HOW TO IMPLEMENT ENGAGING PROBLEM SOLVING IN YOUR MATH CLASSROOM

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Using the digits 1 to 9 at most one time each, place a digit in each box to make the product as close to 7,000 as possible.

□□ x □□

Source: Paolo Tolomeo on openmiddle.com

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Name: Date:

MULTIPLICATION PRACTICE

66 x 23	49 x 72	52 x 44	26 x 35	18 x 87	63 x 55

4

STUDENTING BEHAVIOR

- slacking – not attempting to work at all
- stalling – doing legitimate off-task behavior
- faking – pretending to do the task but in reality, doing nothing
- mimicking – mindlessly repeating what they have in their notes
- trying it on their own – attempting to work through a problem

- thinking - what you do when you don't know what to do

Source: Dr. Darien Allan via Peter Liljedahl's *Building Thinking Classrooms*

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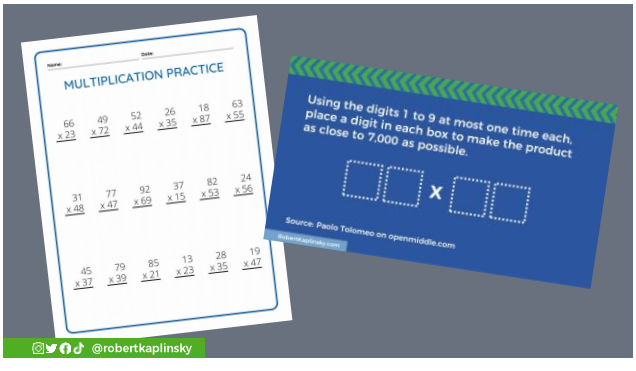

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DISCUSSION TIME

- Why was our engagement and thinking when working on the multiplication problem different than it would have been with a worksheet?

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CHECKPOINTS

- ❑ HOW DO WE GET STUDENTS THINKING?
- ❑ HOW DO WE DO IT WITH REAL WORLD PROBLEMS?
- ❑ HOW DO WE DO IT WITH OPEN MIDDLE PROBLEMS?

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- 1/2 cup butter
- 1/2 cup white sugar
- 1/3 cup packed brown sugar
- 1/2 teaspoon vanilla extract

11

12

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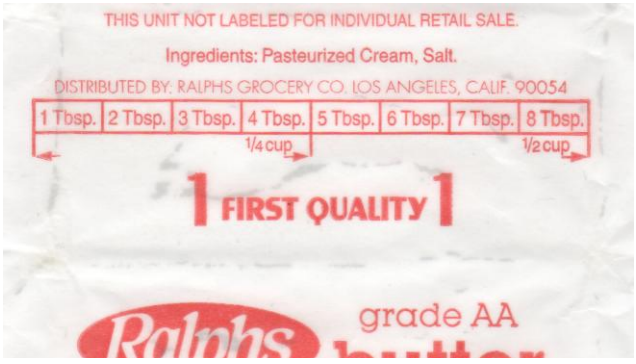

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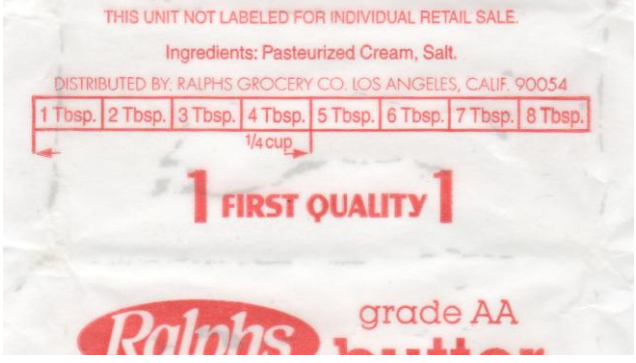
- 1/3 cup butter
- 1/3 cup white sugar
- 3 tablespoons and 1-3/4 teaspoons packed brown sugar
- 1/3 cup peanut butter
- 1/4 teaspoon vanilla extract

15



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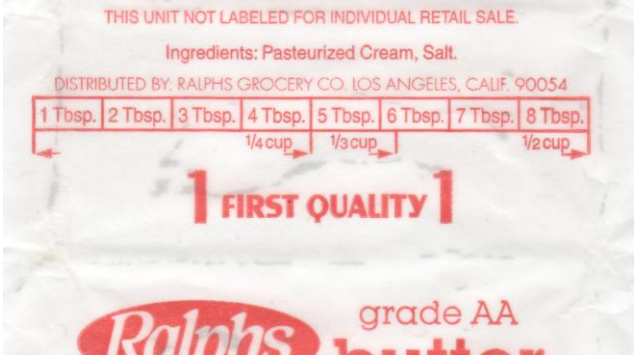

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TOPICS

- ❑ IGNORANCE IS BLISS
- ❑ WORKSHEET-IFY
- ❑ 5 PRACTICES
- ❑ BUILDING THINKING CLASSROOMS
- ❑ WHAT I'M STILL WORKING ON

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20. Baking

A stick of butter has 1/2 cup of butter. How much of a stick do you need for 1/3 of a cup of butter?

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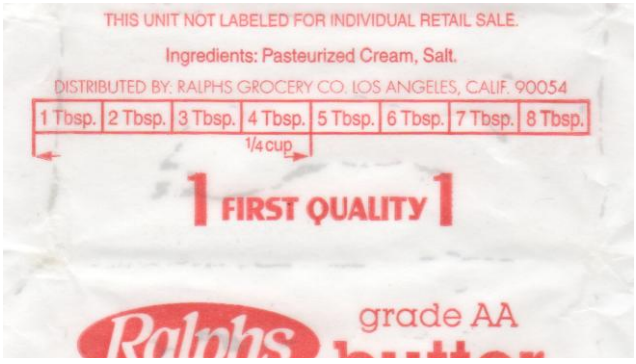

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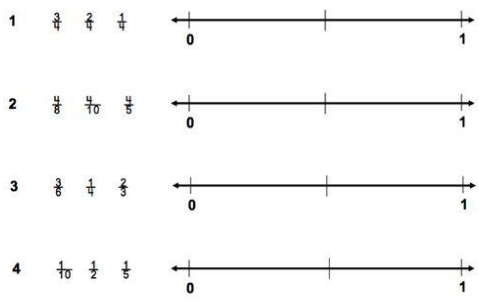

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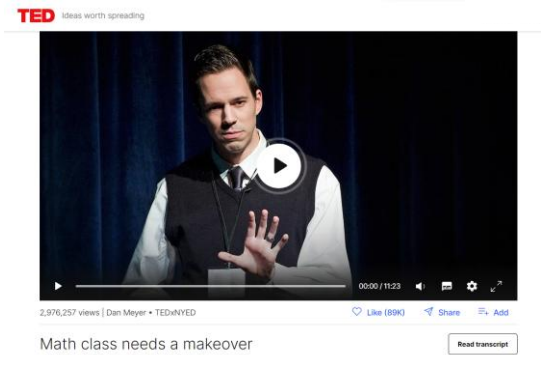

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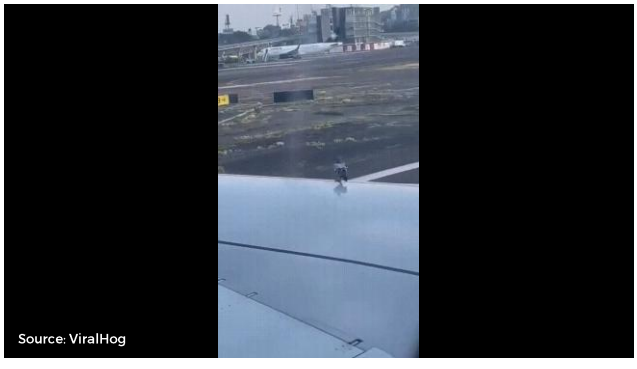

