Deborah Loewenberg Ball

Camp Michigania Faculty Forum

Thursday, June 30, 2016

(HOW) CAN AMERICANS BE GOOD AT MATH?

SCHOOL OF EDUCATION
UNIVERSITY OF MICHIGAN

KNOWING MATHEMATICS

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

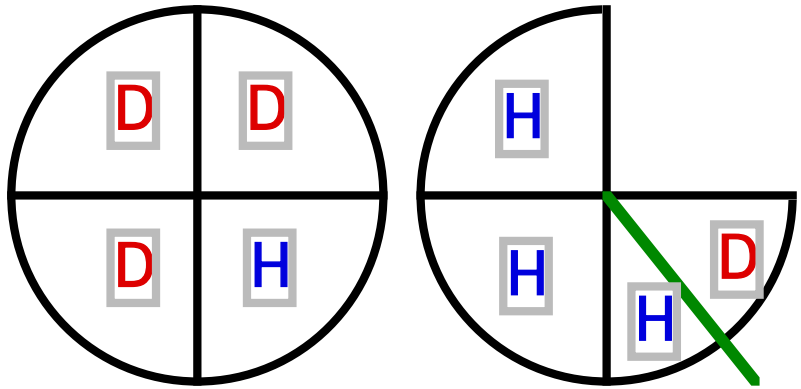
EDUCATION

KNOWING MATH FOR TEACHING
WRITE A STORY OR DRAW A REPRESENTATION

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

EDUCATION

I have two pizzas. My friend eats one quarter of one of the pizzas. I have one and three quarters pizzas left. Then I split it evenly between two of my other friends. Each person gets three and a half pieces of pizza.

