HOW TO IMPLEMENT ENGAGING PROBLEM SOLVING IN YOUR MATH CLASSROOM

ROBERT KAPLINSKY

robert@robertkaplinsky.com

robertkaplinsky.com/engaging

@robertkaplinsky

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.

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

Source: Paolo Tolomeo on openmiddle.com

Name: _____ Date: _____

MULTIPLICATION PRACTICE

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

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*

Name: _____ Date: _____

MULTIPLICATION PRACTICE

66 x 23	49 x 72	52 x 44	26 x 35	18 x 87	63 x 55
31 x 48	77 x 47	92 x 69	37 x 15	82 x 53	24 x 56
45 x 37	79 x 39	85 x 21	13 x 23	28 x 35	19 x 47

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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DISCUSSION TIME

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

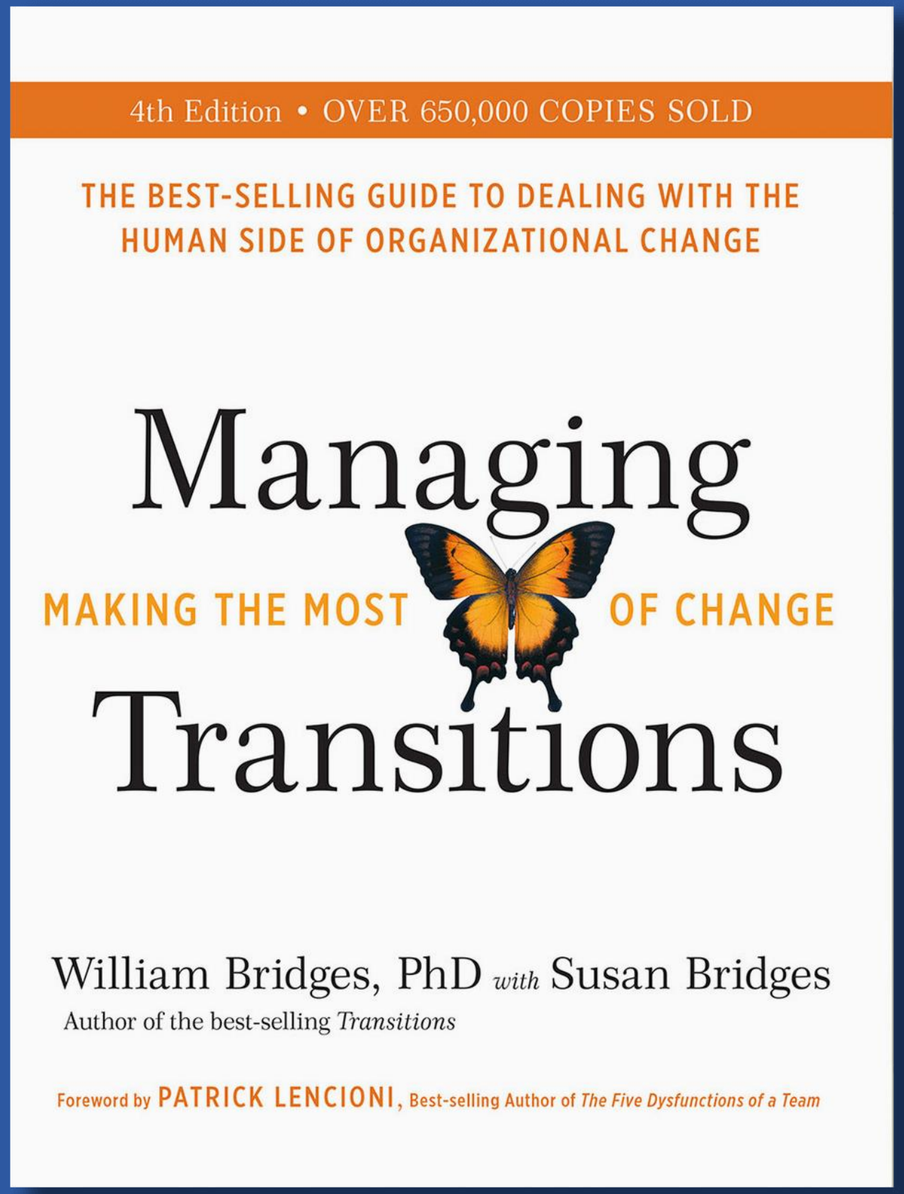
CHECKPOINTS

- ❑ WHY IS MATH EDUCATION BROKEN?
- ❑ HOW DO WE GET STUDENTS THINKING?
- ❑ HOW DO WE GET MORE PRACTICE?
- ❑ HOW DO WE DEAL WITH MISCONCEPTIONS?
- ❑ HOW DO WE GET MORE PRACTICE?

Source: World War Z

TOPICS

- ❑ WHAT IS THE PROBLEM?
- ❑ WHAT SHOULD THE GOAL BE?
- ❑ HOW DO WE ACHIEVE IT?
- ❑ HOW DO WE GET SUPPORT?



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DEFINING THE PROBLEM

1. What is the problem?
2. Who says so, and on what evidence?
3. What would occur if no one acted to solve this problem?
4. And what would happen to us if that occurred?

US math education is broken.

Adapted from Dan Meyer

DEFINING THE PROBLEM

1. What is the problem?
2. Who says so, and on what evidence?

- Community

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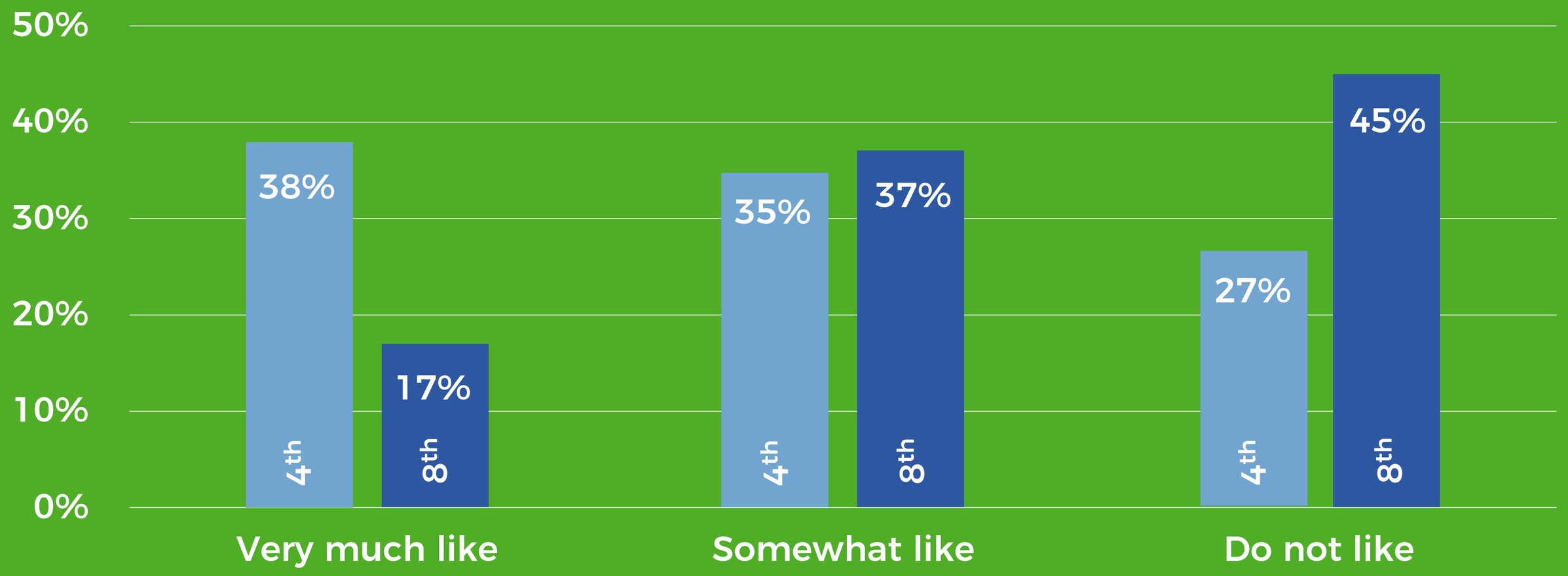
- Community
- Students

DO U.S. STUDENTS LIKE LEARNING MATH?



Source: Trends in International Mathematics and Science Study (TIMMS) 2019

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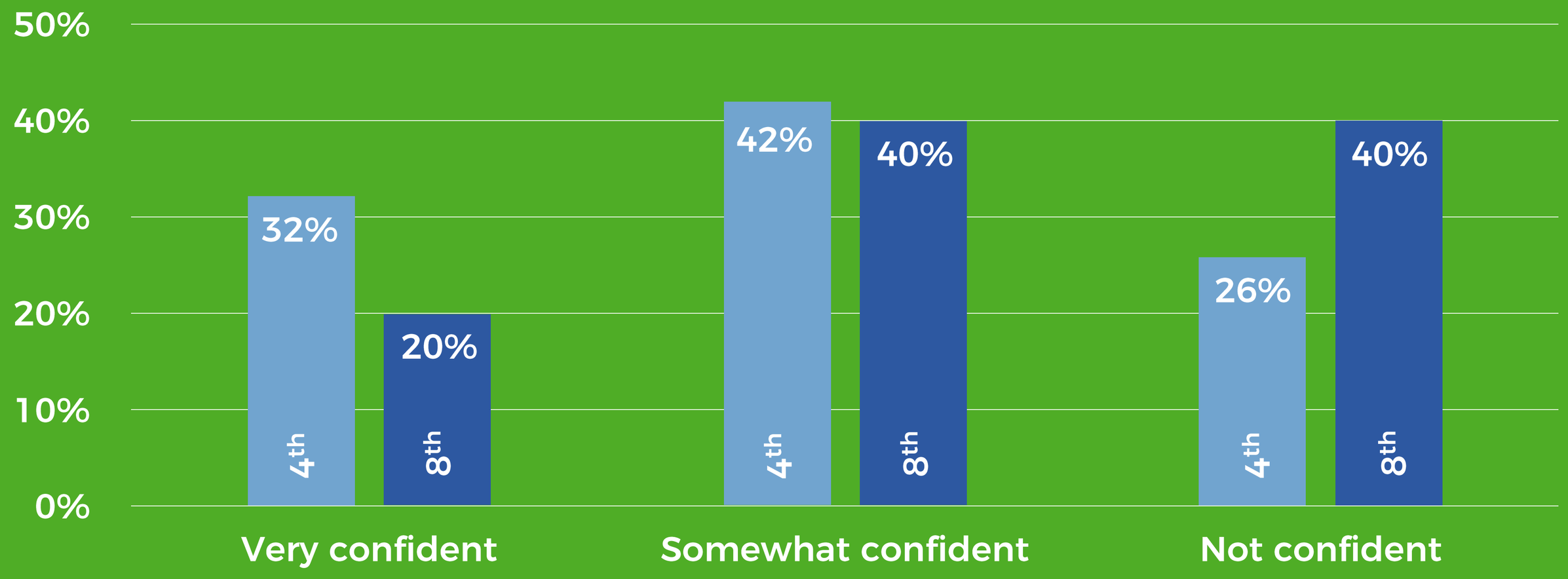
HOW CONFIDENT ARE U.S. MATH STUDENTS?



Source: Trends in International Mathematics and Science Study (TIMMS) 2019

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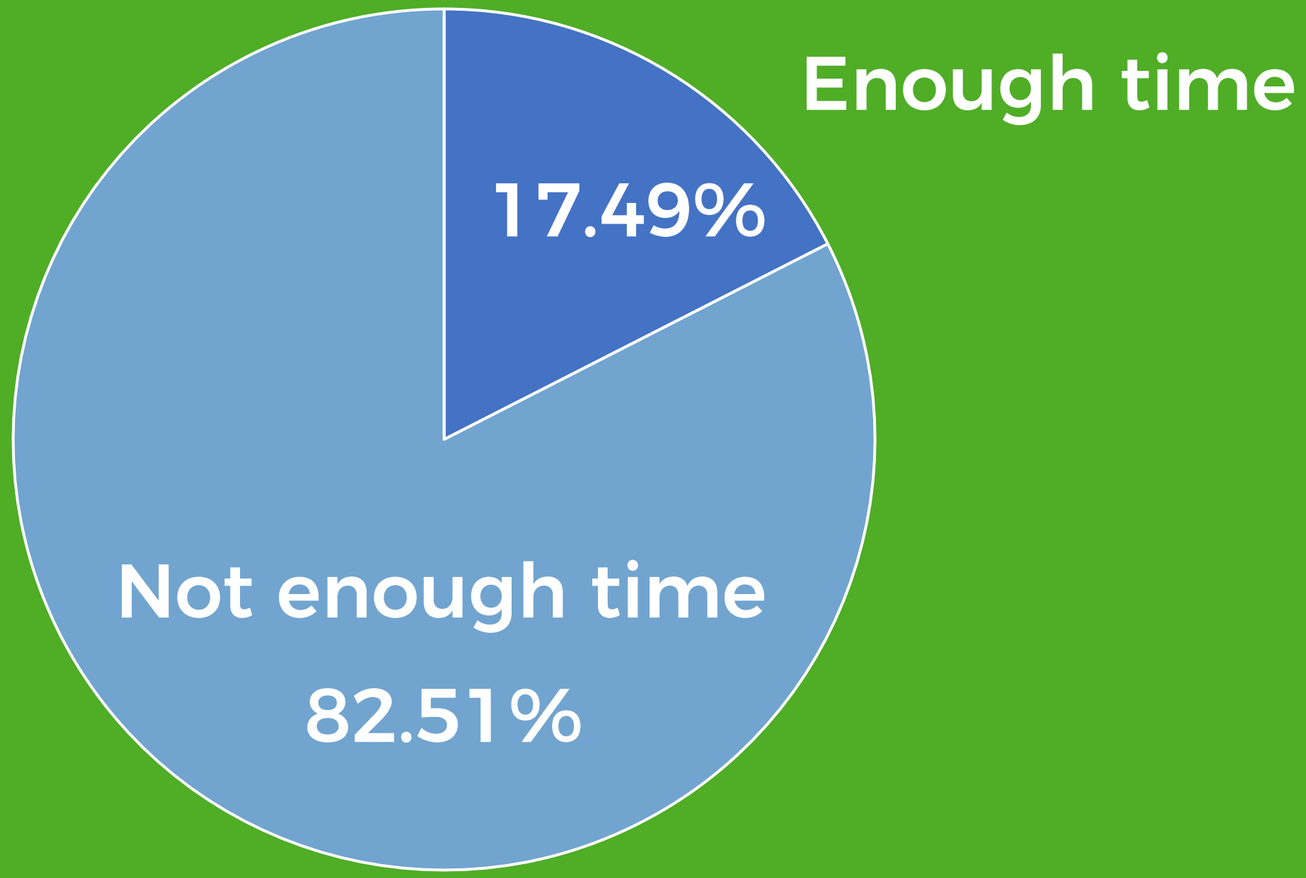
- Community
- Students
- Teachers

DO YOU HAVE ENOUGH TIME?



Source: Robert Kaplinsky online survey

RobertKaplinsky.com

Nick Corley
@MrCorleyMath

Replying to @robertkaplinsky

I used to have 42 min daily, now have 80 min daily. I can now cover all standards. #needmoretimeinmath

11:05 AM · Mar 24, 2017 · Twitter for iPhone

Josh Zagorski
@JZagorski1

Replying to @robertkaplinsky

yes 80 mins of math K-8 in our district

6:47 PM · Mar 25, 2017 · Twitter for Android

Zoe Rooney @positv_slope · Mar 27, 2017

@nc_teach I feel as though I have enough time over the year but not before the state test

1 1

Zoe Rooney
@positv_slope

Replying to @positv_slope @robertkaplinsky and @nc_teach

(This is with 90 minutes per day)

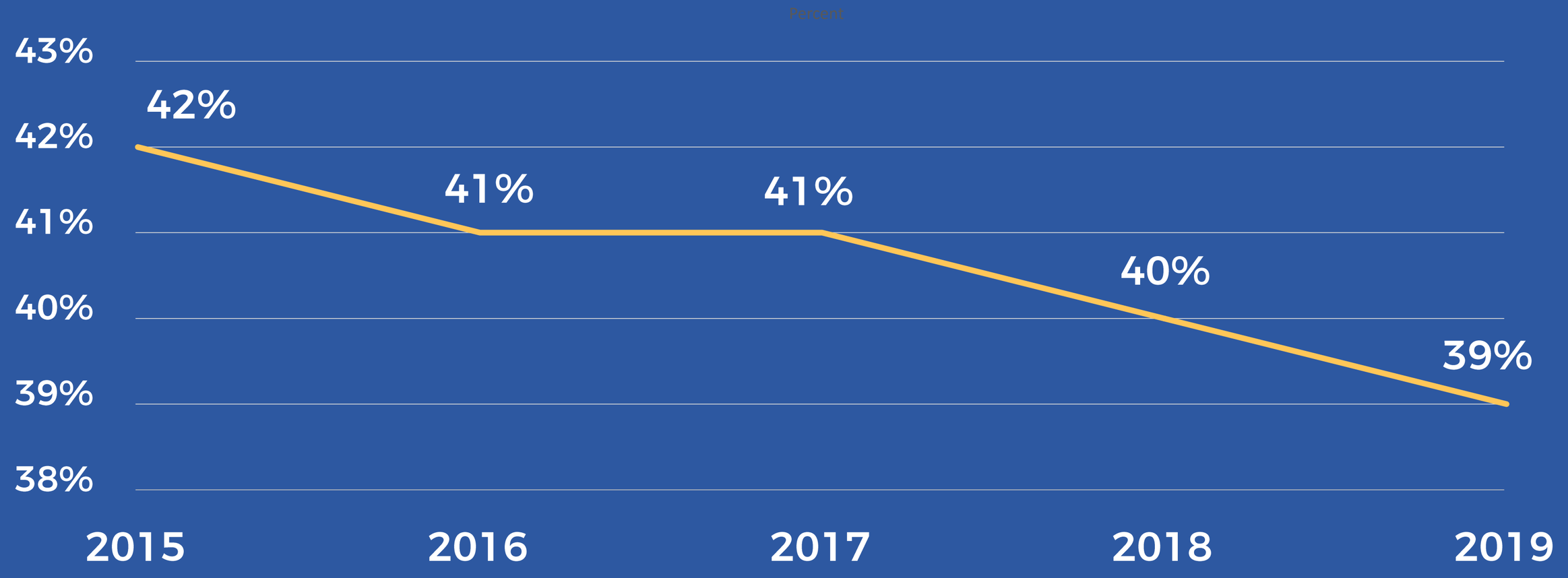
3:24 AM · Mar 27, 2017 · Twitter for iPhone

WHAT ARE THE IMPLICATIONS?

- Teachers are either not teaching all standards or don’t have enough time for students to learn them.
- Students will have gaps in their understanding.
- Future teachers will be challenged to do the same with students missing key skills.

- Community
- Students
- Teachers
- Universities

COLLEGE READINESS - MATHEMATICS



Source: ACT - *The Condition of College & Career Readiness* - 2019

WHAT DOES IT MEAN?

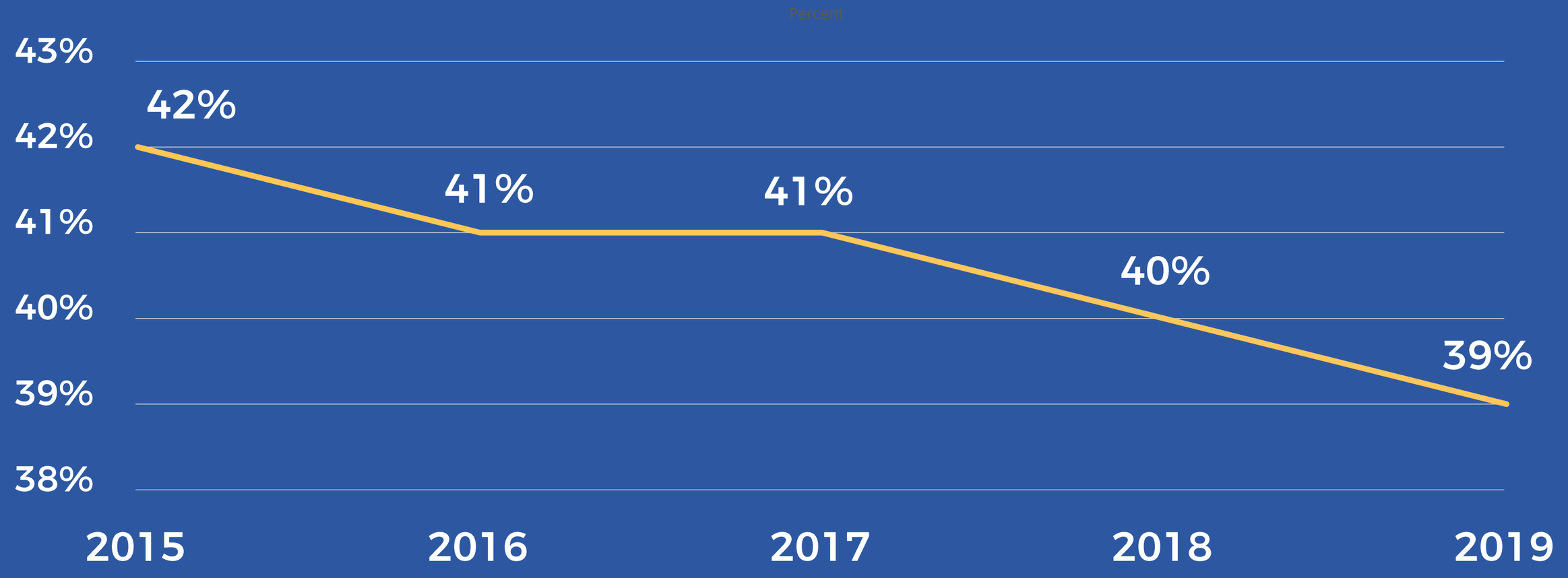
"[They] represent the level of achievement required for students to have a 50% chance of obtaining a B or higher or about a 75% chance of obtaining a C or higher in corresponding credit-bearing first-year college courses."

Source: ACT The Condition of College & Career Readiness 2019

WHAT COLLEGE COURSE?

- College Algebra
  - What's covered in "College Algebra" varies by institution.
  - Often considered to be the "greatest hits" of Algebra 1 and Algebra 2.

COLLEGE READINESS - MATHEMATICS



Source: ACT - *The Condition of College & Career Readiness* - 2019

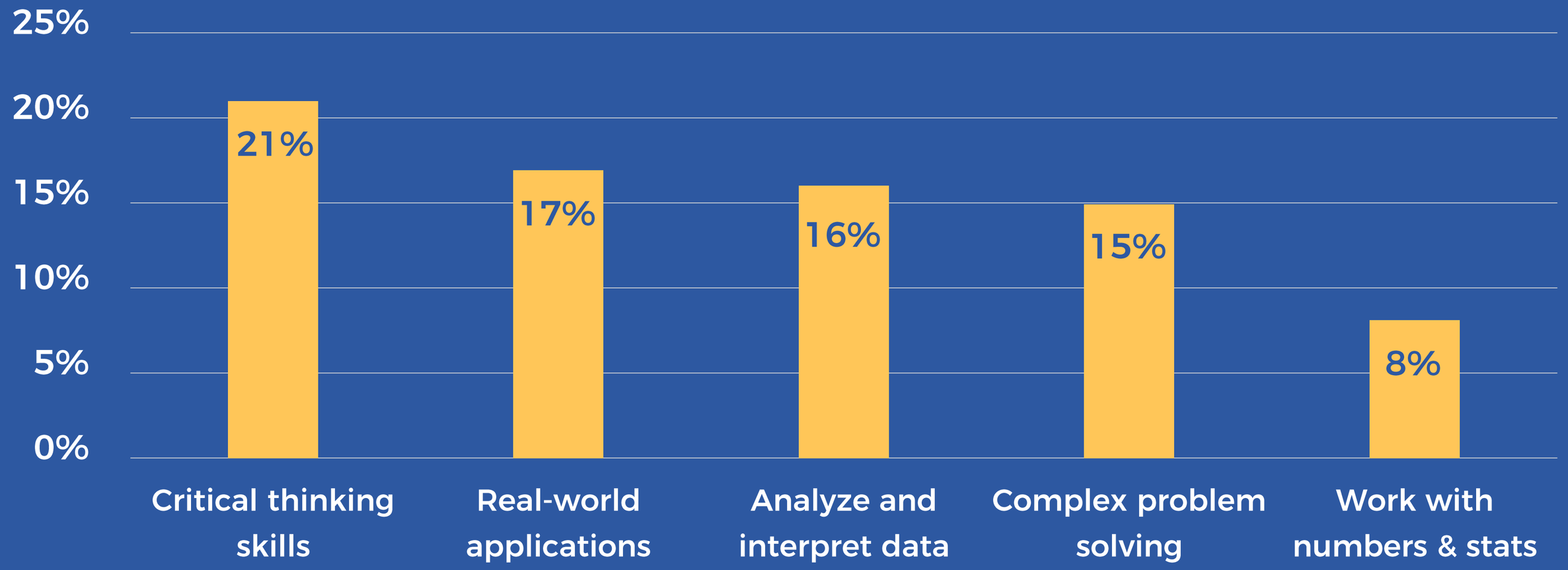
- Community
- Students
- Teachers
- Universities
- Employers

THE PREPAREDNESS GAP

- Surveyed 496 employers including private & public companies, and nonprofit organizations.
- They were asked:
  - whether a skill is “very important”
  - whether recent graduates were “very well prepared” on that skill.
- The difference between them is the preparedness gap.

