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Principles to Action with Tech

Scott Farrar
@farrarscott

NCTM 2017

Goals:

1. Understand what can tech can/should support

2. Have teachers leverage that support

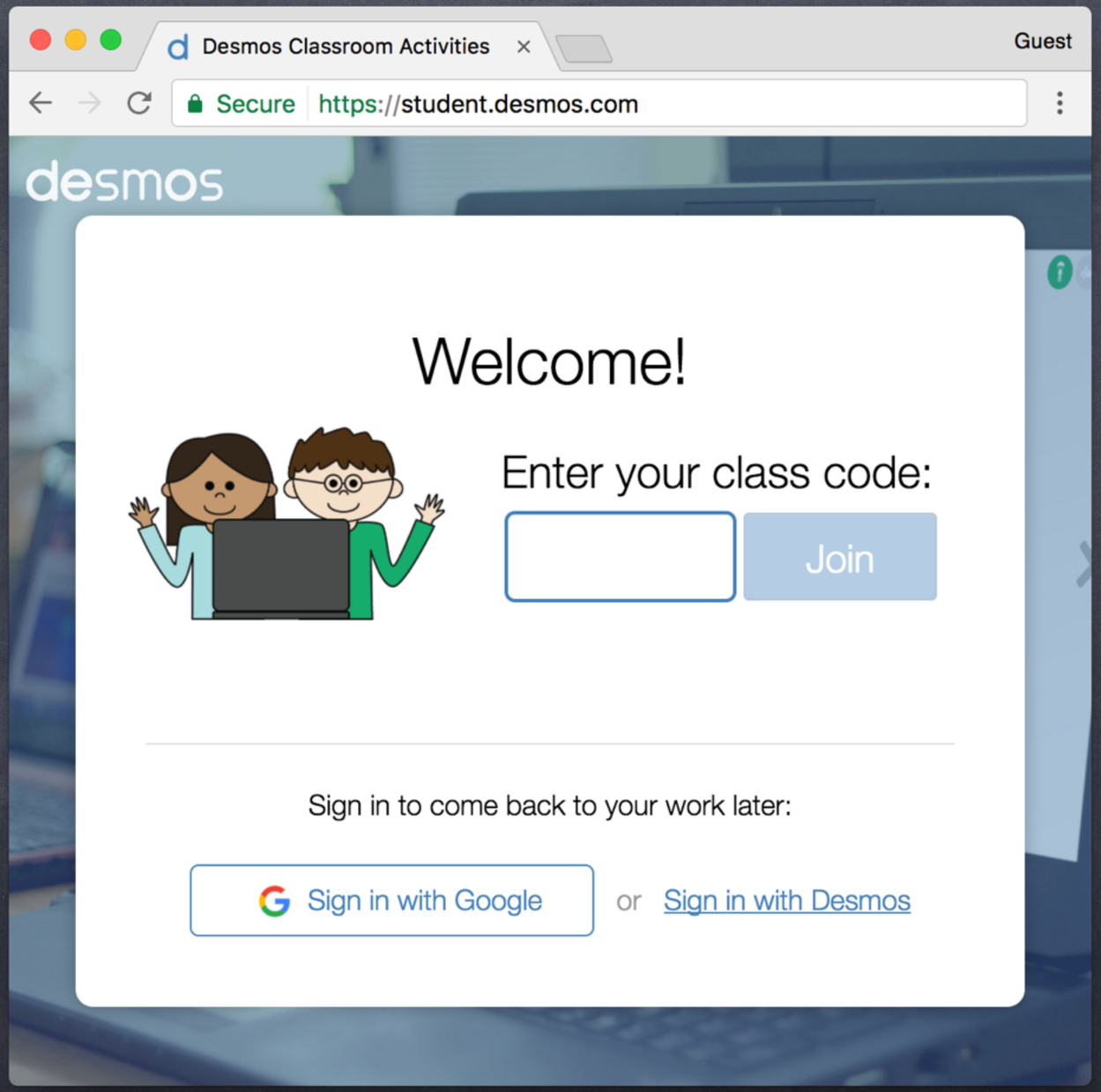
Goals:

1. Understand what can tech can/should support

2. Have teachers leverage that support

student.desmos.com

695S7



695S7

Your experience?

Think of a modern tech tool you've used or observed in a classroom,

what made it 'good'? or not?

talk with your neighbor

695S7

Share!

Think of a tech example...

Think of a modern tech tool you've used or observed in a classroom.

What made the tech good for learning? Or, not good for learning?

Submit to Class

695S7

Farrar: Principles to Action wit

Guest

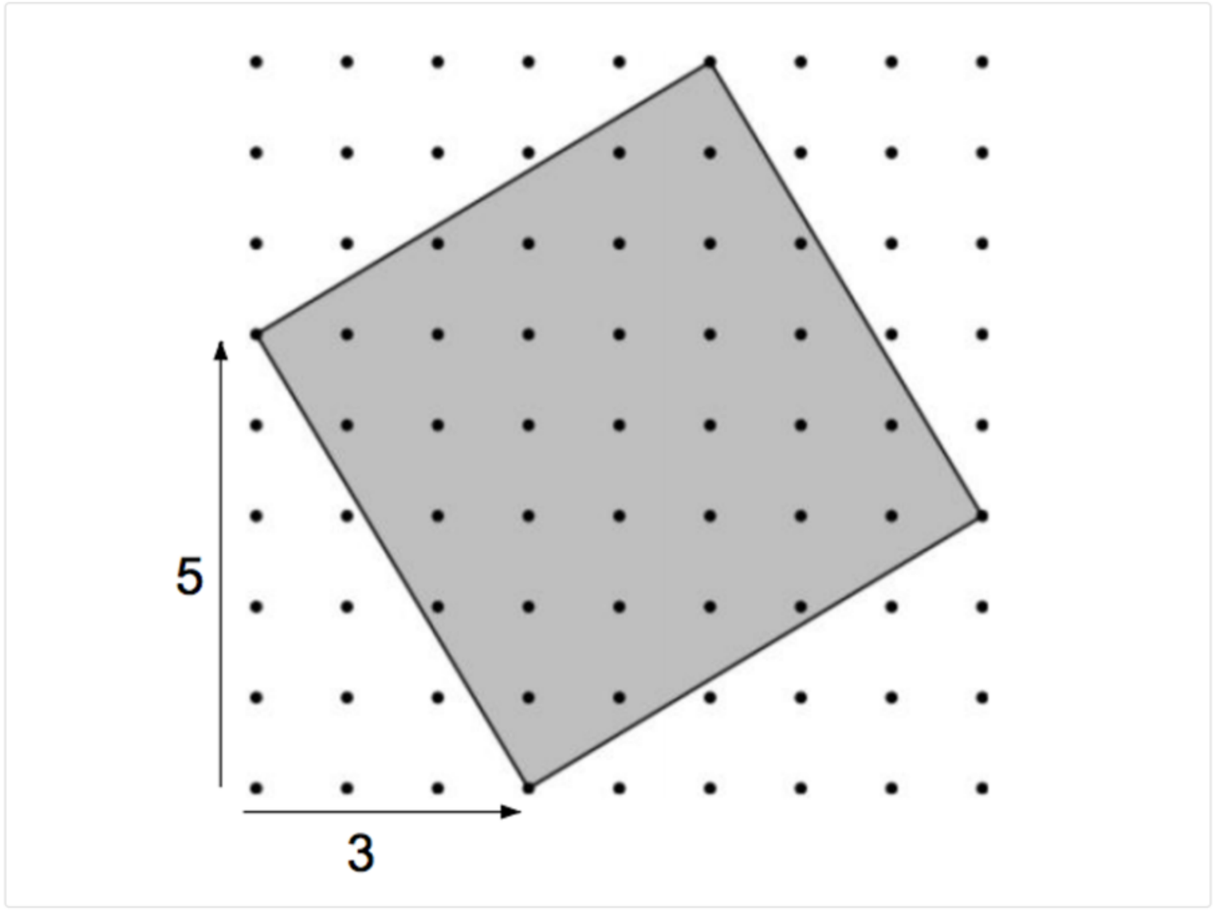
Secure https://student.desmos.com/activitybuilder/student/58dedfbc9cccc90613e1d928

Farrar: Principles to Act…

2 of 5

Guest Create Account or Sign In

Find the area of the tilted square. Show your reasoning.