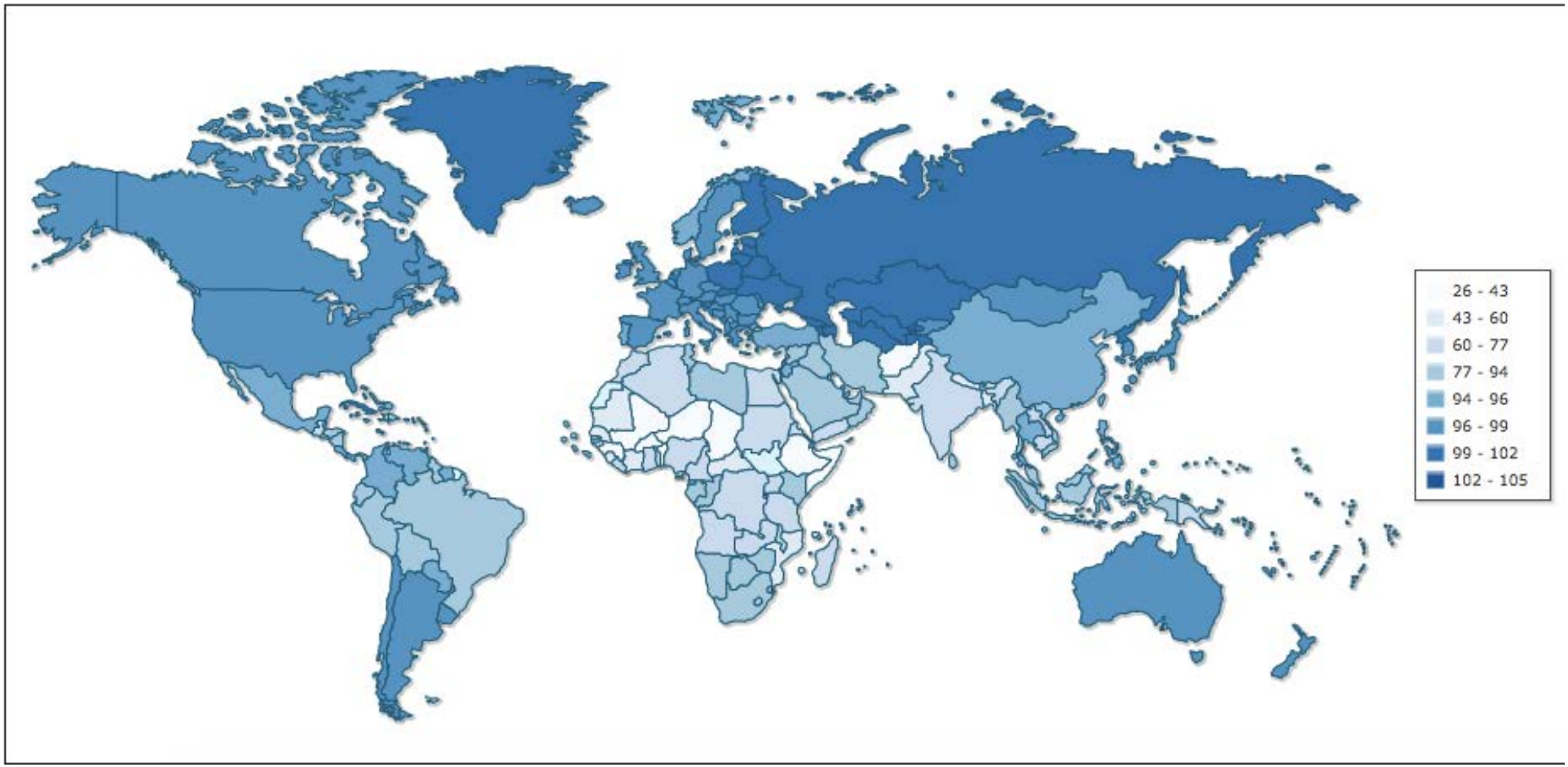


1. What is wrong with this?
2. Write a story problem that correctly represents the division.

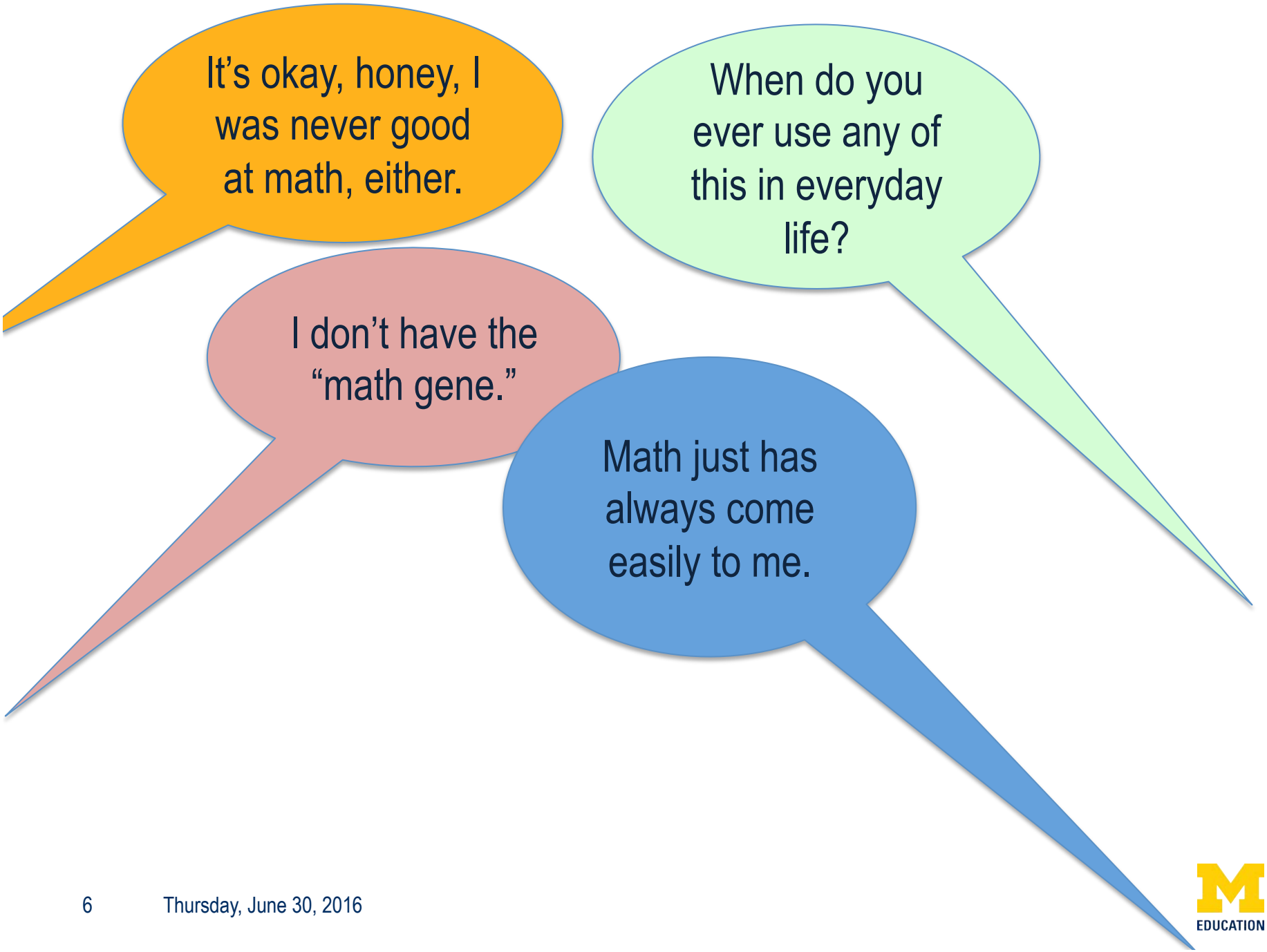
EDUCATION

LITERACY RATES IN INTERNATIONAL PERSPECTIVE

- http://www.indexmundi.com/map/?v=39



EDUCATION



EDUCATION

Write an equation using the variables S and P to represent the following statement: "**There are six times as many students as professors at this university**." Use S for the number of students and P for the number of professors.

About 1/3 to ½ of educated adults write: 6S =P

Clement, Lochhead, and Monk, 1981

EDUCATION

An army bus holds 36 soldiers. If 1128 soldiers are being bussed to their training site, how many buses are needed?

a) 32
b) 31 R 12
c) 31.333…
d) 31

National Assessment of Educational Progress, 1981

EDUCATION

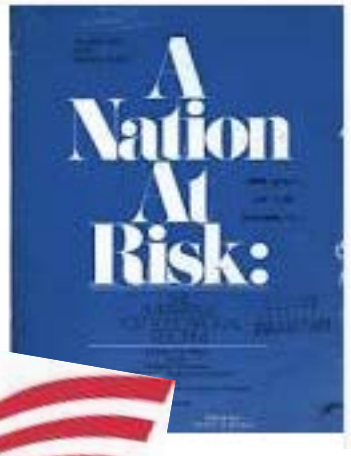
WHAT DOES IT MEAN TO BE "LITERATE"?

- Reading and writing?
  - Decode text and interpret meaning of texts, fiction, expository, informational
  - Many methods for determining the reading difficulty of texts
- Mathematics?