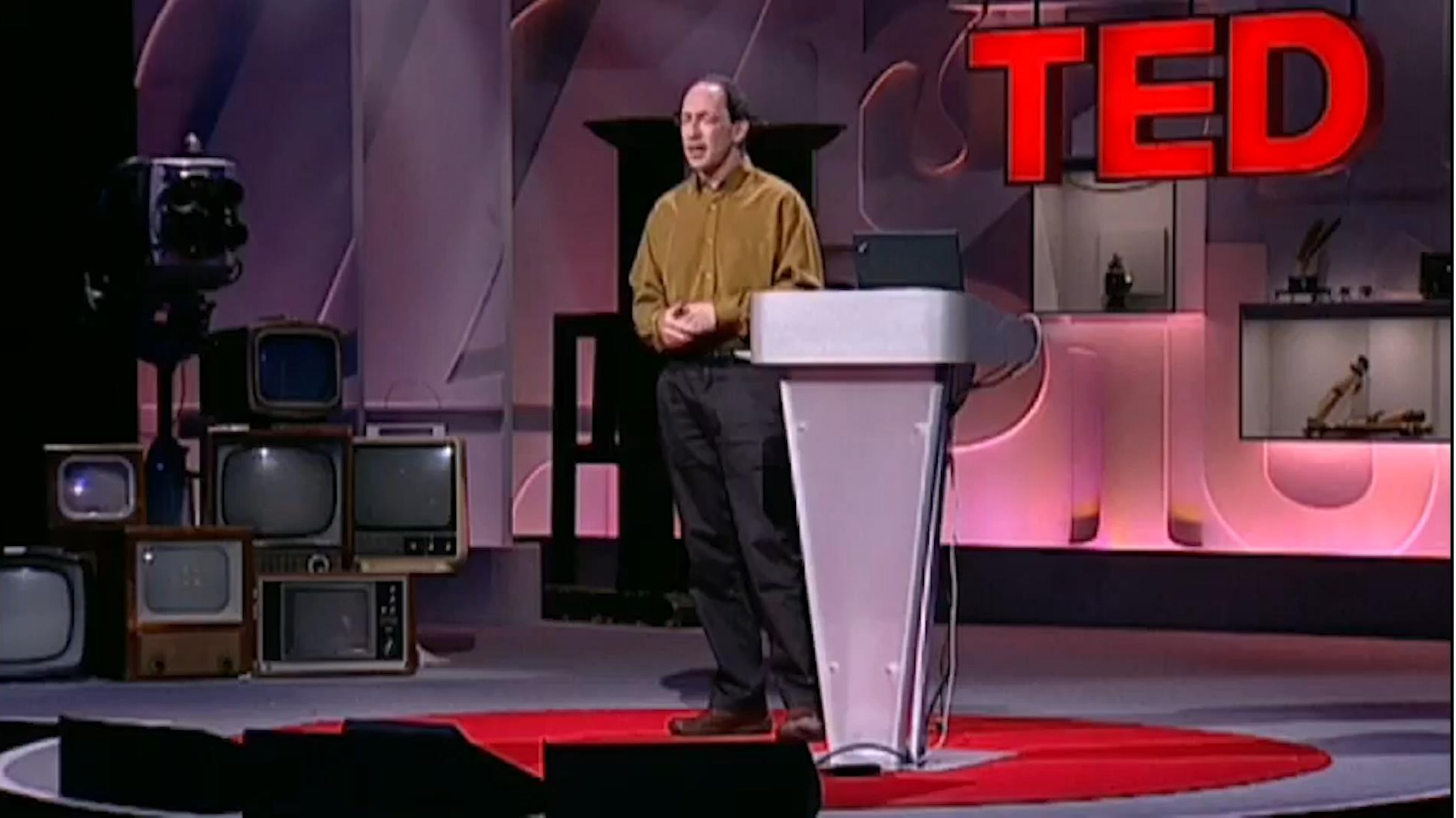
Source: Hanover Research - Employer Views on What Matters Most – 2021

THE PREPAREDNESS GAP



Source: Hanover Research - Employer Views on What Matters Most – 2021

- Community
- Students
- Teachers
- Universities
- Employers
- Experts

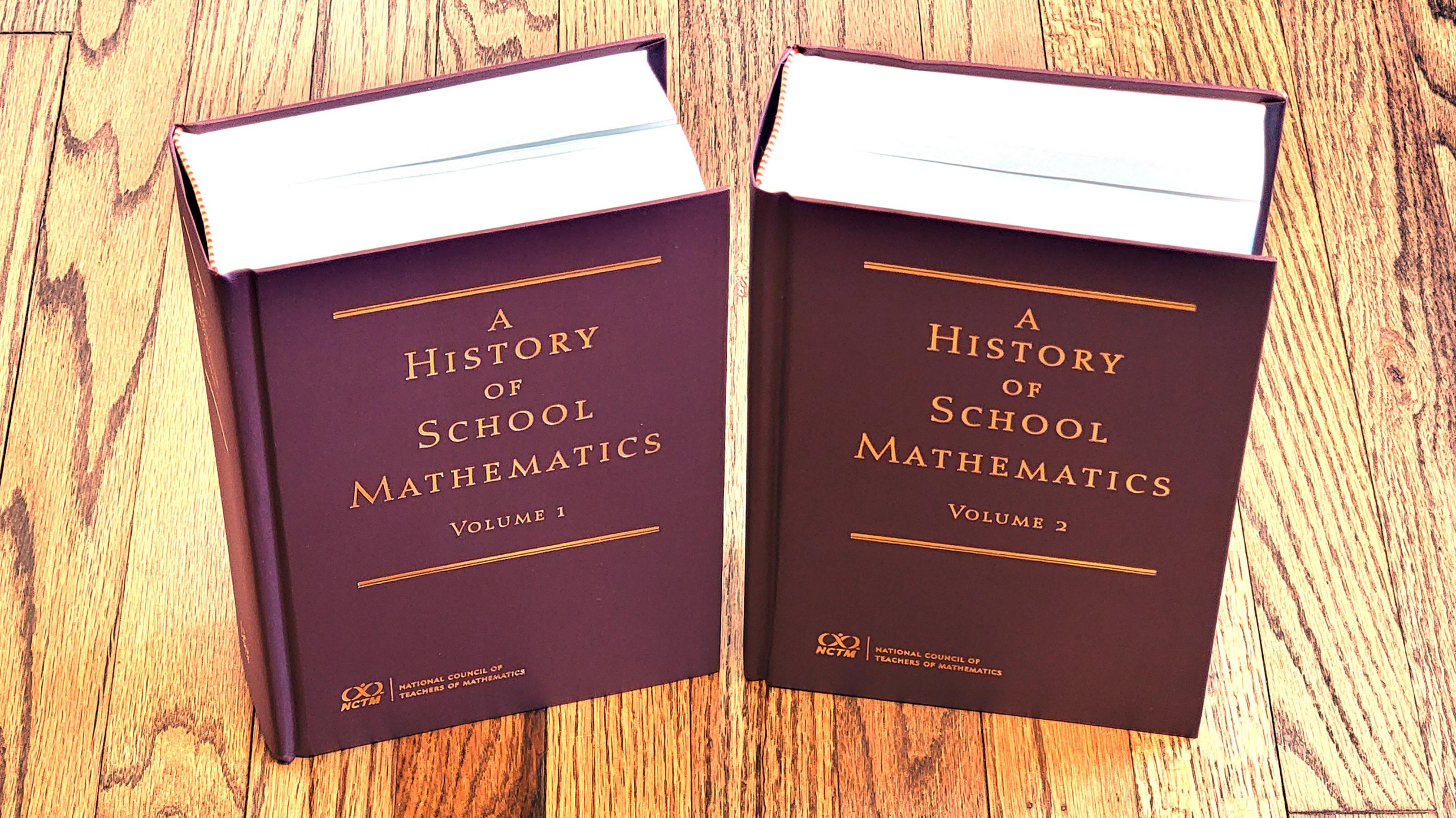

TED

- Community
- Students
- Teachers
- Universities
- Employers
- Experts

DEFINING THE PROBLEM

1. What is the problem?
2. Who says so, and on what evidence?
3. What would occur if no one acted to solve this problem?

Where did our math pathway come from?


A History of School Mathematics
Volume 1
NCTM
National Council of Teachers of Mathematics
A History of School Mathematics
Volume 2
NCTM
National Council of Teachers of Mathematics

WHERE DID IT COME FROM?

- In 1957, Sputnik launched.
- In 1959, the Commission on Mathematics of the College Entrance Examination Board (CEEB) made a recommendation for a new math pathway.

Source: A History of School Mathematics, Volume 1 - Fey, J. T., & Graeber, A. O. (2003).

WHAT DID THEY RECOMMEND?

- Logic
- Modern algebra
- Probability
- Statistics
- Geometry
- Advanced algebra and trigonometry

Source: A History of School Mathematics, Volume 1 - Fey, J. T., & Graeber, A. O. (2003).

WHAT WAS THEIR GOAL?

"students could proceed more quickly to the frontiers of mathematics and meet the national need for a sophisticated scientific workforce."

Source: A History of School Mathematics, Volume 1 - Fey, J. T., & Graeber, A. O. (2003).

WHAT DOES THIS MEAN FOR US?

- Societal needs changed in the 50s and 60s.
- Math education changed to meet them.
- Societal needs continue to change.
- Math education has not.

DEFINING THE PROBLEM

1. What is the problem?
2. Who says so, and on what evidence?
3. What would occur if no one acted to solve this problem?
4. And what would happen to us if that occurred?

Cryptocurrencies
Climate change
Artificial intelligence
Cyber security
Space exploration
Pandemics

Energy production
Resource collection
Medical research
Pollution reduction
Comet mining
3D manufacturing

We can’t solve 2060 problems with a 1960 education.

DISCUSSION TIME

- Why is defining the problem so important?
- Which evidence confirms something you already believed?
- Which evidence pushed your thinking most?

TOPICS

- ☑ WHAT IS THE PROBLEM?
- ☐ WHAT SHOULD THE GOAL BE?
- ☐ HOW DO WE ACHIEVE IT?
- ☐ HOW DO WE GET SUPPORT?

U.S. STATES ARE IN AGREEMENT

- Common Core State Standards: “to succeed in college, career, and life.”
- Alaska: “a foundation for college and career readiness.”
- Nebraska: “work towards college and career readiness.”
- Indiana: “prepared for both college and career opportunities.”
- Oklahoma: “college and the skills desired by many employers.”
- Florida: “success in career and college for students.”

U.S. STATES ARE IN AGREEMENT

- Texas: “guided by the college and career readiness standards”
- Minnesota: “keep learning and, beyond secondary school, to successfully navigate toward and adapt to an economically viable career.”
- Virginia: “success in entry-level, credit-bearing mathematics courses in college or career training.”
- South Carolina: The South Carolina College- and Career-Ready Standards for Mathematics

College and career readiness

THOUGHT EXPERIMENT

- Imagine we asked teachers in every state to write down what “college and career readiness” means to them.
- How likely is it that we share a common understanding?


Hilton Grand Vacations
VENETIAN
hollywood
TREASURE ISLAND
Aria
TOM FORD
NEW YORK NEW YORK
MGM
JABB AWOC KEEZ
EXCALIBUR
LUXOR
Tropicana

What about the beauty of math?!

DISCUSSION TIME

- How is it possible that we share a common goal of college and career readiness yet are not achieving it?
- What does college and career readiness mean to you?

TOPICS

- ☑ WHAT IS THE PROBLEM?
- ☑ WHAT SHOULD THE GOAL BE?
- ☐ HOW DO WE ACHIEVE IT?
- ☐ HOW DO WE GET SUPPORT?

- ~~Students~~
- ~~Parents~~
- Teachers

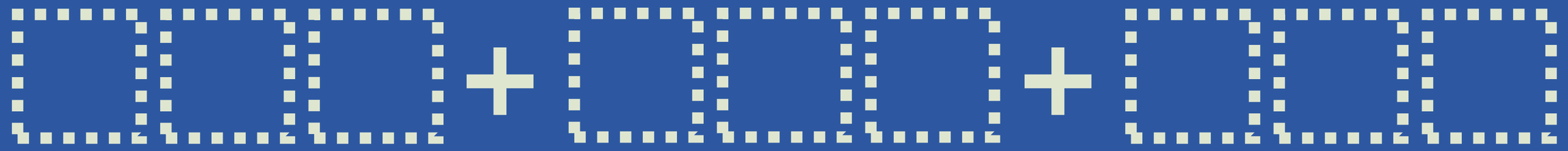
Column Addition (A)

Find each sum.

461	470	745	702	527
732	102	443	520	361
+ 769	+ 776	+ 861	+ 994	+ 747

553	694	187	245	749
502	591	537	415	794
+ 783	+ 669	+ 399	+ 441	+ 166

Using the digits 1 to 9 exactly one time each, place a digit in each box to make the sum as close to 1000 as possible.



Source: John Ulbright and Robert Kaplinsky on openmiddle.com

20. Shopping

There are eight hot dogs and twelve hot dog buns in each package. How many packages of hot dogs and hot dog buns should you buy so that there are no extra hot dogs or hot dog buns?

CONRAD WOLFRAM'S POINTS

1. Posing the right questions
2. Real world → math formulation
3. Computation
4. Math formulation → real world, verification

CONRAD WOLFRAM'S POINTS

1. Posing the right questions
2. Real world → math formulation
3. Computation
4. Math formulation → real world, verification


MIF 0 - 0 SF
Zebra 2
21
3
41
11
9
HANSEN
KIRKENS BYMISJON
27
HANSEN

Teachers decide how math is taught

- ~~Students~~
- ~~Parents~~
- Teachers
- Administrators

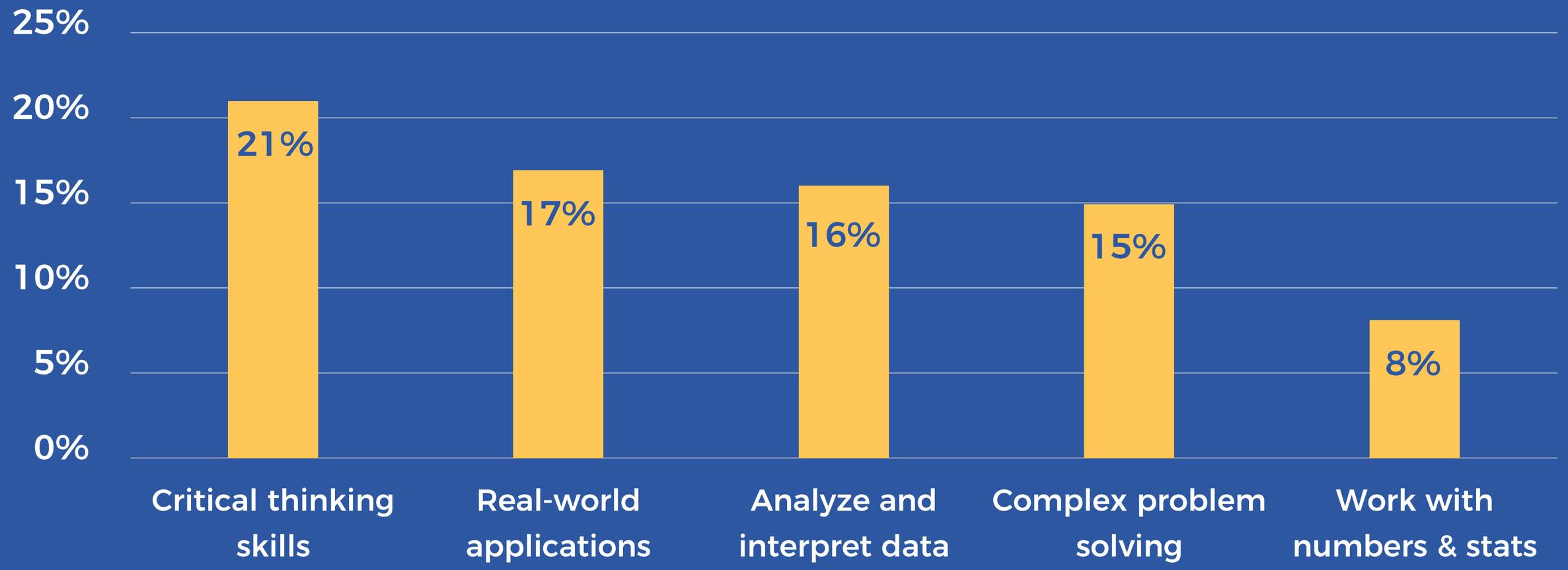
INTRODUCTION TO DATA SCIENCE

- Marriage of statistics and computer science
- Helps kids learn how to use data and technology to answer questions.
- Prepares them for careers in statistics, medicine, public policy, social sciences, law, etc.

INTRODUCTION TO DATA SCIENCE

- Alternative high school mathematics pathway
- May be taken in lieu of Algebra 2 for Universities of California.
- Los Angeles USD began offering this in 2013.
- Fourteen other districts have joined them.

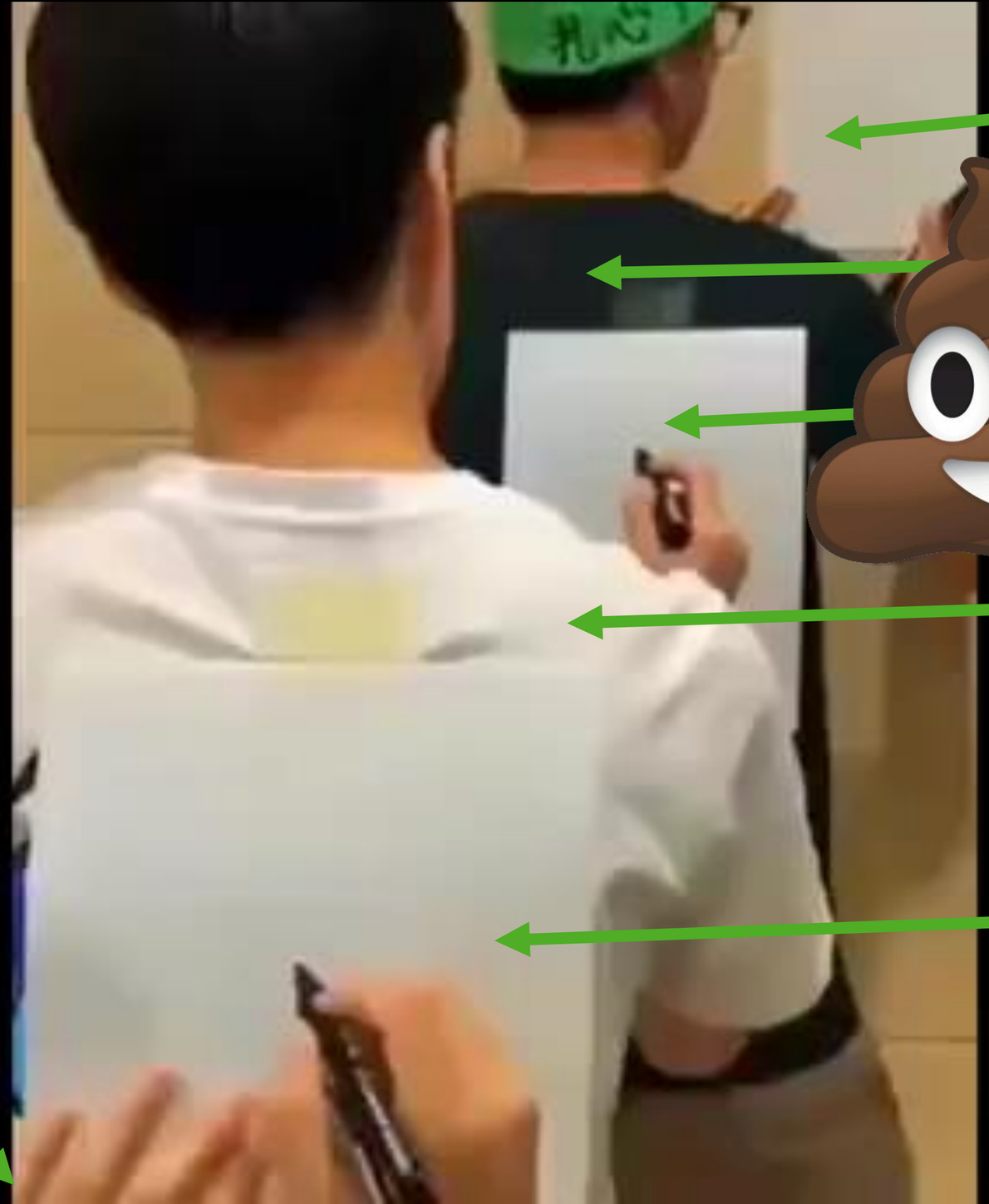
THE PREPAREDNESS GAP



Source: Hanover Research - Employer Views on What Matters Most – 2021

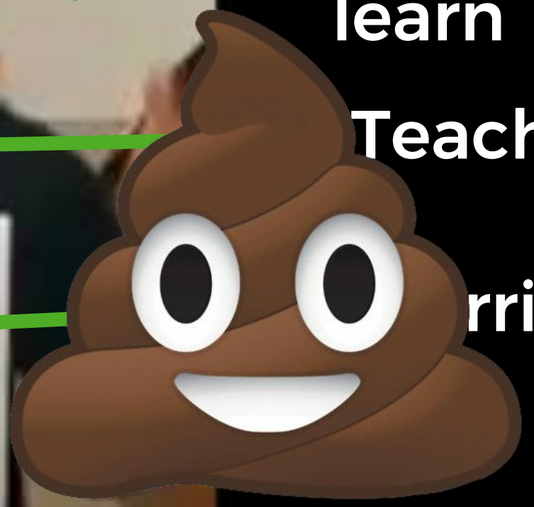
Administrators should advocate for better math pathways.

- ~~Students~~
- ~~Parents~~
- Teachers
- Administrators
- State standards and assessment writers



What students learn

Teacher



rriculum

Curriculum writer

Standards

Skills needed to be truly college and career ready.

THOUGHT EXPERIMENT

- Imagine that math standards have never been created.
- Tomorrow they will be written down for the first time.
- What are the odds that we'd end up with the exact same standards?
- What does it imply if some standards go away or we get new ones?

Standards writers need to modernize and prioritize.

- ~~Students~~
- ~~Parents~~
- Teachers
- Administrators
- State standards and assessment writers
- Curriculum writers

CURRICULUM WRITERS

- Make books they hope people will buy.
- Try to be everyone's least hated book.
- End up with a familiar book that has something for everyone in it.

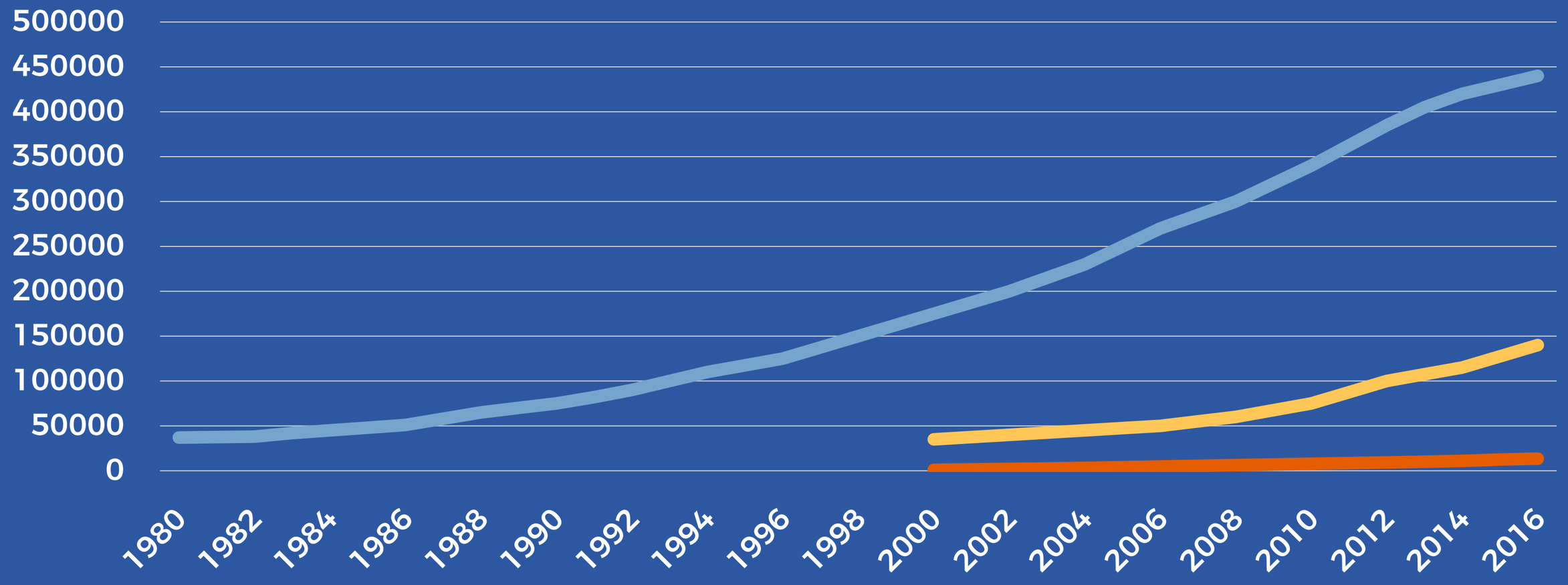
Curriculum writers should emphasize best practices over familiarity.