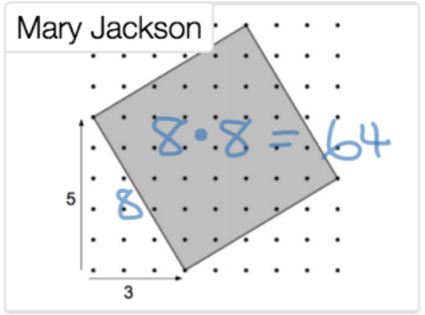


Desmos &

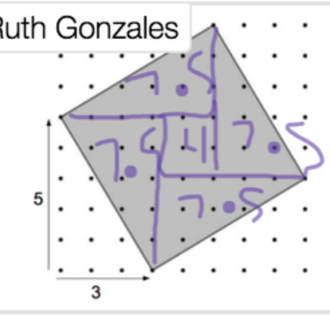
http://map.mathshell.org/lessons.php?collection=8&unit=8315

Aggregation

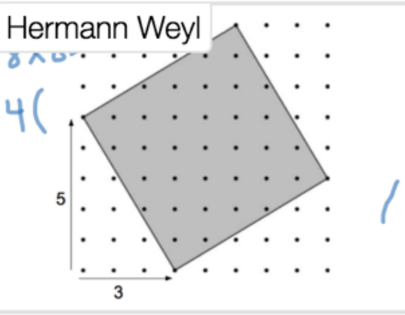
Mary Jackson



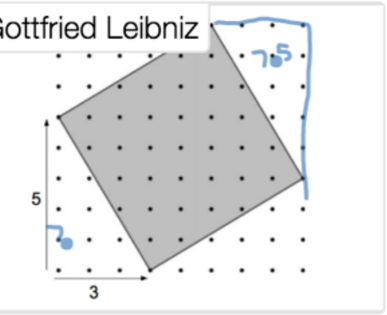
Ruth Gonzales



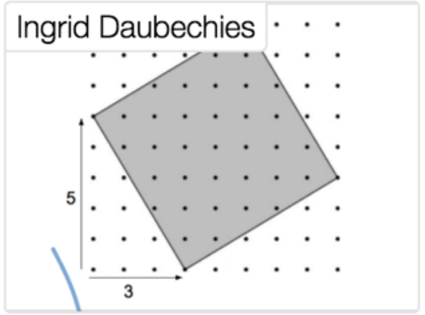
Hermann Weyl



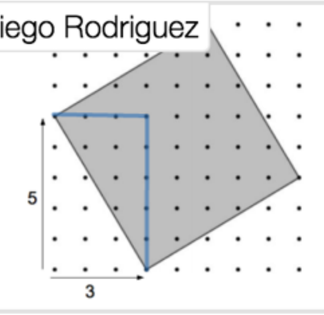
Gottfried Leibniz



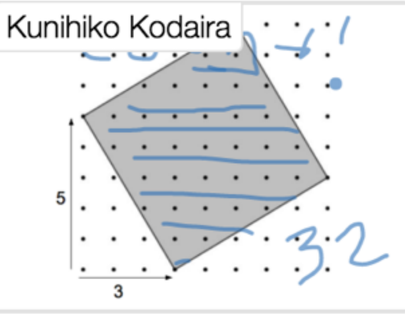
Ingrid Daubechies



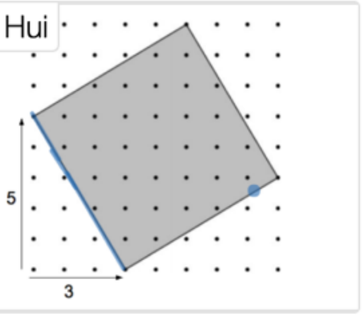
Diego Rodriguez



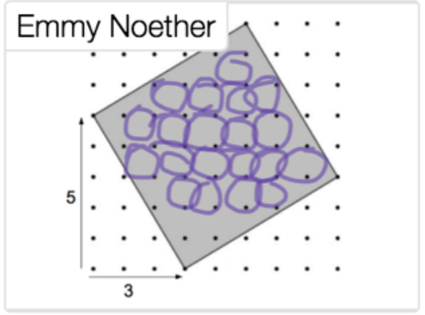
Kunihiko Kodaira



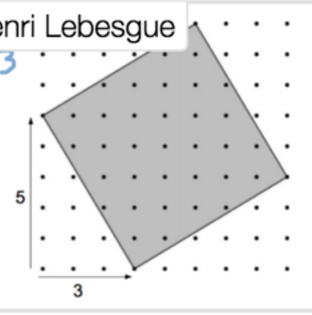
Liu Hui



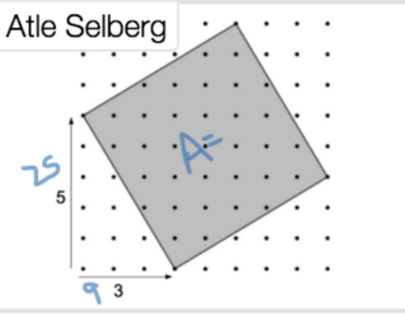
Emmy Noether



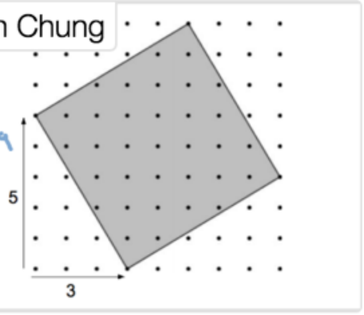
Henri Lebesgue



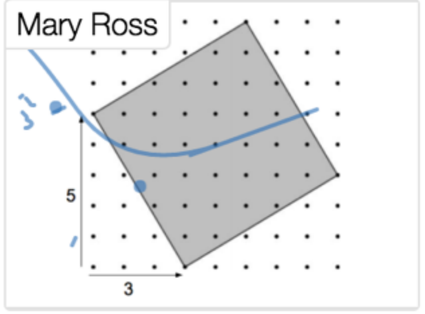
Atle Selberg



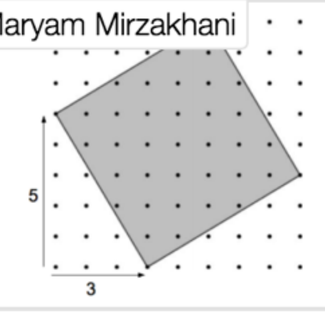
Fan Chung



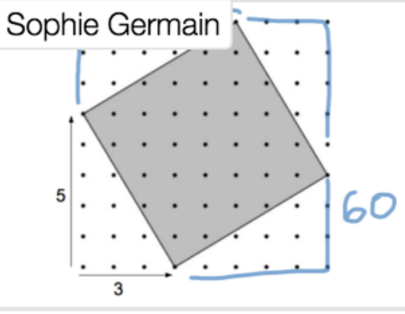
Mary Ross



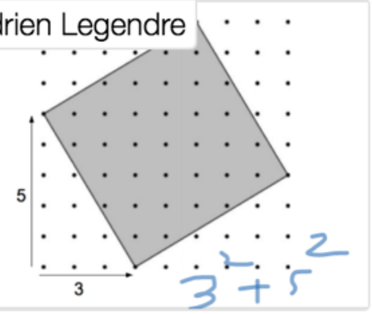
Maryam Mirzakhani



Sophie Germain



Adrien Legendre



Formative

Scott

goformative.com/teacher/#/assignments/RRCA334/live-results/27666410

This is sqrt 34. This is a square.