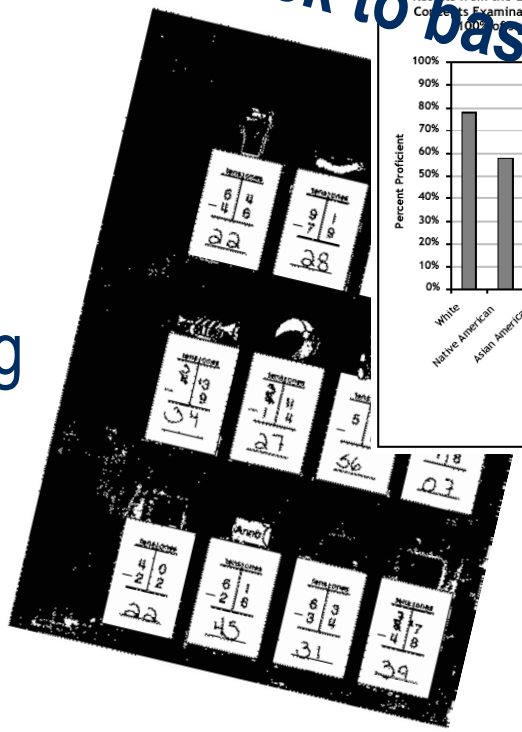
EDUCATION

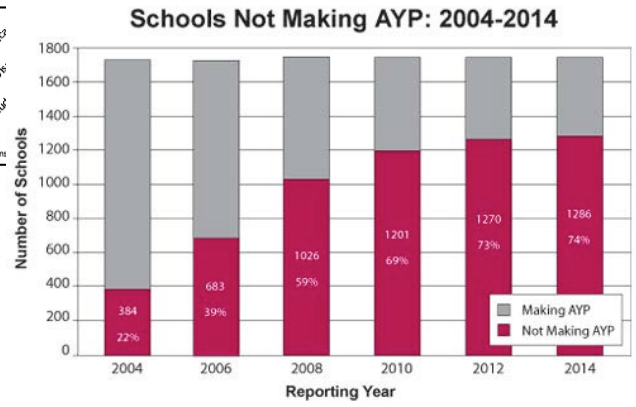
REFORM—AGAIN AND AGAIN AND . . .

- The U.S. has a long history of trying to "fix" education
- And an almost equally long history of failing to do so



Back to basics





The "New Math"

EDUCATION

WHAT WOULD IT TAKE TO BE DIFFERENT THIS TIME? AND TO MAKE US A NATION OF MATHEMATICALLY LITERATE PEOPLE?

1. We would have to develop a reasonably shared view of **what it means to be mathematically literate**.
2. We would need to not skip over teaching, and work deliberately to ensure that teachers have sufficient **specialized mathematical knowledge for teaching**.
3. Outside of school, we would **play with children with quantities, chance, and space**, much like we do with language.

EDUCATION

BEING MATHEMATICALLY LITERATE INVOLVES BEING ABLE TO . . .

- Deploy mathematical skill and understanding
- Frame and solve problems involving quantity, space, and probability
- Interpret and reason about quantitative, probabilistic, and spatial information and situations
- Use mathematical language, symbols, and representations to communicate about mathematical ideas
- Think with and use data

