#22

Avi & Priya Read the Dice

Combinatorics
Sample Space Unknown

Making sense of word problems with mathematical comprehension & operation sense.

Mathematizing Story Maps
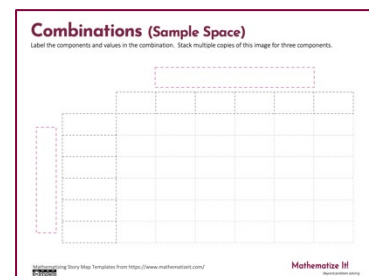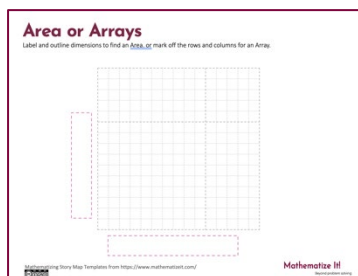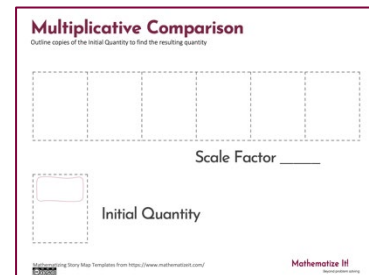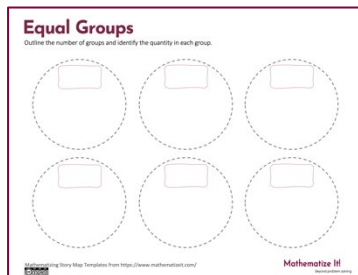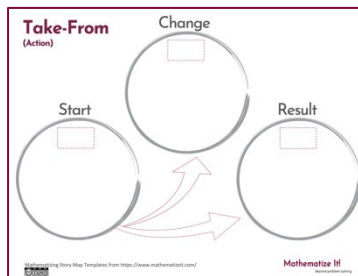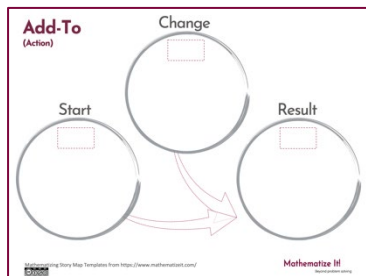
Add-To (Action)
Change
Start
Result

Take-From (Action)
Change
Start
Result

Part-Part-Whole (Relationship)
Part
Part
Whole

Additive Comparison (Relationship)
Lesser
Difference
Greater

Equal Groups
Outline the number of groups and identify the quantity in each group.
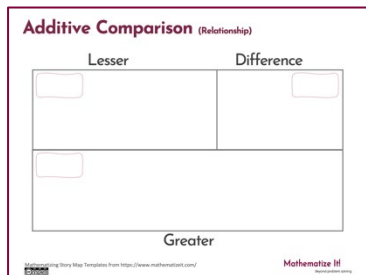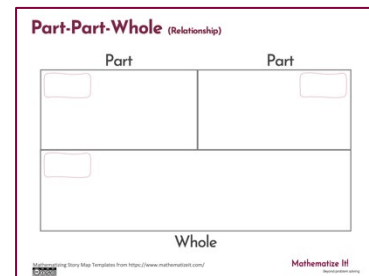
Multiplicative Comparison
Outline copies of the Initial Quantity to find the resulting quantity
Scale Factor _____
Initial Quantity

Area or Arrays
Label and outline dimensions to find an Area, or mark off the rows and columns for an Array.

Combinations (Sample Space)
Label the components and values in the combination. Stack multiple copies of this image for three components.

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Beyond problem solving

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Label the components and values in the combination. Stack multiple copies of this image for three components.