So the area is sqrt 34 * sqrt 3

Pythagorean Theorem: 3^2 + 5^2 = c^2
c= square root of 34
Area of a square is side length squared:
c^2 = (square root of 34)^2 = 34

8x8 = 64
7.5*4=30
64-30=34

34, because there are four 3x5

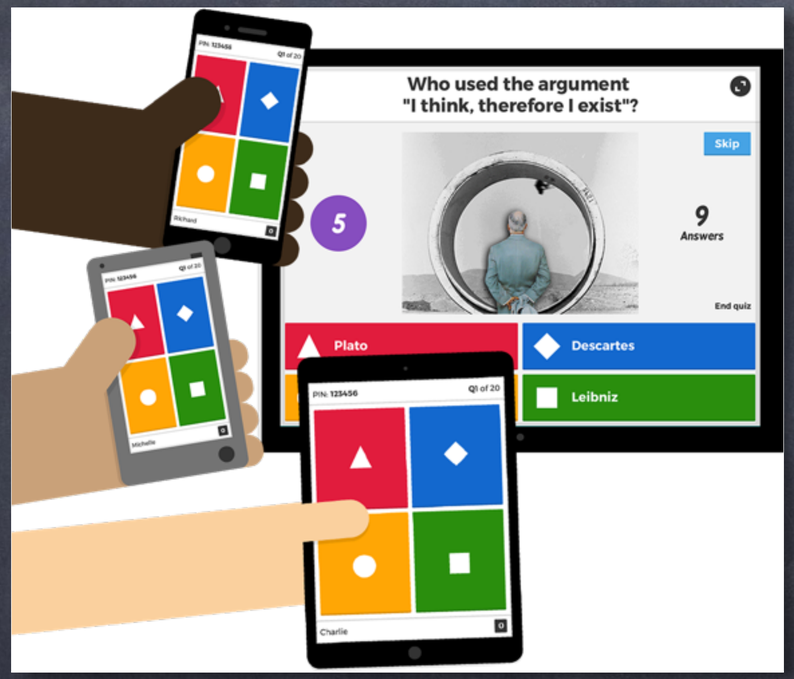
Zoom

3

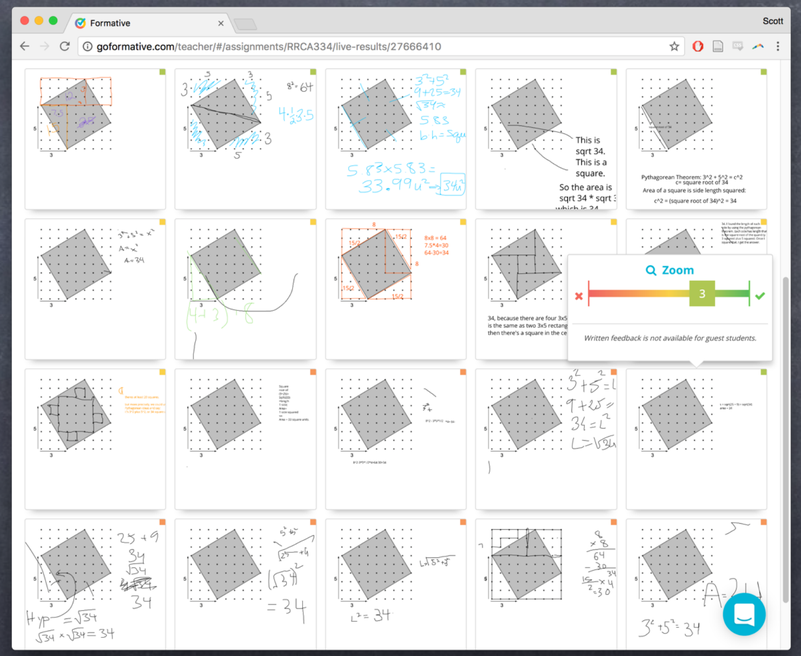
Written feedback is not available for guest students.

goFormative

answer only vs. open work

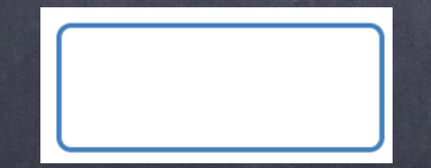


teacher can see answers

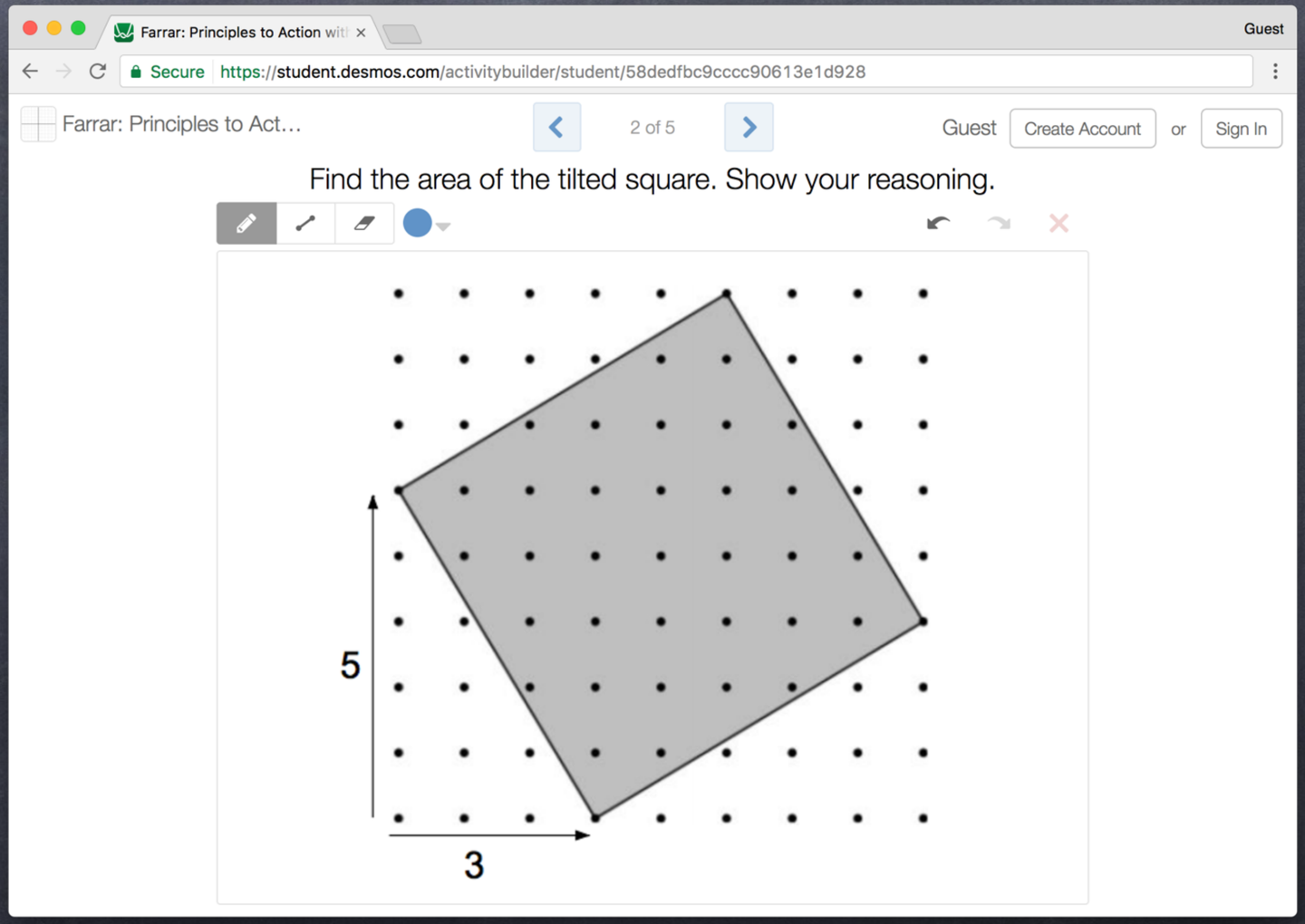


teacher can see work

answer only vs. open work



Submit

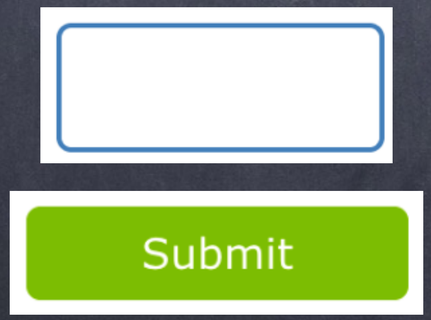


(fake mockup)