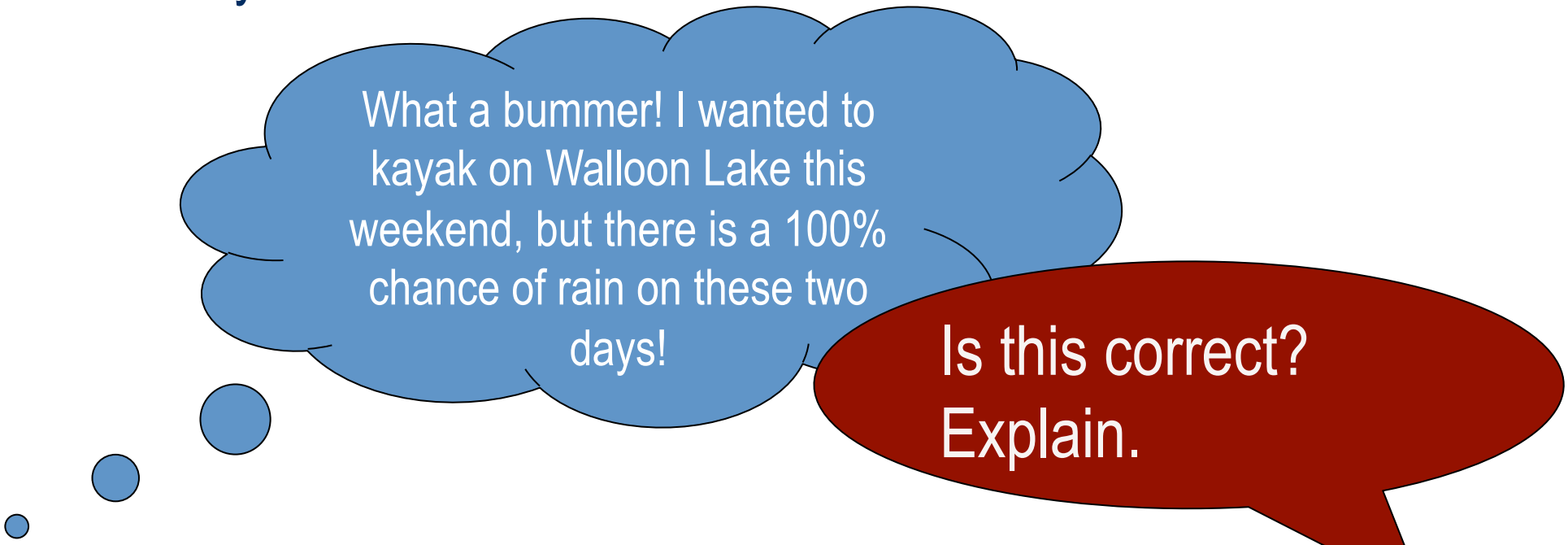
EDUCATION

WHAT IS THE CHANCE OF RAIN?

Weather forecast:

Thursday: 50% chance of rain

Friday: 50% chance of rain



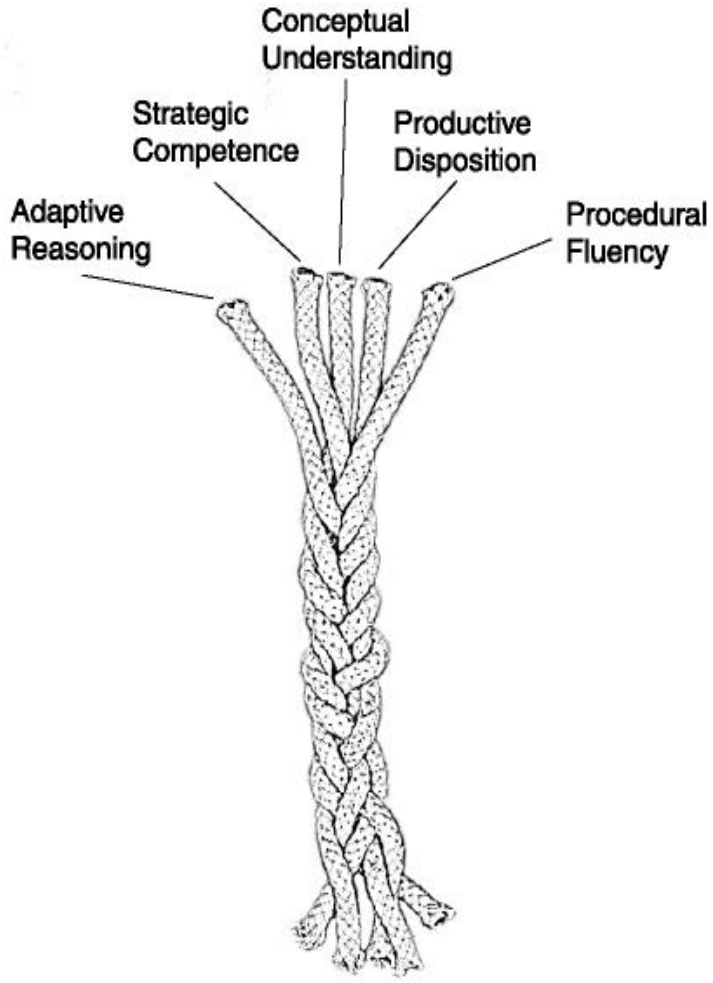
EDUCATION

WHAT IS THE CHANCE OF RAIN ON THE WEEKEND?

EDUCATION

MATHEMATICAL PROFICIENCY

- Procedural fluency
- Conceptual understanding
- Adaptive reasoning
- Strategic competence
- Productive disposition



Kilpatrick, Swafford, & Findell, (2001). *Adding It Up*, National Research Council.