- ~~Students~~
- ~~Parents~~
- Teachers
- Administrators
- State standards and assessment writers
- Curriculum writers
- Colleges and universities

THOUGHT EXPERIMENT

- "While students can still take AP Calculus in high school, colleges and universities no longer give it preference in the admissions process."
- What would change about the way we teach math in K-12?

HOW MANY ARE TAKING AP CALC?



Source: National Center for Education Statistics (NCES) longitudinal study

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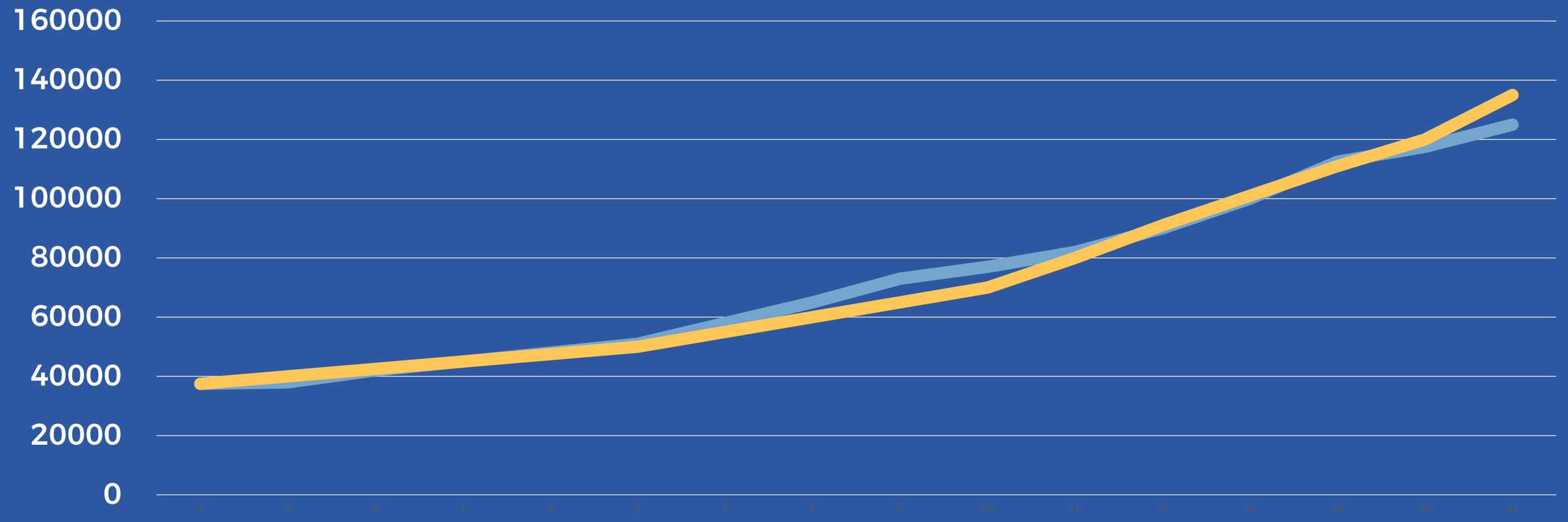
AP CALCULUS GROWTH OVER TIME



Source: National Center for Education Statistics (NCES) longitudinal study

RobertKaplinsky.com

WHY DO KIDS TAKE CALCULUS?

- 332 Rutgers students who had taken an AP Calculus exam were surveyed to determine why they chose to take calculus while in high school.
- About 80% said they took the course because it "looks good on college applications."

Source: Rosenstein, J. and Ahluwalia, A.(n.d.), *Putting brakes on the rush to AP Calculus.*

HOW DO THEY GET TO CALCULUS?

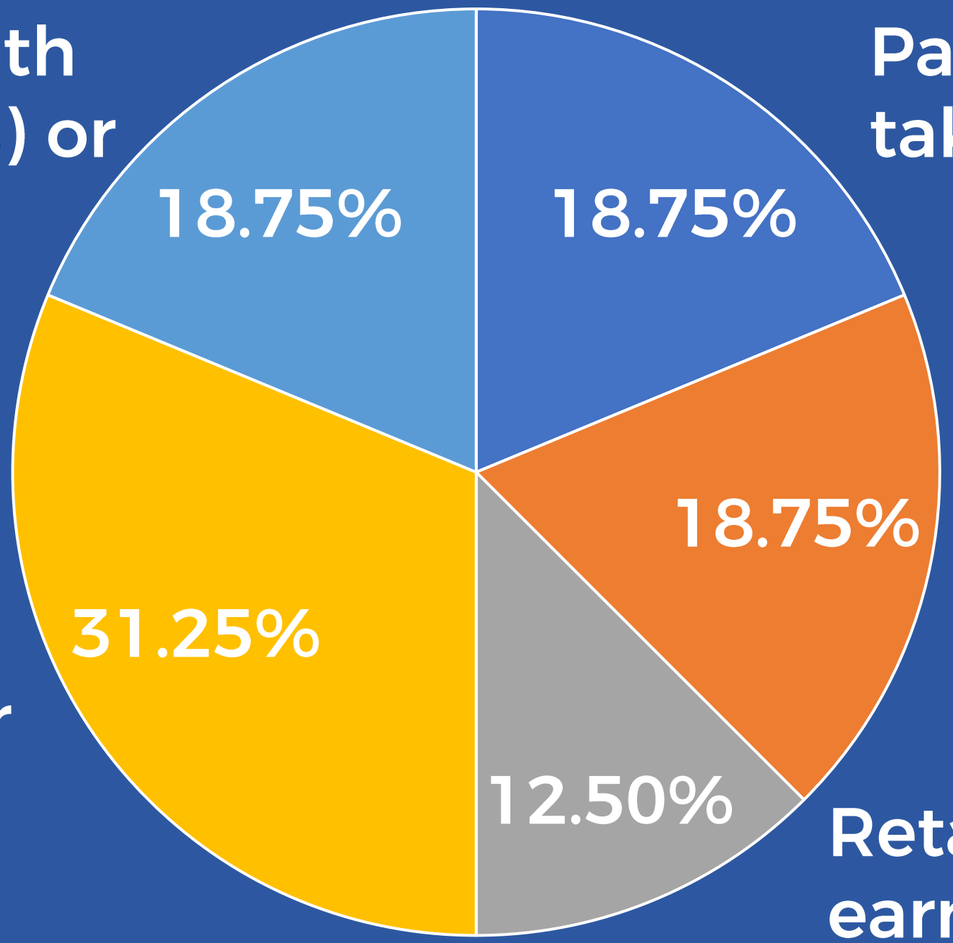
	6th Grade	7th Grade	8th Grade	9th Grade	10th Grade	11th Grade	12th Grade
Traditional	Math 6	Math 7	Math 8	Algebra 1	Geometry	Algebra 2	Pre-Calc AP Calc AB
Accelerated (3 years in 2)	Math 6 + half of Math 7	Half of Math 7 + Math 8	Algebra 1	Geometry	Algebra 2	Pre-Calc	AP Calc AB
Accelerated (5 years in 3)	Math 6 + Math 7	Math 7 + Math 8 + Algebra 1	Algebra 1 + Geometry	Algebra 2	AP Calc AB	AP Calc BC	AP Calc D

WHAT ABOUT FLORIDA?

	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade	7th Grade	8th Grade	9th Grade	10th Grade	11th Grade	12th Grade
Regular	Grade 2 Math	Grade 3 Math	Grade 4 Math	Grade 5 Math	Grade 6 Math	Grade 7 Math	Grade 8 Math	Algebra 1	Geometry	Algebra 2	Pre-Calc or AP Calc AB
Accelerated (6 years in 4)	Grade 2 Math	Grade 3 + Half of Grade 4	Half of Grade 4 + Grade 5	Grade 6 + Half of Grade 7	Half of Grade 7 + Grade 8	Algebra 1	Geometry	Algebra 2	Pre-Calc	AP Calc AB	???

Source: Florida B.E.S.T. Standards' "Comparison of Regular Courses to Accelerated Course"

WHAT HAPPENS AFTER AP CALC?



Source: National Center for Education Statistics (NCES) longitudinal study

RobertKaplinsky.com

THOUGHT EXPERIMENT

- "While students can still take AP Calculus in high school, colleges and universities no longer give it preference in the admissions process."
- What would change about the way we teach math in K-12?

- Students will be more likely to take calculus only if they feel it will help them achieve their goals.
- Far less acceleration and pressure to rush through standards.
- More time to focus on foundational concepts, especially in middle school.

Robert Kaplinsky
@robertkaplinsky

I just heard about a school that compacts 6th, 7th, & 8th grade math into one year. This is a travesty to students and their teachers. 1/2

4:08 PM · Feb 28, 2017 · TweetDeck

- “All of our campuses recommend a 4th year of math, but no specific mathematics course is ‘preferred’ over another.”
- “Calculus is… certainly not required and will not be the deciding factor in any admission decision.”

Source: University of California, Office of the President

- “Calculus is neither a requirement nor a preference for admission to Harvard. We understand that many students have no intention to pursue college coursework that requires a knowledge of calculus, and that other students are unsure of their future college studies.”
- “Thus, we encourage applicants to pursue the pathways through math that are available to them and aligned with their interests and goals.”

Source: Harvard Application Requirements

Colleges and universities should not give AP Calculus preference in the admissions process.

TOPICS

- ☑ WHAT IS THE PROBLEM?
- ☑ WHAT SHOULD THE GOAL BE?
- ☑ HOW DO WE ACHIEVE IT?
- ☐ HOW DO WE GET SUPPORT?

There is no single break through step

FOUR MAKE OR BREAK QUESTIONS

1. What is the problem?
2. Who says so, and on what evidence?
3. What would occur if no one acted to solve this problem?
4. And what would happen to us if that occurred?

THE FIVE WHYS - TOYOTA

- What's the problem?
  - Many vehicles are not starting.
- Why?
  - Their batteries are dead.
- Why?
  - Their alternator is not functioning.
- Why?
  - Their alternator belt has broken.
- Why?
  - The alternator belt was not replaced when it should have been.
- Why?
  - The vehicle was not maintained according to the recommended service schedule.

THE FIVE WHYS – MATH ED

- What's the problem?
  - The way we teach math is not meeting students' needs.

- Why?
  a) Not enough time to teach it all.
  b) Students aren't ready for university math.
  c) Students lack skills employers need.
  d) We focus too much on skills calculators can do.
  e) ???
  f) ???

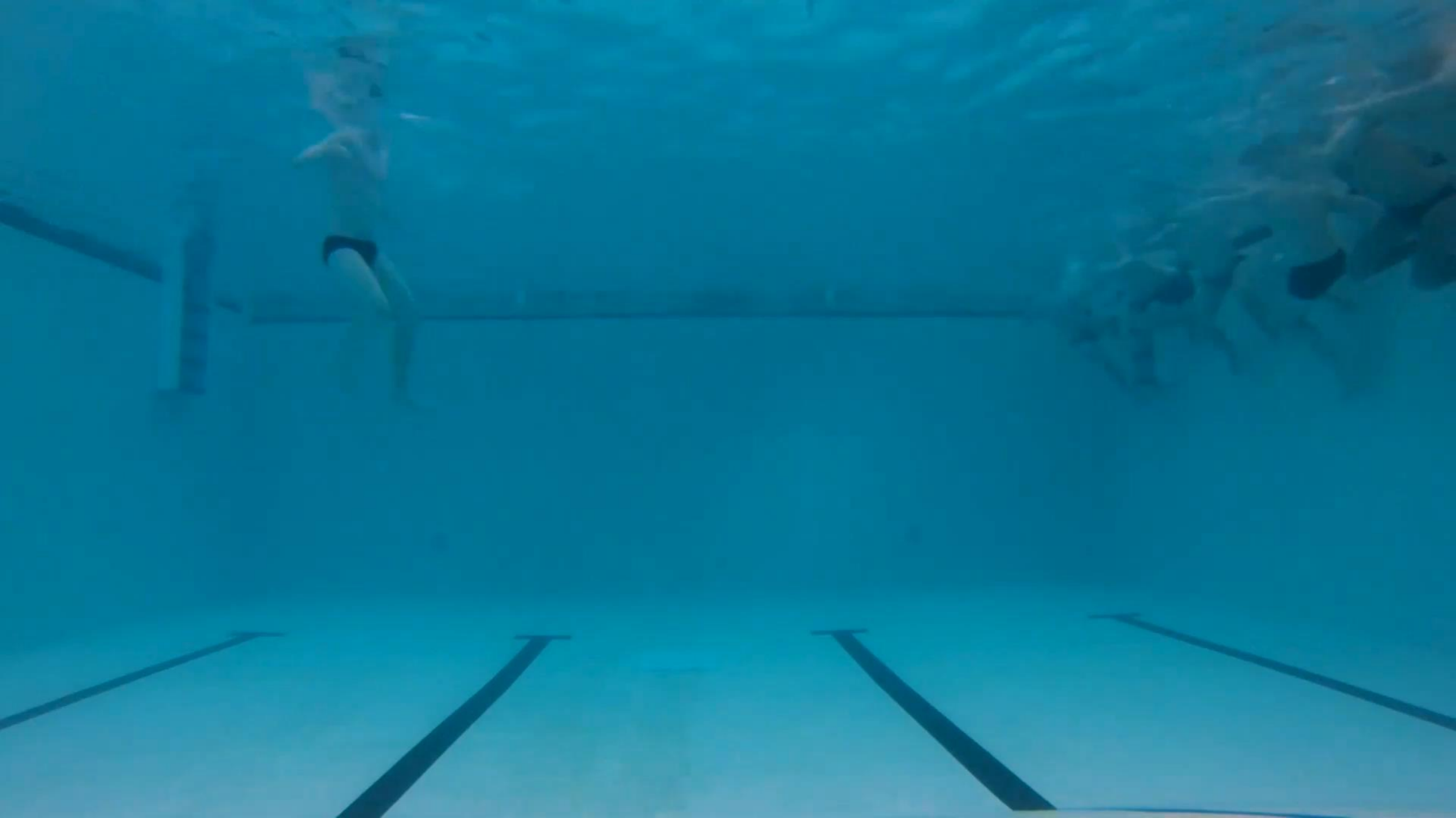
THE FIVE WHYS – MATH ED

- What's the problem?
  - The way we teach math is not meeting students' needs.
- Why?
  - Students aren't ready for university math.
- Why?
  - They are not scoring well on placement exams.
- Why?
  - They're missing many foundational skills.
- Why?
  - They didn't deeply learn them in their secondary math classes.
- Why?
  - There wasn't enough time to go deeply into concepts because of acceleration.

BE STRATEGIC WHEN YOU BEGIN

- Some groups wield more influence:
  - Teachers
  - Standards writers
  - Universities
- Talk to them!

Who do you begin with?



TOPICS

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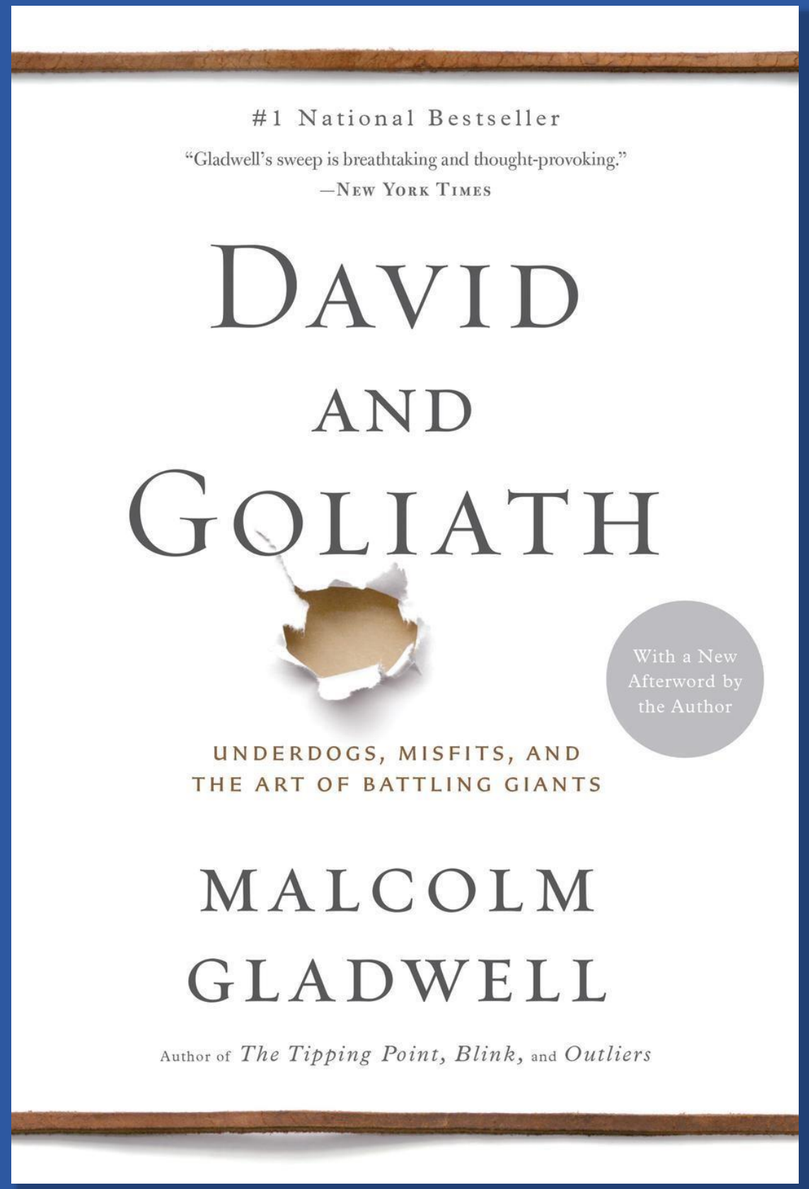

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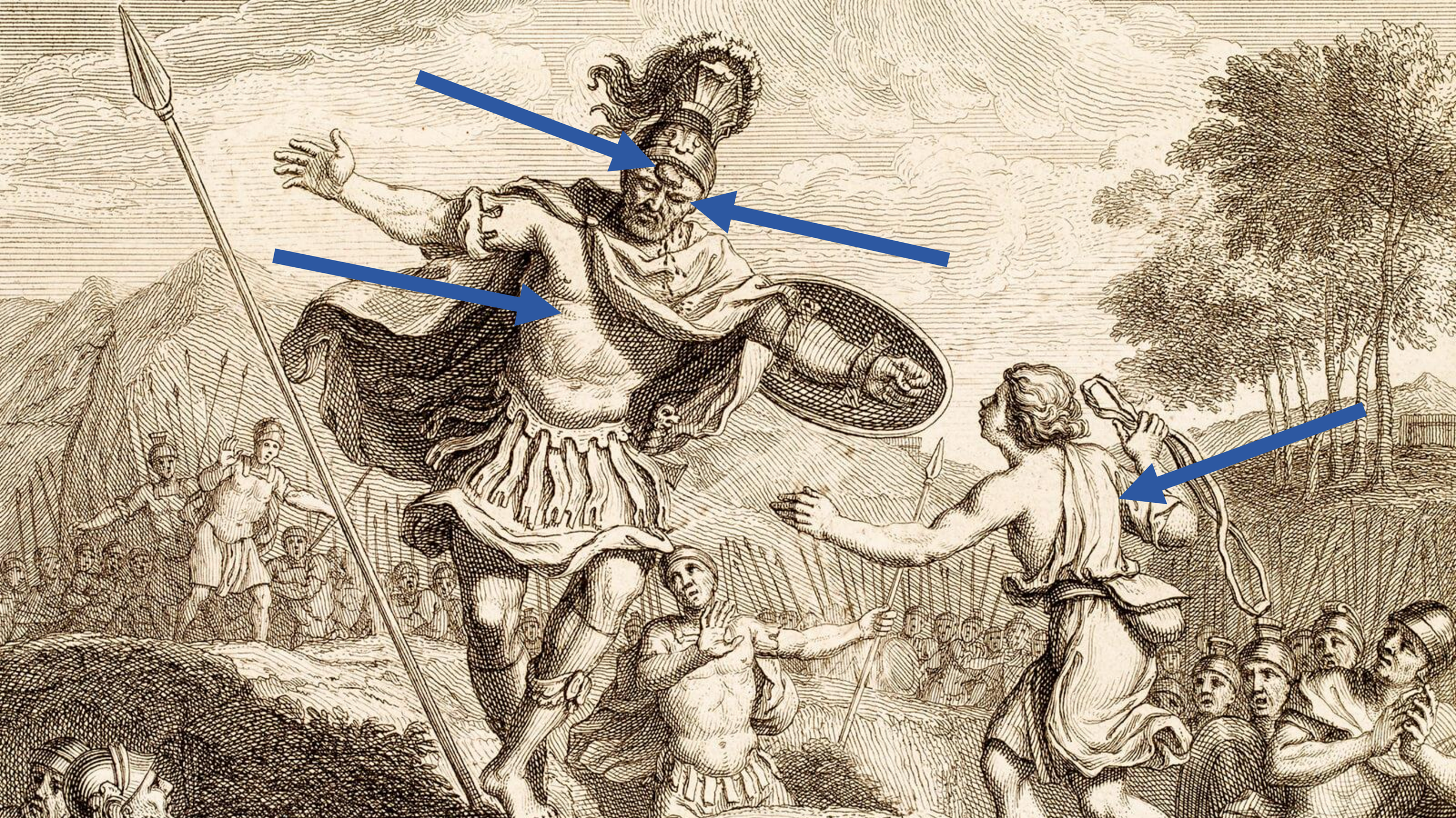


Source: Practical Paracord on YouTube

Sometimes perceived weaknesses are actually strengths

WE CAN DO WHAT THEY CAN'T

- We can help students and parents see the unintended consequences of acceleration and get them on our side.
- We can choose how we teach standards.
- We can influence district acceleration policies.
- We can influence state standard revisions.
- We can demand the curriculum writers aim higher.
- We can advocate to our local colleges and universities for better admission policies.

DISCUSSION TIME

Which actions feel most achievable? Why?

- help students and parents see the unintended consequences of acceleration
- choose how we teach standards
- influence district acceleration policies.
- influence state standard revisions.
- demand the curriculum writers aim higher.
- advocate to for better admission policies

Change must begin with us.

CHECKPOINTS

- ☑ WHY IS MATH EDUCATION BROKEN?
- ☐ HOW DO WE GET STUDENTS THINKING?
- ☐ HOW DO WE GET MORE PRACTICE?
- ☐ HOW DO WE DEAL WITH MISCONCEPTIONS?
- ☐ HOW DO WE GET MORE PRACTICE?

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


Ralphs
grade AA
butter
NET WT. 4 OZ. (113g)

THIS UNIT NOT LABELED FOR INDIVIDUAL RETAIL SALE.

Ingredients: Pasteurized Cream, Salt.

DISTRIBUTED BY: RALPHS GROCERY CO. LOS ANGELES, CALIF. 90054

1 Tbsp.	2 Tbsp.	3 Tbsp.	4 Tbsp.	5 Tbsp.	6 Tbsp.	7 Tbsp.	8 Tbsp.
←			1/4 cup →				

1 FIRST QUALITY 1

Ralphs

grade AA

butter

THIS UNIT NOT LABELED FOR INDIVIDUAL RETAIL SALE.

Ingredients: Pasteurized Cream, Salt.

DISTRIBUTED BY: RALPHS GROCERY CO. LOS ANGELES, CALIF. 90054

1 Tbsp.	2 Tbsp.	3 Tbsp.	4 Tbsp.	5 Tbsp.	6 Tbsp.	7 Tbsp.	8 Tbsp.
←			1/4 cup →				1/2 cup →

1 FIRST QUALITY 1

Ralphs

grade AA

butter

- 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

THIS UNIT NOT LABELED FOR INDIVIDUAL RETAIL SALE.

Ingredients: Pasteurized Cream, Salt.

DISTRIBUTED BY: RALPHS GROCERY CO. LOS ANGELES, CALIF. 90054

1 Tbsp.	2 Tbsp.	3 Tbsp.	4 Tbsp.	5 Tbsp.	6 Tbsp.	7 Tbsp.	8 Tbsp.
←			1/4 cup →				

1 FIRST QUALITY 1

Ralphs

grade AA

butter

THIS UNIT NOT LABELED FOR INDIVIDUAL RETAIL SALE.

Ingredients: Pasteurized Cream, Salt.

DISTRIBUTED BY: RALPHS GROCERY CO. LOS ANGELES, CALIF. 90054

1 Tbsp.	2 Tbsp.	3 Tbsp.	4 Tbsp.	5 Tbsp.	6 Tbsp.	7 Tbsp.	8 Tbsp.
			1/4 cup	1/3 cup			1/2 cup

1 FIRST QUALITY 1

Ralphs

grade AA

butter

TOPICS

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

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?

