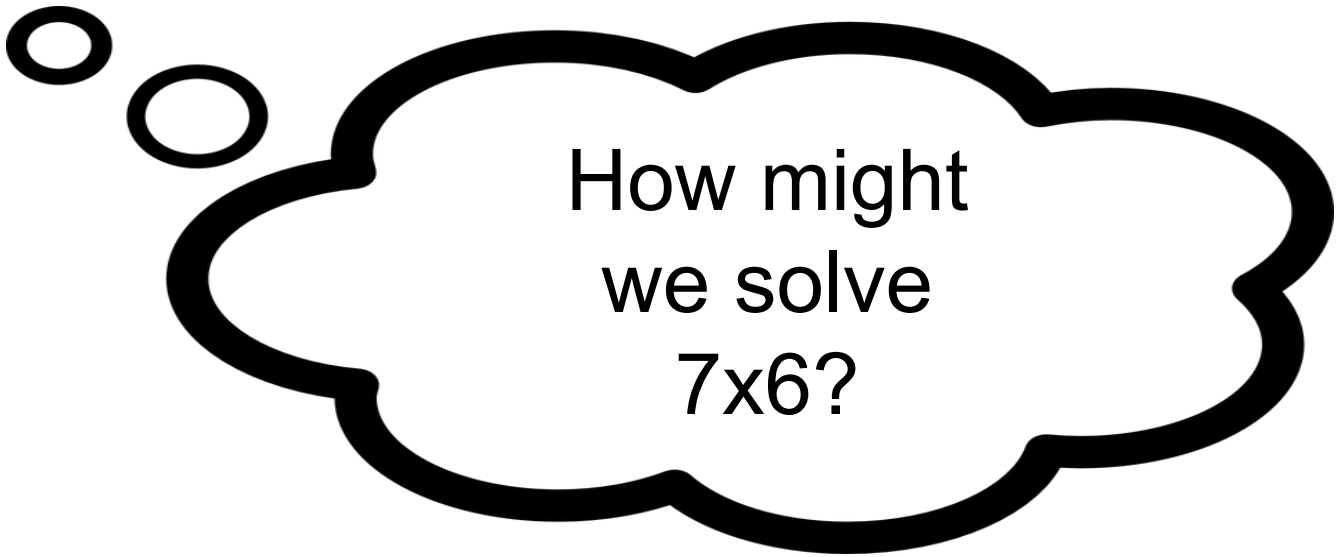
Bay-Williams, J., & Kling, G. (2019). *Math Fact Fluency: 60+ Games and Assessment Tools to Support Learning and Retention*. Alexandria, VA: ASCD.

Doubling (4s, 6s, 8s)

Look for an even factor. Find the fact for half of that factor, then double it.

Example: I don't know 6 x 8 so I think “3x8=24” and double that to get 48.



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Multiplication Stories

Carefully sequenced stories can encourage the use of halving and doubling. The area model can help students visualize how doubling one of the factors leads to doubling the area, or product.

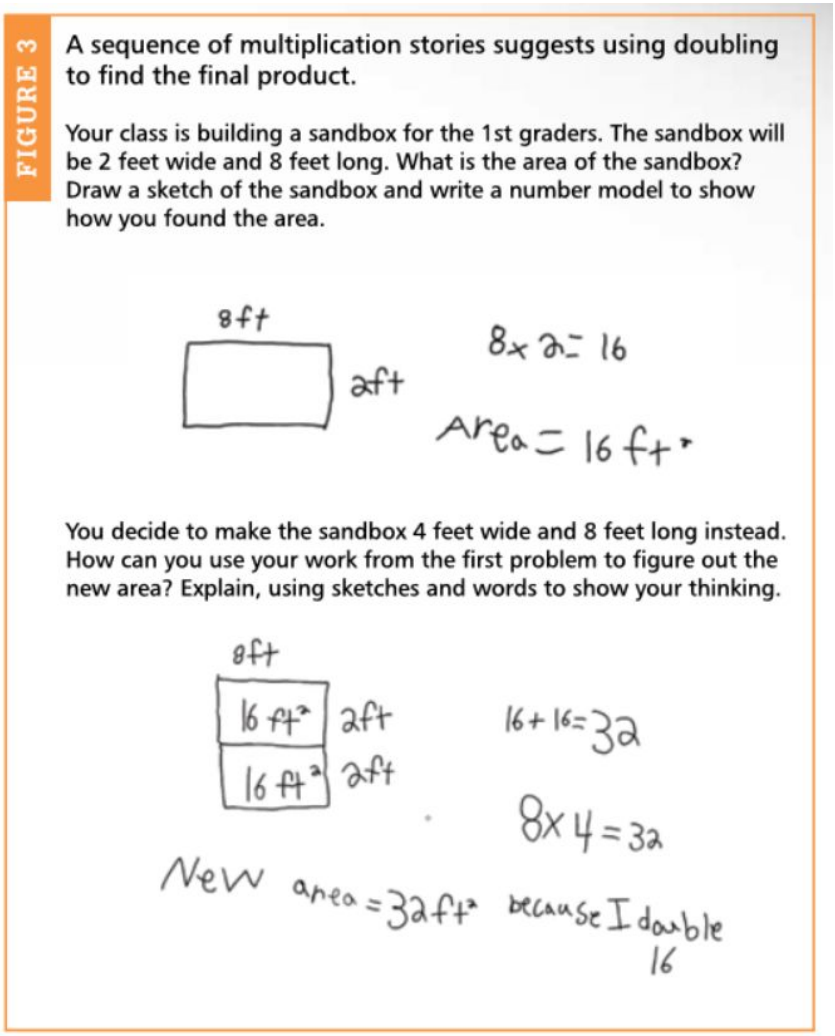


FIGURE 3

A sequence of multiplication stories suggests using doubling to find the final product.

Your class is building a sandbox for the 1st graders. The sandbox will be 2 feet wide and 8 feet long. What is the area of the sandbox? Draw a sketch of the sandbox and write a number model to show how you found the area.

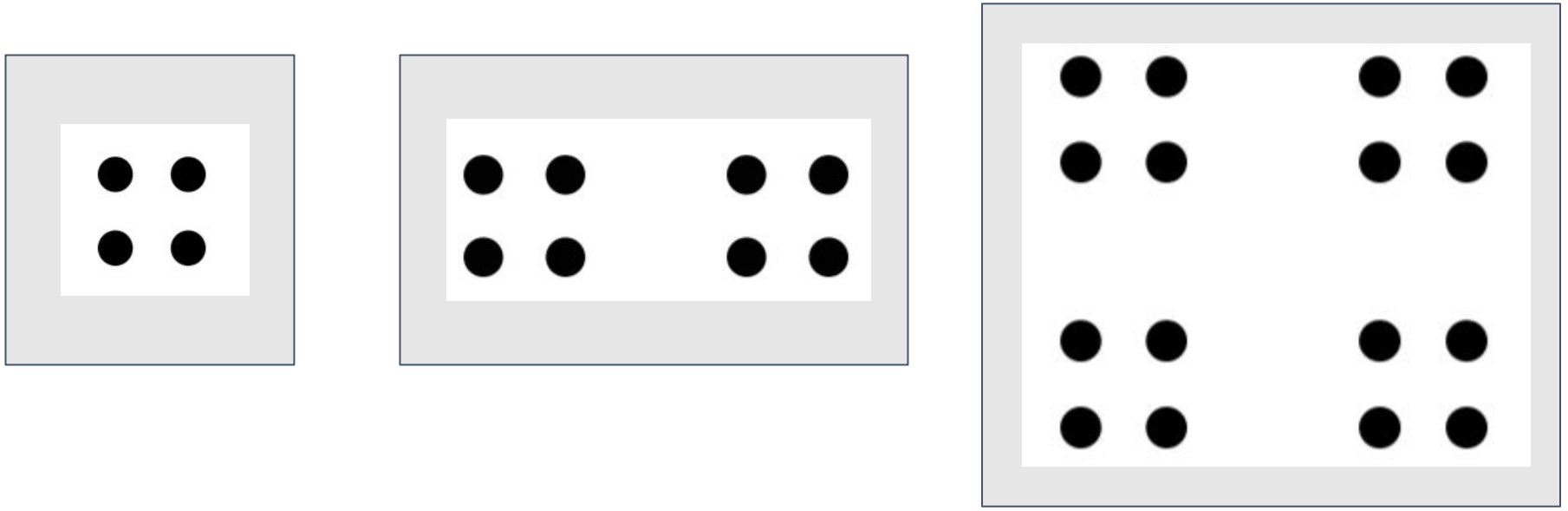
8 ft
2 ft
8 × 2 = 16
Area = 16 ft²

You decide to make the sandbox 4 feet wide and 8 feet long instead. How can you use your work from the first problem to figure out the new area? Explain, using sketches and words to show your thinking.