“Answer only” trims out information

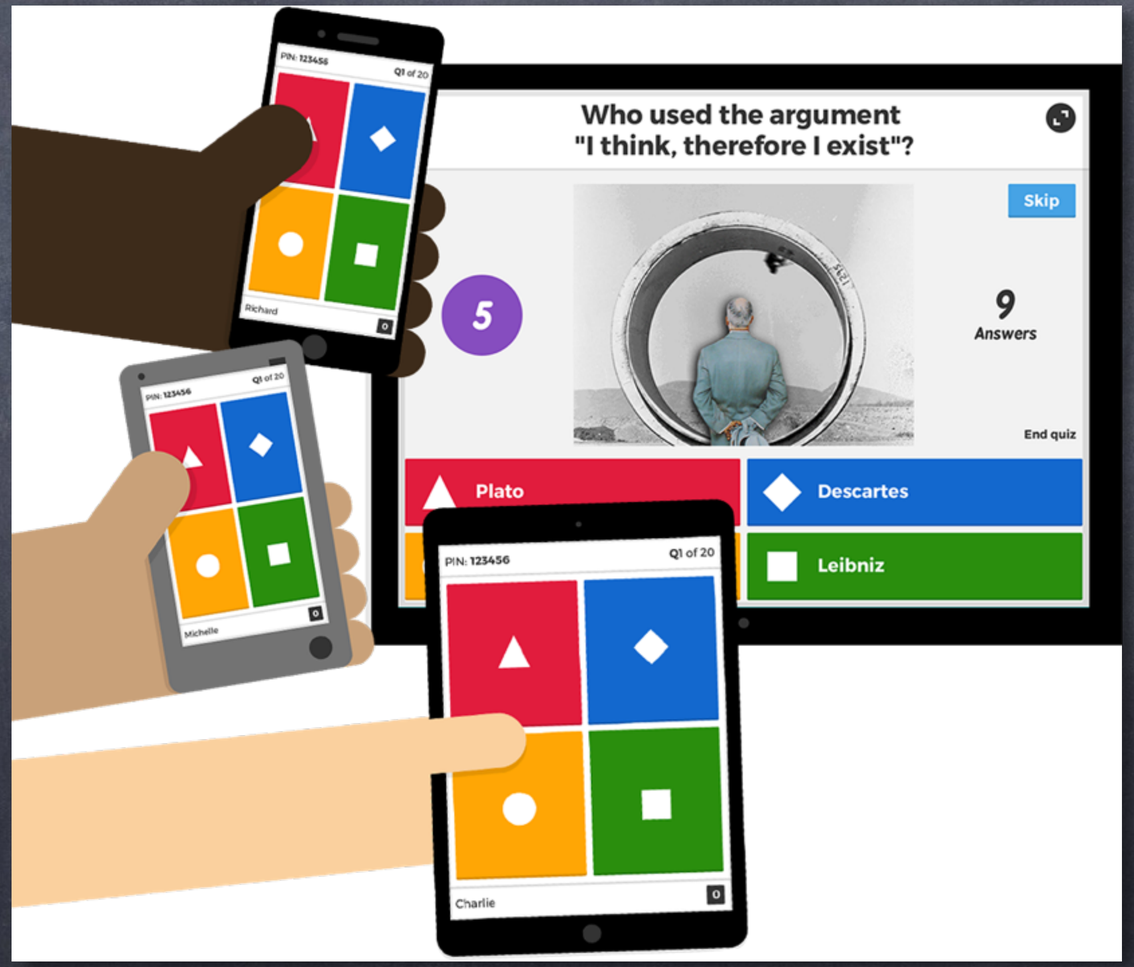
correct rate?
85% correct

maybe linked to standards?
STAN.1.1 : 85%



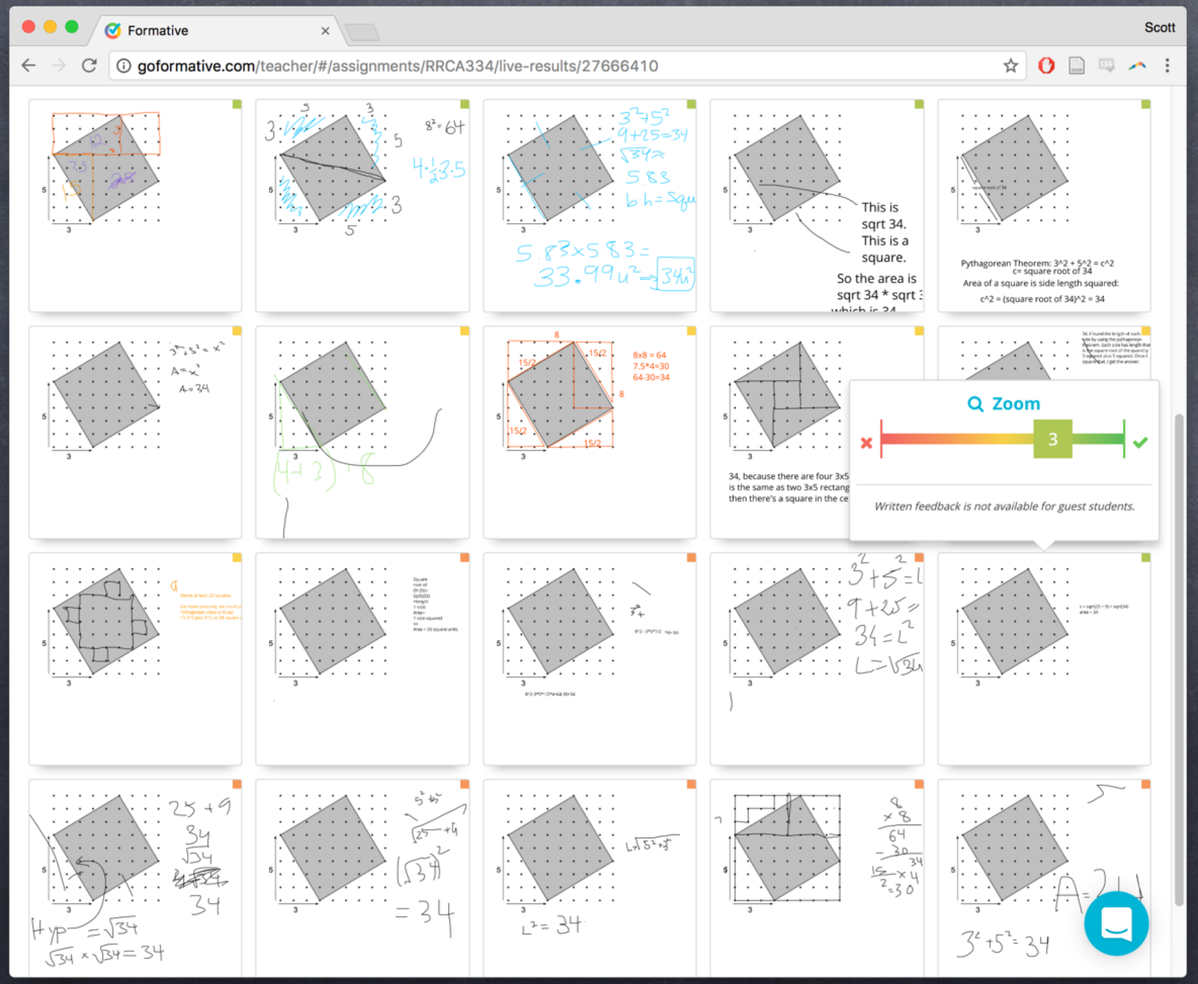
if you’re lucky, a distribution
34, 34, 34, 34, 34, 34, 34
sqrt(34)
15, 15, 15
30

“answer only” tech is for… answers only.



Kahoot

“open work” allows thought to be seen



goFormative

Goals:

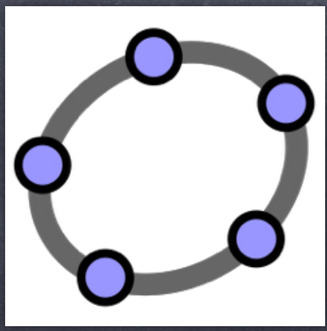
1. Understand what can tech can/should support