28

Cutting Butter Activity

Name: _____

Period: _____

1. Copy the image of the stick of butter and circle where 1/4 cup is:

2. If half a stick is 1/4 cup of butter, how much is 1/2 cup of butter?

_____

3. Estimate where you think you should cut the stick for 1/3 cup of butter. How do you know?

_____

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	Before using the problem	Working on the problem
Worksheet	Made a worksheet	Guided students with the worksheet

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30

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TOPICS

- ☑ IGNORANCE IS BLISS
- ☑ WORKSHEET-IFY
- ❑ 5 PRACTICES
- ❑ BUILDING THINKING CLASSROOMS
- ❑ WHAT I'M STILL WORKING ON

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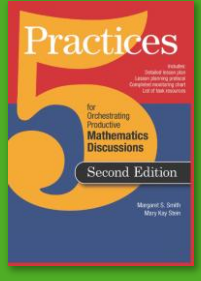

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- Predictable
- Powerful
- Repeatable

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5 PRACTICES

1. Anticipating
2. Monitoring
3. Selecting
4. Sequencing
5. Connecting

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ANTICIPATING

- Count 16 tablespoons and divide by 3.
- Use two sticks to make a whole cup and:
  - Slice the whole cup into thirds.
  - Break each tablespoon into thirds and collect them.
  - Make groups of five tablespoons and split the 16th.
- Take two thirds of one stick.
- One third is marked as less than one fourth.
- 15 tablespoons were distributed but not the 16th.

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MONITORING

- Use a student strategy tracker
- Keep track of who is using what
- Nudge people as needed

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Strategy	Student Name(s) and Notes	Order

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SELECTING, SEQUENCING, & CONNECTING

- Pick useful student work
- Order it to tell a story
- Ask questions to make connections

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Strategy	Student Name(s) and Notes	Order
Count 16 tablespoons and divide by 3.		
Use two sticks to make a whole cup and slice the whole cup into thirds.		3
Use two sticks to make a whole cup and break each tablespoon into thirds and collect them.		1
Use two sticks to make a whole cup and make groups of five tablespoons and split the 16th.		2

41

TAKEAWAYS

- No more crime scene investigation
- Getting the answer is the middle, not the end.
- Sometimes I fake student work

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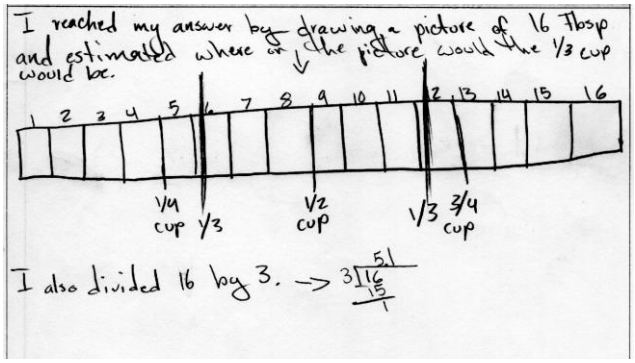
42



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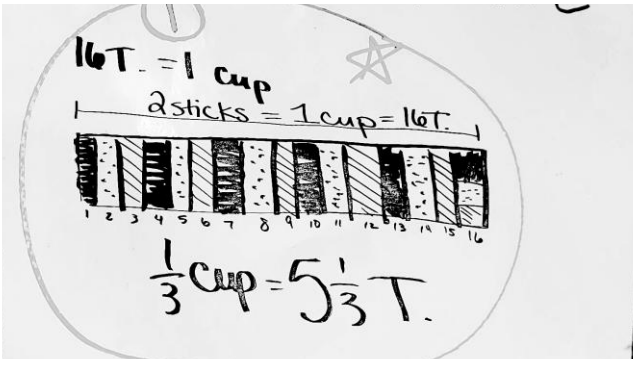

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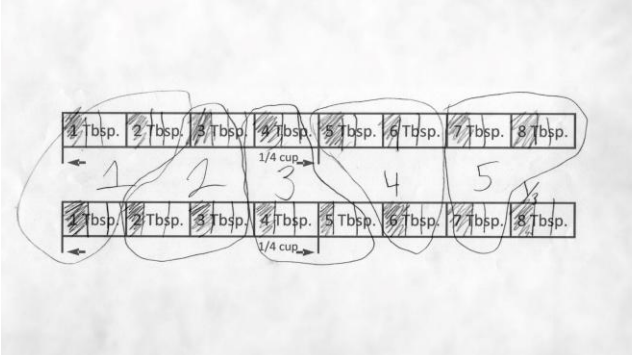

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TAKEAWAYS

- No more crime scene investigation
- Getting the answer is the middle, not the end.
- Sometimes I fake student work
- Everyone getting the problem wrong is an opportunity, not a failure.

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	Before using the problem	Working on the problem	Facilitating the conversation
Worksheet	Made a worksheet	Guided students with the worksheet	Shared answers
5 Practices	Anticipated	Monitored	Selected Sequenced Connected

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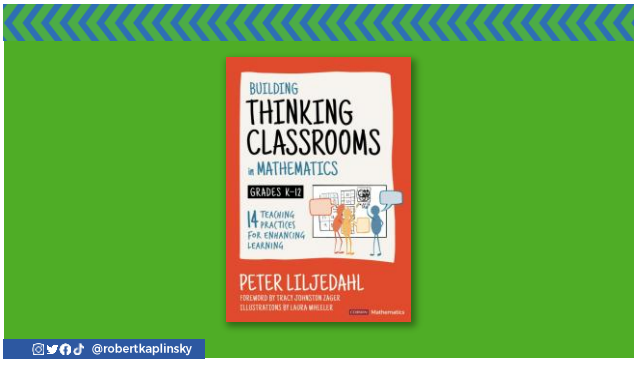

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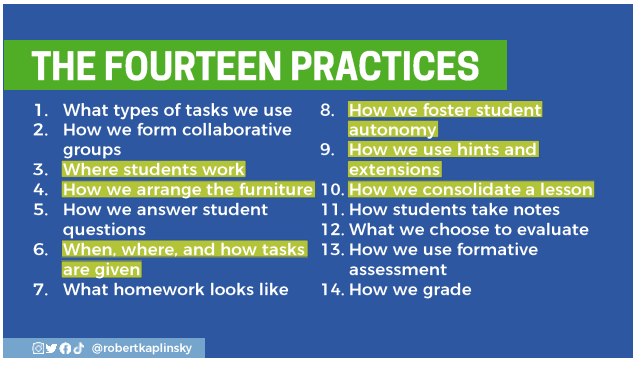

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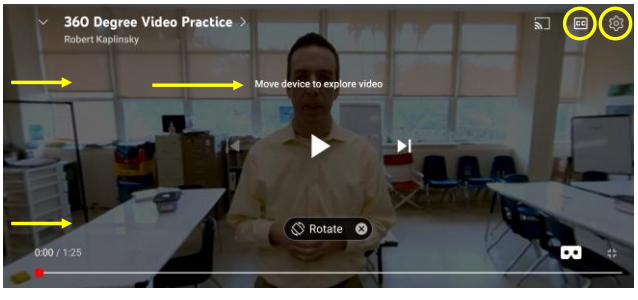

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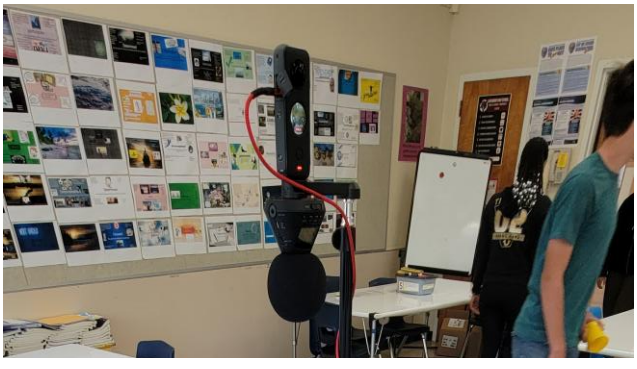