THIS UNIT NOT LABELED FOR INDIVIDUAL RETAIL SALE.

Ingredients: Pasteurized Cream, Salt.

DISTRIBUTED BY: RALPHS GROCERY CO. LOS ANGELES, CALIF. 90054

1 Tbsp.	2 Tbsp.	3 Tbsp.	4 Tbsp.	5 Tbsp.	6 Tbsp.	7 Tbsp.	8 Tbsp.
←			1/4 cup →				

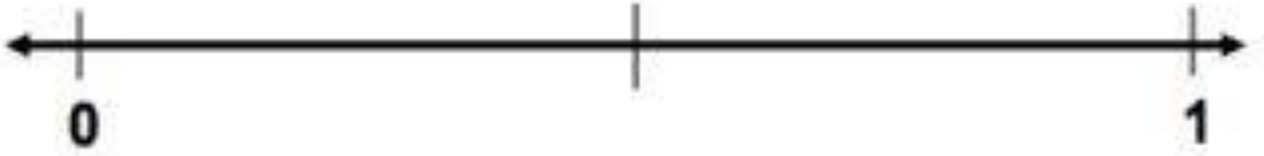
1 FIRST QUALITY 1

Ralphs

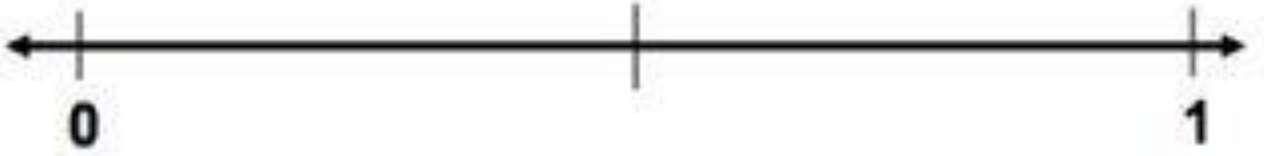
grade AA

butter

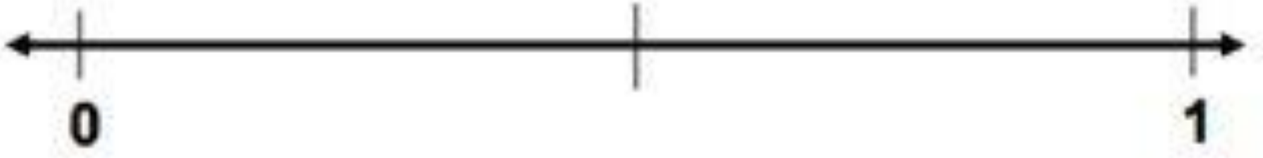
1 $\frac{3}{4}$ $\frac{2}{4}$ $\frac{1}{4}$



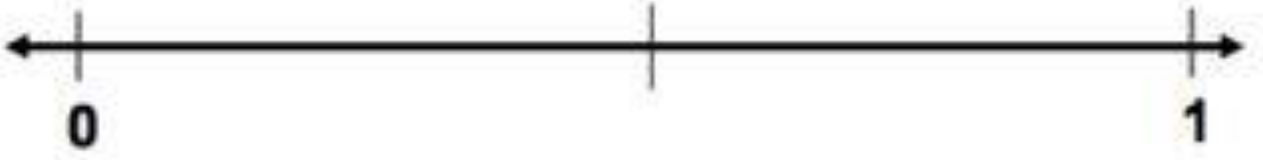
2 $\frac{4}{8}$ $\frac{4}{10}$ $\frac{4}{5}$



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



4 $\frac{1}{10}$ $\frac{1}{2}$ $\frac{1}{5}$



TOPICS

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

TED Ideas worth spreading

2,976,257 views | Dan Meyer • TEDxNYED

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Math class needs a makeover

Read transcript

THIS UNIT NOT LABELED FOR INDIVIDUAL RETAIL SALE.

Ingredients: Pasteurized Cream, Salt.

DISTRIBUTED BY: RALPHS GROCERY CO. LOS ANGELES, CALIF. 90054

1 Tbsp.	2 Tbsp.	3 Tbsp.	4 Tbsp.	5 Tbsp.	6 Tbsp.	7 Tbsp.	8 Tbsp.
←			1/4 cup →				

1 FIRST QUALITY 1

Ralphs

grade AA

butter

Source: ViralHog

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?

_____

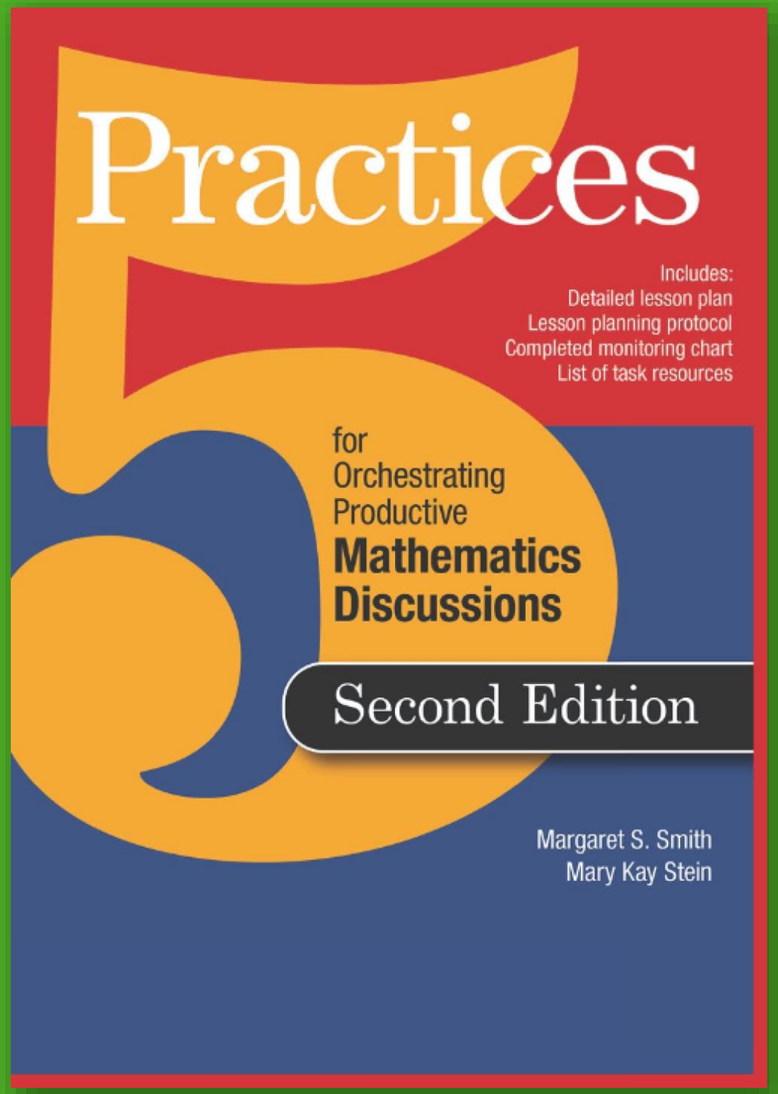
3. Estimate where you think you should cut the stick for 1/3 cup of butter. How do you know?

_____

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

TOPICS

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



RobertKaplinsky.com

- Predictable
- Powerful
- Repeatable

5 PRACTICES

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

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.

MONITORING

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

First, I got the total amount of tablespoons that equal a cup, which is 16 tbsp. After that, I divided 16 by 3 to find 1/3 of a cup. My quotient was 5 with a remainder of 1. So I divided the remainder to all three equal groups. My answer was that 1/3 of a cup of butter is 5.33 or 5 1/3 cups. To check, I multiplied 5.33 by 3 and my answer was 15.99. If you round that, you get 16.00 as the answer.

SELECTING, SEQUENCING, & CONNECTING

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

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

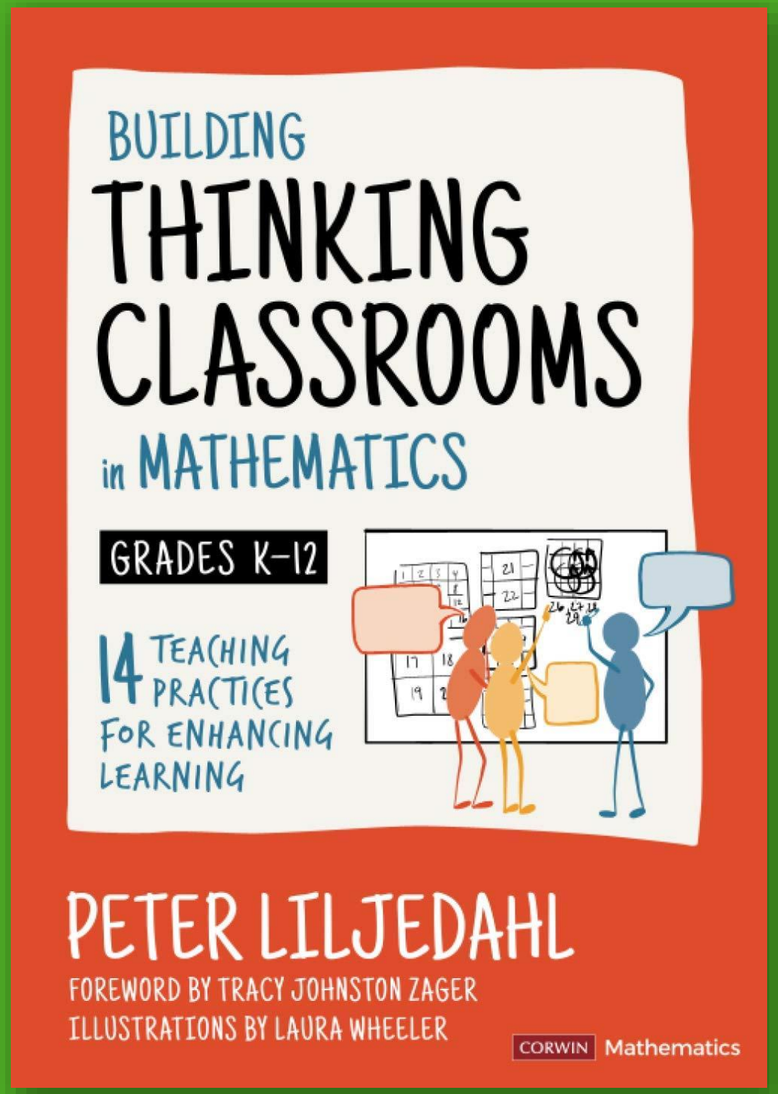
TAKEAWAYS

- 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.

	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

TOPICS

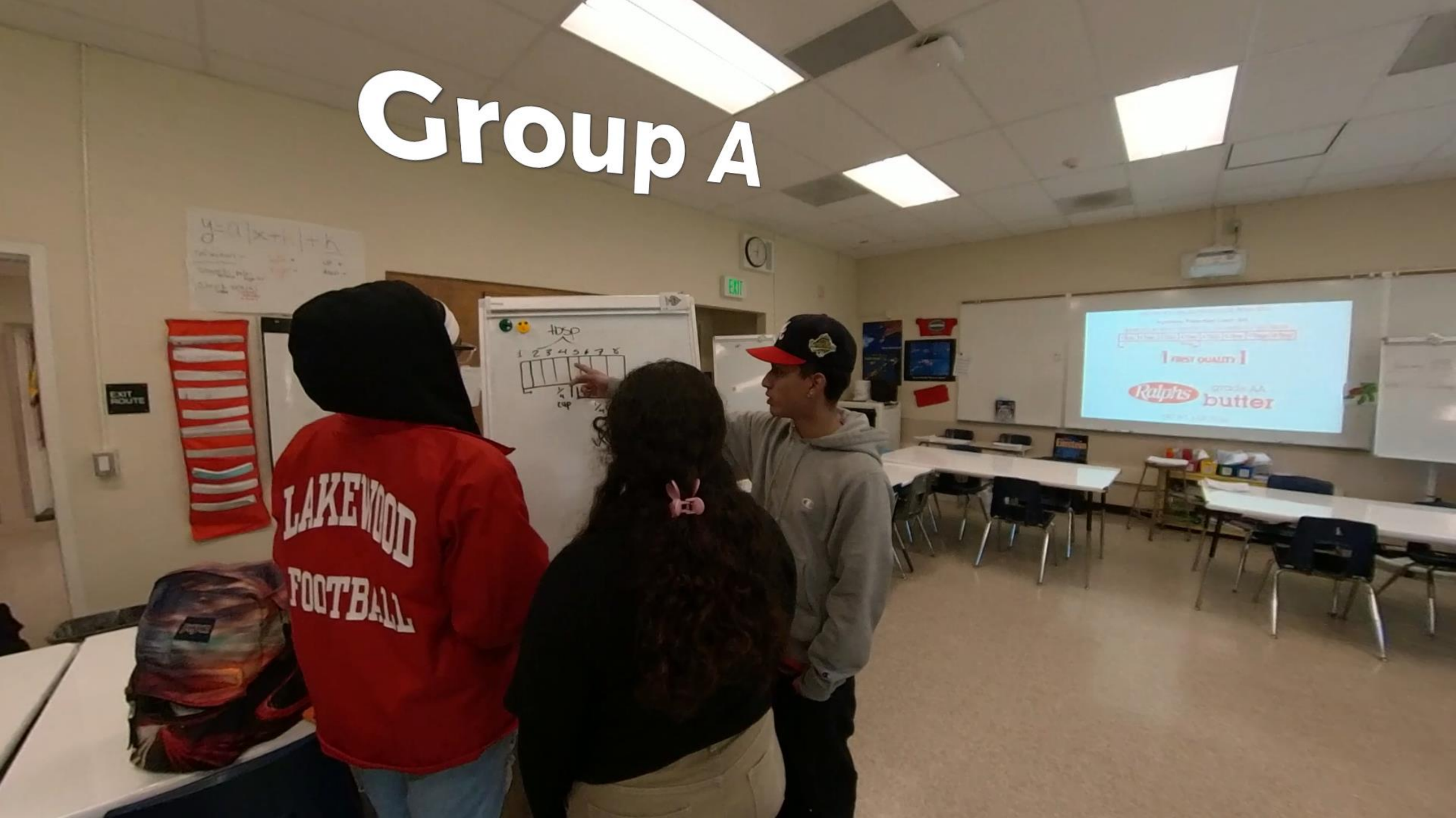
- ☑ IGNORANCE IS BLISS
- ☑ WORKSHEET-IFY
- ☑ 5 PRACTICES
- ☐ BUILDING THINKING CLASSROOMS
- ☐ WHAT I'M STILL WORKING ON

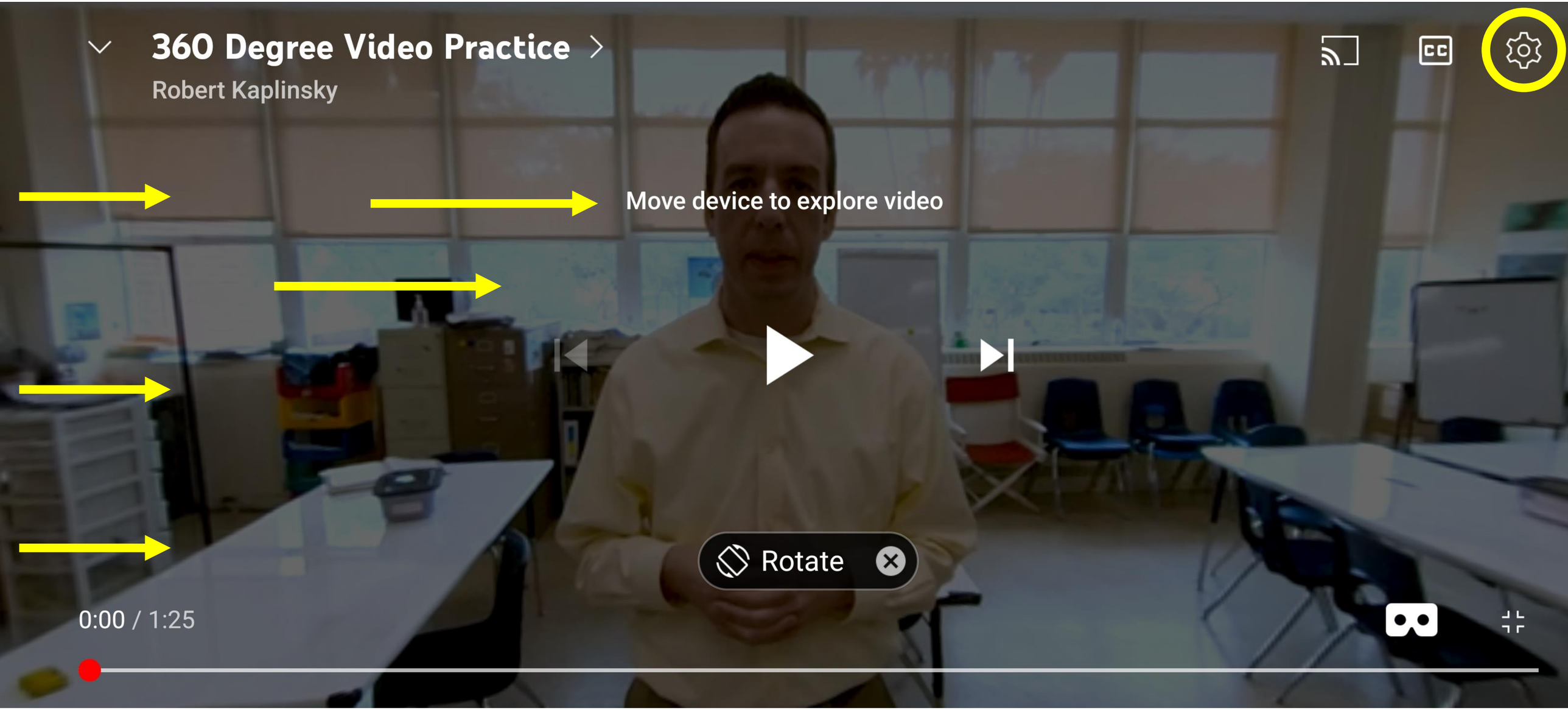

BUILDING
THINKING
CLASSROOMS
in MATHEMATICS
GRADES K–12
14 TEACHING PRACTICES FOR ENHANCING LEARNING
PETER LILJEDAHL
FOREWORD BY TRACY JOHNSTON ZAGER
ILLUSTRATIONS BY LAURA WHEELER
CORWIN Mathematics

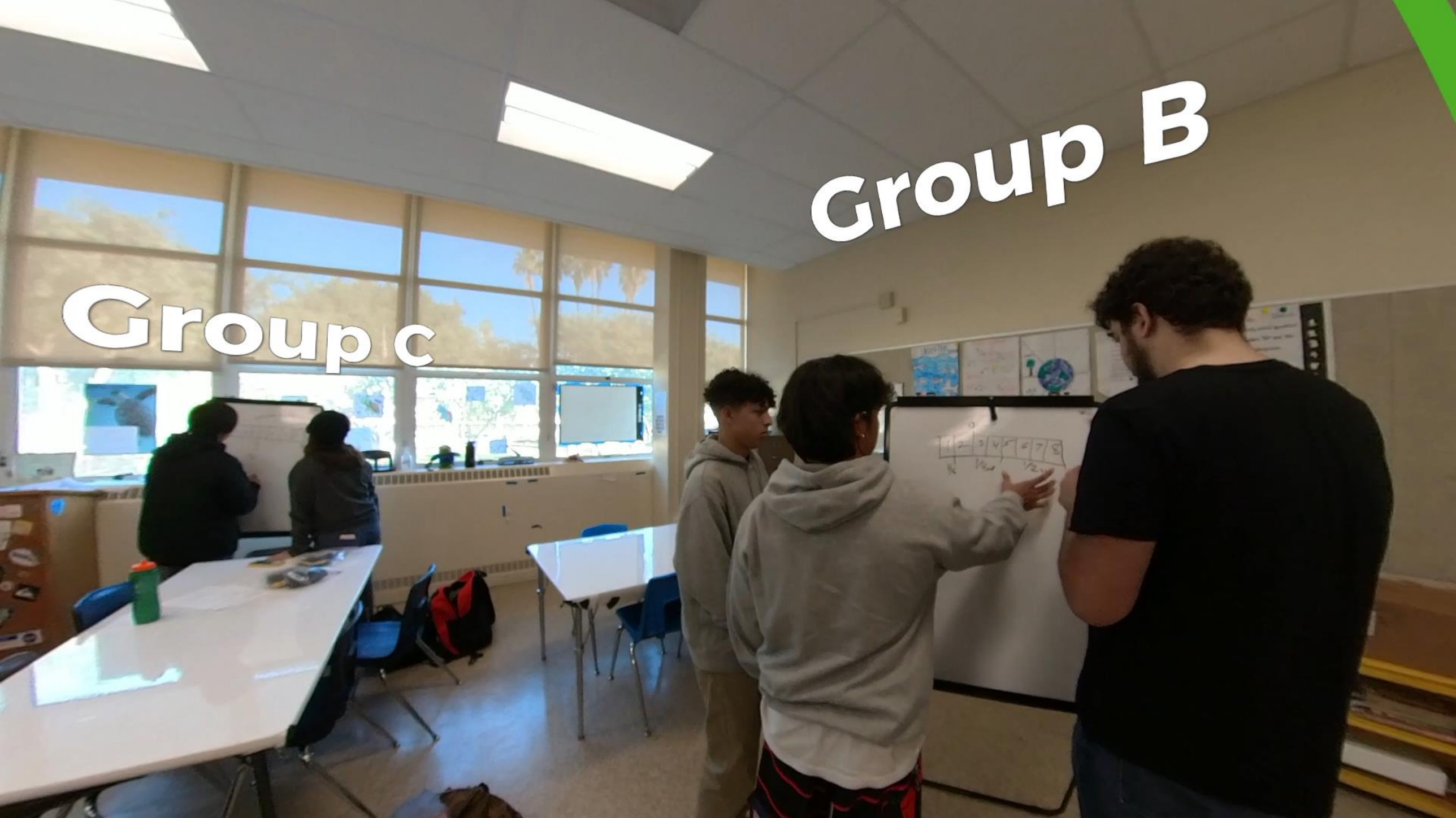
THE FOURTEEN PRACTICES

1. What types of tasks we use
2. How we form collaborative groups
3. Where students work
4. How we arrange the furniture
5. How we answer student questions
6. When, where, and how tasks are given
7. What homework looks like
8. How we foster student autonomy
9. How we use hints and extensions
10. How we consolidate a lesson
11. How students take notes
12. What we choose to evaluate
13. How we use formative assessment
14. How we grade