aggregate student open work

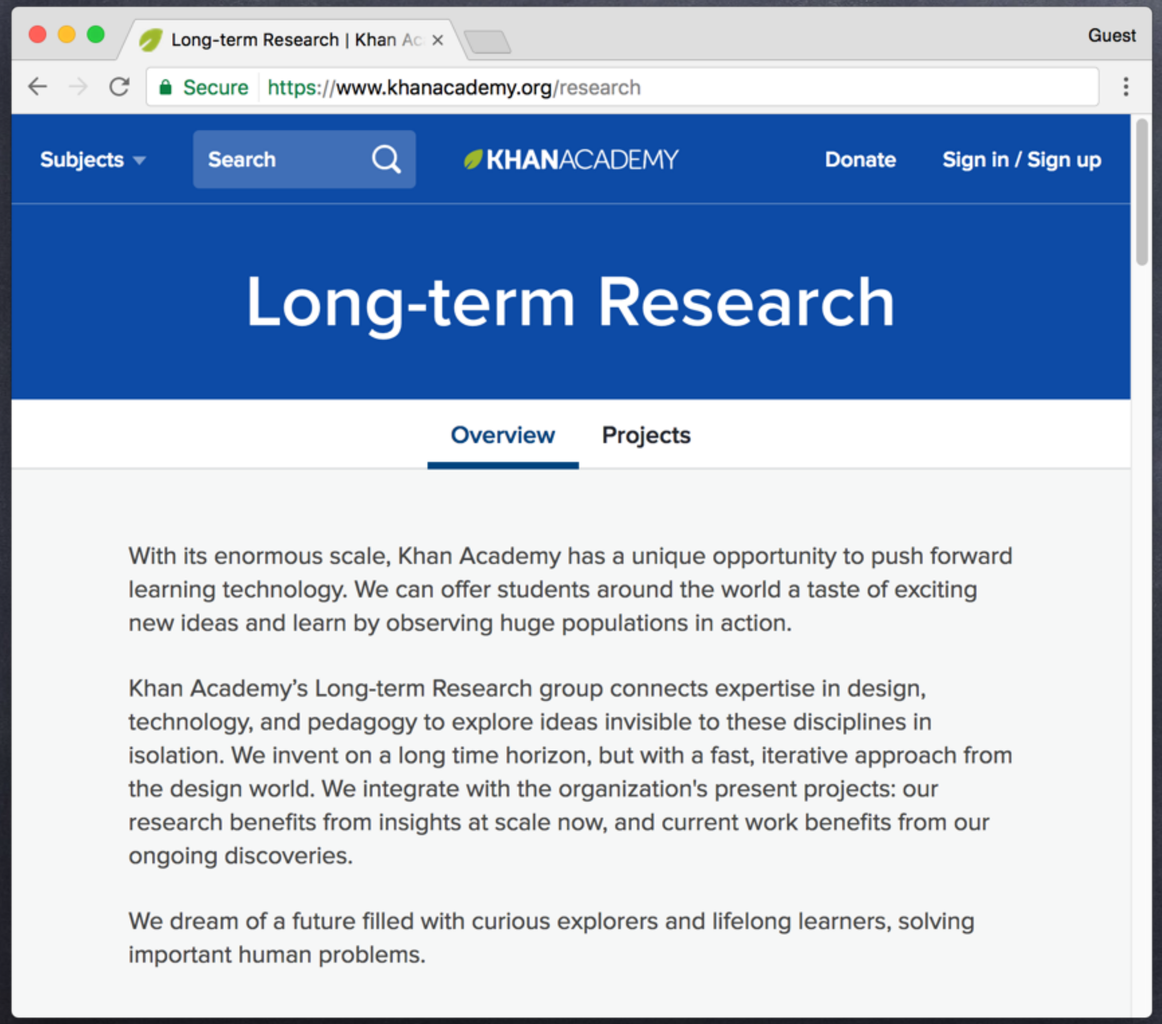
2. Have teachers leverage that support

Scott Farrar

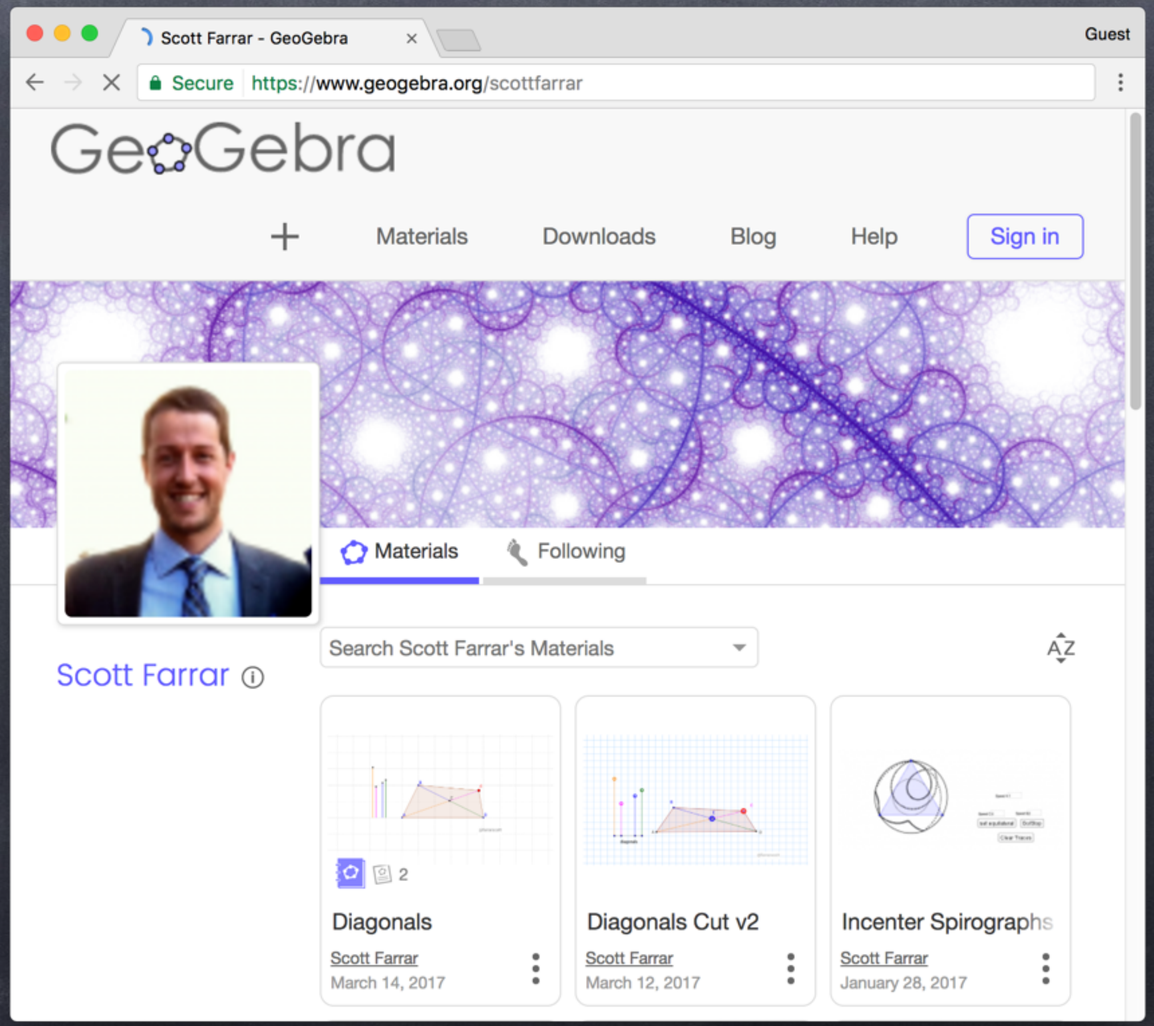
- Teaching, Leading, Coaching for 8 years
- 2014: Jumped to researching EdTech, thesis on **Desmos**
- 2016: Joined **GeoGebra** network and **Khan Academy** Long-term Research Team

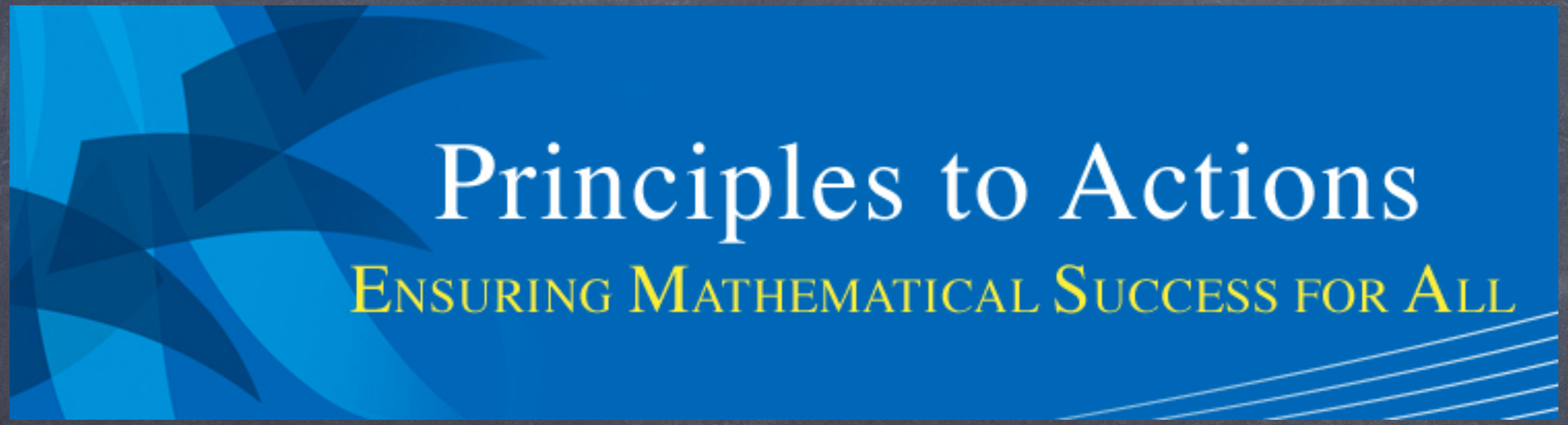


khanacademy.org /research



geogebra.org /scottfarrar




Principles to Actions
Ensuring Mathematical Success for All

Principles to Actions

Ensuring Mathematical Success for All

Tools and Technology. *An excellent mathematics program integrates the use of mathematical tools and technology as essential resources to help students learn and make sense of mathematical ideas, reason mathematically, and communicate their mathematical thinking.*