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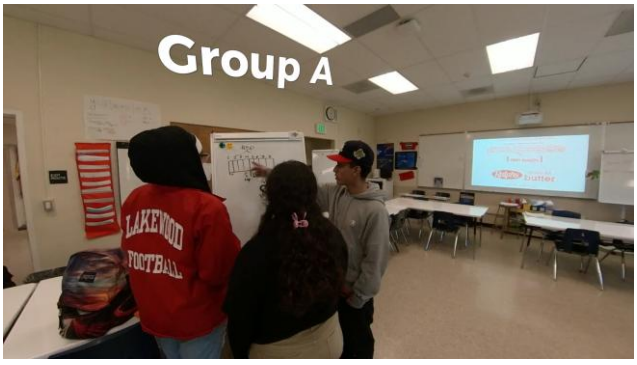

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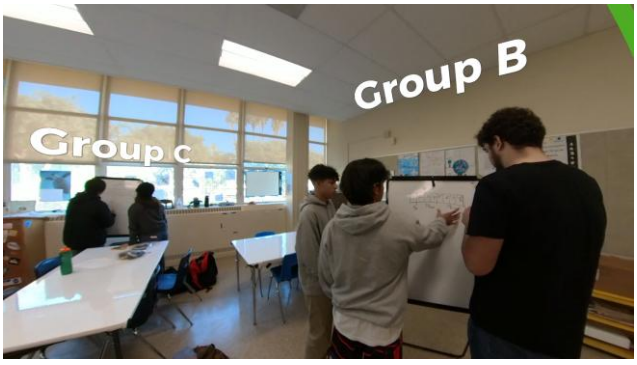

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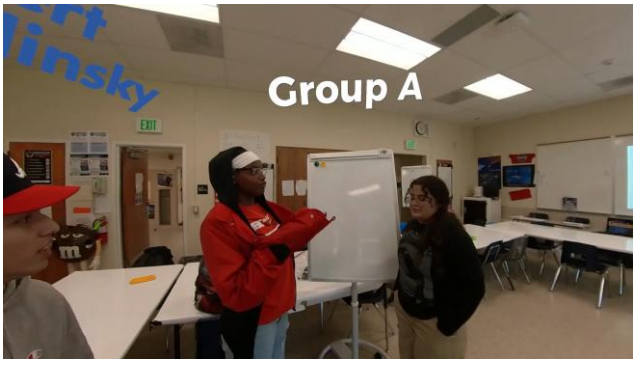

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DISCUSSION TIME

- How do you think having groups of three students sharing vertical whiteboards scattered around the room impacted the way they interacted?

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DISCUSSION TIME

- What was the teacher's role in facilitating group conversations and helping them when they got stuck?

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DISCUSSION TIME

- Why was Group C walking to check out what other groups were doing a really good sign?

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DISCUSSION TIME

- What do you notice and wonder about the way this conversation took place?

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TAKEAWAYS

- Small changes make huge differences
- Giving up control is not bad
- Students are more comfortable

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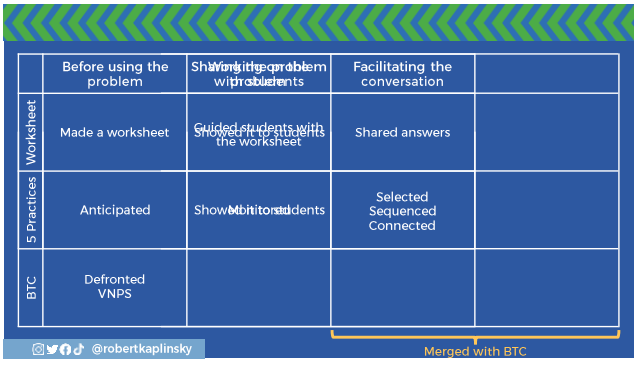

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TOPICS

- ☑ IGNORANCE IS BLISS
- ☑ WORKSHEET-IFY
- ☑ 5 PRACTICES
- ☑ BUILDING THINKING CLASSROOMS
- ☐ WHAT I'M STILL WORKING ON

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WHAT I'M STILL WORKING ON

- How much wait time do I give?
- What do conversations look like?
- Who should do the explaining?
- How do I ensure all students are participating?

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TOPICS

- ☑ IGNORANCE IS BLISS
- ☑ WORKSHEET-IFY
- ☑ 5 PRACTICES
- ☑ BUILDING THINKING CLASSROOMS
- ☑ WHAT I'M STILL WORKING ON

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DISCUSSION TIME

- What parts of this reinforced what you've already been working to implement?
- What parts most challenged your beliefs and/or experiences?

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CHECKPOINTS

- ☑ HOW DO WE GET STUDENTS THINKING?
- ❑ HOW DO WE DO IT WITH REAL WORLD PROBLEMS?
- ❑ HOW DO WE DO IT WITH OPEN MIDDLE PROBLEMS?

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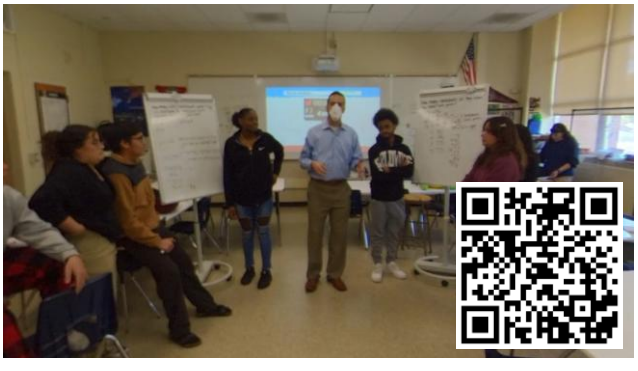

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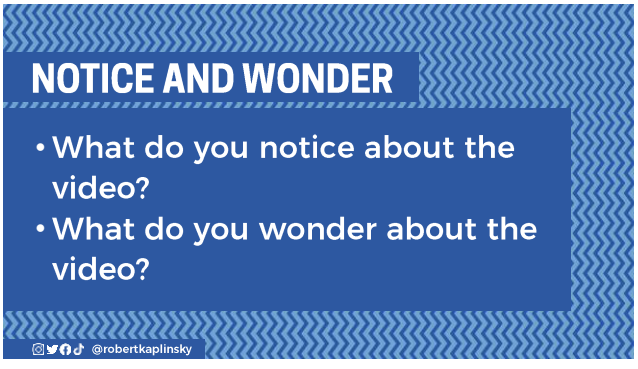

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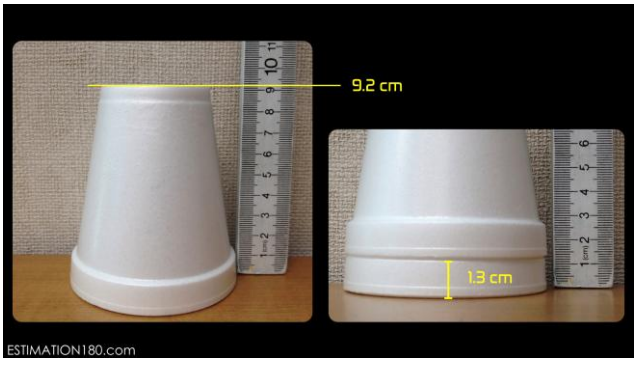

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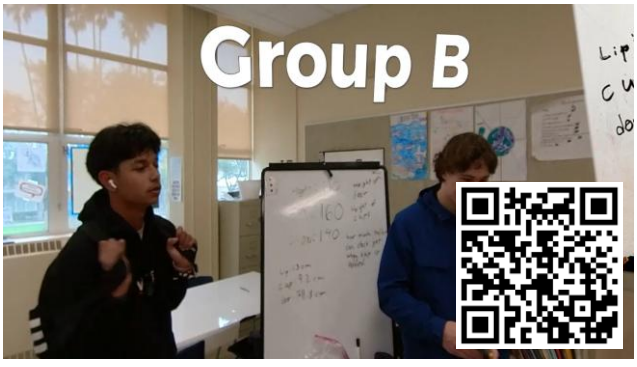