8 ft
16 ft² 2 ft
16 ft² 2 ft
16 + 16 = 32
8 × 4 = 32
New area = 32 ft² because I double 16

Bay-Williams, Jennifer & Kling, Gina 2015. "Three Steps to Mastering Multiplication Facts," *Teaching Children Mathematics* Vol. 21, No. 9 (May 2015), pp. 548-559

Sequenced Quick Looks for Doubling



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Bay-Williams, J., & Kling, G. (2019). *Math Fact Fluency: 60+ Games and Assessment Tools to Support Learning and Retention*. Alexandria, VA: ASCD.

Games for *Doubling* and Learning Facts

Game: *Switch* (2 players)

Materials:

- ✓ One piece of paper, shared by all players
- ✓ 5 or 6 unique game pieces per player (e.g., colored counters or heads/tails of coins)
- ✓ Deck of cards, with Kings and Jacks removed; Queens = 0; Aces = 1

How to play:

1. Write the multiples of **4** (0, 4, 8, 12, 16, 20, 24, 28, 32, 36, and 40) on a piece of paper (mix up the order of products to discourage skip counting as you play - see below).

2. Shuffle the deck of cards and place them face down in a draw pile.

3. Players take turns drawing one card and multiplying the drawn card by **4**. The player places his/her game piece above the resulting product. For example, if a player draws the number 7, the player multiplies 7 by **4** and places a game piece above 28. Players share their strategy aloud (e.g., "I doubled 7 to get 14, and doubled again to get 28.").

4. If a player's resulting product already has an opponent's game piece on it, that player gets to SWITCH, placing their own game piece above that number, and returning their opponent's game piece. If the player's resulting product is one that they themselves already have, they lose that turn.

5. To win:

   Option 1: First to get 5 game pieces on the board

   Option 2: Have the most game pieces when the board is completely covered (as illustrated here).

   Pick an option and play best 3 out of 5!

More ways to play:
Play with any fact set by creating a game board with the multiples of that set (e.g., × 7).
Play with three people (use three different colors of counters or three different coins).

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Game: *Fixed Factor War* (Game 32, p. 88, *Math Fact Fluency*) (2 players)

Materials:

- ✓ Deck of cards, with Kings and Jacks removed. Queens = 0; Aces = 1.

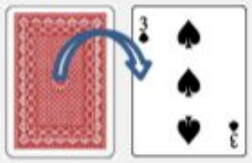
How to Play:

1. Find a 4 in the deck and place it between the two players (or 6 or 8) face up. That number is the fixed factor.
2. Deal the rest of the cards equally, face down.
3. Each player takes a turn to flip over the top card of his/her pile of cards. The player must state the product of the "fixed" factor card and the card they flipped, and share how they know (see example below).
4. The player who correctly states the greater product in the round gets both players' cards. (The "middle" fixed factor card stays.)
5. If there is a tie, a "war" is declared, and players repeat the process, with the winner taking all played cards.
6. The player with the most cards wins when time is up.

More ways to play: Use different Fixed Factors (e.g., a 6). Play *Factor War* – No fixed factor, each player draws 2 cards. Play with addition, too! (*Fixed Addend War* or *Addend War*)

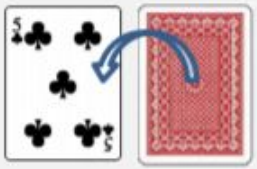
Fixed Factor Card →
(Does not change.)

Player



Nicolas turns over a 3. He says, "Twelve. I doubled 3 to get 6 and doubled again to get 12."

Player



MacKenna turns over a 5. She says, "Twenty. I just know my 5s, 5 times 4 equals 20."

Break Apart (3s, 4s, 6s, 7s, 8s, 9s)

Partition one of the factors into a convenient sum of known facts, find the two known facts, and combine the products.

Example: I don't know 7x6. I break the 7 into 2 and 5, because I know 2x6 and 5x6. Then I add 12 and 30 to get 42.

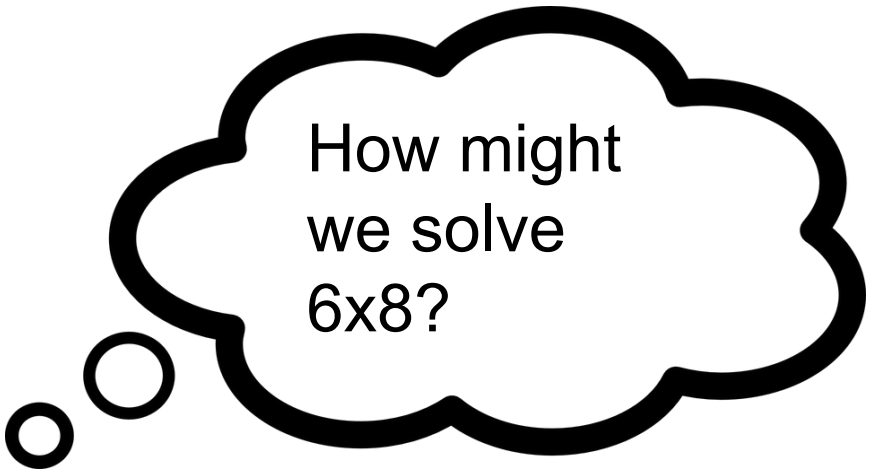


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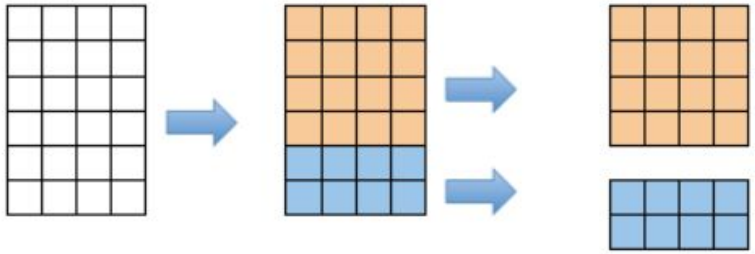
FIGURE 4

Array and area models and equal-groups interpretations work well for the early stages of learning the decomposing strategy, when using a representation is a crucial part of a student's process.

(a) Using an equal-groups interpretation to decompose the fact 7 × 8

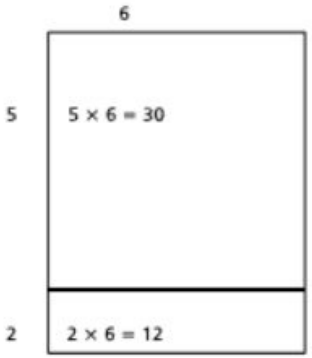
I think of 7 × 8 as 7 groups of 8 things. I don't know what that is, so I start with 5 groups of 8 things, which is 40.	5 × 8 = 40
I have to have 7 groups in the end, so I need to add 2 more groups of 8 things. I know that 2 groups of 8 things is 16.	2 × 8 = 16
So, to find 7 groups of 8 things, I add 40 + 16, which is 56.	7 × 8 = 5 × 8 + 2 × 8 = 40 + 16 = 56

(b) Using an array representation to decompose the fact 6 × 4

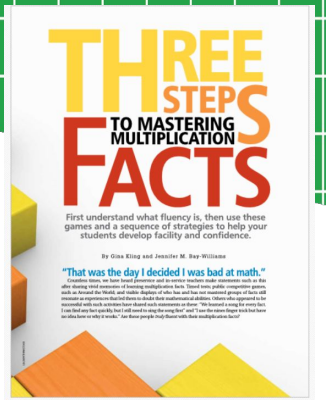


I can split my 6 × 4 array into two smaller arrays, one that is 4 × 4 and one that is 2 × 4. I know that 4 × 4 =16 and 2 × 4 = 8. I then add the smaller products of 16 and 8 and get 24 for my answer.