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Beyond problem solving
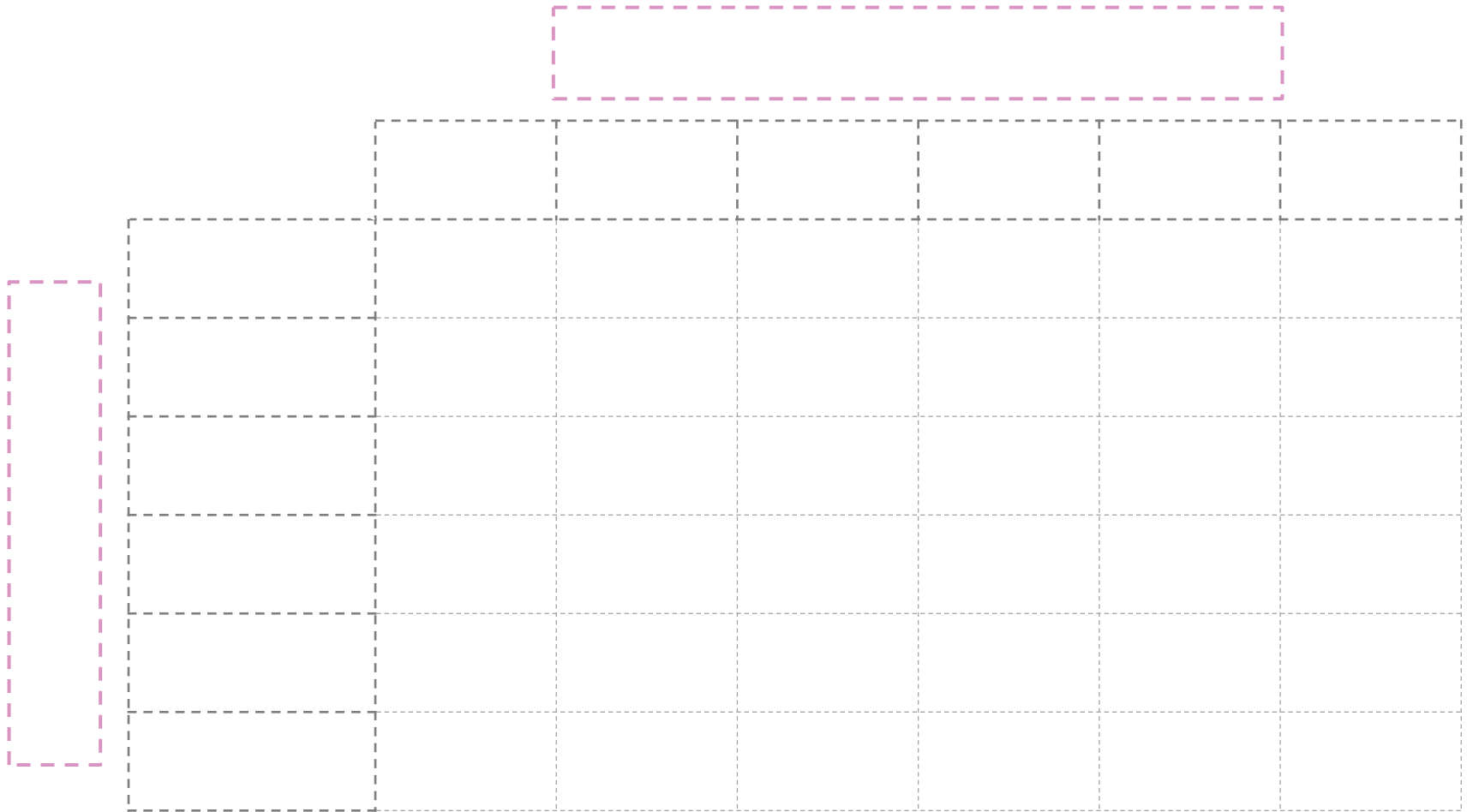
••• Mathematizing Story Maps •••

How do your students approach word problems?

Key words don't always help. What are we supposed to underline in CUBES anyway?

Sometimes it feels like students just pick an operation and they don't know why!

These strategies don't prepare students to formulate and solve problems that matter to them.
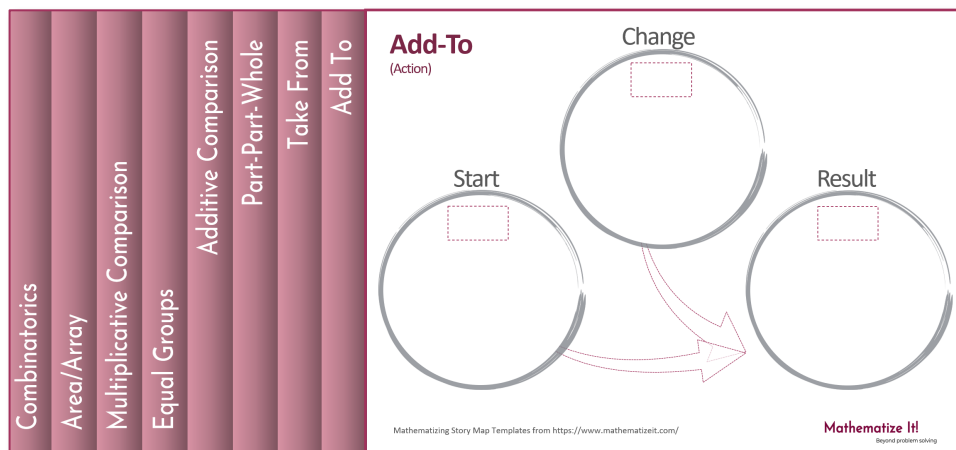
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Prepare students to DO math!