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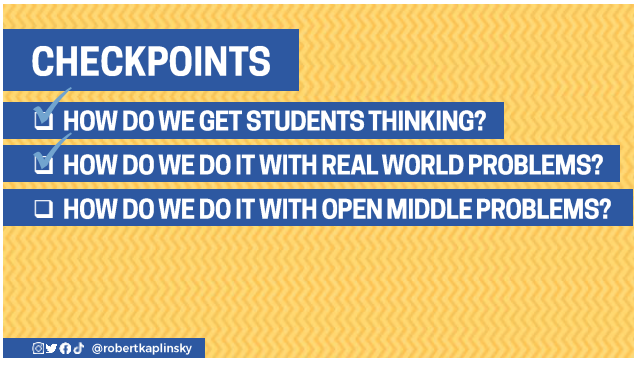

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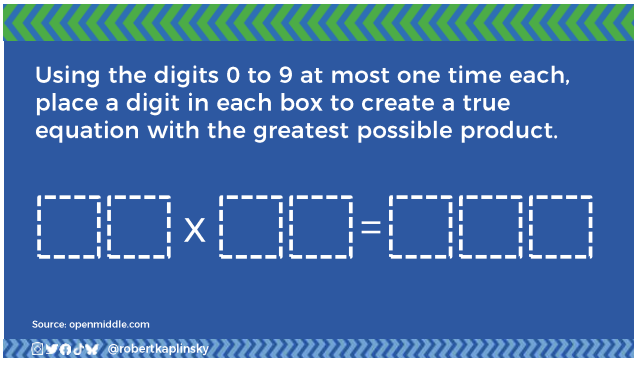

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DISCUSSION TIME

- Share with your neighbor(s) how you each solved the problem.
- What other correct and incorrect strategies might students use?

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PARTS OF A MATH PROBLEM

- Beginning
- Middle
- End

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Correct	Concerns
•	•
•	•
•	•
•	•
•	•

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Correct	Concerns
• Guess and check without conceptual understanding	

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111

Using the digits 0 to 9 at most one time each, place a digit in each box to create a true equation with the greatest possible product.

$$\square\square \times \square\square = \square\square\square$$

Source: openmiddle.com

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112

Correct

- Guess and check without conceptual understanding
- Guess and check with conceptual understanding

Concerns

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113

Using the digits 0 to 9 at most one time each, place a digit in each box to create a true equation with the greatest possible product.

$$\square\square \times \square\square = 9\square\square$$

Source: openmiddle.com

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114

Using the digits 0 to 9 at most one time each, place a digit in each box to create a true equation with the greatest possible product.

$$0\square \times \square 5 = \square\square 8$$

Source: openmiddle.com

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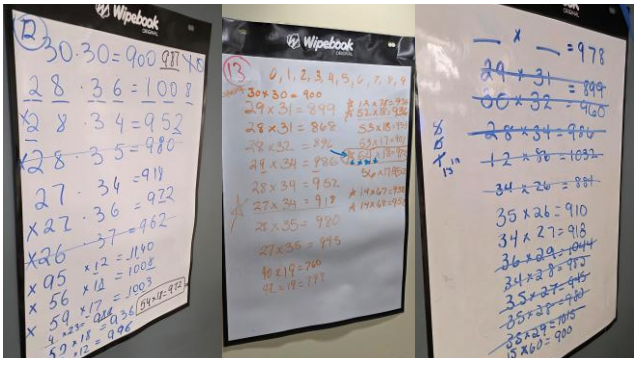
115



116

Correct

- Guess and check without conceptual understanding
- Guess and check with conceptual understanding
- Division

Concerns

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117

987 ÷ 53
987 ÷ 52
987 ÷ 51
987 ÷ 50
987 ÷ 49

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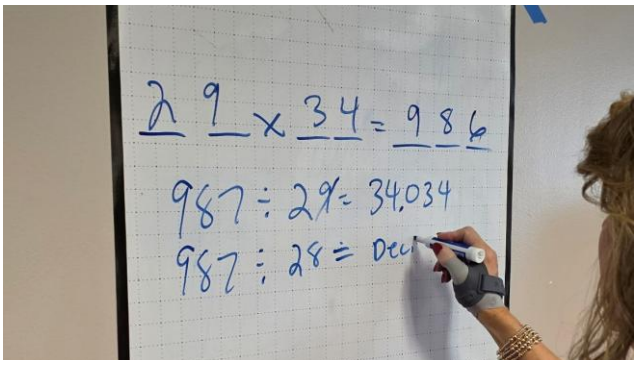
118



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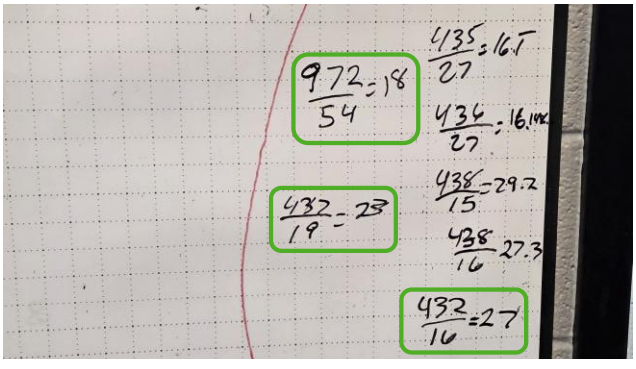

120

Correct

- Guess and check without conceptual understanding
- Guess and check with conceptual understanding
- Division
- Giant times table

Concerns

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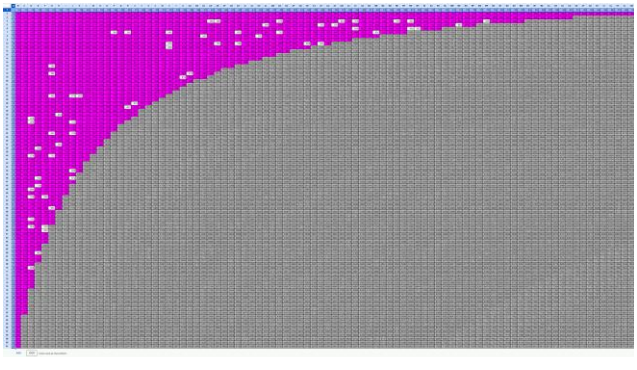
121



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930
936
938
952
972

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123

Correct

- Guess and check without conceptual understanding
- Guess and check with conceptual understanding
- Division
- Giant times table
- Prime factorization

Concerns

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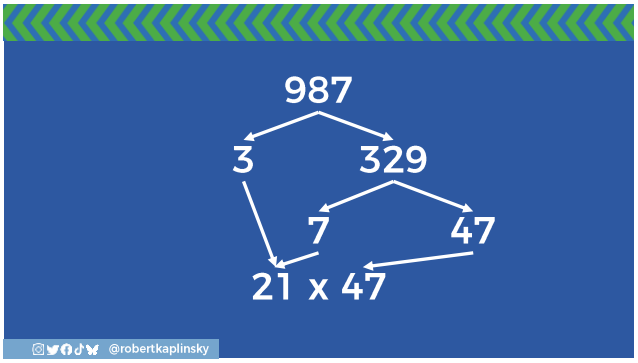
124



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Using the digits 0 to 9 at most one time each, place a digit in each box to create a true equation with the greatest possible product.

$$\square\square \times \square\square = \square\square\square$$

Source: openmiddle.com

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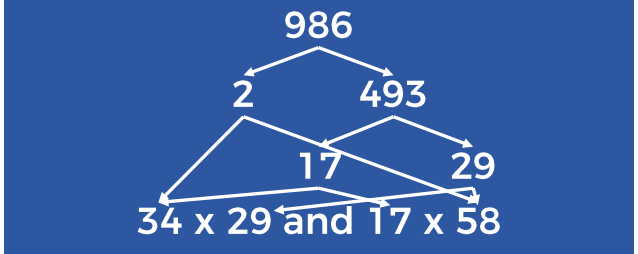