(c) Using an area representation to decompose the fact 7 × 6



$7 \times 6 = 5 \times 6 + 2 \times 6$
$= 30 + 12$
$= 42$



When students begin to break apart numbers, using a representation is key to keeping track of their process.

Bay-Williams, Jennifer & Kling, Gina 2015. "Three Steps to Mastering Multiplication Facts," *Teaching Children Mathematics* Vol. 21, No. 9 (May 2015), pp. 548-559

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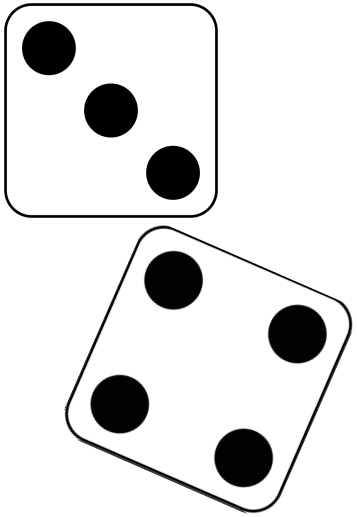
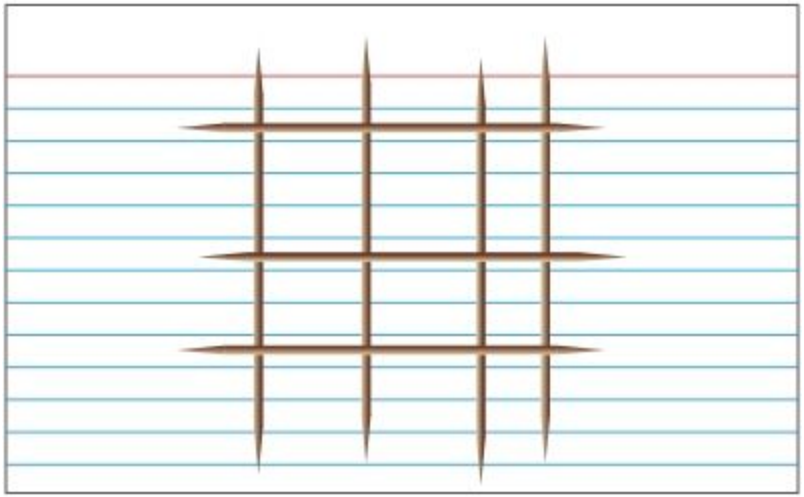
Streets, Avenues and Stoplights





How might a student figure out the number of stoplights needed for this town?

Horizontal toothpicks= streets

Vertical toothpicks= avenues

Intersections= stoplights

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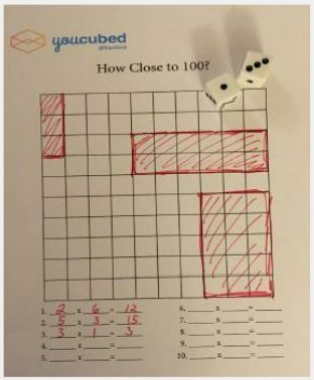
Modeling Multiplication With Streets and Avenues

How Close to 100?



Topics:
Number Sense, Shape, Space + Measures

Grades:
3, 4, 5, 6, 7, 8

GET HANDOUT


youcubed
Updated January 26, 2015

Fluency Without Fear: Research Evidence on the Best Ways to Learn Math Facts

Introduction

How Close to 100?

This has become one of our most popular tasks and we are hearing about all sorts of creative adaptations. Some youcubians have made grids of 400 and added dice, others have adapted it to let the grid represent 100%. Please post how you use this task with your students.

Task Instructions

- This game is played in partners. Two children share a blank 100 grid.
- The first partner rolls two number dice.
- The numbers that come up are the numbers the child uses to make an array on the 100 grid.
- They can put the array anywhere on the grid, but the goal is to fill up the grid to get it as full as possible.
- After the player draws the array on the grid, she writes in the number sentence that describes the grid.
- The second player then rolls the dice, draws the number grid and records their number sentence.
- The game ends when both players have rolled the dice and cannot put any more arrays on the grid.

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How Close to 100?

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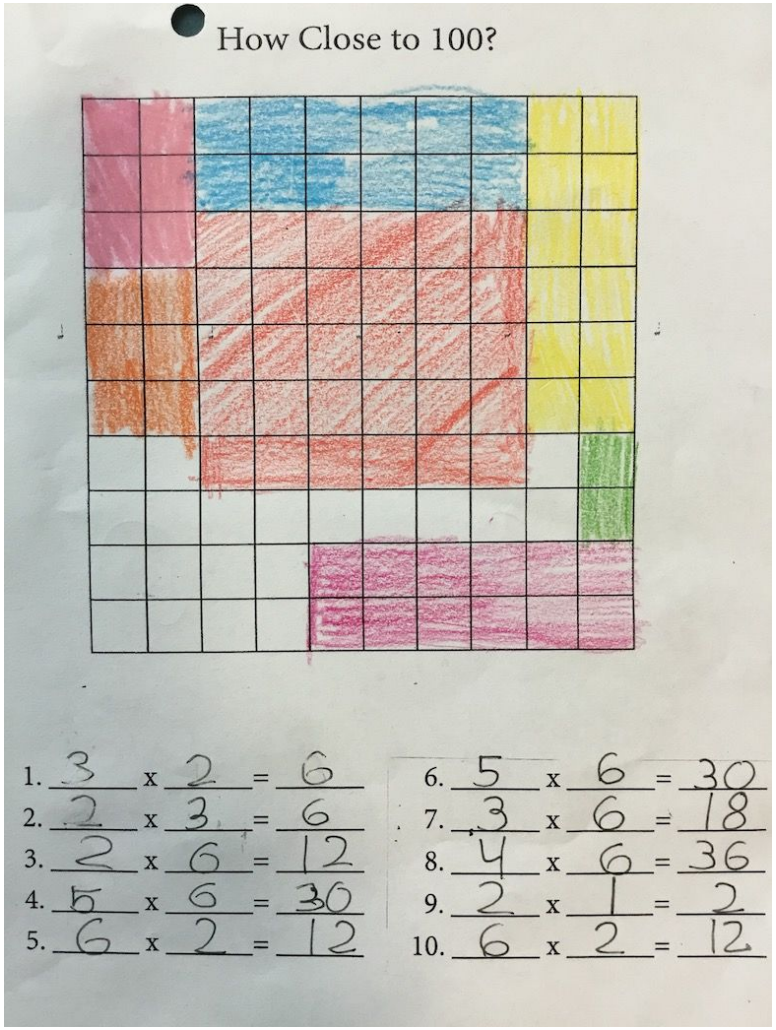