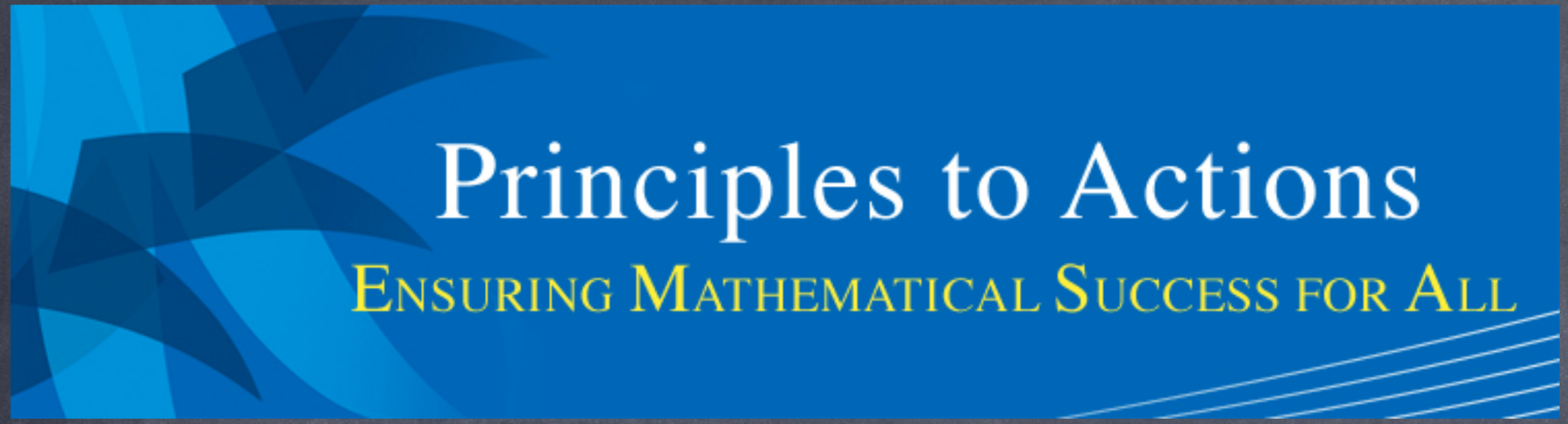
Available tools and technology help teachers and students visualize and concretize mathematics abstractions, and when these resources are used appropriately, they support effective teaching and meaningful learning.

Principles to Actions

Ensuring Mathematical Success for All

Tools and Technology. *An excellent mathematics program integrates the use of mathematical tools and technology as essential resources to help students learn and make sense of mathematical ideas, reason mathematically, and communicate their mathematical thinking.*

Available tools and technology help teachers and students visualize and concretize mathematics abstractions, and when these resources are used appropriately, they support effective teaching and meaningful learning.



Tools and Technology.

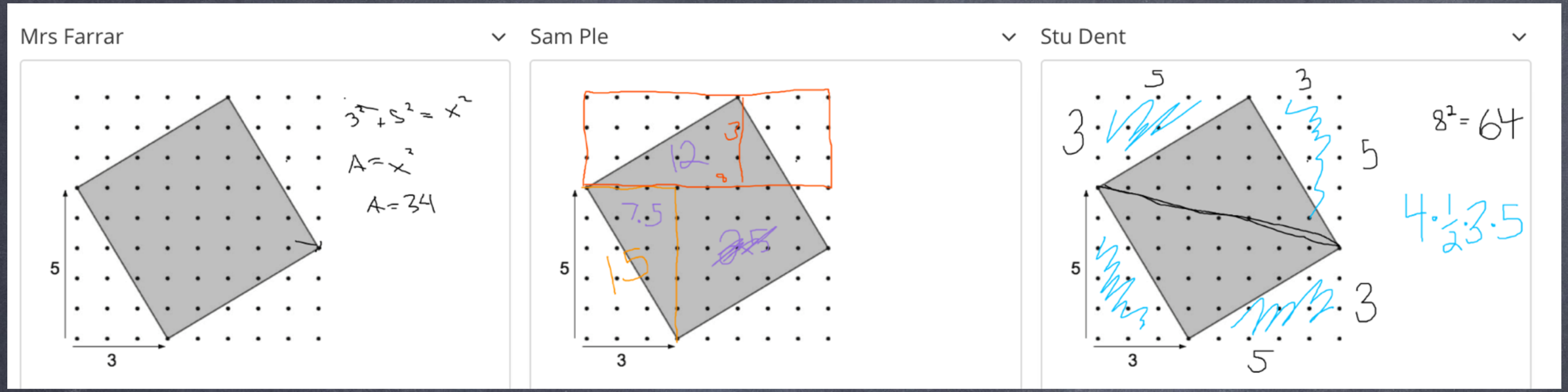
1. Tech should help teachers and students **visualize** and **concretize** mathematics abstractions.

2. Tech should support **effective teaching** and **meaningful learning**.

PtA: Tech

- visualizing mathematics
- effective teaching
- concretizing abstractions
- meaningful learning

Sketching Aggregation



- visualizing mathematics
- concretizing abstractions
- effective teaching
- meaningful learning

Understand

PtA Goals for Tech

- visualizing mathematics
- effective teaching
- concretizing abstractions
- meaningful learning

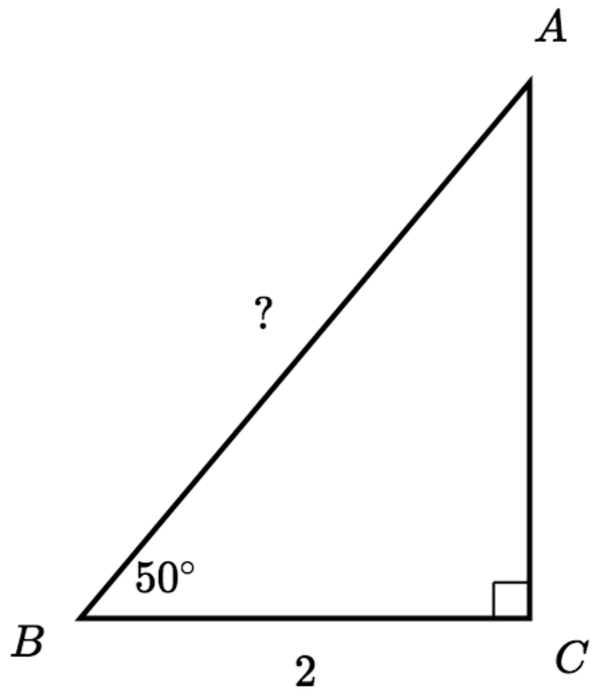
aggregation

Compare to:
Right/Wrong Assessment

Khan Academy Exercise

$AB =$ ☐

Round your answer to the nearest hundredth.

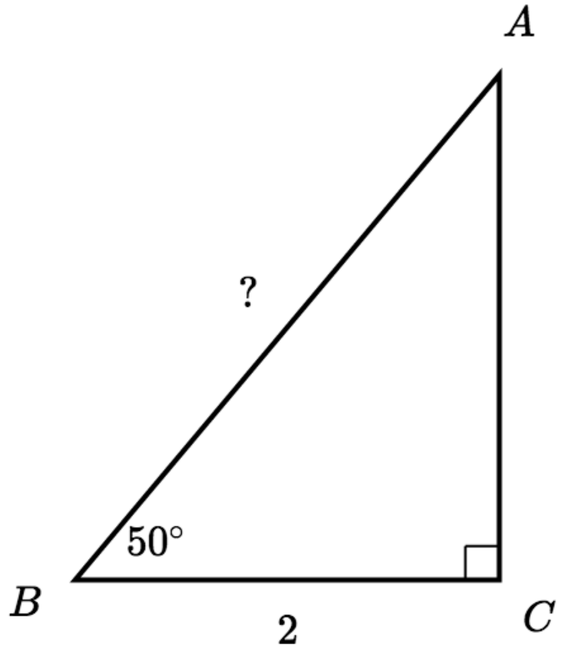


Right/Wrong Exercises

S2: [to S3] you forgot 50… after the sine
S3: so its 2… divided by… sin 50 ?
S2: x
S3: x?
S2: this [points] is multiply
S3: so its 2 divided by sin 50 x
S2: [confused now] oh… you skipped one step. oh ok those numbers don't divide by x you cross multiply. Erase this part… keep the 2. So 2 times [inaudible] by itself right? Equals sin 50. x.