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Using the digits 0 to 9 at most one time each, place a digit in each box to create a true equation with the greatest possible product.

$$34 \times 29 = 986$$

Source: openmiddle.com

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128

Using the digits 0 to 9 at most one time each, place a digit in each box to create a true equation with the greatest possible product.

$$17 \times 58 = 986$$

Source: openmiddle.com

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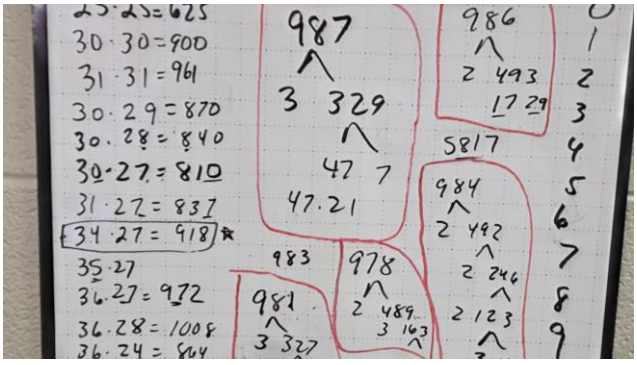

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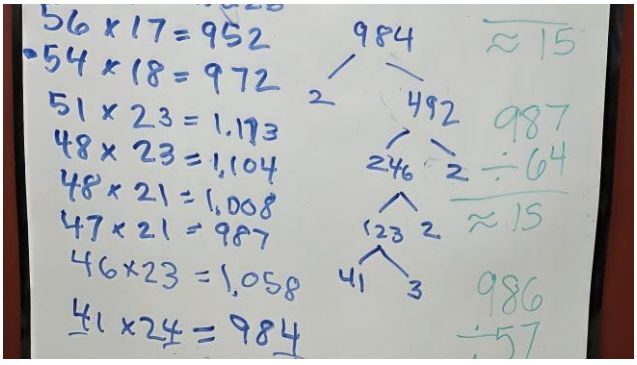

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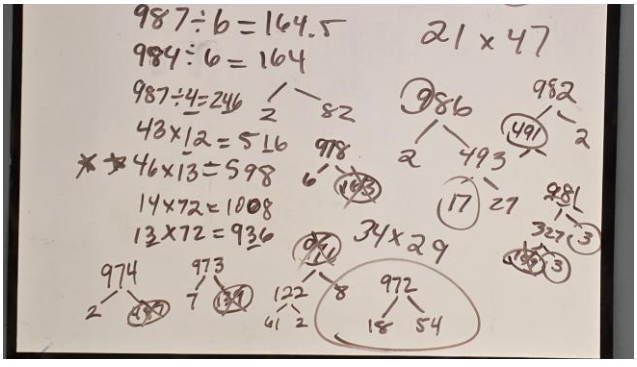

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Correct

- Guess and check without conceptual understanding
- Guess and check with conceptual understanding
- Division
- Giant times table
- Prime factorization
- Strategic brute force with calculator

Concerns

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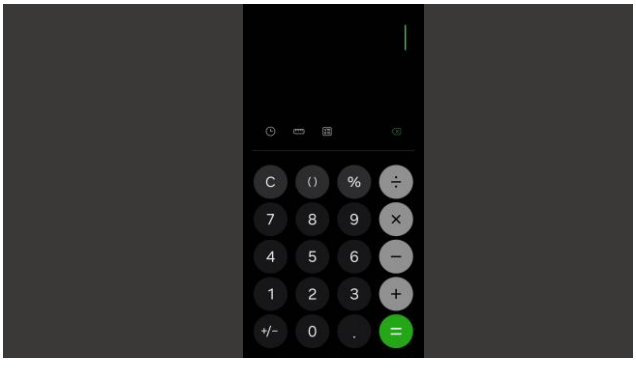
133



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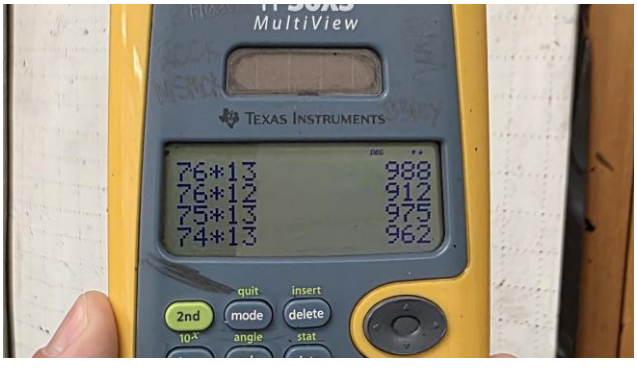

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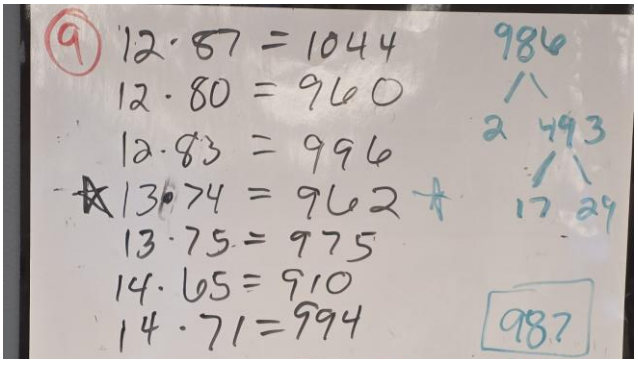

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Correct

- Guess and check without conceptual understanding
- Guess and check with conceptual understanding
- Division
- Giant times table
- Prime factorization
- Strategic brute force with calculator
- Brute force with coding

Concerns

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```
results = []