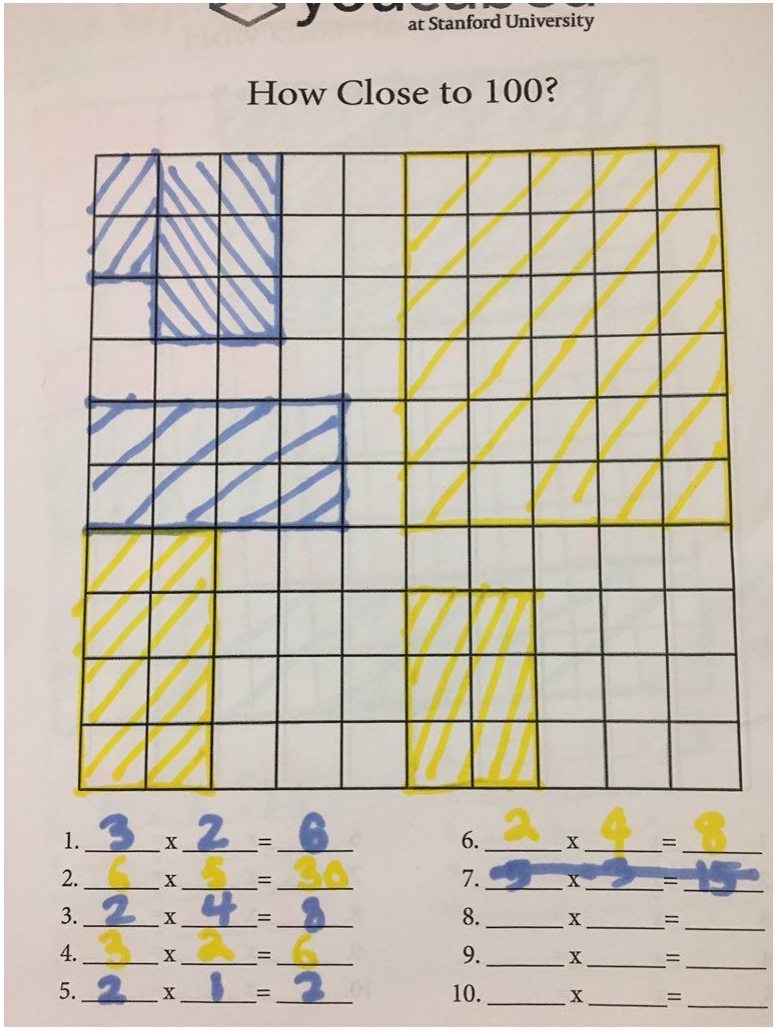

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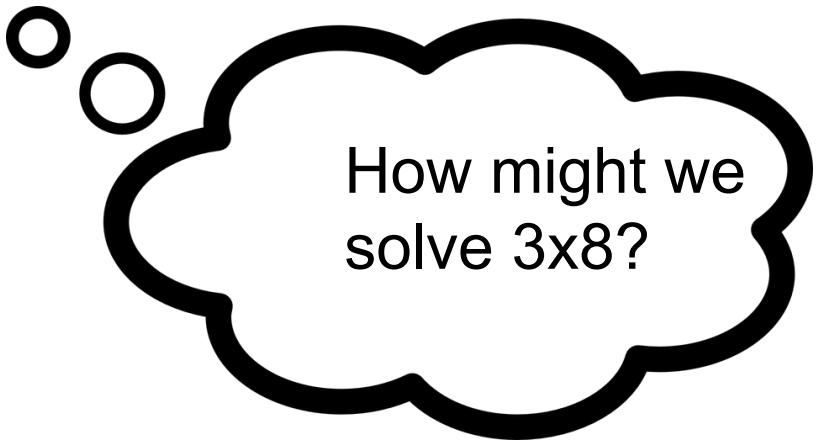
Adding a Group (3s, 6s)

Start with a nearby 2s, 5s or 10s fact, then add the group.

Example: I don't know 6x7, but I do know my 5s, so I can first find 5x7. I know 5 groups of 7 is 35. I have to add one more group of 7 to 35 and that equals 42.



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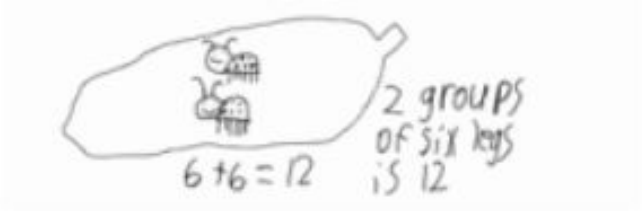
Stories Provide Context

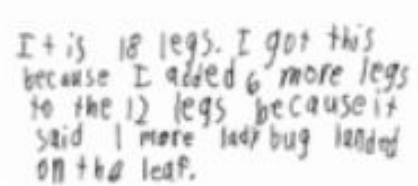
FIGURE 2

In this example for connecting 3s to 2s, the context and structure of the stories facilitate student learning. Story problems can connect foundational facts to other facts.

There are 2 ladybugs sitting on a leaf. Each ladybug has 6 legs. How many legs do they have altogether? Draw a picture to show your thinking.



A third ladybug lands on the leaf. How many legs are there altogether now? Explain how you can use your first picture to help you figure this out.



Sequenced number stories help students make sense of the add a group strategy. A sequenced number story comes in two parts , with the first part involving known facts and the second part providing a change in the story so that another group is added.

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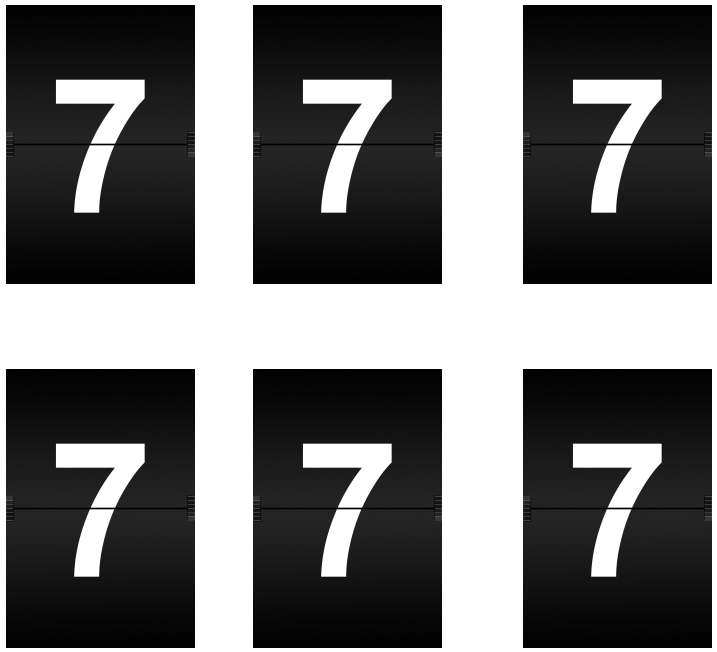
Quick Sketches for Adding a Group Strategy



6 x 7 means 6 groups of 7

5 groups of 7 equal 35

35 + 7 = 42

6 groups of 7 = 42

The equal groups meaning of multiplication must remain at the forefront of strategy work. Without that solid foundation, students may be able to start with the helper fact but become confused on what to do next

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Bay-Williams, J., & Kling, G. (2019). *Math Fact Fluency: 60+ Games and Assessment Tools to Support Learning and Retention*. Alexandria, VA: ASCD.

Multiplication

This week your student will work with the build-up strategy for multiplication. This strategy can be used anytime you multiply a number by 6 by building up from a known 5's facts. For example, 5 groups of 8 is 40, so 6 groups of 8 must be 8 more, so the answer is 48. Watch the ORIGO ONE video about the build-up strategy before working with your student (also available in Spanish). This will help you to assist your student as they work through the activities this week. Encourage your student to look for patterns as they multiply by 6.