EDUCATION

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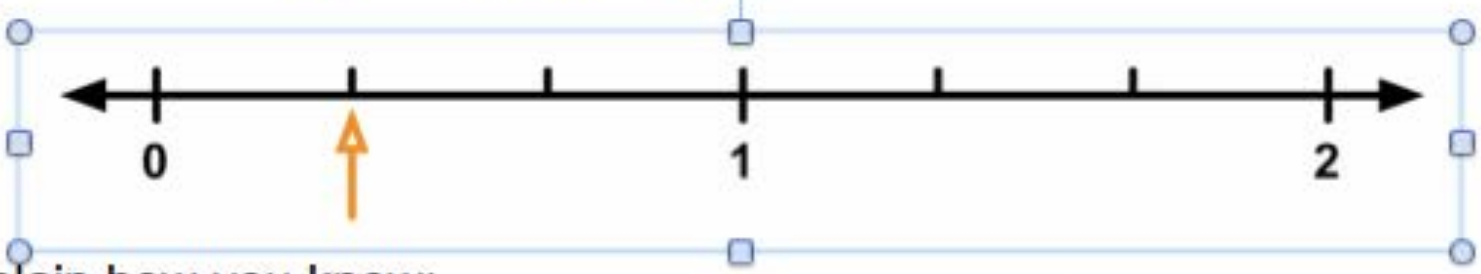
EDUCATION

TASK

What number does the orange arrow point to? _____



Explain how you know: _____

_____

_____

_____

_____

EDUCATION

VIDEO: WHAT DO YOU SEE AND HEAR ABOUT ANIYAH AND TONI IN THIS SHORT CLIP?

This video and additional supporting materials are available online here.

EDUCATION

WHAT DO PEOPLE TYPICALLY SEE?

ANIYAH

- Wrong answer, not identifying the correct whole

TONI

- Giggling while talking
- Playing with her hair

EDUCATION

WHAT STRENGTHS DO YOU SEE?

ANIYAH

- Her presentation skills
- Production of a mathematically well-structured explanation
- Knowing the definition for a fraction, which she uses carefully

TONI

- Her careful attention to another child's thinking
- Her skill in asking a perfectly posed question about Aniyah's reasoning

EDUCATION

COMMON CONTENT KNOWLEDGE (CCK)

Calculate:

$$\frac{5}{6} \div \frac{1}{3}$$

EDUCATION

SPECIALIZED CONTENT KNOWLEDGE (SCK)

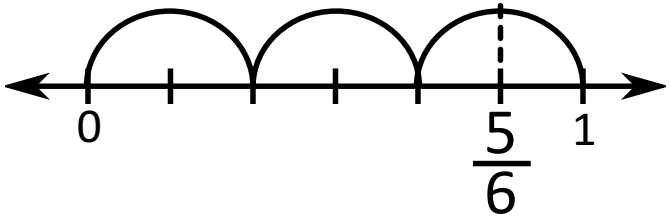
$$\frac{5}{6} \div \frac{1}{3} = \frac{10}{12} \div \frac{4}{12} = 10 \div 4 = 2\frac{1}{2}$$

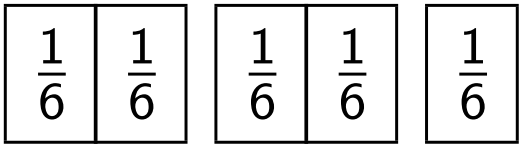
Is this a fluke?
Does it work in general?
If so, why does it work?