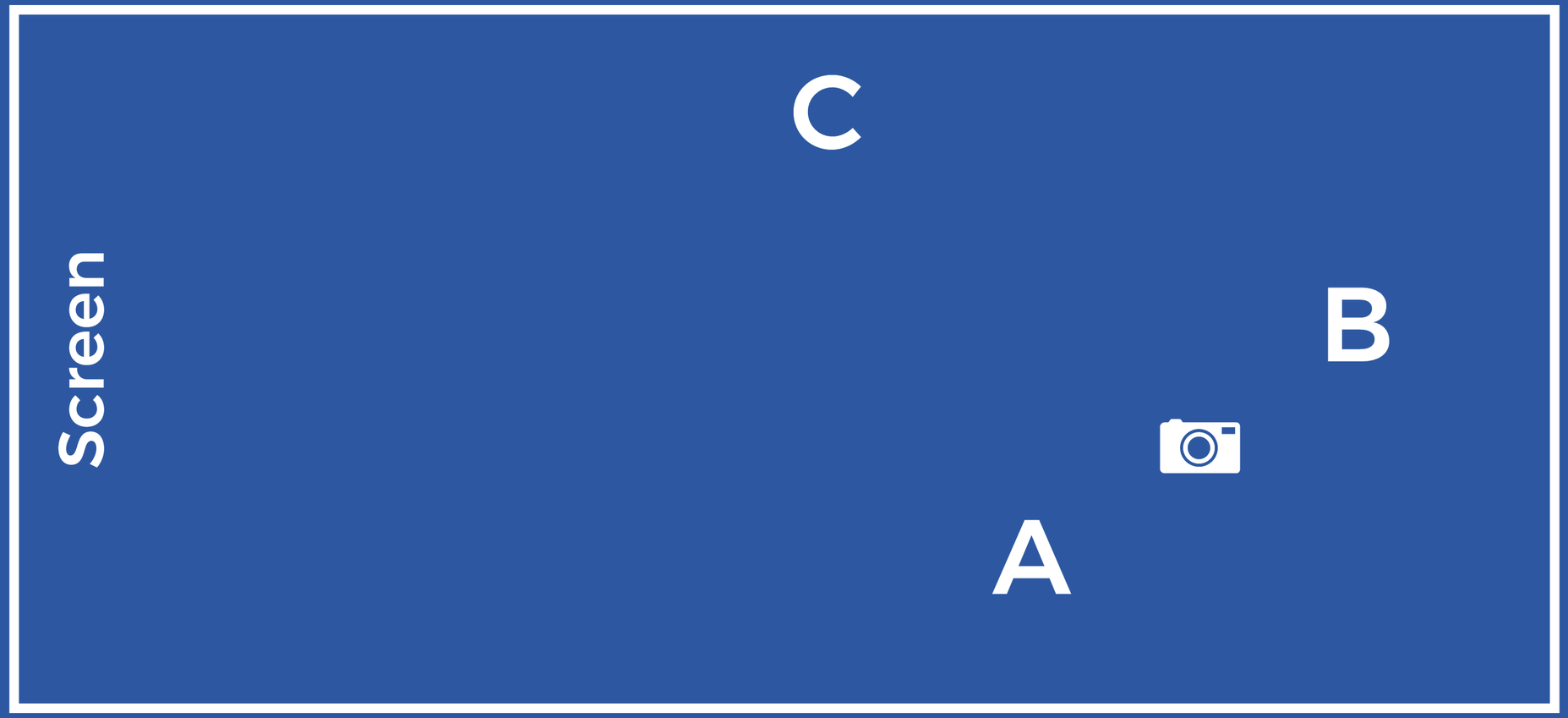
Group A

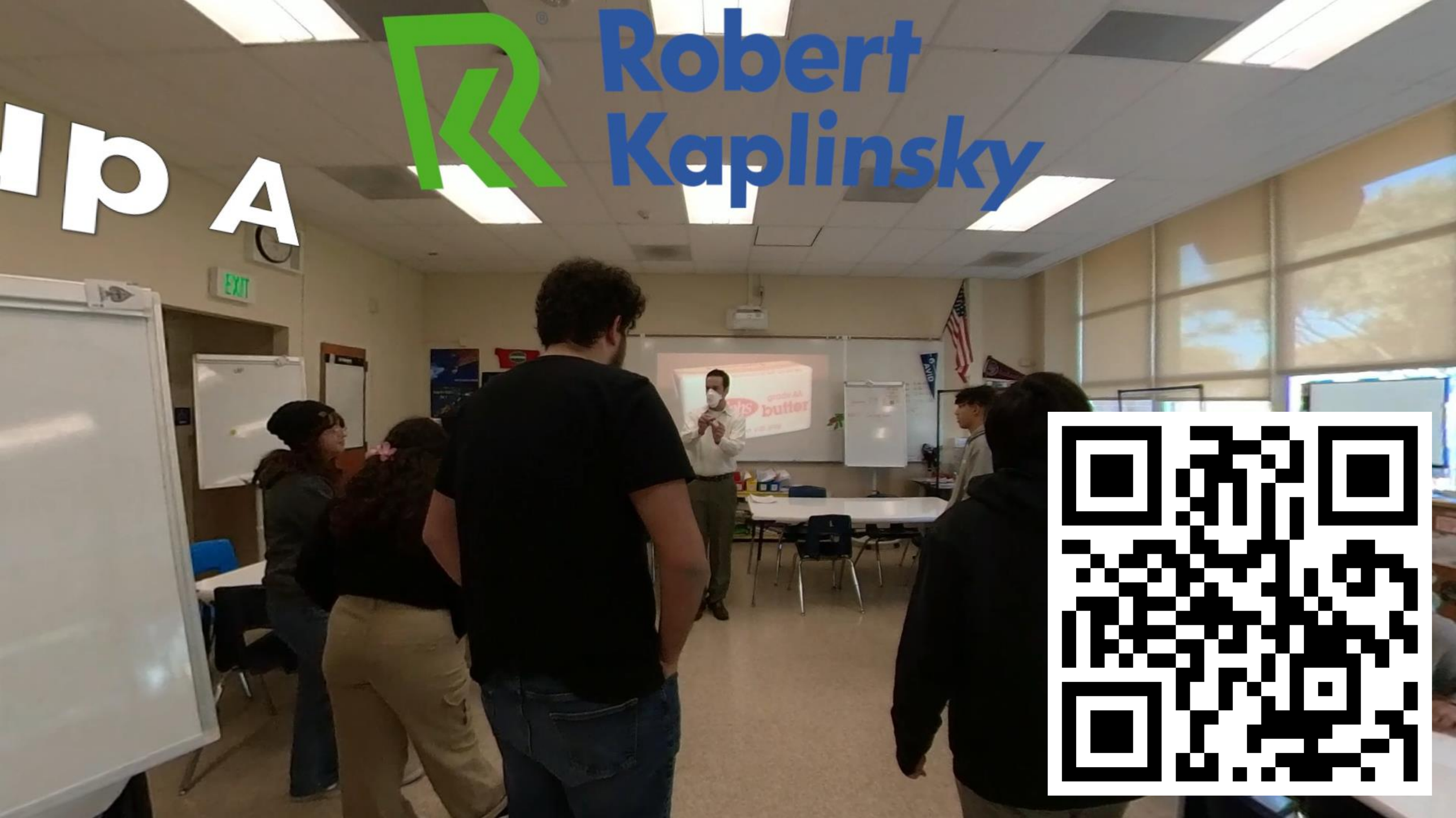



360 Degree Video Practice
Robert Kaplinsky
Move device to explore video
Rotate
0:00 / 1:25


Group B
Group c

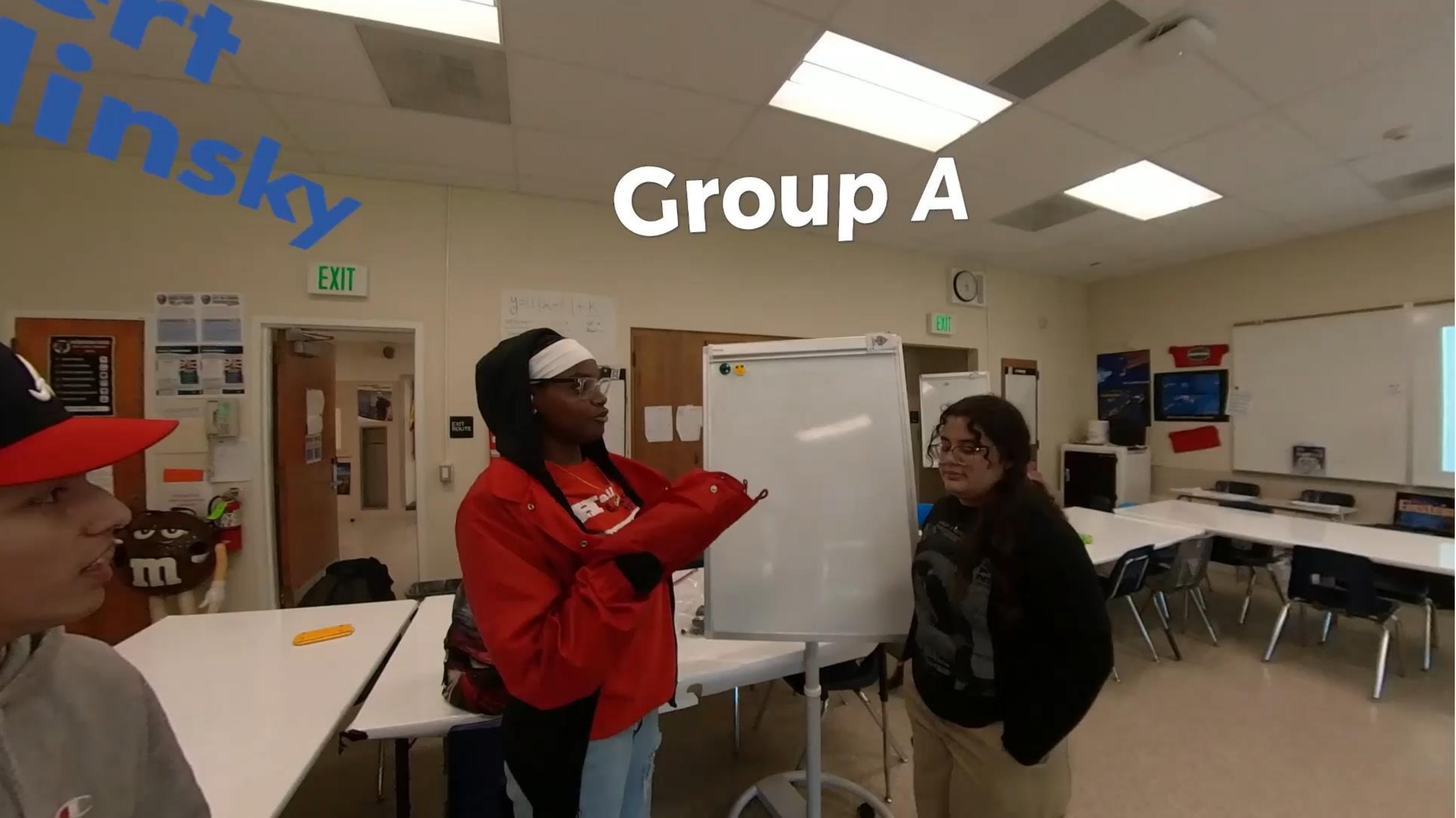
CLASSROOM LAYOUT




Robert
Kaplinsky
EXIT

DISCUSSION TIME

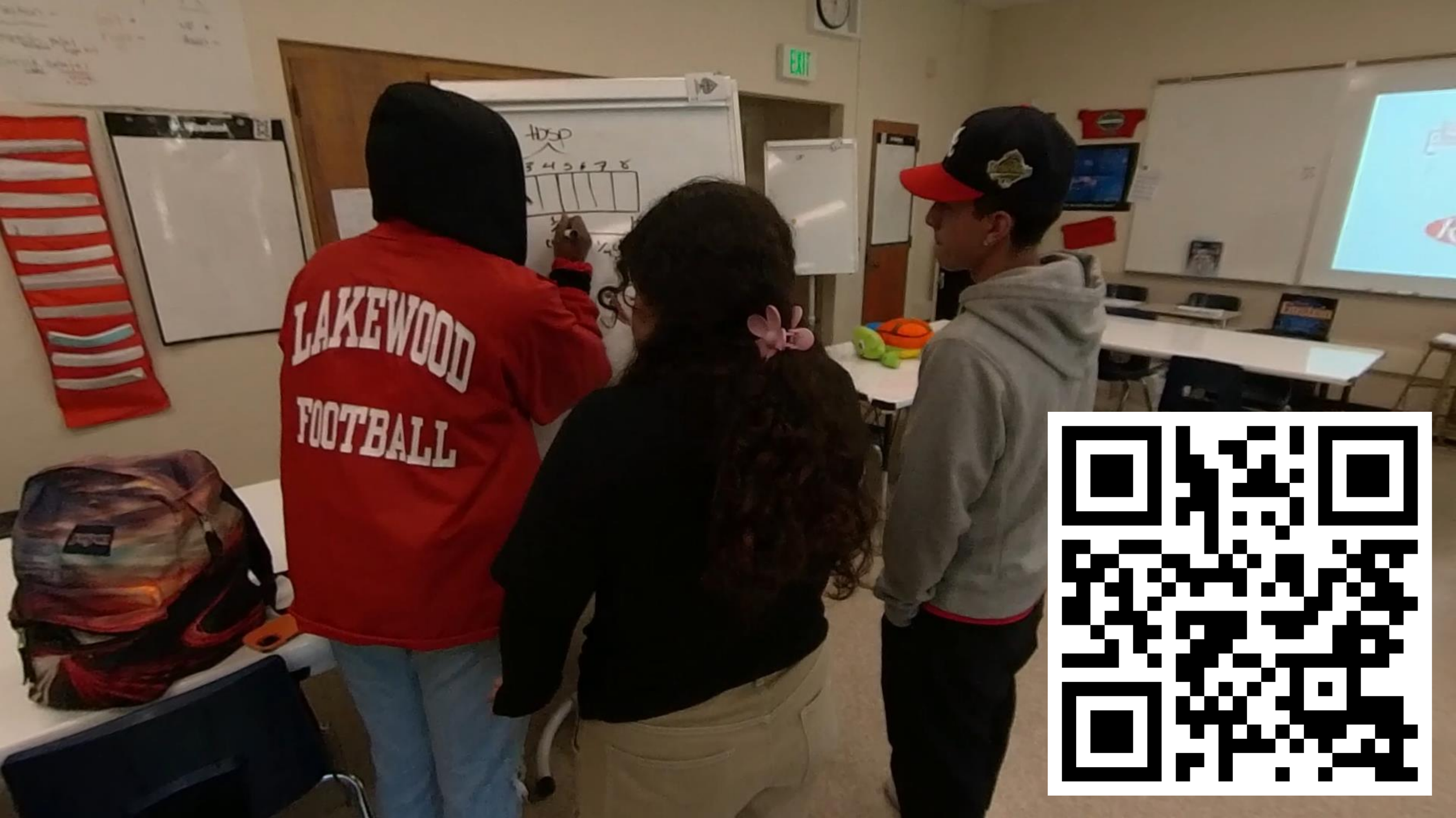
- How is the way I shared this problem with students different than what you experienced as students?


Group A
EXIT


Group A
EXIT
EXIT

DISCUSSION TIME

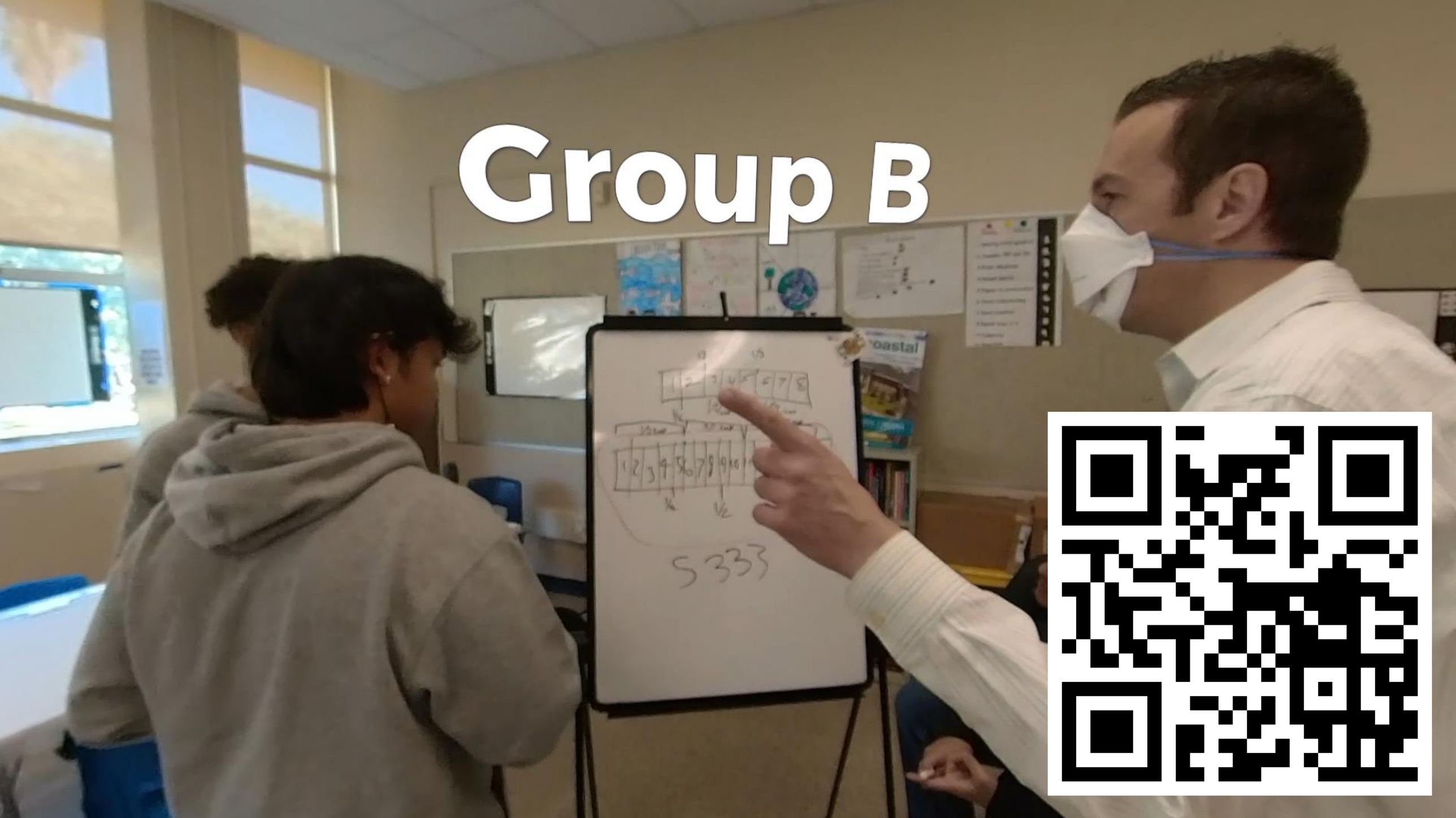
- How do you think having groups of three students sharing vertical whiteboards scattered around the room impacted the way they interacted?


EXIT
LAKEWOOD
FOOTBALL

DISCUSSION TIME

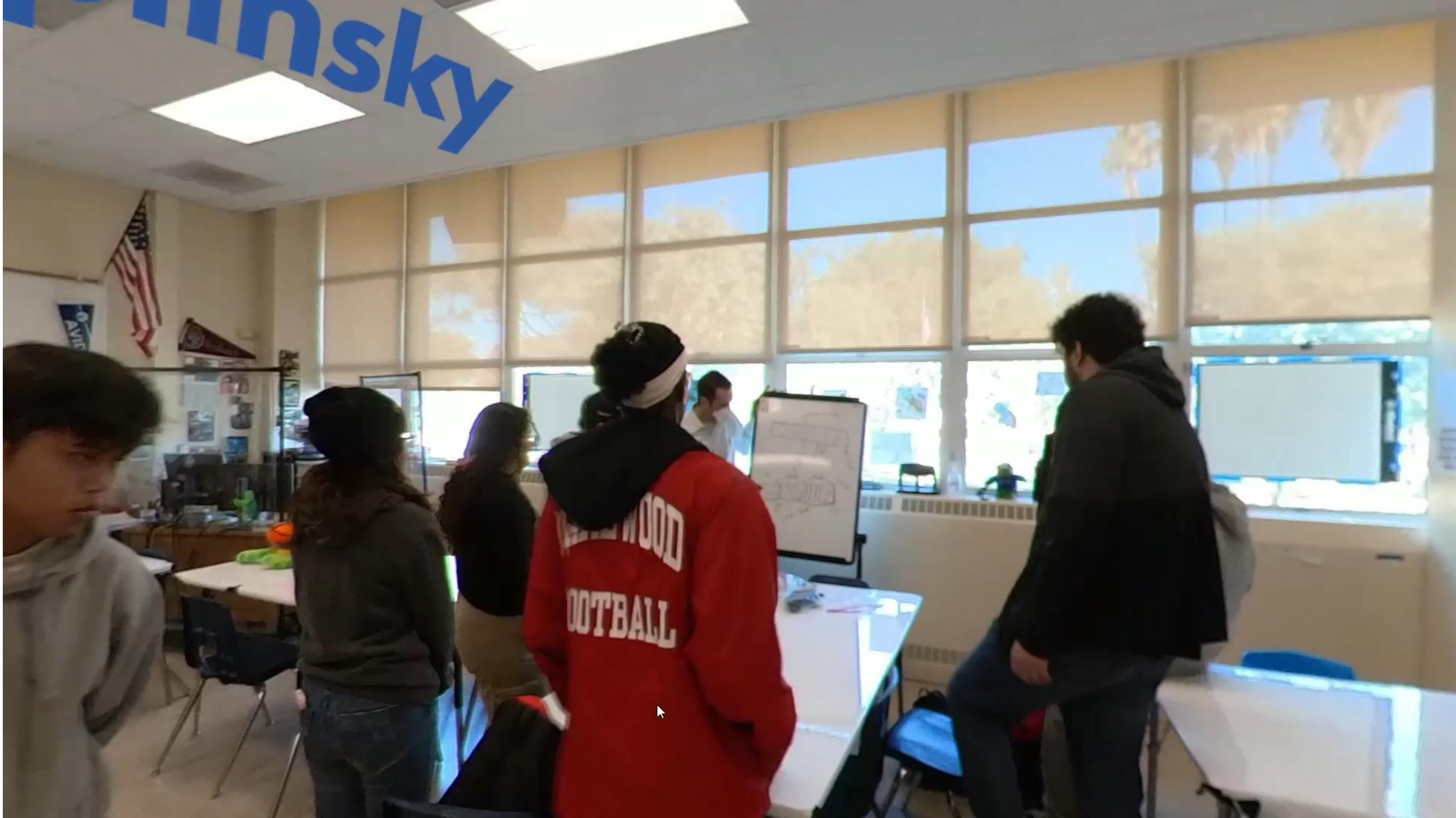
- What was the teacher's role in facilitating group conversations and helping them when they got stuck?

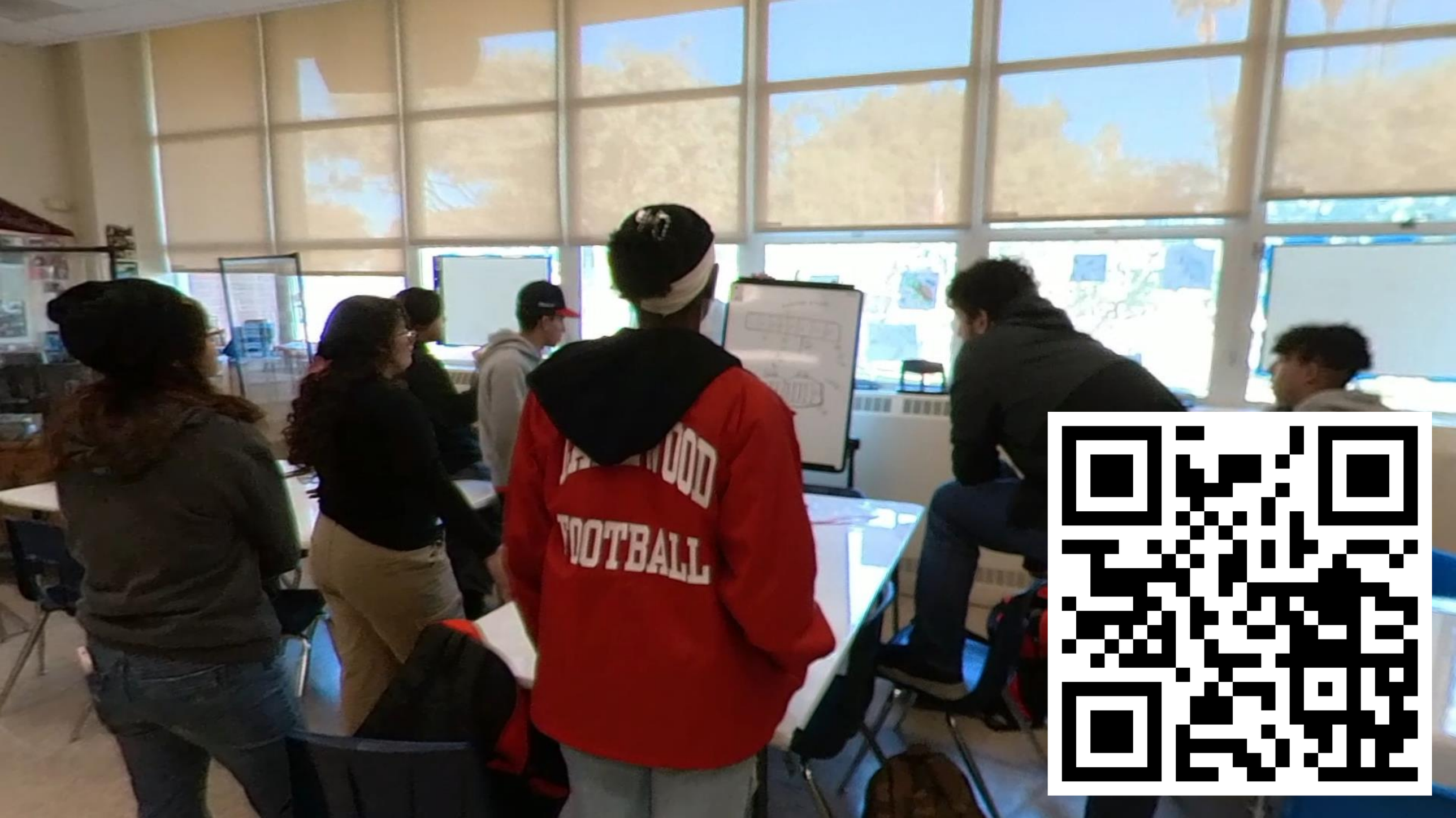
Group B



DISCUSSION TIME

- Why do you think Group C started walking to look at what the other groups were doing?


nsky
OOTBALL


FOOTBALL

DISCUSSION TIME

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

TAKEAWAYS

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

	Before using the problem	Sharing the problem with students	Facilitating the conversation	
Worksheet	Made a worksheet	Showed it to students Guided students with the worksheet	Shared answers	
5 Practices	Anticipated	Showed it to students Monitored students	Selected Sequenced Connected	
BTC	Defronted VNPS			

Merged with BTC

TOPICS

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

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?