Monday — Watch and Talk
Tuesday — Hands-on Math
Wednesday — Problem-solving
Thursday — Game Day
Friday — Practice

6×1	6×2	6×3
6×4	6×5	6×6
6×7	6×8	6×9

85 Game board

36	18	42
12	6	24
30	48	54

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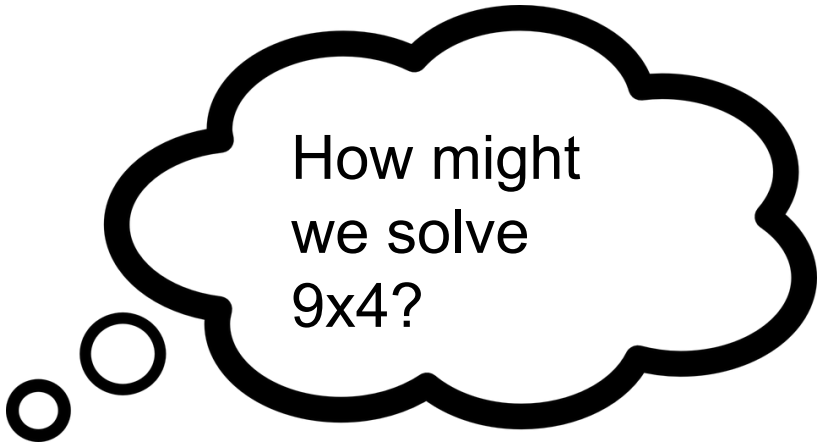
Subtracting a Group (9s, 4s)

Start with a nearby 2s, 5s or 10s fact, then subtract the group.

Example: I don't know 8x7, but I do know my 10s facts, so I can first find 10x7. I know ten groups of 7 is 70. That is two groups too many. I have to subtract two groups of 7 from 70 and that is 70-14=56.So, 8x7=56



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Sequenced Number Story for Subtracting a Group

1. Amanda is stacking cans on the shelf at the grocery store. She has room for 10 rows of cans. She can put 6 cans in each row. How many cans can Amanda stack on the shelf?

2. A customer bought a row of cans. Now Amanda only has 9 rows with 6 cans in each row. Use what you already know to figure out how many cans Amanda has on the shelf now.

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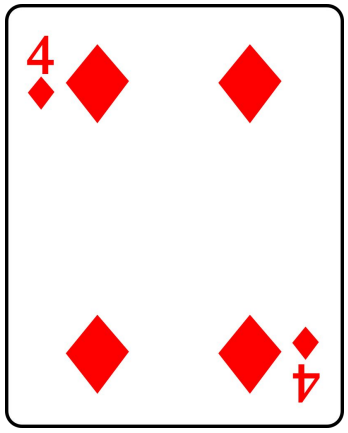
Grade 3 – Week 1

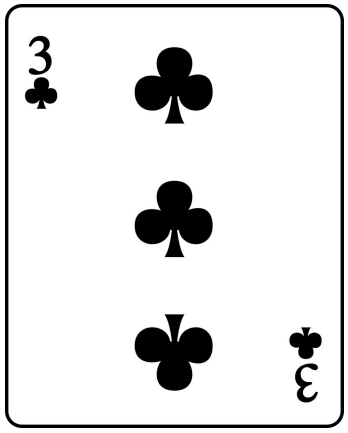
ORIGO at Home

Multiplication

This week will focus on the *build-down* strategy for multiplication. This strategy can be used when multiplying a number by 9. If you have time, watch the ORIGO ONE video about the build-down strategy before working with your student (also available in Spanish). This will help you to assist your student as they work through the activities for this week. Encourage your student to look for patterns as they multiply by 9.

Monday — Watch and Talk
Tuesday — Hands-on Math
Wednesday — Problem-solving
Thursday — Game day
Friday — Practice day





Add the cards then multiply by 9.

SUPPORT

81 Game board

45	0	72	36
90	54	63	18
27	0	45	81
36	9	72	90

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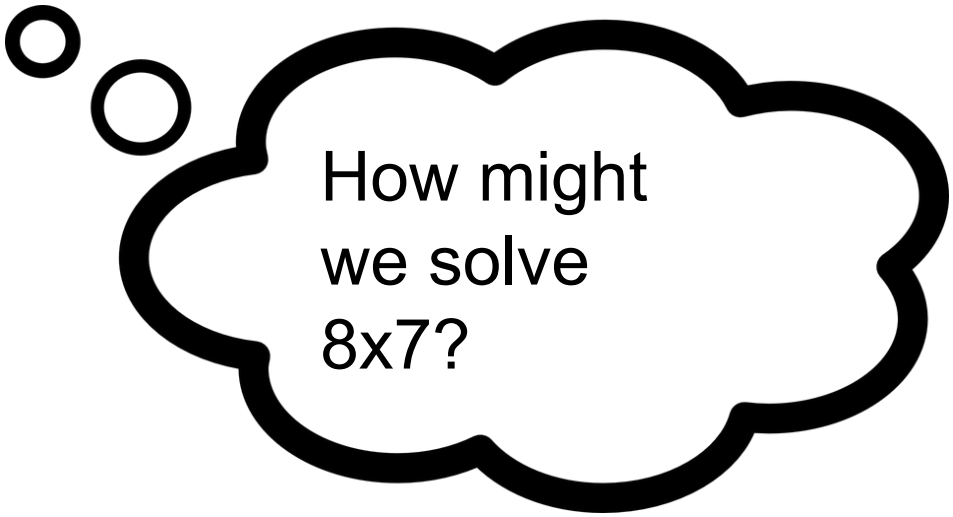
Near Squares

Look for a nearby square. Find that fact and add on or subtract off the extra group.

Example: I don't know 7x6. I use 6x6 and add one more 6 to get 42.

I don't know 7x6. I use 7x7 and subtract one more 7 to get 42.



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Near Squares Kaboom

Squares/ Near Squares Kaboom

Materials: Popsicle sticks with an individual fact from the list below on each stick. Write Kaboom on three or more additional popsicle sticks. Optional: calculator/ multiplication chart to check answers.

Directions: Put all the popsicle sticks face down so students cannot see what is written on them. Here is how to play:

1. First student pulls out a popsicle stick.

2. The student identifies the answer and explains his/her thinking to the group/partner. If the answer is correct, the student gets to keep the popsicle stick. If the student answers it incorrectly, the stick must go back in the cup.

3. The students continue around the circle, or with a partner, selecting one popsicle stick at a time and answering their question.

4. Any student who pulls a KABOOM! stick must place all the popsicle sticks they have accumulated back into the cup, leaving them with zero.

5. The student with the most sticks after 5 rounds, time is up, etc. is the winner.

1 x 1		
2 x 2	2 x 1	2 x 3
3 x 3	3 x 4	3 x 2
4 x 4	4 x 5	4 x 3
5 x 5	5 x 6	5 x 4
6 x 6	6 x 7	6 x 5
7 x 7	7 x 8	7 x 6
8 x 8	8 x 9	8 x 7
9 x 9	9 x 10	9 x 8

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Multiplication Version 1

(No Distractor Cards)

Grade 3

Formative Assessment Lesson

Designed and revised by the Kentucky Department of Education
Field-tested by Kentucky Mathematics Leadership Network Teachers

If you encounter errors or other issues with this file, please contact the KDE math team at: kdemath@education.ky.gov

Revised 2019

Name _____ Student Materials

Multiplication

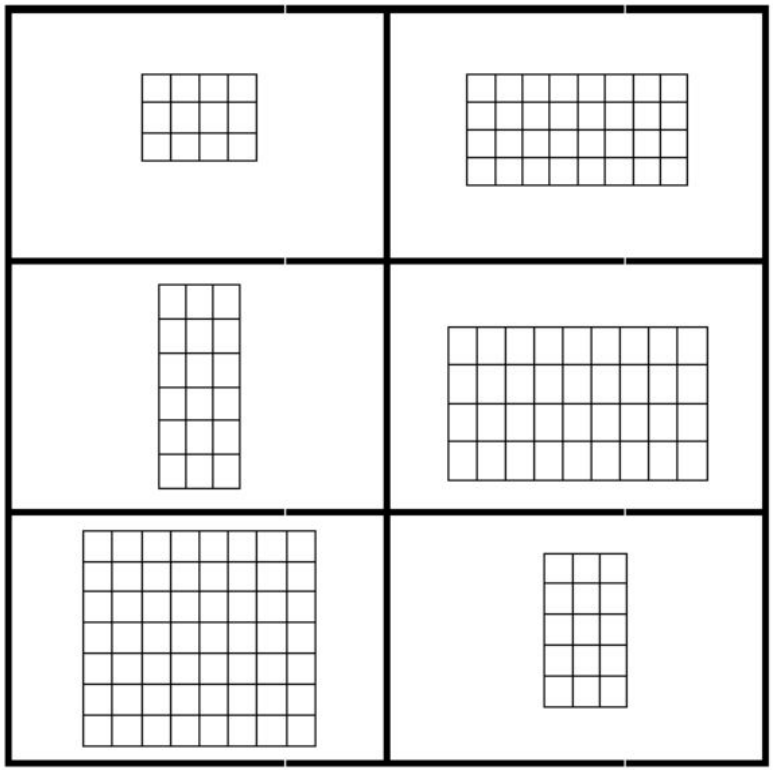
Using the multiplication problem at the top of each chart, create a representation of the problem that matches the labels in each of the four boxes.