for a in range(10, 100):        # factor 1 (10 to 99)
    for b in range(10, 100):    # factor 2 (10 to 99)
        product = a * b         # multiply them
        if product < 1000:      # keep 999 or less
            results.append((a, b, product))
```

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	A	B	C
1	Factor	Factor	Product
2	10	10	100
3	10	11	110
4	10	12	120
5	10	13	130
6	10	14	140
7	10	15	150
8	10	16	160
9	10	17	170
10	10	18	180
11	10	19	190
12	10	20	200
13	10	21	210
14	10	22	220
15	10	23	230
16	10	24	240
17	10	25	250
18	10	26	260
19	10	27	270
20	10	28	280
21	10	29	290
22	10	30	300
23	10	31	310
24	10	32	320
25	10	33	330
26	10	34	340

139

	A	B	C
1	Factor	Factor	Product
2	27	37	999
3	37	27	999
4	12	83	996
5	83	12	996
6	14	71	994
7	71	14	994
8	16	62	992
9	31	32	992
10	32	31	992
11	62	16	992
12	10	99	990
13	11	90	990
14	15	66	990
15	18	55	990
16	22	45	990
17	30	33	990
18	33	30	990
19	45	22	990
20	55	18	990
21	66	15	990
22	90	11	990
23	99	10	990
24	23	43	989
25	43	23	989
26	13	76	988

140

	A	B	C
1	Factor	Factor	Product
2	27	37	999
3	37	27	999
4	12	83	996
5	83	12	996
6	14	71	994
7	71	14	994
8	16	62	992
9	31	32	992
10	32	31	992
11	62	16	992
12	10	99	990
13	11	90	990
14	15	66	990
15	18	55	990
16	22	45	990
17	30	33	990
18	33	30	990
19	45	22	990
20	55	18	990
21	66	15	990
22	90	11	990
23	99	10	990
24	23	43	989
25	43	23	989
26	13	76	988

141

Correct

- Guess and check without conceptual understanding
- Guess and check with conceptual understanding
- Division
- Giant times table
- Prime factorization
- Strategic brute force with calculator
- Brute force with coding

Concerns

- Math issues
  - Students struggle with two-digit multiplication

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Correct

- Guess and check without conceptual understanding
- Guess and check with conceptual understanding
- Division
- Giant times table
- Prime factorization
- Strategic brute force with calculator
- Brute force with coding

Concerns

- Math issues
  - Students struggle with two-digit multiplication
  - Students lack place value conceptual understanding

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144

Using the digits 0 to 9 at most one time each, place a digit in each box to create a true equation with the greatest possible product.

9 8 x 7 6 = ☐ ☐ ☐

Source: openmiddle.com

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Correct

- Guess and check without conceptual understanding
- Guess and check with conceptual understanding
- Division
- Giant times table
- Prime factorization
- Strategic brute force with calculator
- Brute force with coding

Concerns

- Math issues
  - Students struggle with two-digit multiplication
  - Students lack place value conceptual understanding
  - Students don't understand what a true equation is

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146

Using the digits 0 to 9 at most one time each, place a digit in each box to create a true equation with the greatest possible product.

6 5 x 4 3 = 9 8 7

Source: openmiddle.com

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147

Correct

- Guess and check without conceptual understanding
- Guess and check with conceptual understanding
- Division
- Giant times table
- Prime factorization
- Strategic brute force with calculator
- Brute force with coding

Concerns

- Math issues
  - Students struggle with two-digit multiplication
  - Students lack place value conceptual understanding