•••

Teacher Background

Mathematizing Story Maps encourage students to model with mathematics and find the math in their everyday lives. Opening stories are written to engage students first in thinking about the story and then about the mathematics.

Mathematizing Story Maps help students understand what the four familiar operations (+ − × ÷) can do. The more students know about how we use subtraction or when we use division, the more skills they will have to match a strategy to a problem.

Combinatorics | Area/Array | Multiplicative Comparison | Equal Groups | Additive Comparison | Part-Part-Whole | Take From | Add To

Add-To (Action)

Change

Start

Result

Mathematizing Story Map Templates from https://www.mathematizeit.com/

Mathematize It! Beyond problem solving

Mathematize It!
Beyond problem solving

How to teach the Mathematizing Story Maps

1. **Read the story**
   a. Think about how your students might respond. What's familiar? What's not?

   b. What mathematics is seen in the story? How might students represent their thinking?

2. **Choose tools you have and that students know.**
   a. What manipulatives might your students use to represent the mathematics in the story? Consider counters, base ten materials, fraction tools, or more!

   b. What visual representations might your students know (ten frames, number tracks, number lines, grid paper, etc.)

3. **Choose a Mathematizing Story Map**
   We share a mathematizing story map for each of 8 categories of problem situations.

● ● ●

Mathematizing Story Maps help students
act out or represent what is happening in a
problem and make sense of it.

● ● ●

What will students do?

Most word problems (story problems) students encounter support their calculation skills. We need to build their understanding of how to use math to solve real problems.

- Find the story behind every mathematical problem situation

- Use one of 8 Mathematizing Story Maps to act it out or show

- Represent the story and choose an operation (+ − × ÷) that matches the story.

- Resist answer-getting. We pay attention to the process of solving problems

What's included?

Each mathematizing story map lesson includes:

- Teaching notes on 8 categories of problem situations.

- Teaching notes for the Mathematizing Story Maps

- A set of questions to pose that focus students on the mathematizing story.

To read more about problem situations and the four operations, check out the *Mathematize It!* book series.
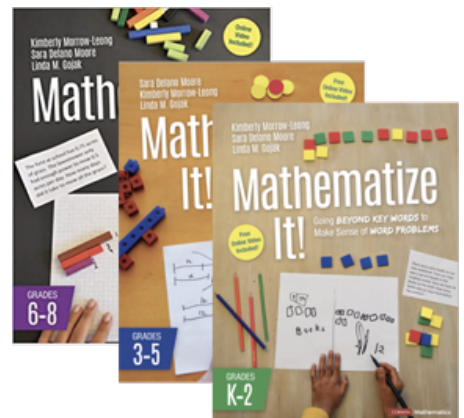
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Teacher Notes
Mathematizing Story Maps
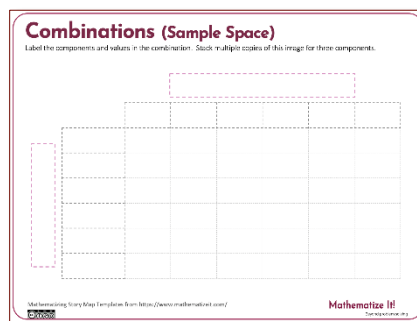## Avi & Priya Read the Dice

Problem Type
This story supports developing mathematical ideas around the Combinatorics job of multiplication. These problem situations represent finding the total number of possible outcomes given a specific set of inputs. For example, tops and pants combine to create outfits. In this situation, each factor does the same job of representing one component of each possible outcome, also known as the Sample Space.

Missing Element
In this story, the sample space, or group of all possible outcomes, is unknown. Students know the number of inputs (each factor) and the range of values for each input (the quantities). They must identify all the possible outcomes of the situation.

The Mathematizing Story Map
The Mathematical Story Map provided supports the Combinatorics job of multiplication by showing the possible combinations of two components. Story maps can be stacked to represent three components.

Combinations (Sample Space)
Label the components and values in the combination. Stack multiple copies of this image for three components.

Mathematizing Story Map Template from https://www.mathematizeit.com/

Mathematize It!
[mathematizeit.org]

Multiplication & Division Problem Situations

Asymmetric Situations	**Equal Groups (Ratio/Rate)**	Product Unknown	Number of Groups (Multiplier) Unknown	Group Size (Measure) Unknown
	Multiplicative Comparison	Resulting Value Unknown	Scale Factor Unknown	Original Value Unknown
Symmetric Situations	**Area/Array**	Product Unknown	One-Dimension Unknown	Both Dimensions Unknown
	Combinatorics	Sample Space (Total Outcomes) Unknown	One Factor Unknown	Both Factors Unknown

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Day 1

Read the story at least once with your class. Talk about the story and support your students as they make sense of the events in the story as you would for any narrative.