$AB =$ ☐

Round your answer to the nearest hundredth.



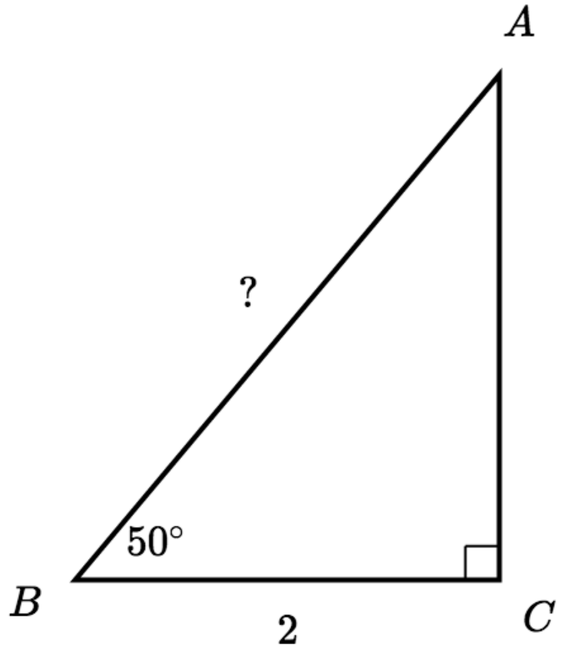
A/V

Right/Wrong Exercises

S2: [to S3] you forgot 50… after the sine
S3: so its 2… divided by… sin 50 ?
S2: x
S3: x?
S2: this [points] is multiply
S3: so its 2 divided by sin 50 x
S2: [confused now] oh… you skipped one step. oh ok those numbers don't divide by x you cross multiply. Erase this part… keep the 2. So 2 times [inaudible] by itself right? Equals sin 50. x.

$AB =$ ☐

Round your answer to the nearest hundredth.



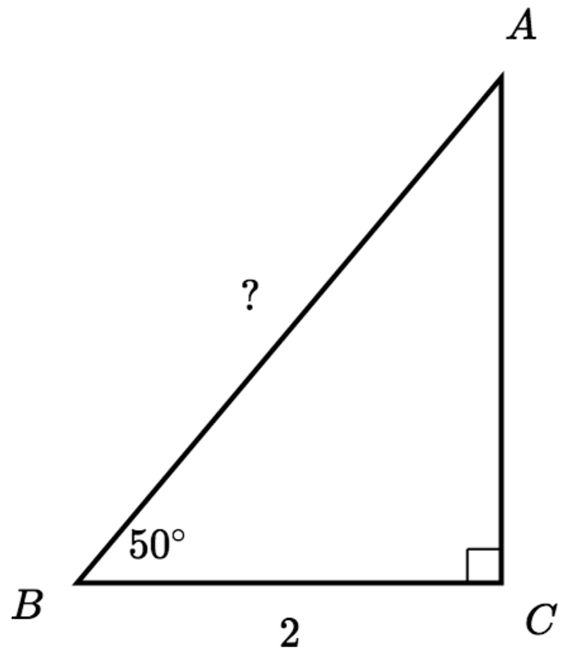
The numeric input doesn’t capture this thinking directly

Right/Wrong Exercises

S3: wait does x go inside the 50? where's x on the calculator?
S2: there is no x.
S1: so what's the equation for sine?
S2: sine is adjacent over hypotenuse
S1: I thought it was opposite
S2: use cosiiiine! No its truuue
S1: you're confusing me. Look, this is the hypotenuse. Use the hypotenuse and the angle to find the opposite side. That's sine.
S2: … then … I did it wrong [grabs her HW from last night]
S3: sine aint working

$AB =$ ☐

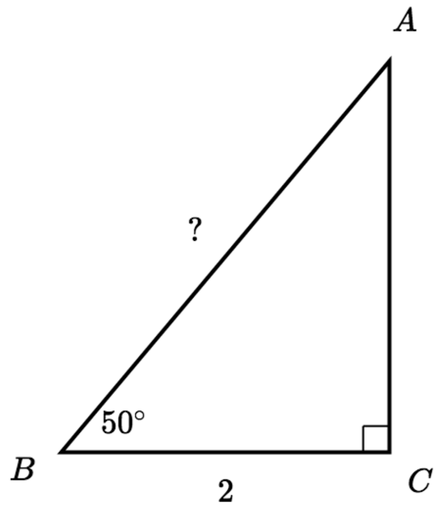
Round your answer to the nearest hundredth.



students weren’t ready for right/wrong practice

$AB =$ ☐

Round your answer to the nearest hundredth.



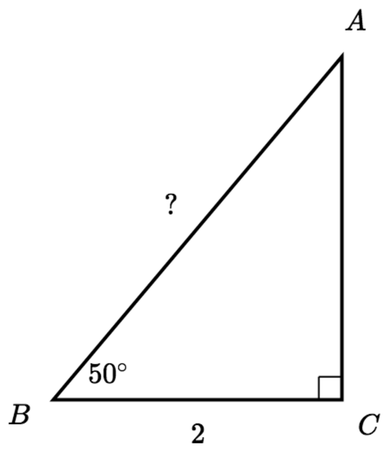
- visualizing mathematics??
- concretizing abstractions??
- effective teaching??
- meaningful learning??

Bonus goal:
Enhance right/wrong practice by having students coming up with good wrong answers.

Top four common wrong answers to this exercises on Khan Academy

$AB =$ ☐

Round your answer to the nearest hundredth.