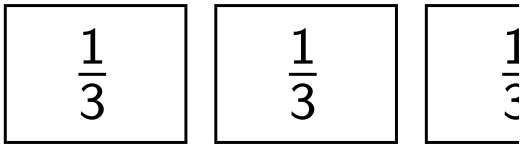
EDUCATION

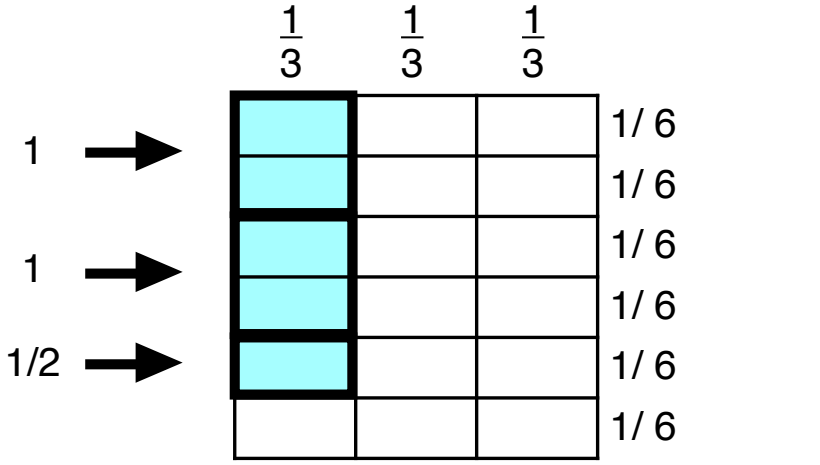
SPECIALIZED CONTENT KNOWLEDGE (SCK)

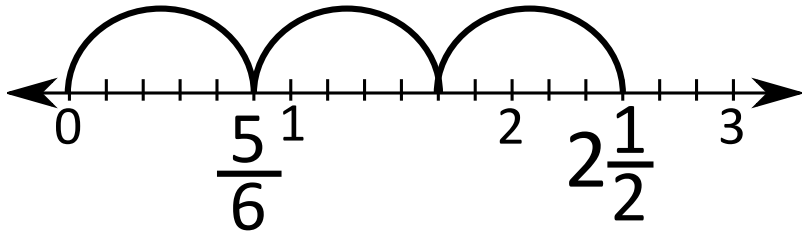
Which of these can be used to represent $\frac{5}{6} \div \frac{1}{3}$?











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EDUCATION

LISTENING AND WATCHING CHILDREN IN EVERYDAY LIFE—LOTS OF MATH TO OVERHEAR, NOTICE, AND BUILD ON

- Negotiating games with friends
- Discussing age, speed, scores
- Assembling things
- Recording and creating systems for recording
- Packing things into a box
- Counting, measuring
- Proving things are more, less, taller, longer, shorter, etc.

EDUCATION

VIDEO: SAMI, AGE "FOUR AND THREE QUARTERS"

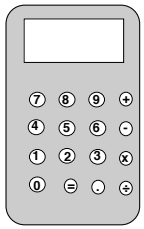
EDUCATION

MATHEMATICAL QUESTIONS GOOD FOR PARENTS AND GRANDPARENTS AS PLAY

- How old will you be next year at Michigania?
- How many forks do you think it would take to go end to end on our table?
- Could you buy more tootsie rolls or ring pops with $1?
- How many coffee cups of water does it take to fill your water bottle?
- Coin toss game for three players (heads, tails, mixed): is it a fair game?

EDUCATION

THE BROKEN CALCULATOR PROBLEM



Mitch's calculator is broken. The problem is that the 6 key doesn't work. If you type 6, it doesn't show anything in the display. Is his calculator useless now, or can Mitch figure out a way to use it to do any problems he wants?

EDUCATION

THE 8s PROBLEM

- Write as many 8s as you like. Insert plus signs so that the expression equals 1000.
- How many different equations can you write following this rule?
- What is your approach?
- Can you find all of them? How do you know?

EDUCATION

THE 8s PROBLEM

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There are exactly 14 solutions. Can you find them all and prove that there are no more?

EDUCATION

SOLUTIONS TO THE 8s PROBLEM

number of 888's	number of 88's	number of 8's	number of terms
0	0	125	125
1	0	14	15
0	1	114	115
1	1	3	5
	2	103	105
	3	92	95
	4	81	85
	5	70	75
	6	59	65
	7	48	55
	8	37	45
	9	26	35
	10	15	25
	11	4	15

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EDUCATION

THANK YOU!

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