Then encourage students to find the mathematics in the story with questions like these:

- *What items are being combined in this situation? (e.g., tops/pants or meat/cheese)*
- *What does each possible combination represent? (e.g., an outfit or a sandwich)*
- *How can you organize to find all the possible combinations?*

If students start calculating numbers right away, particularly if they are "number-plucking" or randomly doing calculations, refocus their attention on the relationship in the story.

Encourage students to use manipulatives as they work on the Mathematizing Story Map to show the relationship that is in the story. Label the quantities and their units. Before ending for the day, give students the opportunity to record their thinking on paper.

Encourage students to use manipulatives and visuals to show their thinking about the math in the story. Students should translate their work from manipulatives and sketches to the mathematical story map.

> You may wish to use the Three Reads Strategy (p.15) to support student understanding of the text itself.

> To focus on the story, create a numberless word problem. Remove the numbers from the story as the class discusses it.

Combinations (Sample Space)
Label the components and values in the combination. Stack multiple copies of this image for three components.

	Tetrahedron			
	1	2	3	4
1	11	21	31	41
2	12	22	32	42
3	13	23	33	43
4	14	24	34	44
5	15	25	35	45
6	16	26	36	46

(Cube labeled on left side)

Day 2

Reread the story and use the Mathematizing Story Map to retell it and act it out. Ask your students to translate their actions on the Mathematizing Story Map into an equation. Each student should be able to connect the elements of the story map to the narrative. Discuss the **quantities** in the story and what strategies students might use to find an answer to the question they have asked. Ask students to consider other mathematical stories (or variations on the current story) they can see in this narrative.

Combinations (Sample Space)
Label the components and values in the combination. Stack multiple copies of this image for three components.

	Tetrahedron				Sum		Count
	1	2	3	4	2	I	1
1	11	21	31	41	3	II	2
2	12	22	32	42	4	III	3
3	13	23	33	43	5	IIII	4
4	14	24	34	44	6	IIIII	5
5	15	25	35	45	7	IIII	4
6	16	26	36	46	8	III	3
					9	II	2
					10	I	1

(Cube labeled on left side)

Mathematize It!
Beyond problem solving

Day 3

Use the mathematizing story map to support solving the word problems provided. Take time for reading comprehension (does the story make sense?) before mathematical comprehension (what is happening in the story?) These questions can help students develop mathematical comprehension.

- *What items are being combined in this situation? (e.g., tops/pants or meat/cheese)*
- *What does each possible combination represent? (e.g., an outfit or a sandwich)*
- *How can you organize to find all the possible combinations?*

Encourage your students to use manipulatives and visuals to show their thinking about the math happening in each problem. Students should translate their work from manipulatives and sketches to the mathematical story map.

Days 4-5

Choose one or more of these options to continue developing student thinking.

- Continue working on the problems provided, focusing on the story map as a tool to develop mathematical comprehension and operation sense.
- Lead a discussion among students focusing on how the story map fits the narrative and problems provided. Use these questions to focus thinking on the job Combinatorics is doing in these situations:
  - *What are the components (factors) limiting the combinations to be made?*
  - *How do the factors combine to make each specific item?*
  - *How can you be sure you have all the possible combinations?*
  - *What number sentence(s) can you write to show these relationships?*
- Ask students to develop new narratives or problems, either from scratch or as extensions of the current storyline, which can also be told using the same mathematical story map. Encourage students to explain the underlying connections which make the mathematics similar even if the story contexts are not the same.

To read more about problem situations and the four operations, check out the **_[Mathematize It!]_** book series.

Mathematize It!

Beyond problem solving

Avi & Priya Read the Dice Practice Problems

Use objects, pictures, numbers, and words to describe what is happening in each problem. Use a mathematizing story map to record your thinking.

Avi's friend said he thought there were 12 different combinations possible if you roll two six-sided dice. Avi thinks there are more possibilities than that. How many possibilities are there?

Priya is getting ready to go to a party. She looks in her closet and finds 3 tops and 2 pairs of pants she might want to wear. Everything matches each other. How many outfits does she have to choose among?

Lakshmi and her friends are thinking about making up a game. "What if we make a game where you roll three dice with 4 sides each – one red, one green, and one white? How many possible combinations do we have to think about?"

Combinatorics Situations, Sample Space Unknown

Mathematize It!

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