4 x 7 = 28	
Area Model	**Equal Groups**

Card Set A

3 x 4	4 x 8

Card Set B



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Tiling With Numbers

M 4448

Connections to CCSS

Activity	Fluency Standard	Additional Standards targeted
M 4448.1	3.OA .7 Fluently multiply and divide within 100…	2.OA.4, 3.MD.5
M 4448.2		2.OA.4, 3.MD.5
M 4448.3		3.OA.7, 3.MD.5, 3.MD.7a
M 4448.4		3.OA.5, 3.OA.7, 3.MD.7c
M 4448.5		3.OA.7

Tiling with Number

I can combine two rectangles to make a larger rectangle and find the total tiles needed to cover each part and the larger rectangle.

KNP # M 4448.4 - Tiling with Number, Purple
Fluency Standard: 3.OA.7
Standard: 3.OA.5, 3.OA.7, 3.MD.7,

Materials: Rectangle Cards, 1 recording sheet per player

Directions:

1. Place all rectangle cards face down in a pile.

2. With a partner take turns selecting a rectangle card without looking. Each player should place their rectangle cards face up in front of them.

3. When you have two cards that can go together to make a larger rectangle, place them together and find the total number of tiles needed to cover both parts.

4. Write the facts for each match on your recording sheet. The "larger rectangle" is not a separate piece – just a composite of the two smaller rectangles.

5. When all the cards are gone, the player with the most 2-piece rectangles wins.

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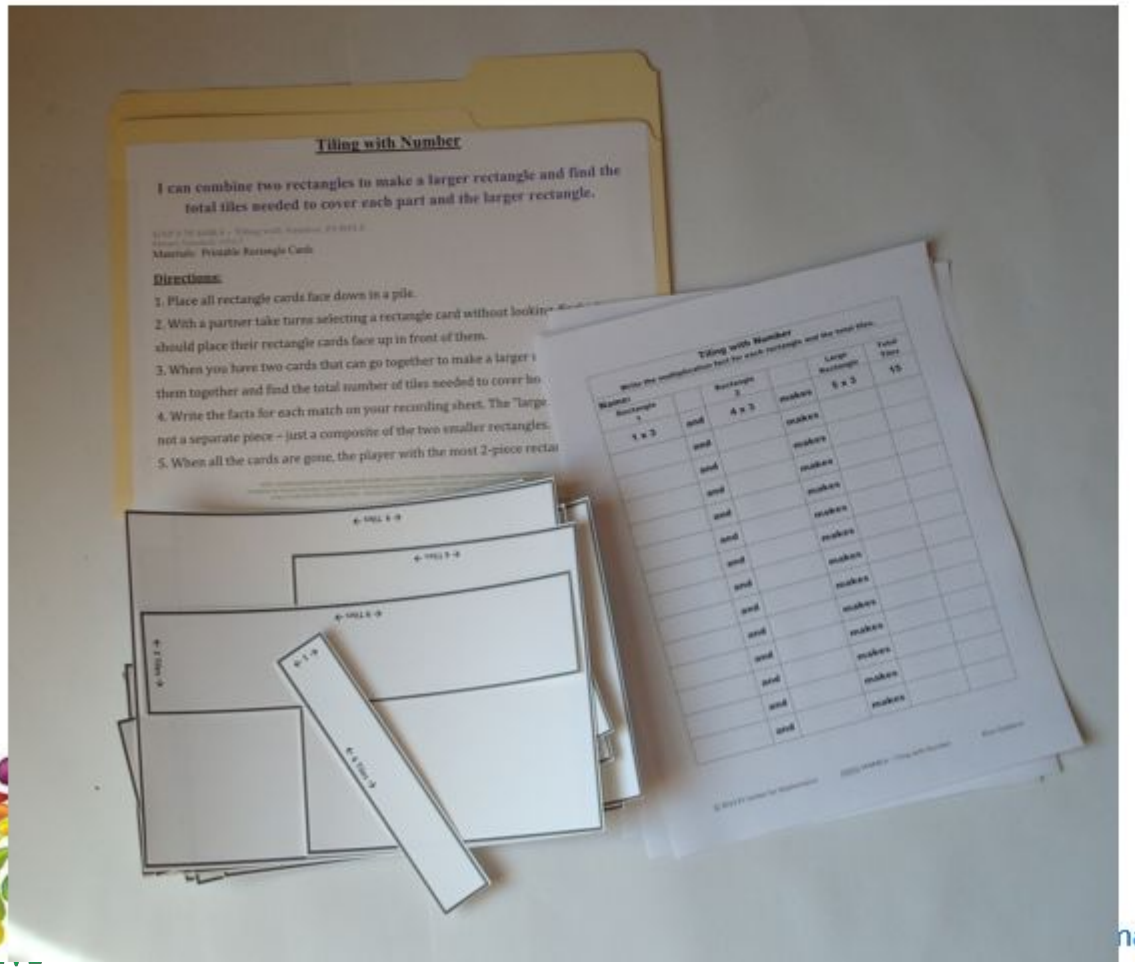
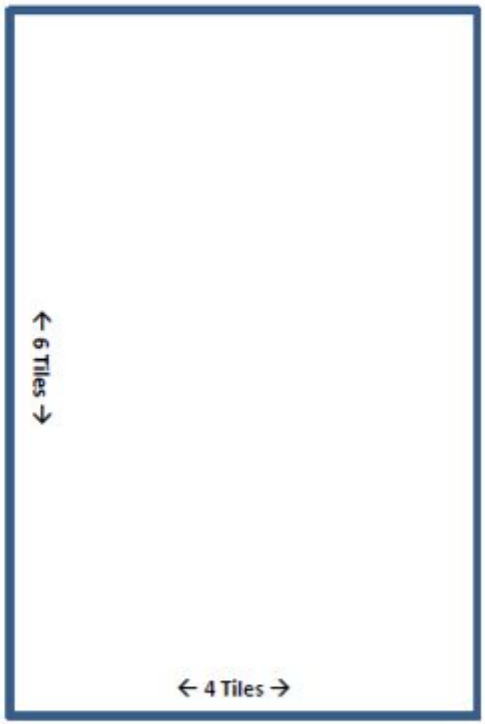
Materials:

- Rectangles with dimensions labeled
- Recording sheets (1 per player)