  - Students don't understand what a true equation is
- Open Middle issues
  - Students use a digit more than once.

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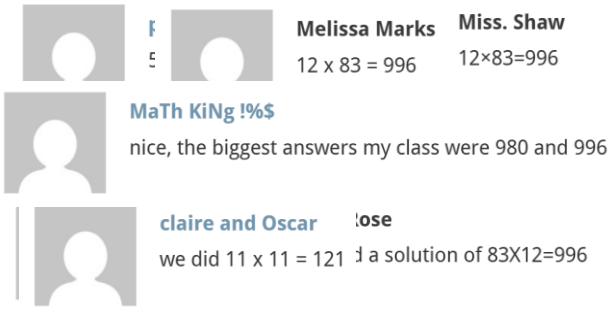
148



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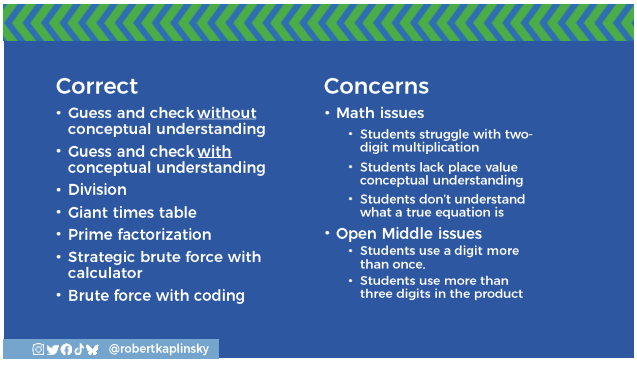

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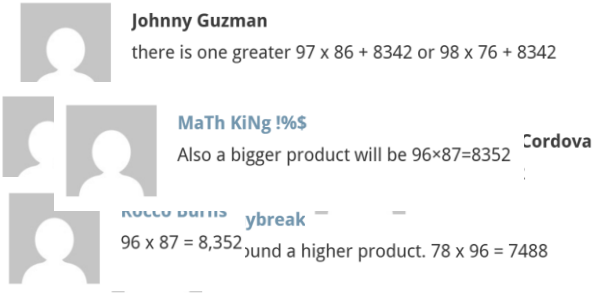

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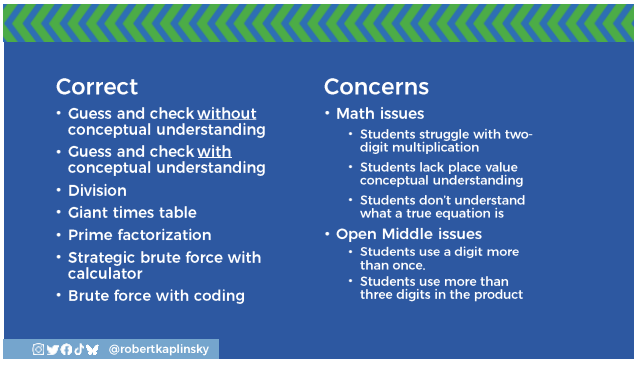

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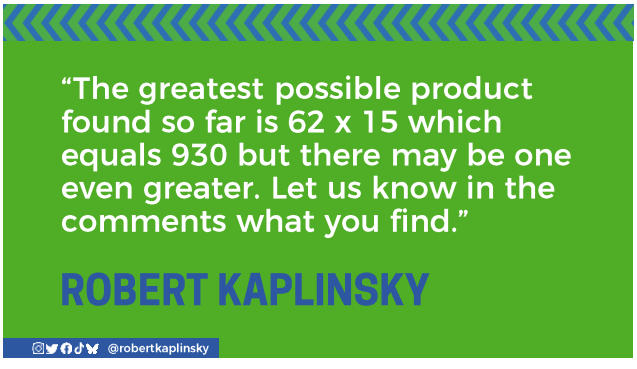

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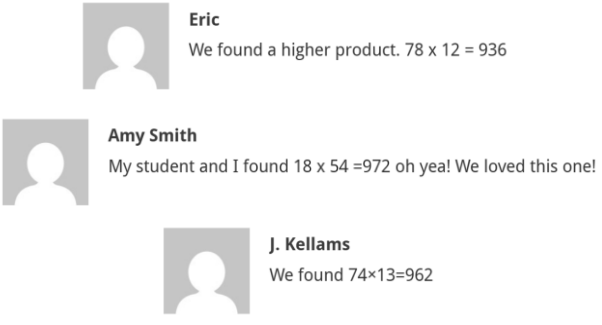

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DISCUSSION TIME

- Which strategy (other than the one you used) did you like most?
- How does spending time anticipating both correct and incorrect strategies impact your ability to facilitate the lesson?

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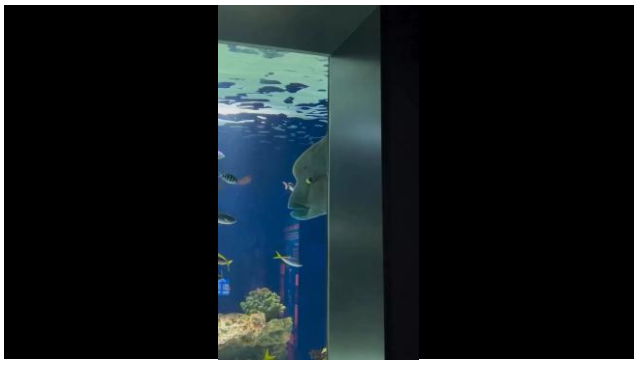

156

When the cook tastes the soup, that's formative; when the guests taste the soup, that's summative.

BOB STAKE

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157

less understanding ← → more understanding

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more understanding ≠ correct answer

less understanding ≠ incorrect answer

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159

$$\frac{3}{4} \div \frac{1}{2}$$

$$\frac{3}{4} \times \frac{2}{1} = \frac{6}{4}$$

$$\frac{3}{2} = 1\frac{1}{2}$$

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Why???

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$$3\overline{)4}\quad 1\frac{1}{3}$$

$$-3$$

$$1$$

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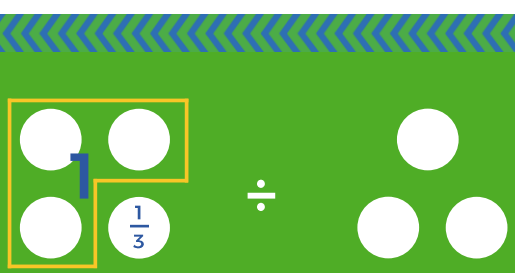

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163

$$\frac{3}{4} \div \frac{1}{2}$$

$$\frac{3}{4} \times \frac{2}{1} = \frac{6}{4}$$

$$\frac{3}{2} = 1\frac{1}{2}$$

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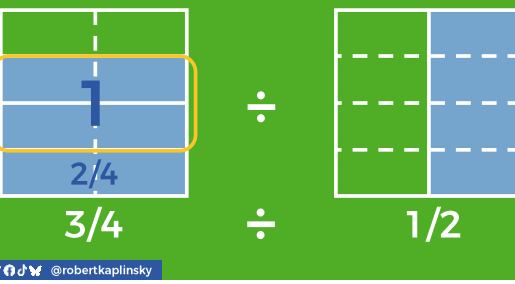

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more understanding ≠ correct answer

less understanding ≠ incorrect answer

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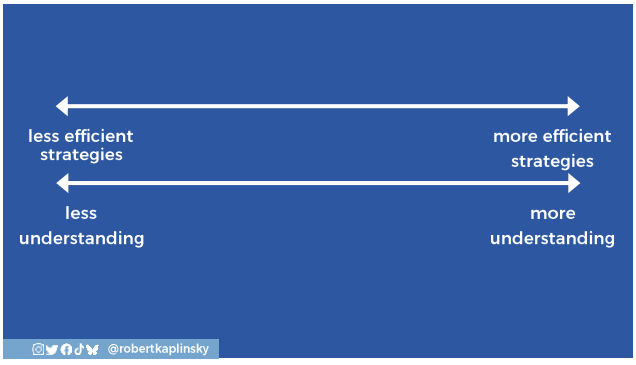

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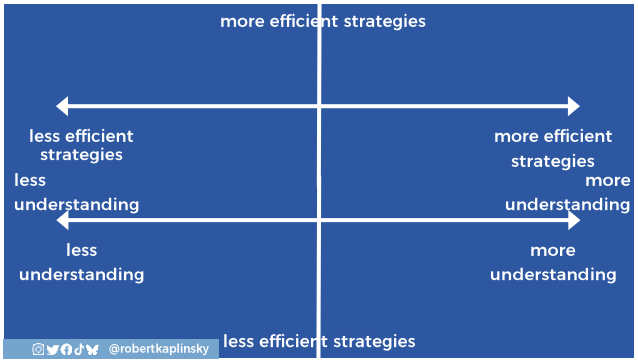

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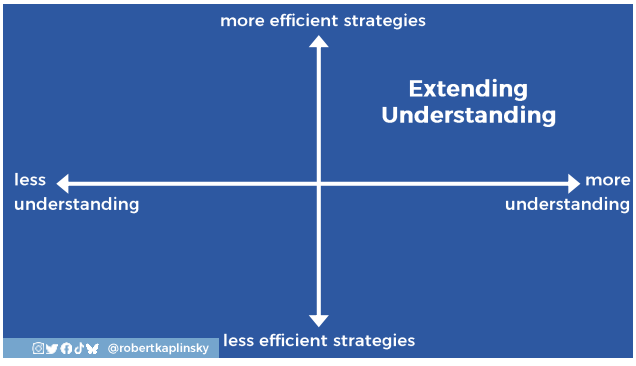

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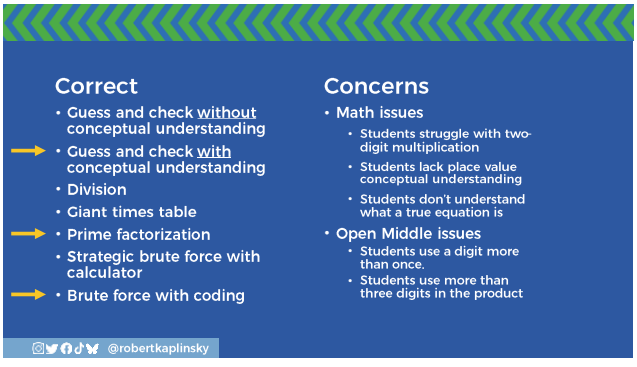

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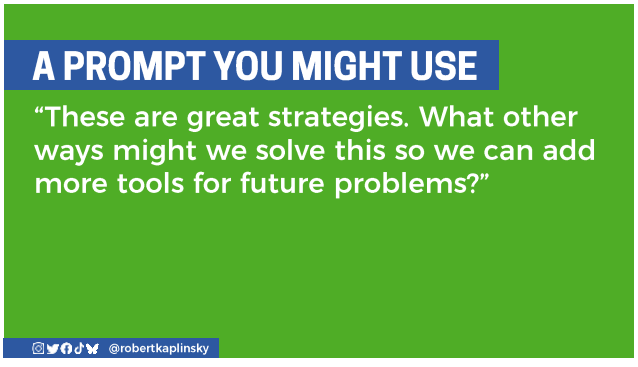

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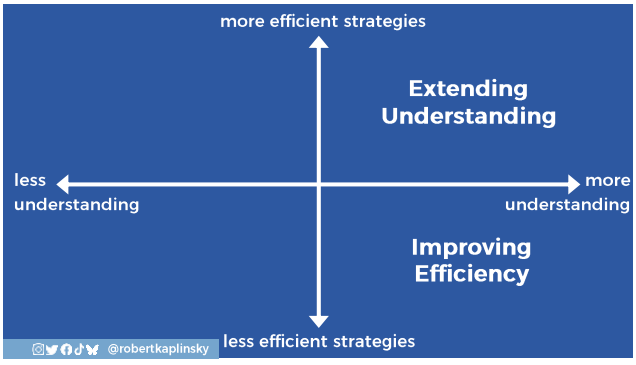

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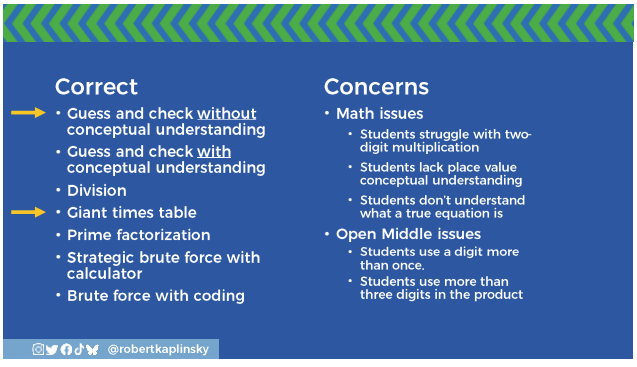

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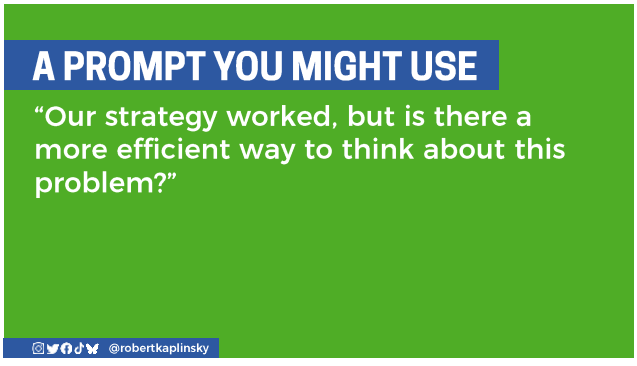

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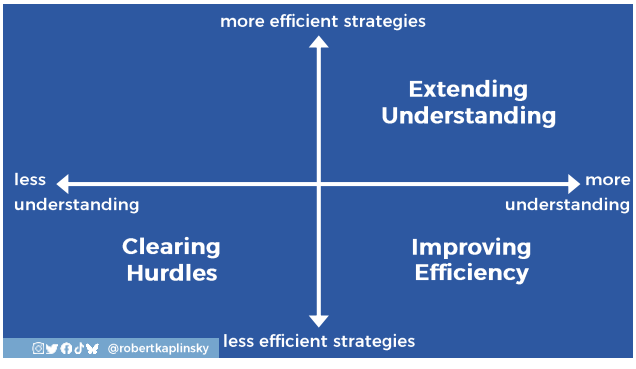

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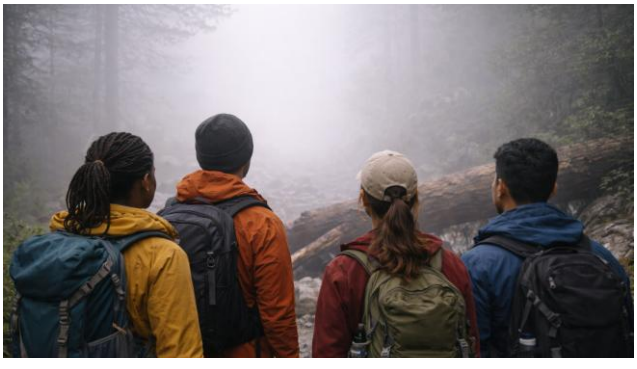

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Correct	Concerns

• Guess and check without conceptual understanding	• Math issues
	  • Students struggle with two-digit multiplication
	  • Students lack place value conceptual understanding