TOPICS

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

DISCUSSION TIME

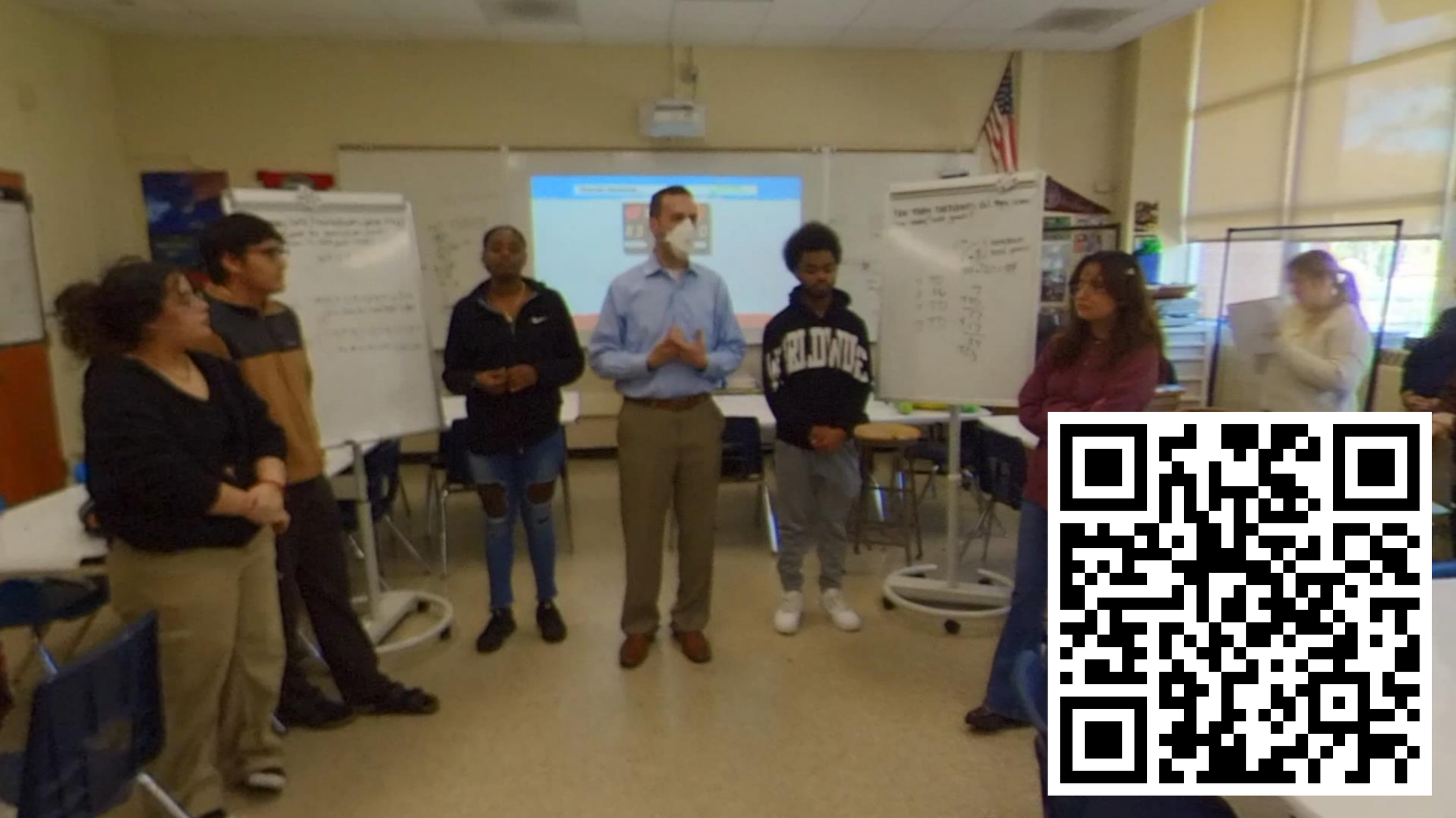
- What part of _____ reinforced what you've already been working to implement?
- What part(s) most challenged your beliefs and/or experiences?

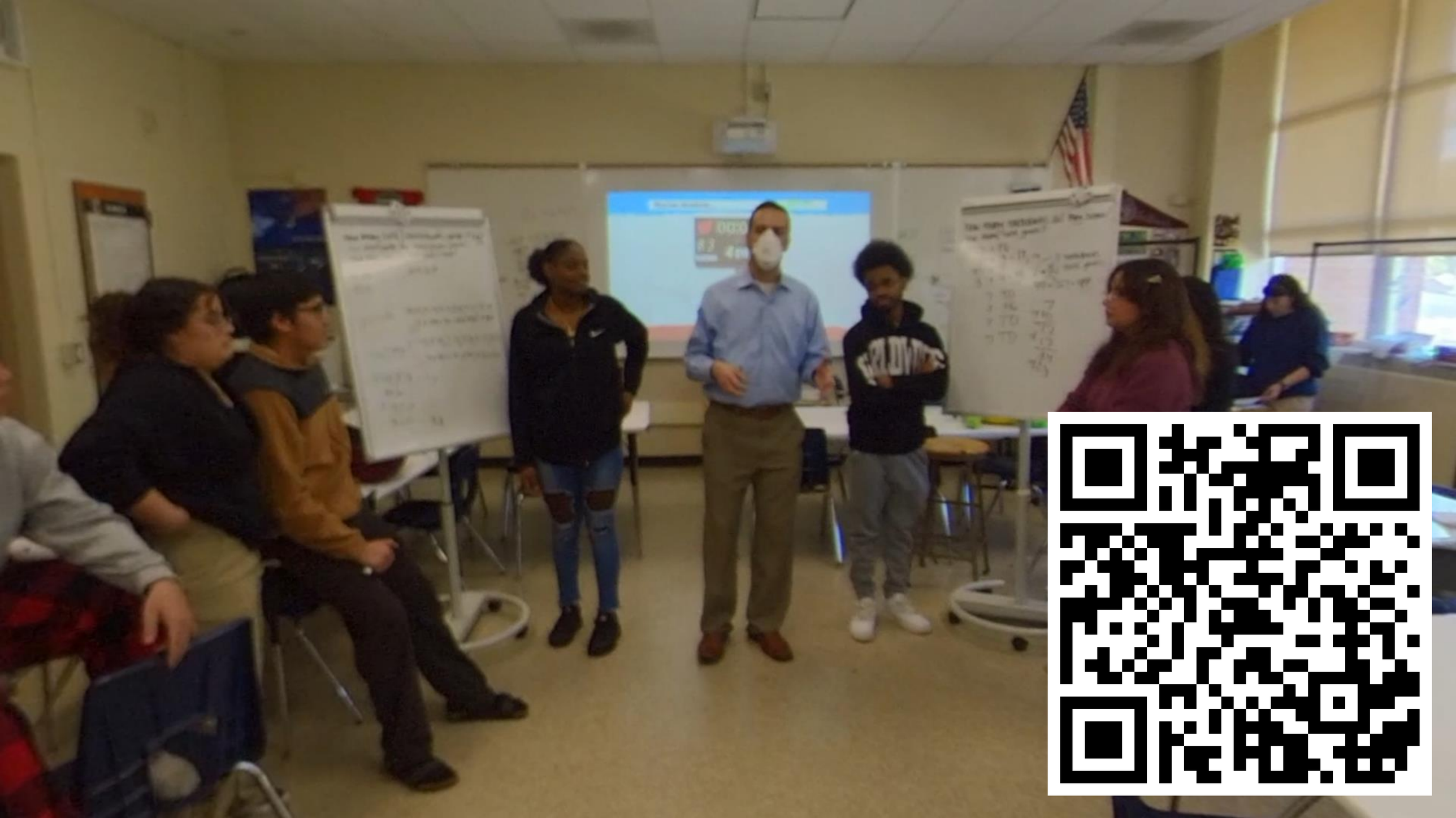
CHECKPOINTS

- ☑ WHY IS MATH EDUCATION BROKEN?
- ☑ HOW DO WE GET STUDENTS THINKING?
- ☐ HOW DO WE GET MORE PRACTICE?
- ☐ HOW DO WE DEAL WITH MISCONCEPTIONS?
- ☐ HOW DO WE GET MORE PRACTICE?

Source: Dan Meyer

Source: Dan Meyer





GAMEHQ

Scores Top 25

Final

Indiana 20
(4-6, 0-6 Big Ten)

(7) Wisconsin 83
(9-1, 5-1 Big Ten)

Check-in 117 Alerts

12:00 PM ET, November 13, 2010
Camp Randall Stadium, MADISON, WI

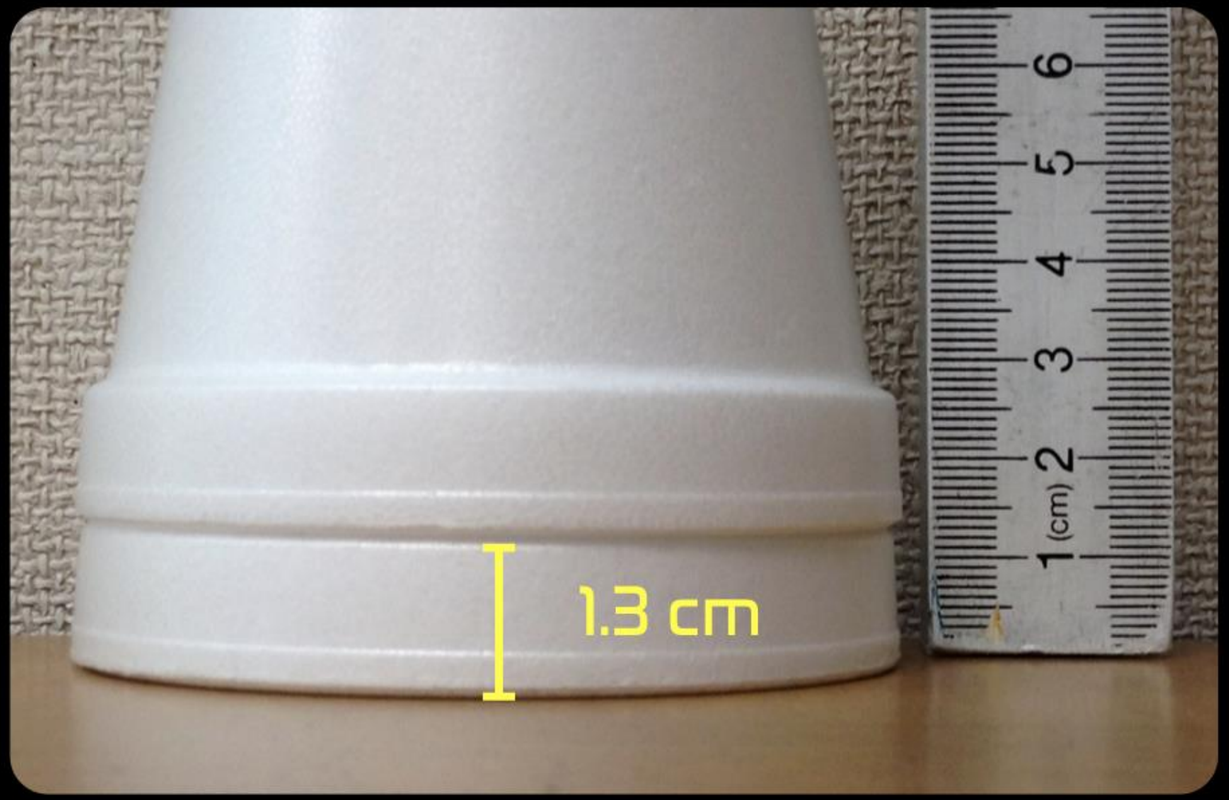
	1	2	3	4	T


00:00
83
WISCONSIN
4 QTR
20
INDIANA


ESTIMATION180.COM

NOTICE AND WONDER

- What do you notice about the video?
- What do you wonder about the video?