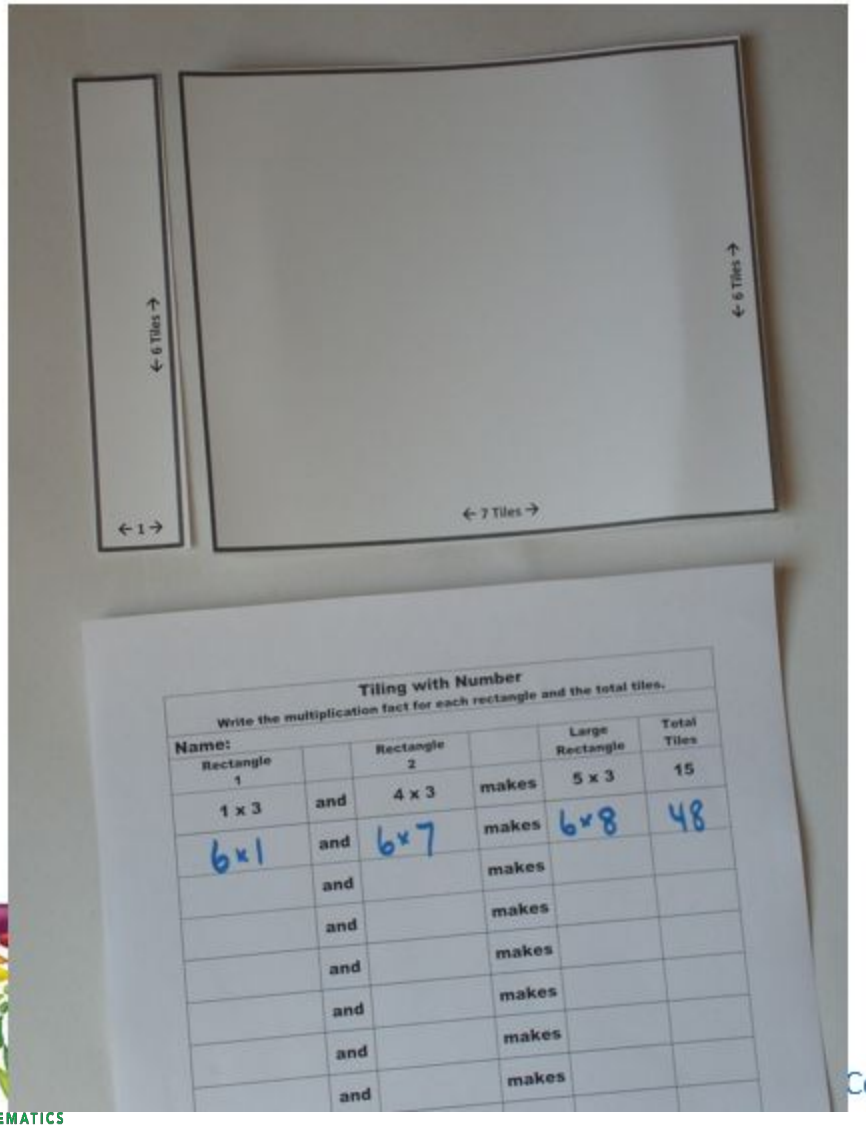
Game Play

On a player's turn, the player will draw 1 rectangle and place it on the table.

If possible, the player will create a larger rectangle by pairing two cards.

Otherwise, the player will pass.

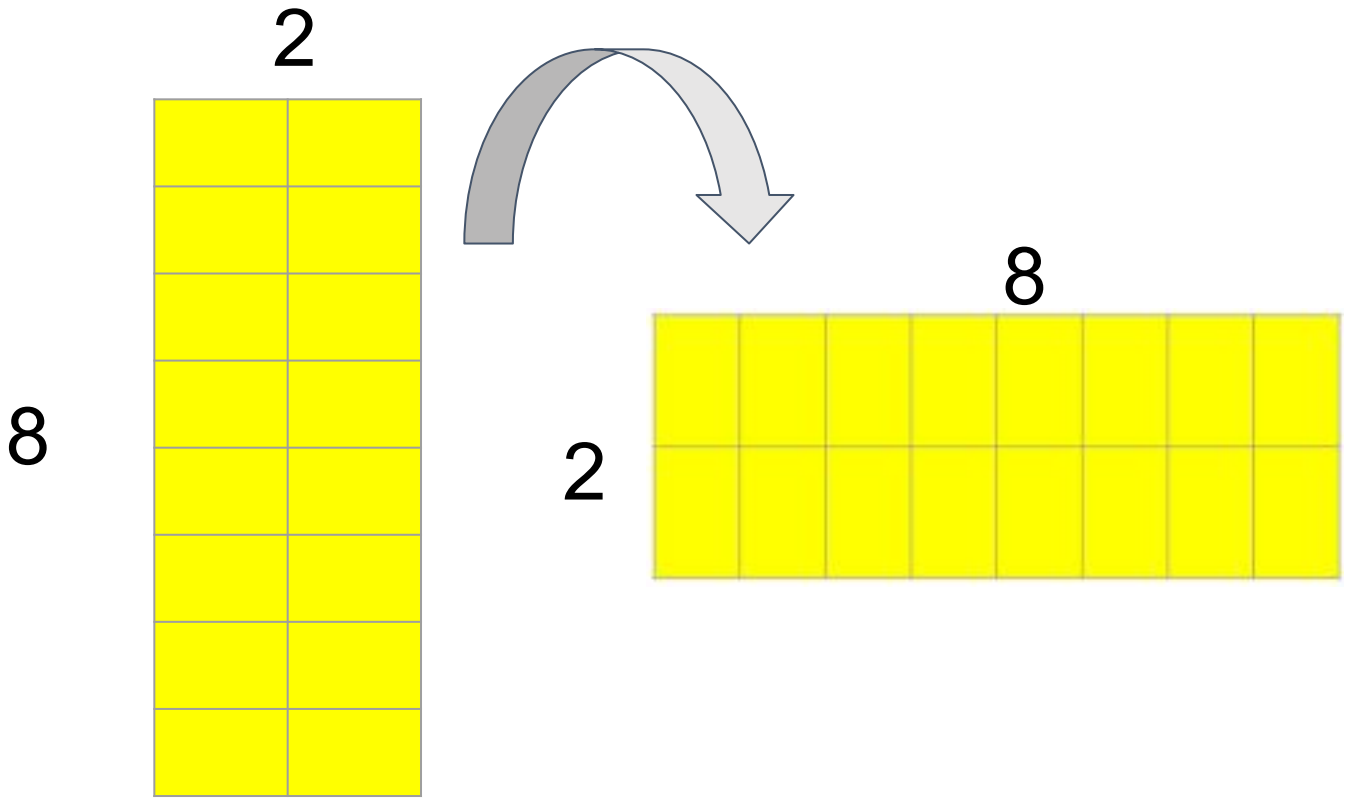
Game Play



Record the multiplication expressions and area on the recording sheet.

Winner is player who creates the most large rectangles.

Commutative Property of Multiplication



$8 \times 2 = 2 \times 8$

Changing the order of the factors does not change the product.

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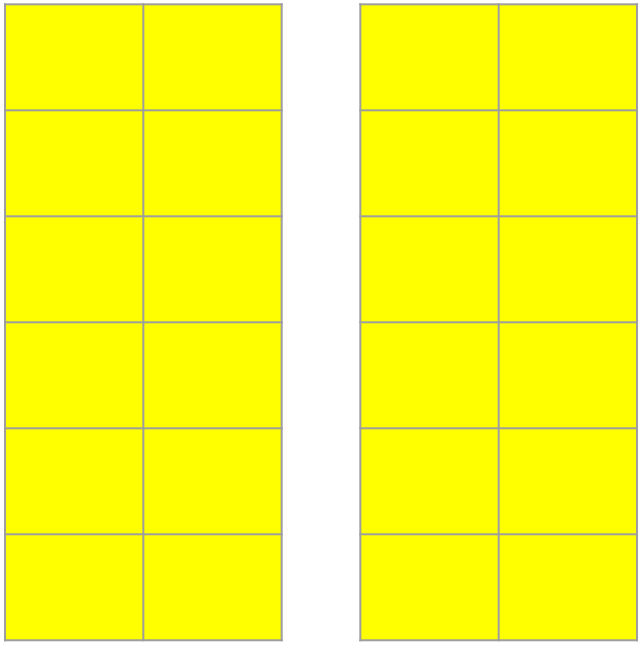
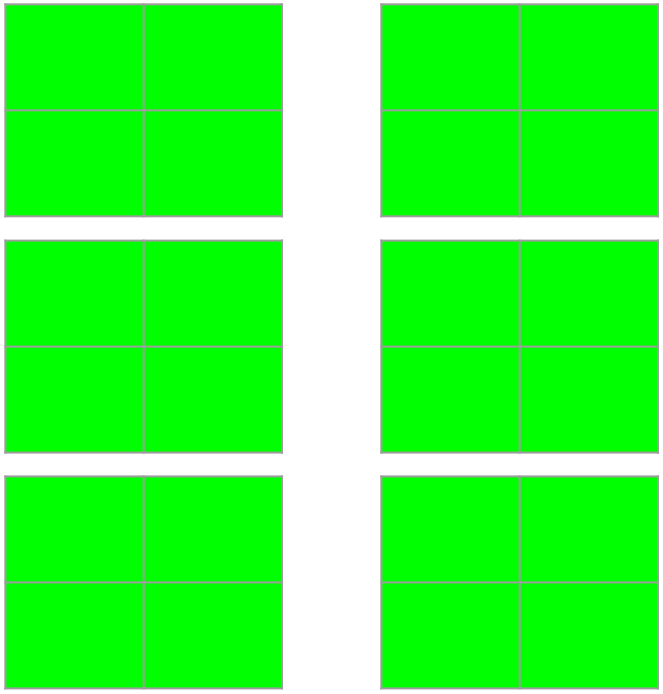
Associative Property of Multiplication