	  • Students don't understand what a true equation is

• Guess and check with conceptual understanding	
• Division	
• Giant times table	

• Prime factorization	• Open Middle issues
	  • Students use a digit more than once.
	  • Students use more than three digits in the product

• Strategic brute force with calculator	
• Brute force with coding	

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MY FAVORITE NO

- Pick a math error
- Share it with the class
- Ask "What in this problem am I happy to see?"
- Ask "Where's the mistake?"

Source: Leah Alcala

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A PROMPT YOU MIGHT USE

"Just like in a video game, everyone makes mistakes at first. What matters is learning from them so we do not repeat them and can go farther next time. Which mistake feels most useful to learn from?"

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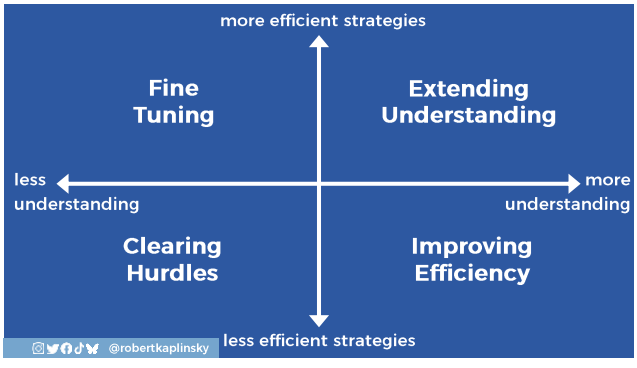

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192

Correct	Concerns

• Guess and check without conceptual understanding	• Math issues
	  • Students struggle with two-digit multiplication
	  • Students lack place value conceptual understanding
	  • Students don't understand what a true equation is

• Guess and check with conceptual understanding	
• Division	
• Giant times table	

• Prime factorization	• Open Middle issues
	  • Students use a digit more than once.
	  • Students use more than three digits in the product

• Strategic brute force with calculator	
• Brute force with coding	

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A PROMPT YOU MIGHT USE

"What about this problem makes this strategy work?"

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DISCUSSION TIME

- How can students get correct answers yet still have less understanding?
- How does viewing students' work through the quadrant structure make it easier to handle most outcomes?

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TOPICS

- [x] HOW SHOULD WE MEASURE A LESSON'S SUCCESS?
- [x] WHAT'S AN EXAMPLE WE CAN EXPLORE?
- [x] WHAT ARE OUR FACILITATING OPTIONS?
- [ ] WHAT DOES THIS LOOK LIKE IN ACTION?
- [ ] CONCLUSION

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DISCUSSION TIME

- What's something you already believed that was reinforced after watching the videos?
- What's something that was different than you expected after watching the videos?

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202

Using the digits 1 to 9 at most one time each, place a digit in each box to make the greatest possible sum.

9 ☐ + ☐ 6 =

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203

Using the digits 1 to 9 at most one time each, place a digit in each box to make the least possible difference.

☐☐ − ☐☐

Source: openmiddle.com

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205

What advice would you give yourself if you were trying this problem again for the first time?

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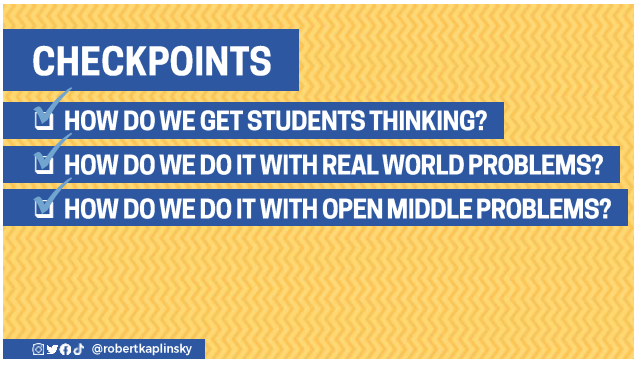

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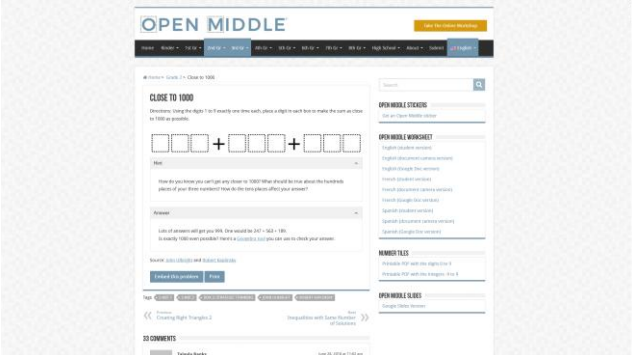

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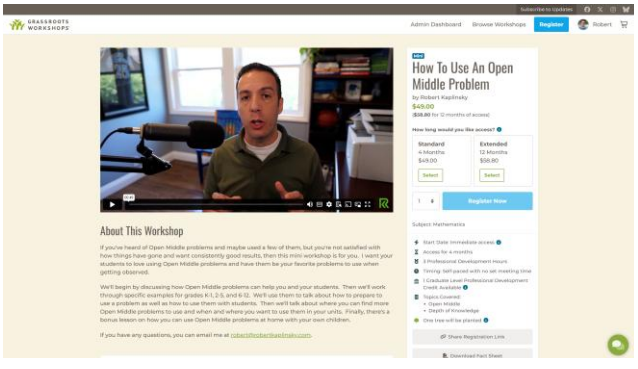

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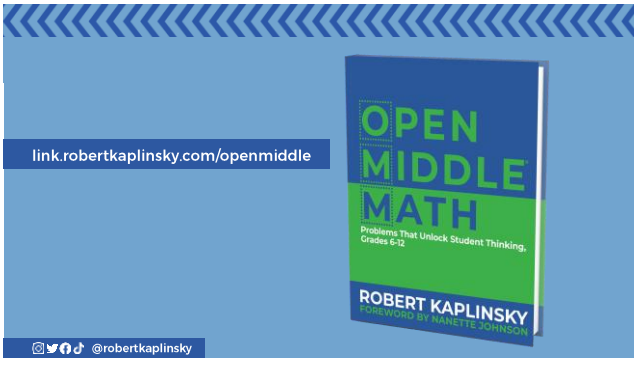

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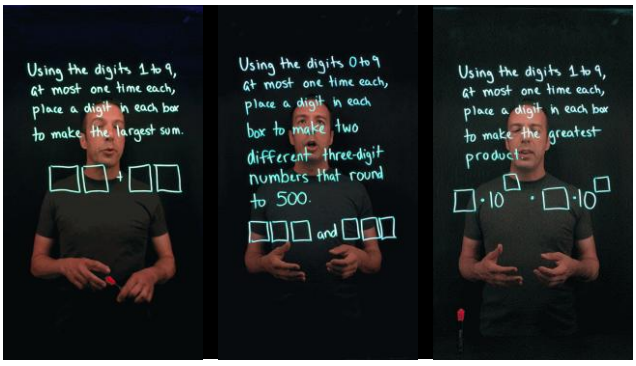

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