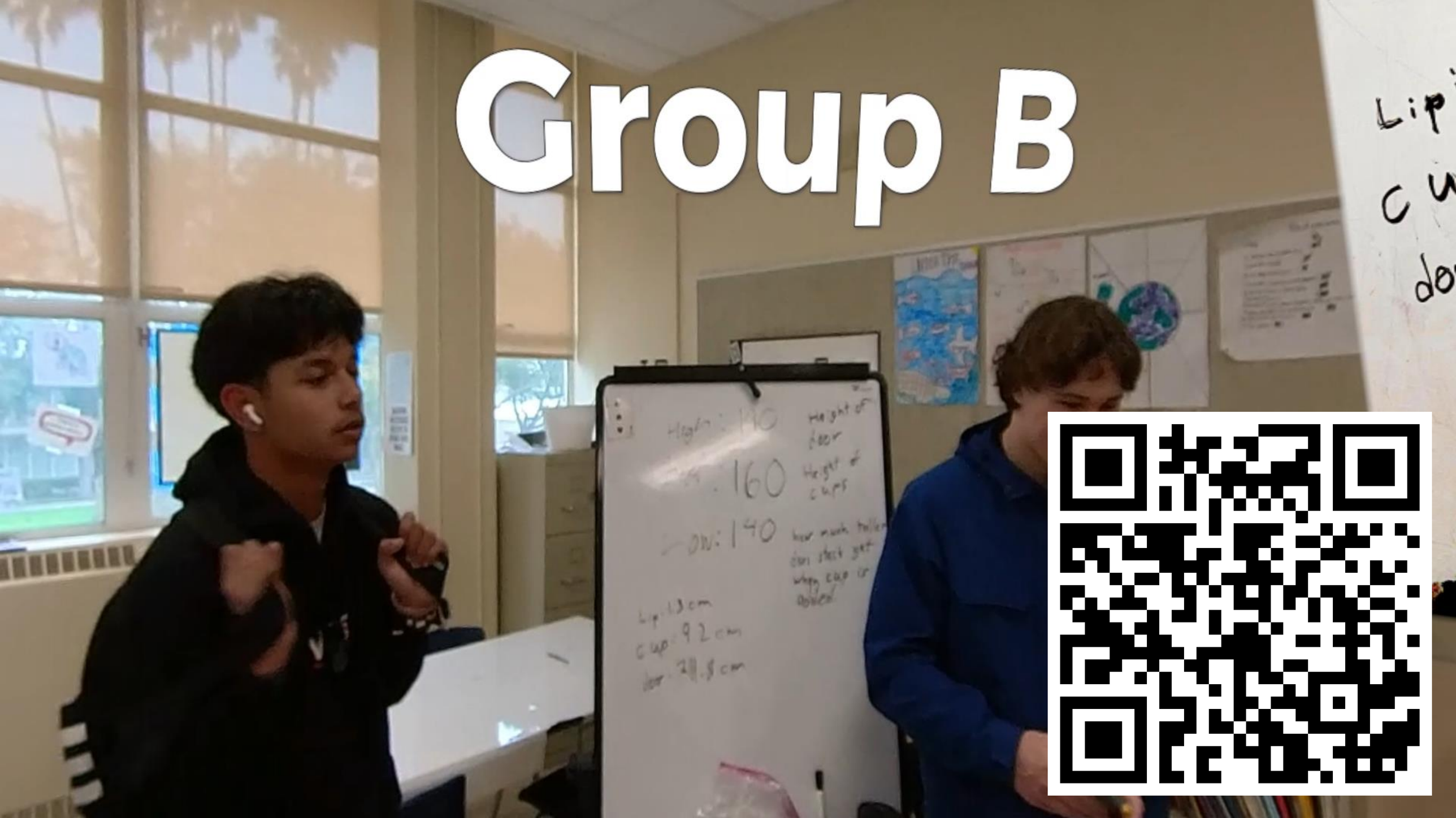


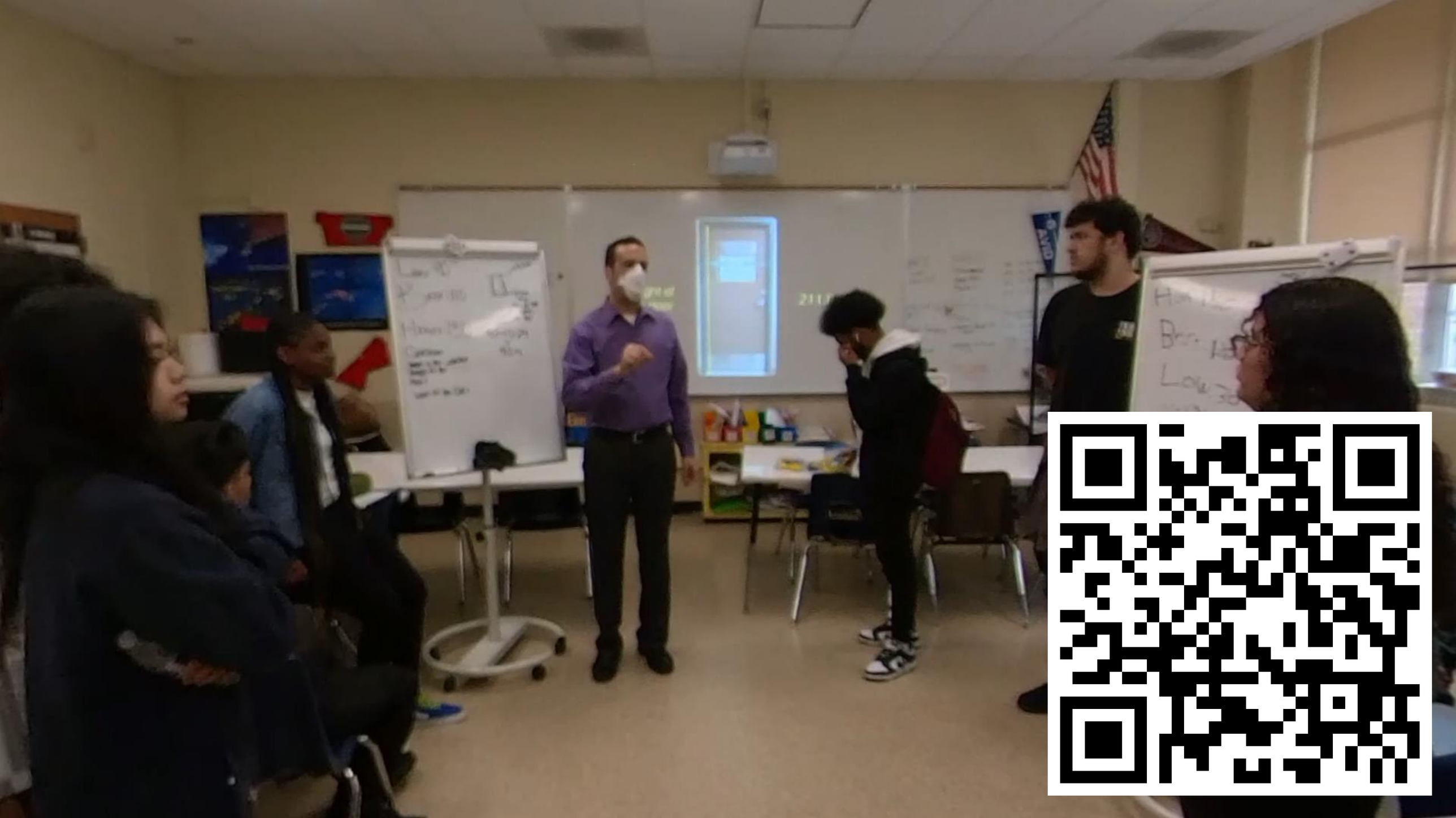
ESTIMATION180.com

height of
the door

211.8 cm

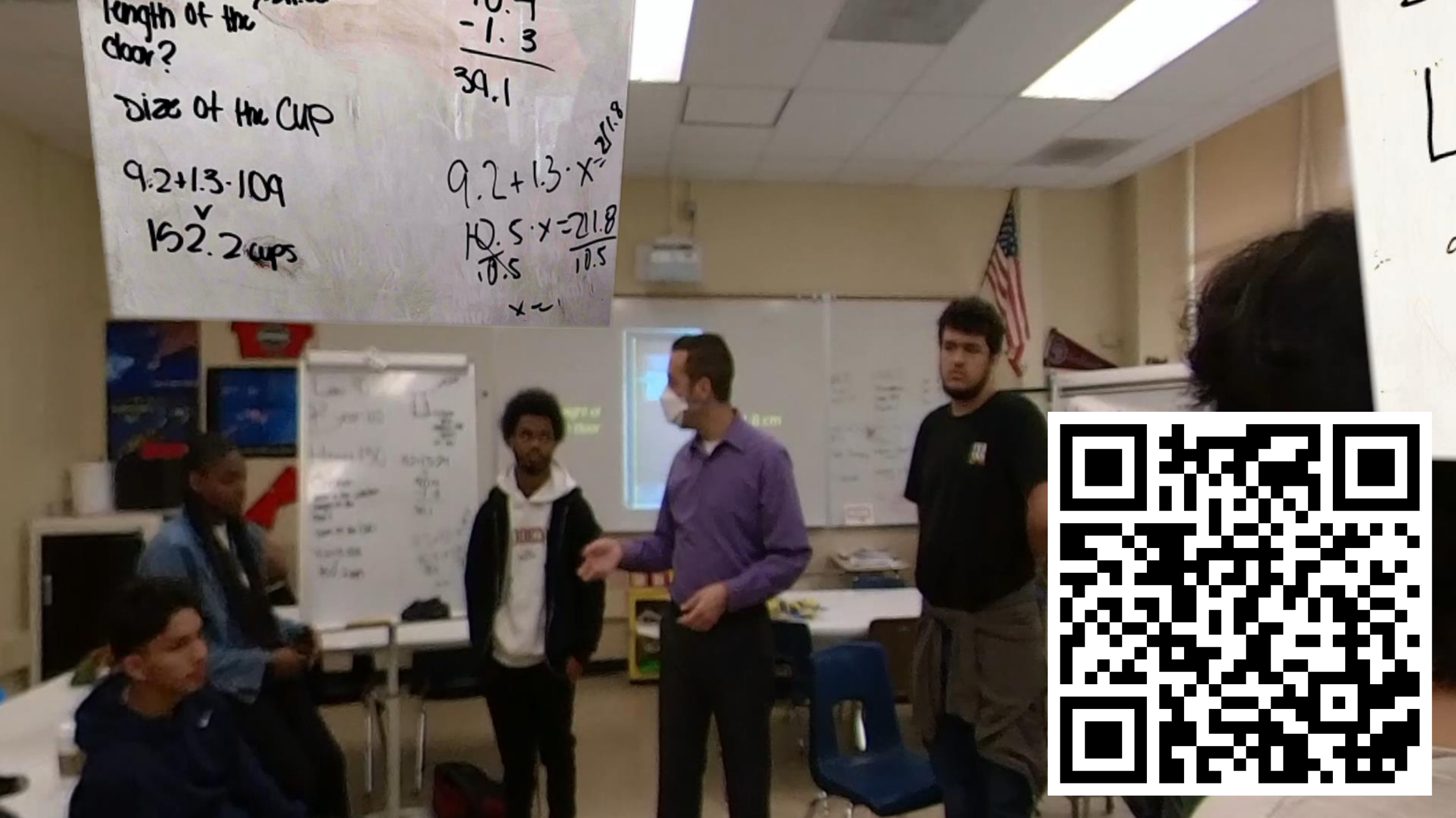
Group B



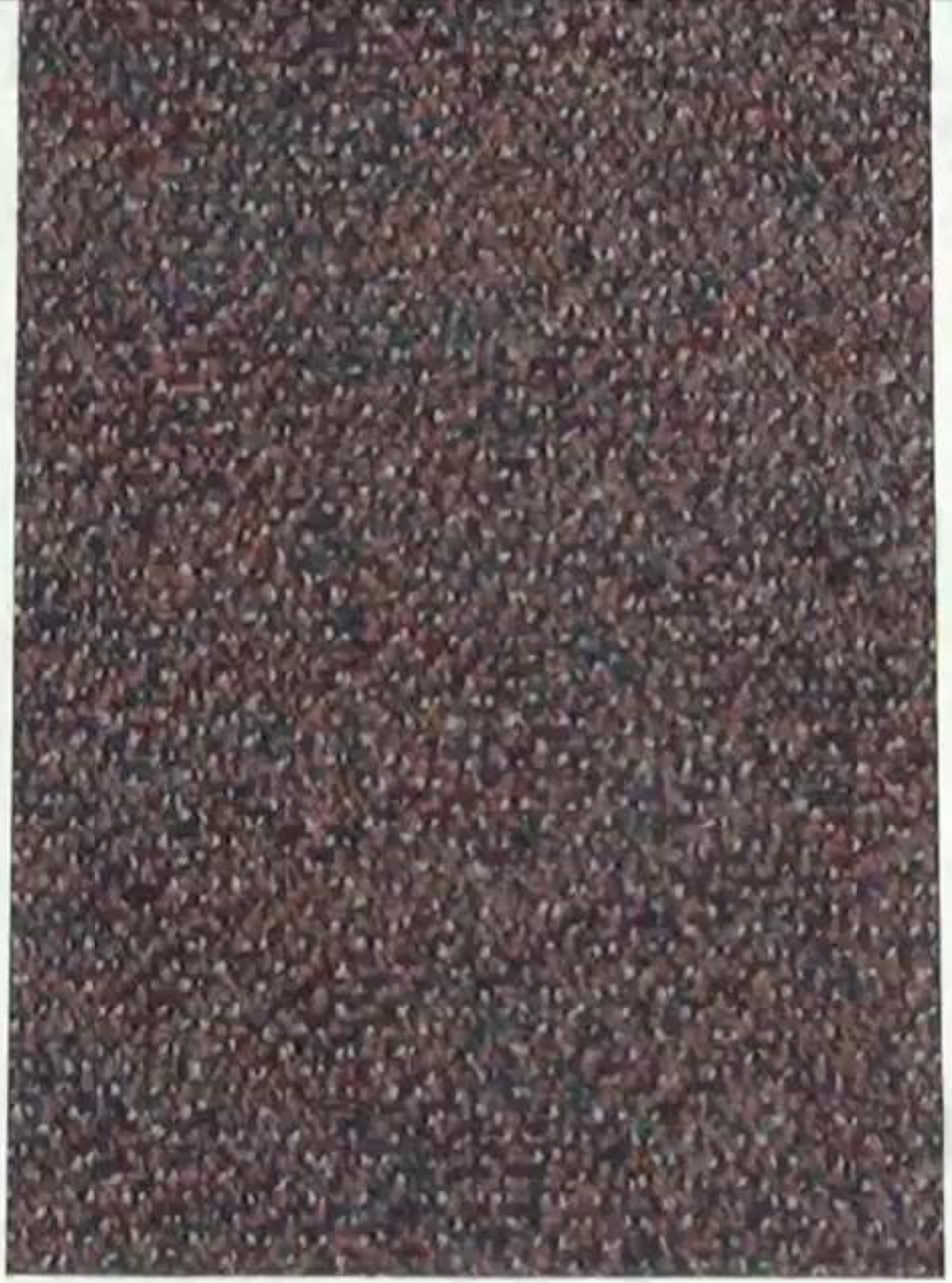


CUPS: 0

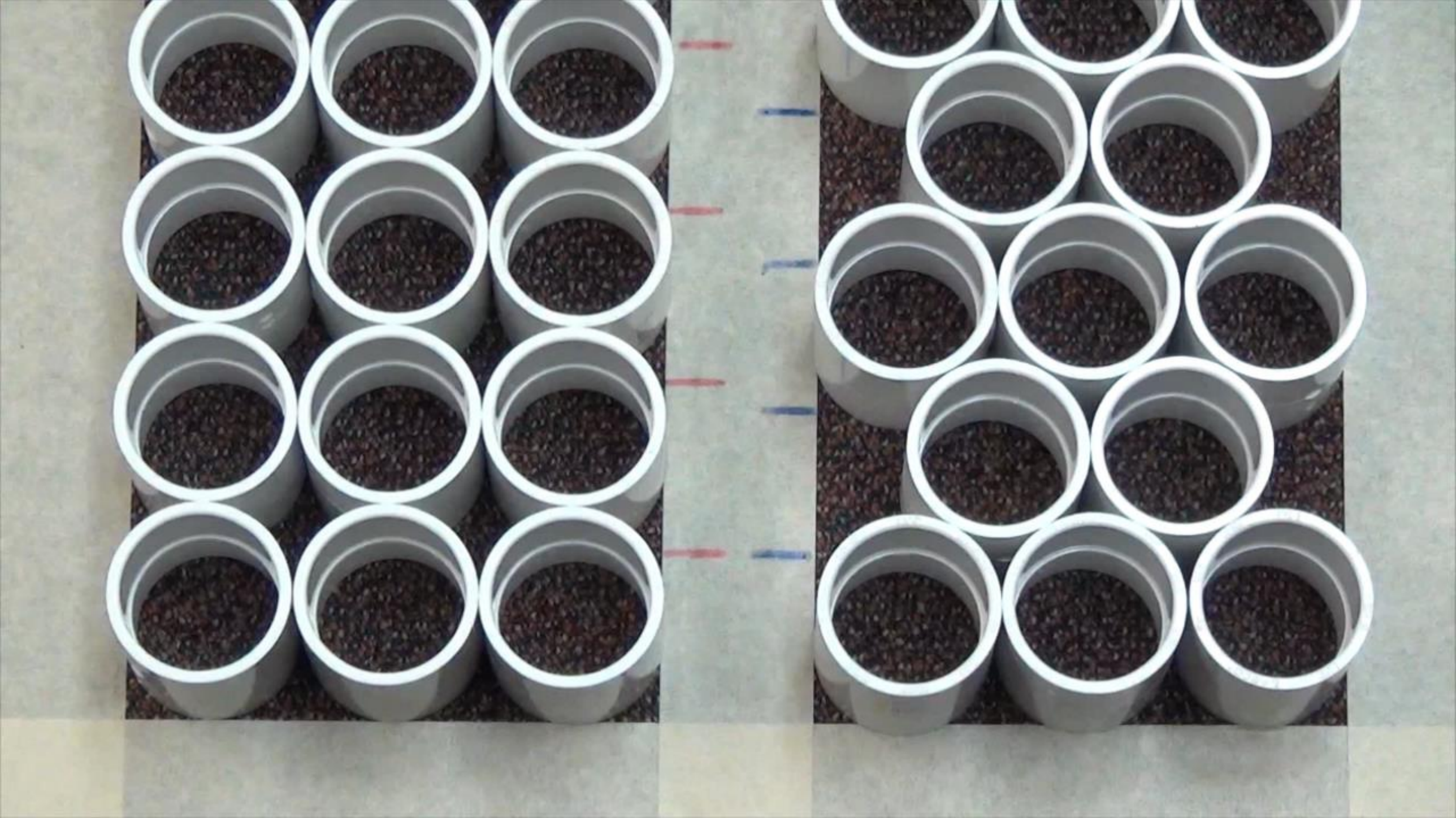
ESTIMATION180.COM

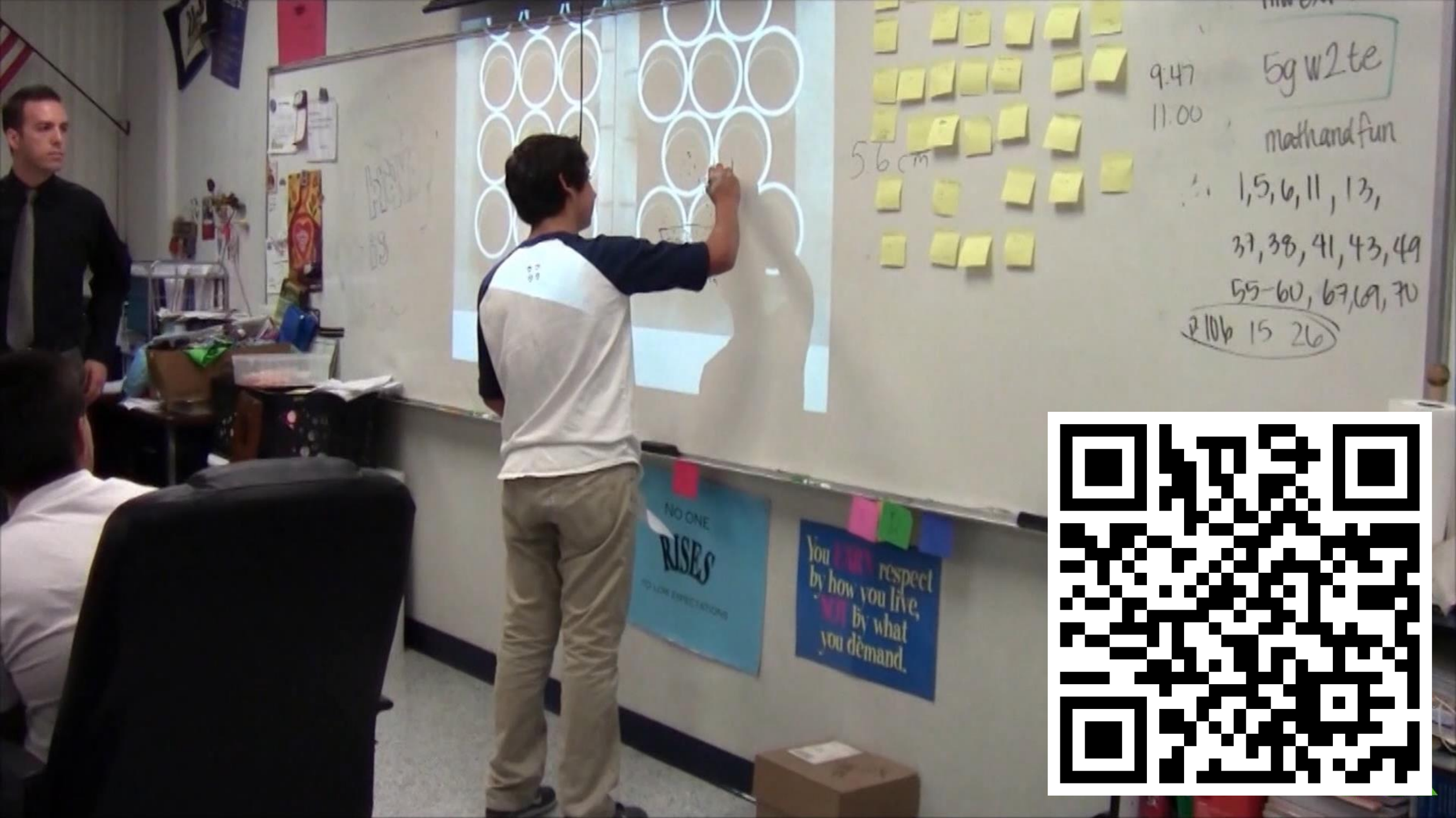

length of the
door?
Size of the Cup
9.2+1.3·109
152.2 cups
-1.3
39.1
9.2+1.3·x=211.8
10.5·x=211.8
10.5
10.5
x=


NON-STAGGERED
STAGGERED




6
7




9.47
11.00
5g w2te
mathandfun
1,5,6,11,13,
37,38,41,43,49
55-60,67,69,70
NO ONE
RISES
You respect
by how you live,
by what
you demand.

Layers: 0


1cm 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

CHECKPOINTS

- ☑ WHY IS MATH EDUCATION BROKEN?
- ☑ HOW DO WE GET STUDENTS THINKING?
- ☑ HOW DO WE GET MORE PRACTICE?
- ☐ HOW DO WE DEAL WITH MISCONCEPTIONS?
- ☐ HOW DO WE GET MORE PRACTICE?

TOPICS

- ❑ KING SOLOMON AND VAN HALEN
- ❑ OPEN MIDDLE
- ❑ ALWAYS, SOMETIMES, NEVER
- ❑ TRUTH TRUTH LIE
- ❑ NEXT STEPS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DOUBLE WORD SCORE
DOUBLE LETTER SCORE
TRIPLE LETTER SCORE

INTERNATIONAL

Winner Of French Scrabble Title Does Not Speak French

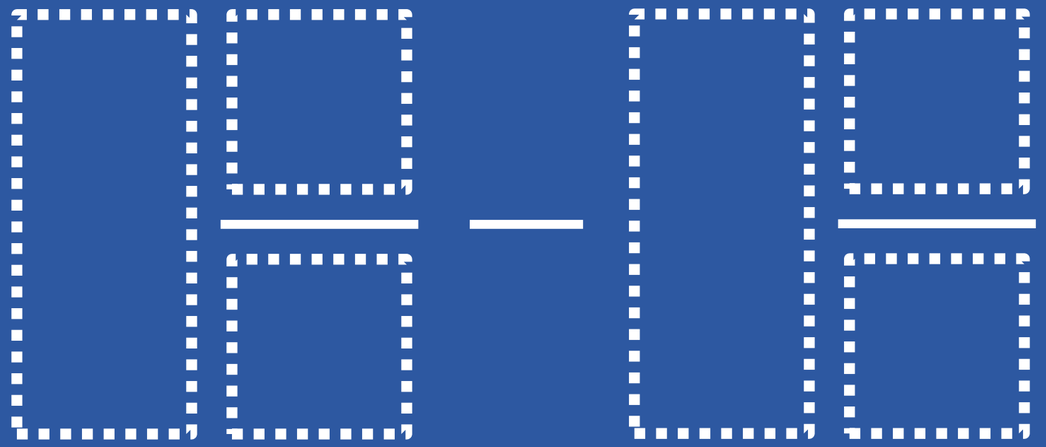
July 21, 2015 · 1:00 PM ET

BILL CHAPPELL

TOPICS

- ☑ KING SOLOMON AND VAN HALEN
- ☐ OPEN MIDDLE
- ☐ ALWAYS, SOMETIMES, NEVER
- ☐ TRUTH TRUTH LIE
- ☐ NEXT STEPS

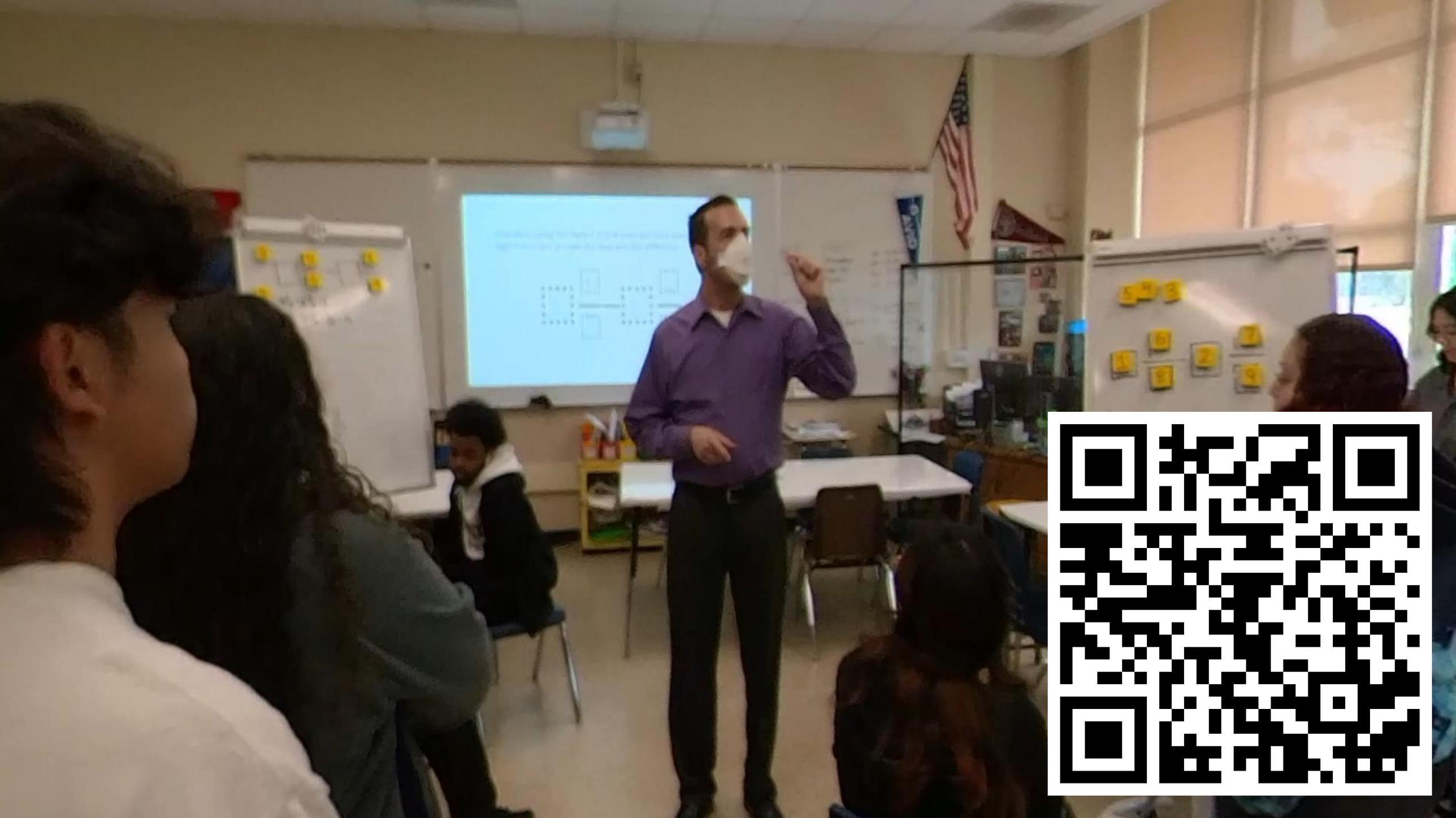
Using the digits 1 to 9 at most one time each, place a digit in each box to make the least possible difference.



Source: openmiddle.com


2 4
3
8 7
6
9 1
5

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



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

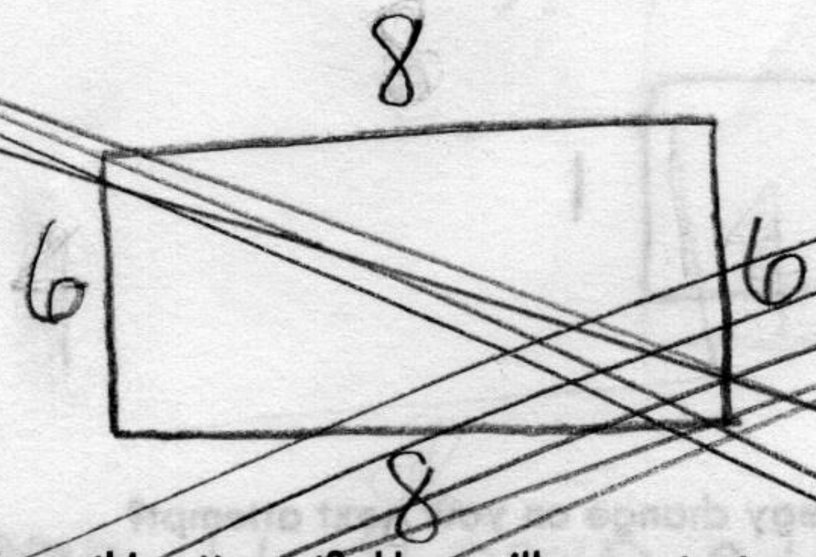
$$\boxed{9}\boxed{8} + \boxed{8}\boxed{6} =$$

What is the perimeter of a rectangle that measures 8 units by 4 units?

List the dimensions of a rectangle with a perimeter of 24 units.

What is the greatest area you can make from a rectangle with a perimeter of 24 units?

First attempt: **Points: ____/2 attempt ____/2 explanation**



area:
48

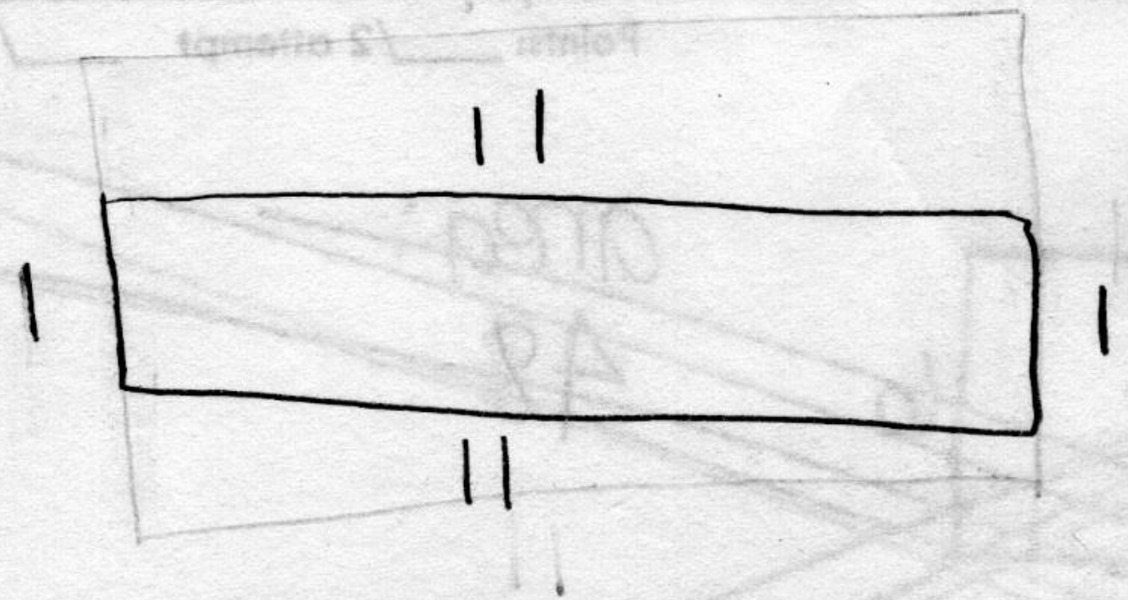
What did you learn from this attempt? How will your strategy change on your next attempt?

This attempt doesn't equal 24.

Second attempt: **Points: ____/2 attempt ____/2 explanation**

area:
32

Fourth attempt: **Points: ____/2 attempt ____/2 explanation**

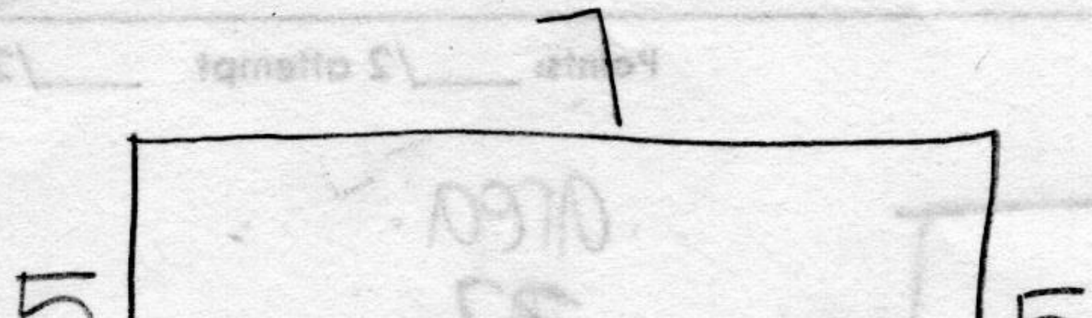


What did you learn from this attempt? How will your strategy change on your next attempt?

The perimeter is 24, but the area is 11 and attempt #2 the area is 32

Strategy: Use #'s with more than one row.

Fifth attempt: **Points: ____/2 attempt ____/2 explanation**



area:
35

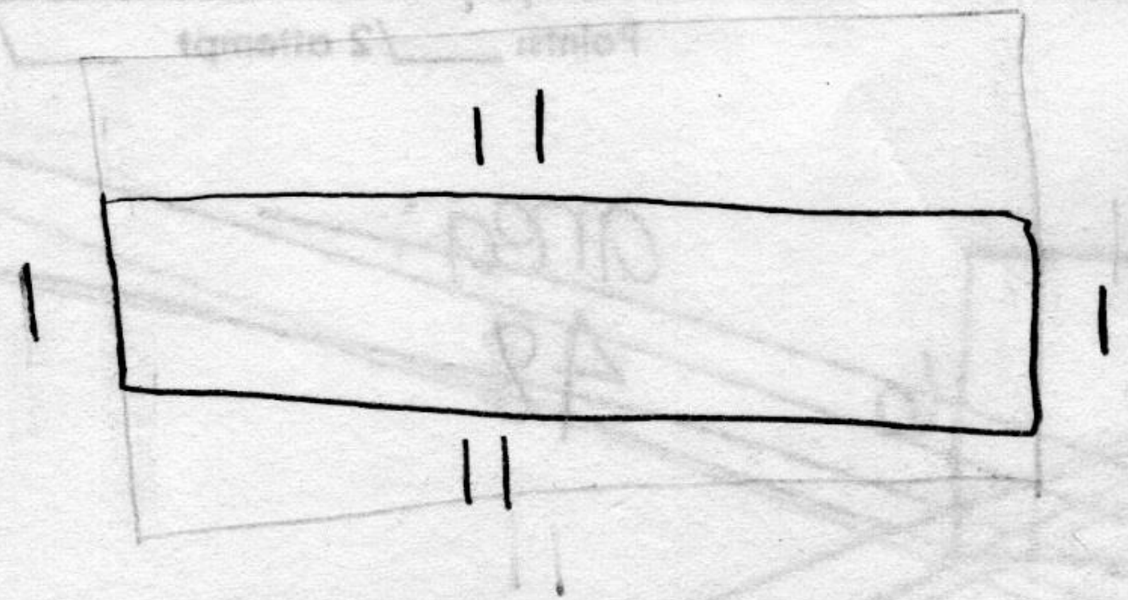
11 units

1 unit

10 units

2 units

Fourth attempt: **Points: ____/2 attempt ____/2 explanation**

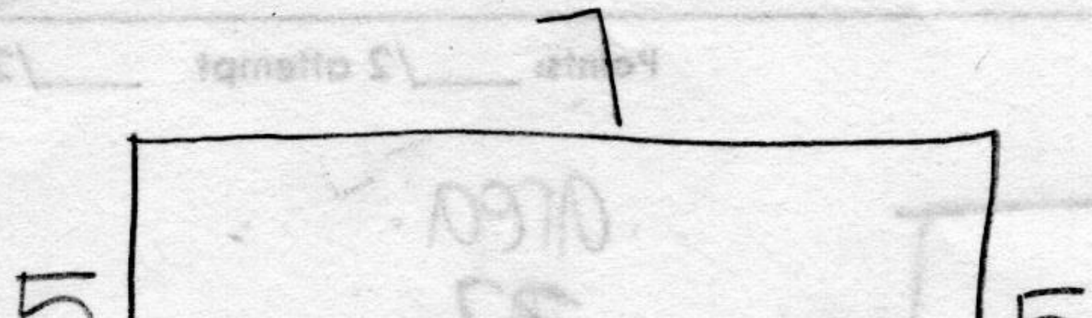


What did you learn from this attempt? How will your strategy change on your next attempt?