(6 x 2) x 2



6 x (2 x 2)



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Changing the groupings of the factors does not change the product.

Distributive Property of Multiplication

7 x 6

A factor can be decomposed into addends and the addends can each be multiplied by the other factor to find partial products, and then those partial products can be added to find the total product.

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Properties of Multiplication

TABLE 2

Students need meaningful practice to move from fluency to mastery. CCSSM 3.OA.B.5: "Apply properties of operations as strategies to multiply and divide."

Applying the properties of multiplication	
Commutative property of multiplication	Important to all facts. If $6 \times 4 = 24$ is known, then $4 \times 6 = 24$ is also known. This cuts the learning of facts in half.
Associative property of multiplication	Used in derived facts, like doubling. A student sees 6×9 and thinks $(2 \times 3) \times 9$, which is the same as $2 \times (3 \times 9)$, which is 2×27, 54.
Distributive property of multiplication over addition	A student realizes that $8 \times 7 = 8 \times (5 + 2)$ and uses this to find the answer, thinking $(8 \times 5) + (8 \times 2) = 40 + 16 = 56$.

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Bay-Williams, Jennifer & Kling, Gina 2015. "Three Steps to Mastering Multiplication Facts," *Teaching Children Mathematics* Vol. 21, No. 9 (May 2015), pp. 548-559

Strategy Focused Game Play: Aligning Strategies With Games

What set of facts will be the focus?

What games will encourage the use of this strategy and focuses on this fact set?

How can I incorporate sequenced story problems?

What strategy aligns with that set of facts?

What Quick Looks/ Number Talks might I use to support student learning?

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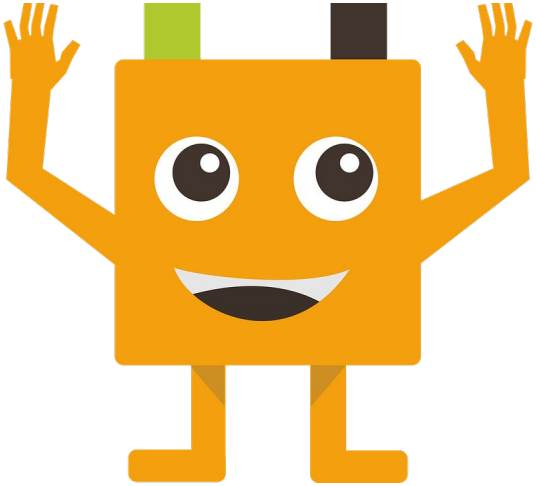
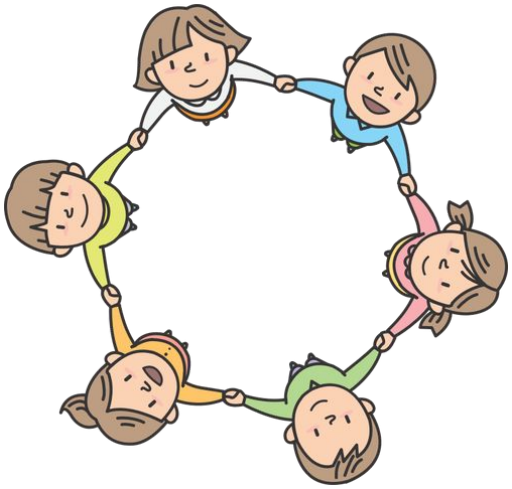
Time to Share!



A POINT (or 3!) you would like to make?

Anything SQUARE with your way of thinking?



Anything still CIRCLING in your mind?

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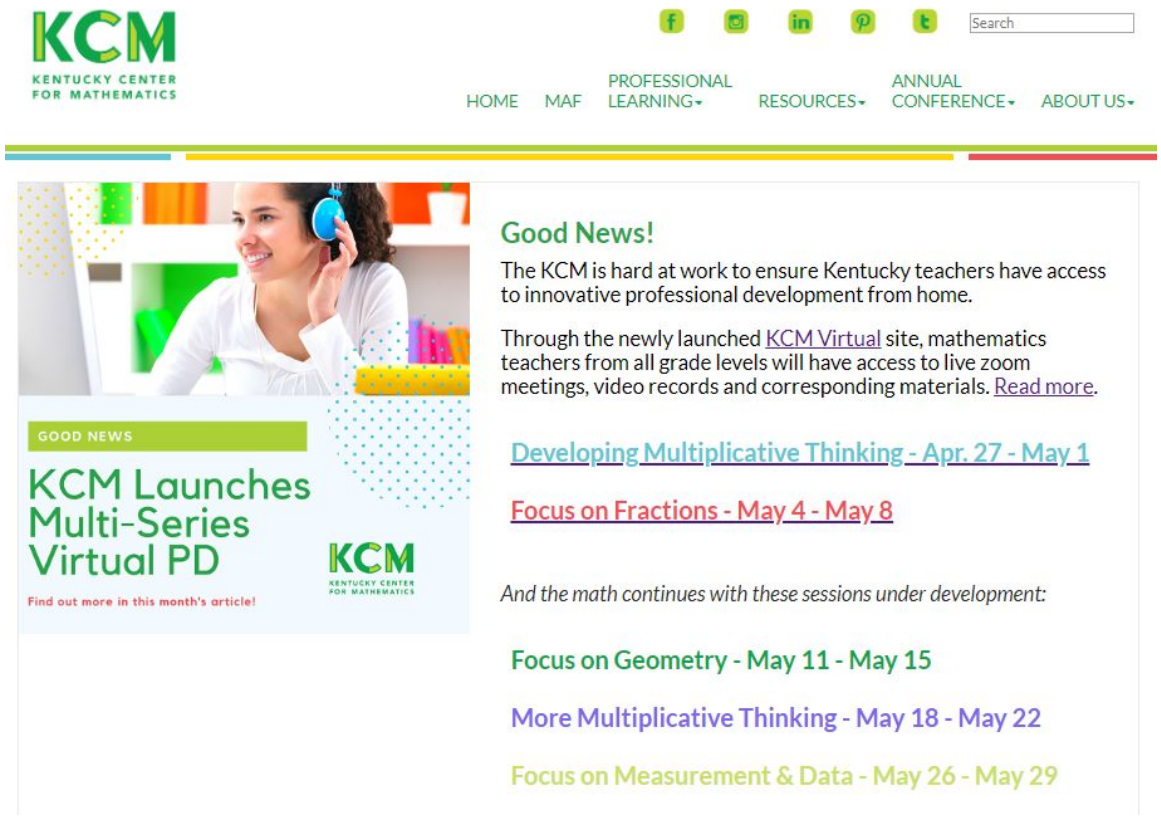

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