The perimeter is 24, but the area is 11 and attempt #2 the area is 32

Strategy: Use #'s with more than one row.

Fifth attempt: **Points: ____/2 attempt ____/2 explanation**



area:
35

TOPICS

- ☑ KING SOLOMON AND VAN HALEN
- ☑ OPEN MIDDLE
- ☐ ALWAYS, SOMETIMES, NEVER
- ☐ TRUTH TRUTH LIE
- ☐ NEXT STEPS

A number with 3 digits is larger than a number with 2 digits.

Source: Joe Schwartz

ALWAYS, SOMETIMES, NEVER

- How do you prove something is:
  - always true?
  - sometimes true?
  - never true?

ALWAYS, SOMETIMES, NEVER

- Can be used:
  - as a collection of statements

Always

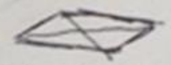
A square has opposite angles congruent.

- yes b/c all angles are 90°

A parallelogram is a quadrilateral.

- yes b/c it has 2 pairs of sides ~~con~~ parallel to each other

A parallelogram has diagonals that bisect each other.



always when both pairs of sides are parallel

A square is a rectangle.

- because it's a rectangle with all equal sides & angles

Sometimes

A rhombus is a rectangle.

- only when there are 90° angles

A square is a rhombus.

- when the angles are all 90°

A rectangle is a rhombus.

- only when it is a square and when the sides are equal

A rhombus is a square.

- only when the angles are 90°

A rhombus has congruent diagonals.

- when all of the sides are equal

Never

A rectangle is a square.

- a square can be a rectangle but a rectangle can never be a square

A trapezoid has legs congruent.

~~- yes b/c one pair is parallel (base)~~ None ~~but they are~~ not ~~pair~~ congruent

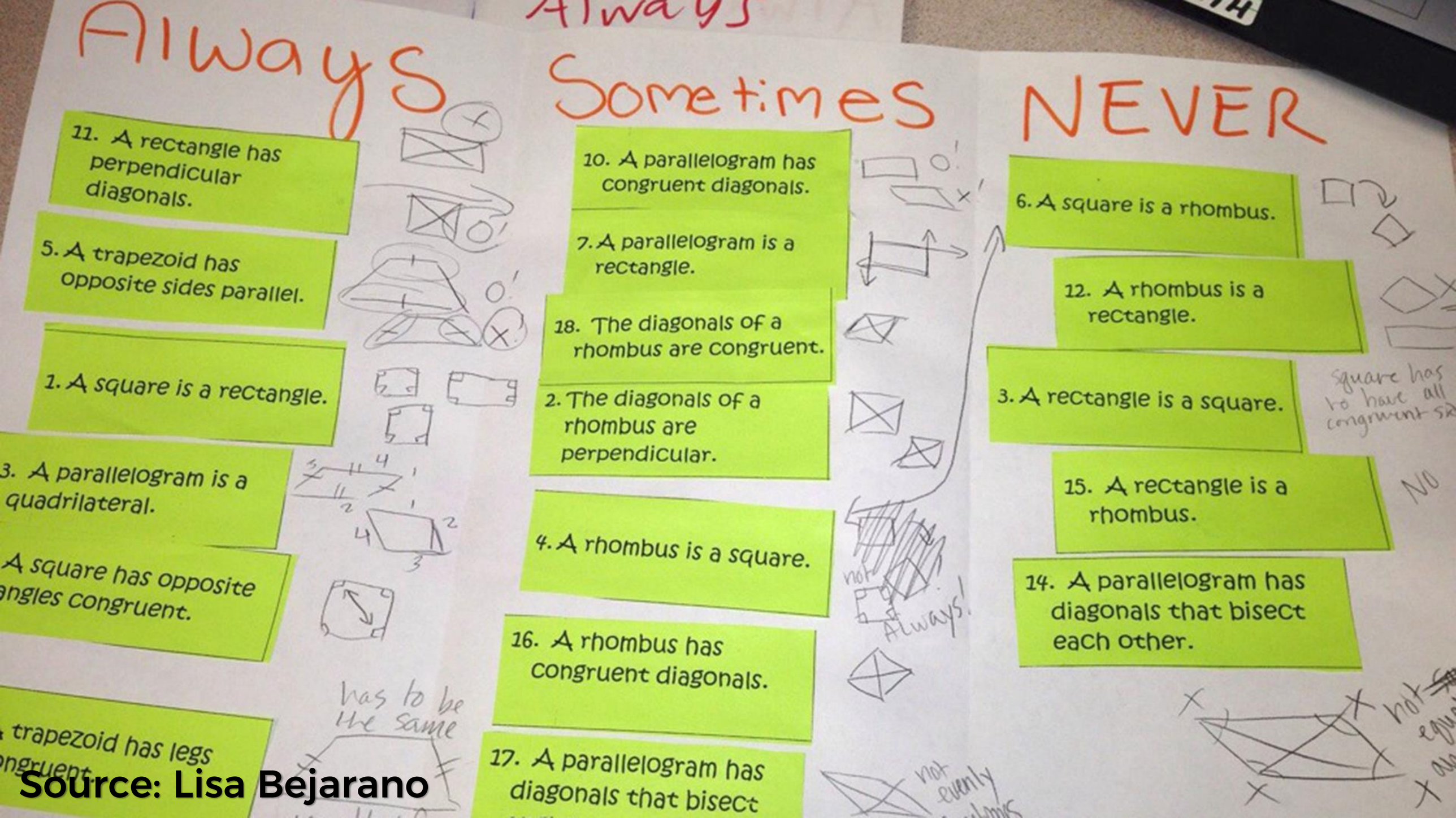
A trapezoid has opposite sides parallel.

- one pair of opposite sides are parallel but the other pair is not.

A rectangle has perpendicular diagonals.

- never because only diagonals are perpendicular with squares and rhombuses

Source: Lisa Bejarano



Source: Lisa Bejarano

ALWAYS, SOMETIMES, NEVER

- Can be used:
  - as a collection of statements
  - a single statement

A Hexagon is...
six sided figure
with equal side lengths
with each side coming
together at a 60° angel
on the inside

Source: mathmistakes.org

ALWAYS, SOMETIMES, NEVER

- Grades K-5: Arithmetic
- Grade 3-8: Fractions
- Grades 9-12: Systems of Equations

Sort the carts into three groups. Put all the statements that are always true with the ALWAYS card. Put all the statements that are sometimes true with the SOMETIMES card. Put all the statements that are never true with the NEVER card.

Fractions are numbers less than one.

Fifths are bigger than sixths

If two fractions have the same denominator, the one with one with the larger numerator is greater.

You can represent the area of the fraction like 1/2 in different ways as long as they have each have the same total area.

Tenths are smaller than hundredths

One-third is one of three pieces.

The fractions 1/2, 3/6, and 4/8 all appear in the same place on a number line.

SOMETIMES

The numerator is less than the denominator.

The bigger the denominator, the bigger the pieces.

Fractions have a value between 0 and 1.

ALWAYS

$\frac{3}{6} > \frac{1}{2}$

You can't simplify a fraction with an odd denominator.

NEVER

$\frac{3}{5} > \frac{3}{4}$

Equal-sized pieces have the same shape.

The bigger the numerator, the more pieces there are.

ALWAYS, SOMETIMES, NEVER

- Grades K-5: Arithmetic
  - robertkaplinsky.com/arithmetic
- Grade 3-8: Fractions
  - robertkaplinsky.com/fractions
- Grades 9-12: Systems of Equations
  - robertkaplinsky.com/systems

LESSONS LEARNED ABOUT ASN

- Be careful using statements that expire:
  - When you subtract a number, you can never take away a larger number from a smaller number.
  - When you divide, the quotient is always smaller.
  - Only positive numbers have square roots.

LESSONS LEARNED ABOUT ASN

- Better in small groups than individually.
- You can jigsaw groups.
- More issues come out during discussions.
- Talk about sufficient reasoning.

ALWAYS, SOMETIMES, NEVER

Lisa Bejarano

Grace Chen

Sarah Carter

Beth Ferguson

Kristin Gray

Chris Luzniak

Fawn Nguyen

Joe Schwartz

Christy Sutton

Tracy Zager

TOPICS

- ☑ KING SOLOMON AND VAN HALEN
- ☑ OPEN MIDDLE
- ☑ ALWAYS, SOMETIMES, NEVER
- ☐ TRUTH TRUTH LIE
- ☐ NEXT STEPS

TRUTH TRUTH LIE

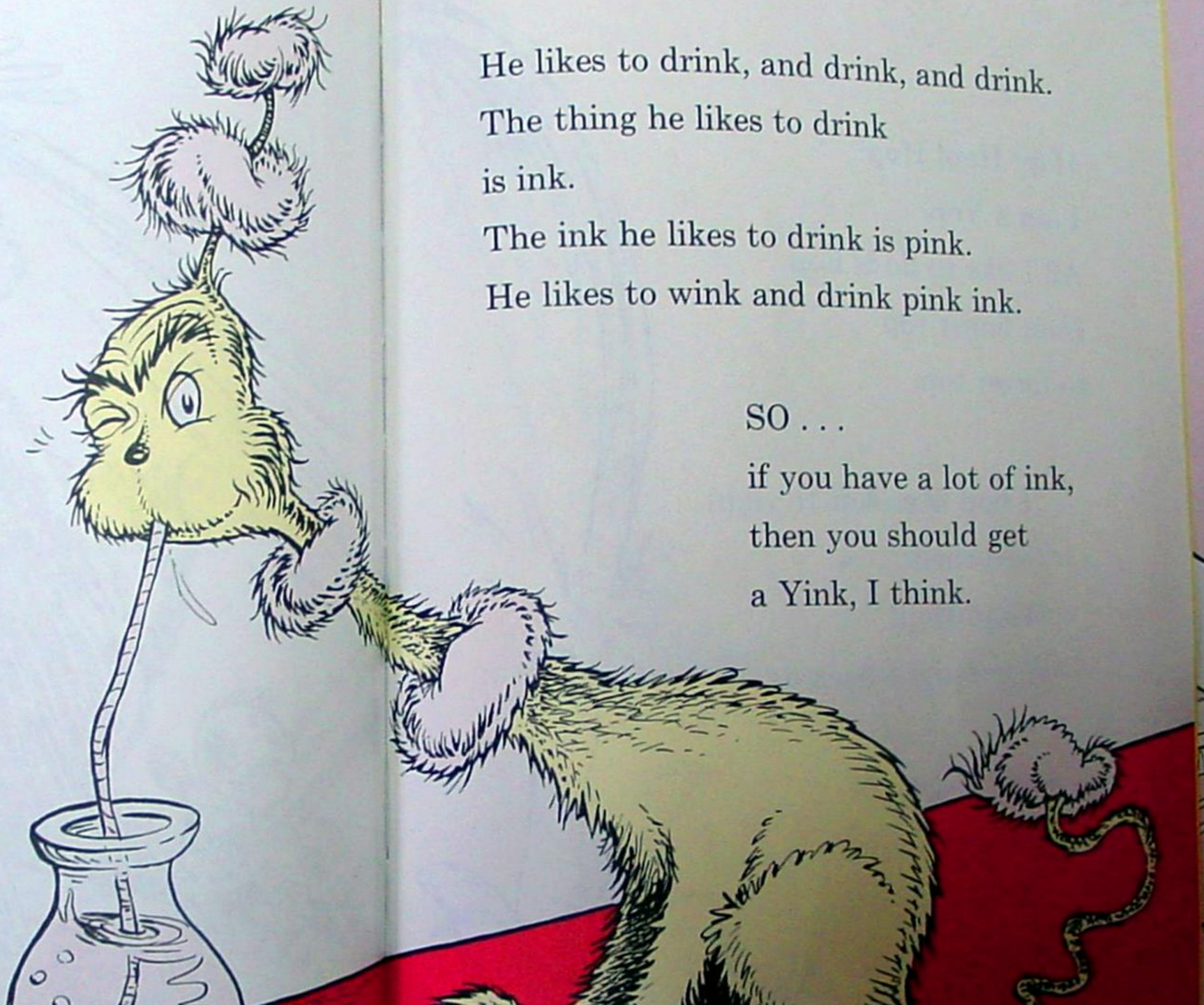
- I’ve been in two commercials but have only seen one of them.
- I always skip a page of the *Cat in the Hat* because it scares me.
- I have a rap video on YouTube with over 19,000 views


KAY-Z

This one,
I think,
is called
a Yink.

He likes to wink,

he likes to drink.



He likes to drink, and drink, and drink.
The thing he likes to drink
is ink.
The ink he likes to drink is pink.
He likes to wink and drink pink ink.

SO . . .
if you have a lot of ink,
then you should get
a Yink, I think.

TRUTH TRUTH LIE

- My name is Robert.
- I eat food.
- I am 14 feet tall.

- Adding two negative numbers always gives you a negative sum.
- Subtracting two negative numbers always gives you a positive difference
- Multiplying two negative numbers always gives you a positive product.

False

- $1 - -1 = 0$
- $-3 - 2 = -5$ ← True
- $2 \cdot 15 = 40$

False?!

Thinking: Mistake is probably the first statement. Need to review subtracting integers.

True

True

Multiplying negatives makes a posative

If you square a negative numbe its posative

Intigers are all rational numbers.

True!?

Thinking: Unclear.

I think Integers are cool

I think integers are boring

I think integers are easy

Thinking: I needed to show more examples and more clearly set expectations.

LESSONS LEARNED ABOUT TTL

- Huge reality check
- Easier to answer than create.
- Smoother later in unit

TOPICS

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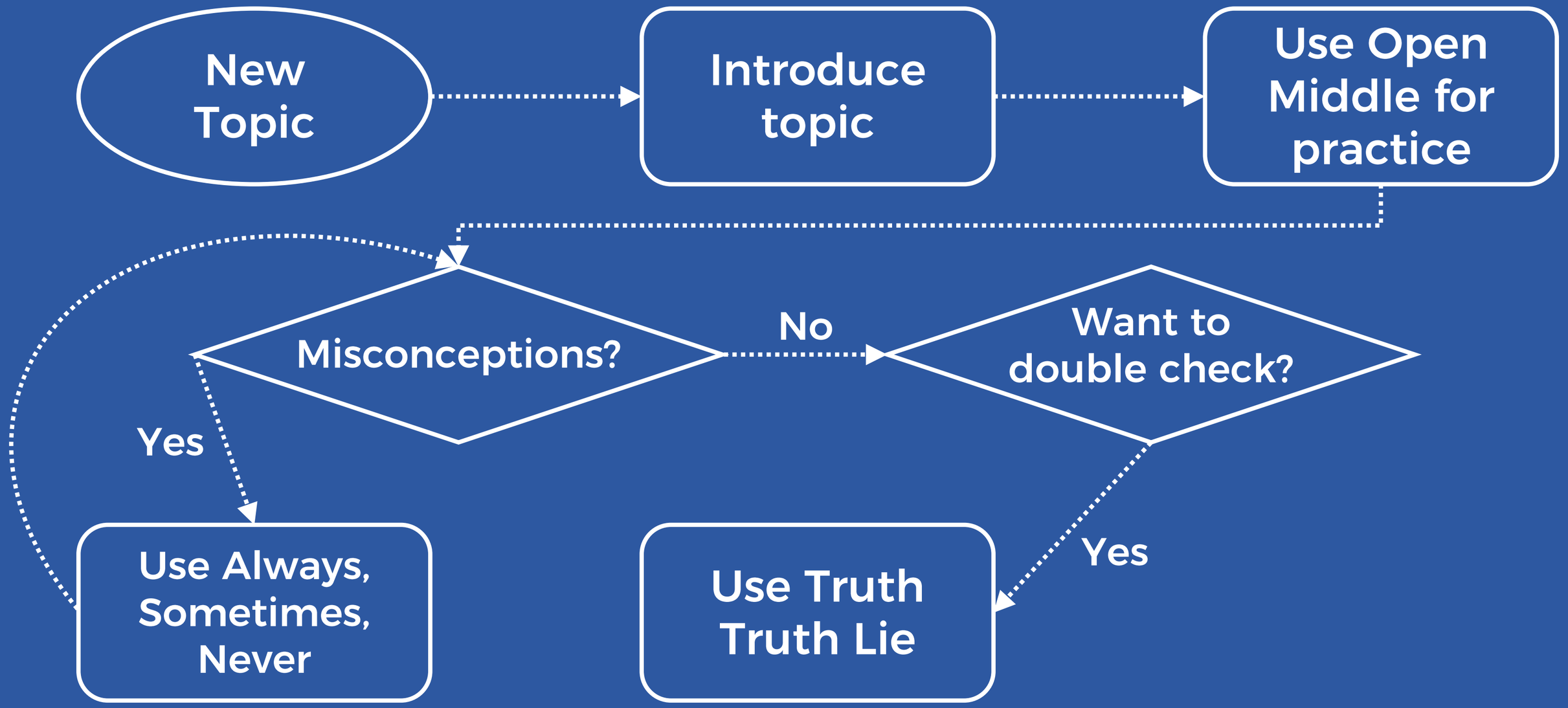
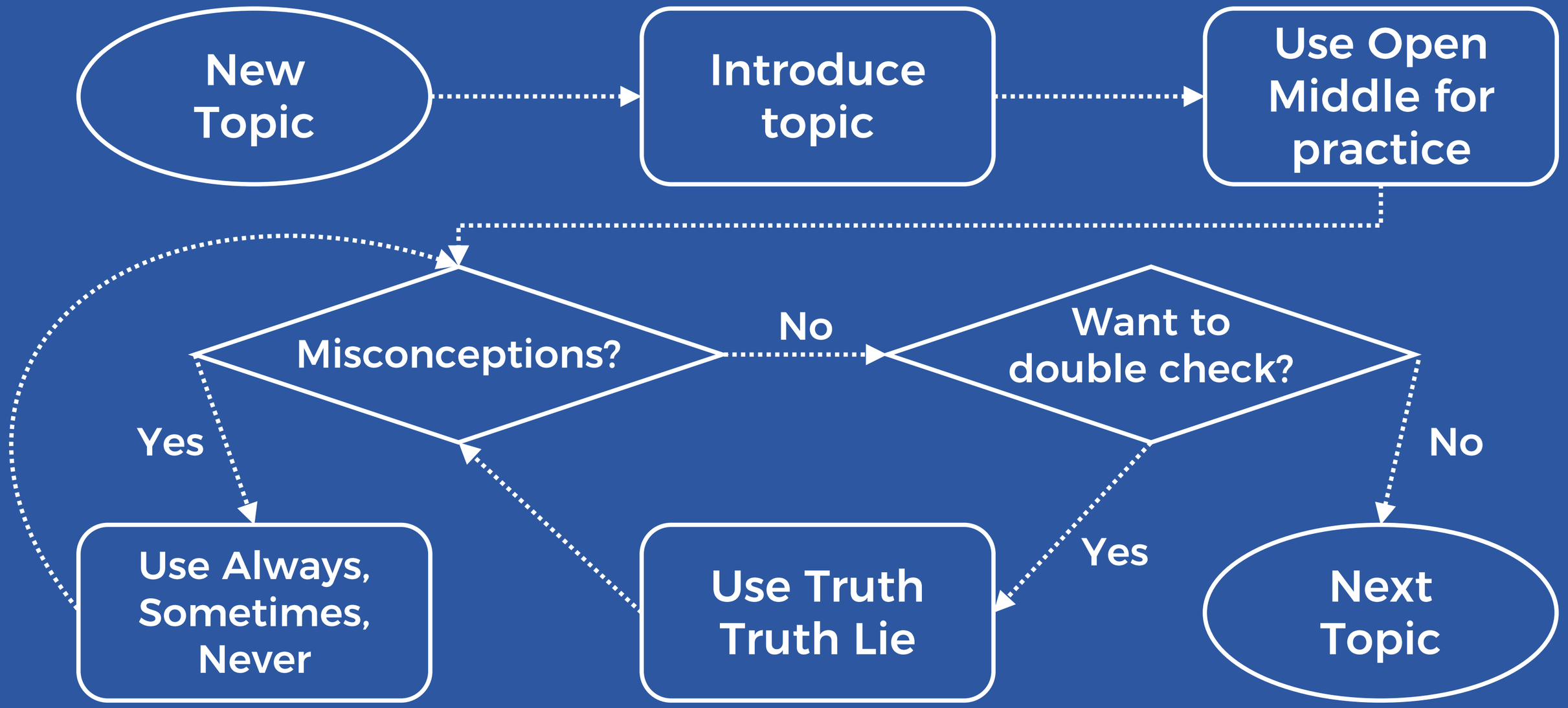

New Topic
Introduce topic
Use Open Middle for practice
Misconceptions?
No
Want to double check?
Yes
Use Always, Sometimes, Never
Use Truth Truth Lie
Yes

1.) a negative Plus a negative is a Positive

2.) adding 2 Numbers together gives you a bigger number

3.) a - Plus a + can be a - & a + depending on which is bigger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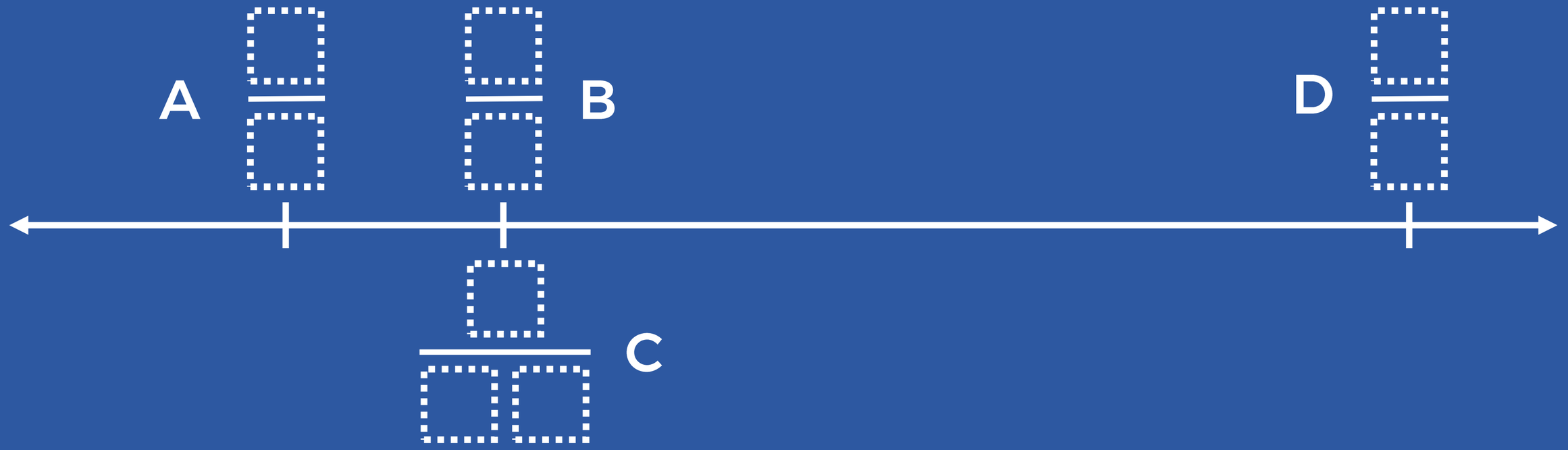
- ☑ KING SOLOMON AND VAN HALEN
- ☑ OPEN MIDDLE
- ☑ ALWAYS, SOMETIMES, NEVER
- ☑ TRUTH TRUTH LIE
- ☑ NEXT STEPS

CHECKPOINTS

- ☑ WHY IS MATH EDUCATION BROKEN?
- ☑ HOW DO WE GET STUDENTS THINKING?
- ☑ HOW DO WE GET MORE PRACTICE?
- ☑ HOW DO WE DEAL WITH MISCONCEPTIONS?
- ☐ HOW DO WE GET MORE PRACTICE?

Using the digits 1 to 9 exactly once, place a digit in each box to create and place 4 fractions on the number line in the correct order. Fractions B & C are equal.



Source: Graham Fletcher, Bowen Kerins, & Kate Nowak on openmiddle.com

Using the digits 0 to 9 at most one time each, place a digit in each box to make a true statement with the greatest possible total.

$$(\square \times \square) + (\square \times \square) = \square\square$$

Source: Owen Kaplinsky and Robert Kaplinsky on openmiddle.com

Using the integers -9 to 9 at most one time each, place an integer in each box to create a system of equations with a solution in that's as close to the origin as possible.

$$y = \frac{\square}{\square}x + \square \qquad y = \frac{\square}{\square}x + \square$$

Source: openmiddle.com

Using the integers -9 to 9 at most one time each, place a digit in each box to create endpoints for the longest possible line segment whose midpoint is (1, 3).

(□ , □) and (□ , □)

Source: openmiddle.com

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HOW TO IMPLEMENT ENGAGING PROBLEM SOLVING IN YOUR MATH CLASSROOM

ROBERT KAPLINSKY

robert@robertkaplinsky.com

robertkaplinsky.com/engaging

@robertkaplinsky