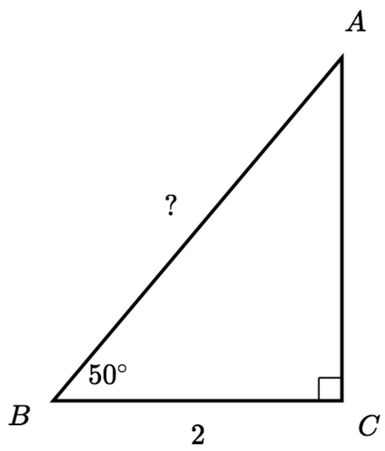


1.29	2.61	2.38	2.07

Top four common wrong answers to this exercises on Khan Academy

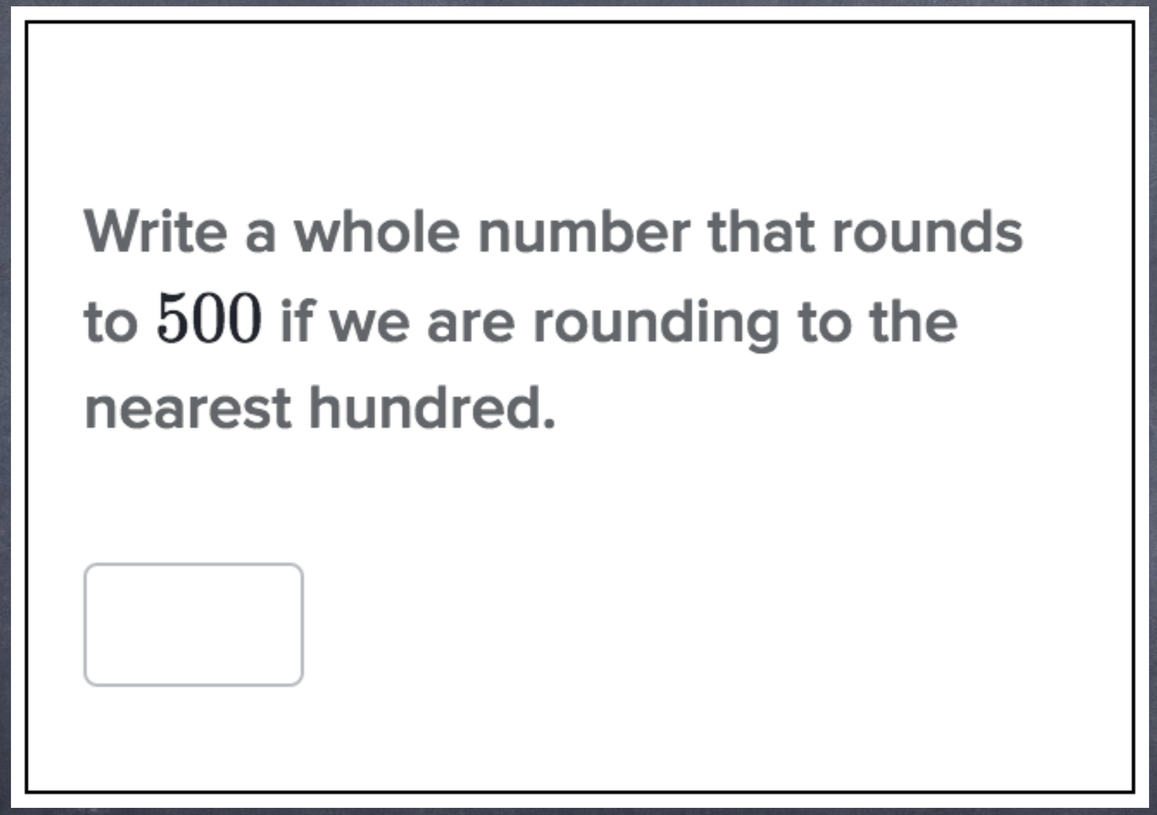
$AB =$ ☐

Round your answer to the nearest hundredth.

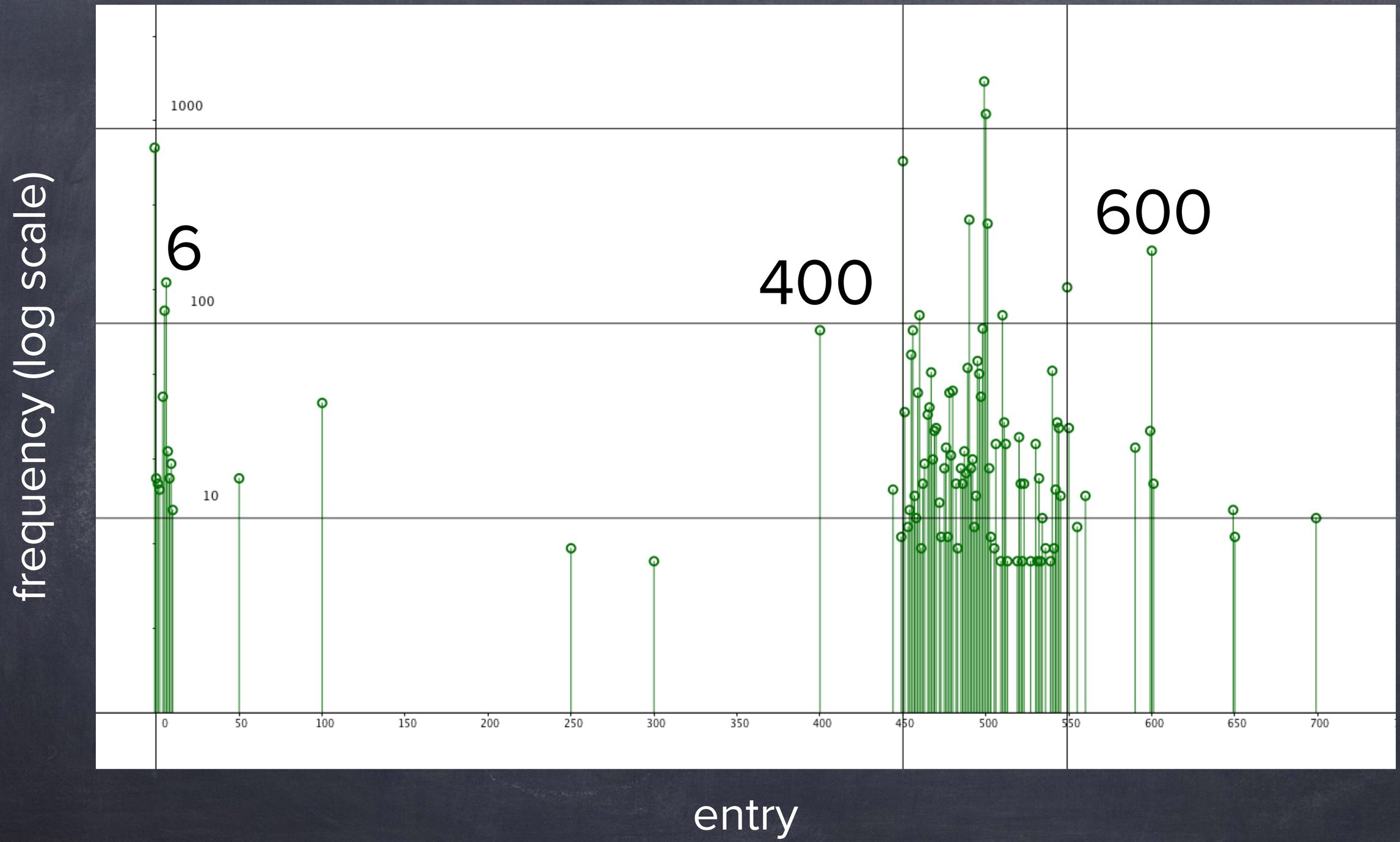


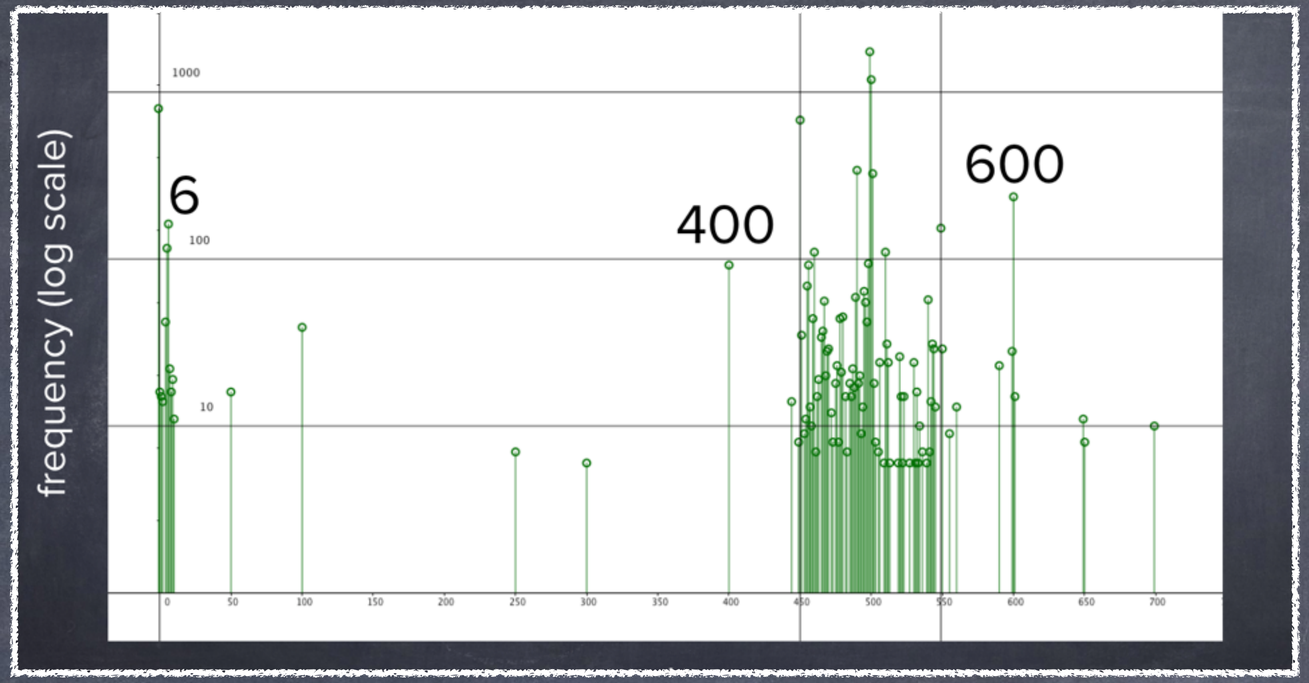
1.29	2.61	2.38	2.07
2cos(50)	2csc(50)	2tan(50)	2sec(50 rad)

KA Research teaser...



What do you think are reasoned wrong answers?

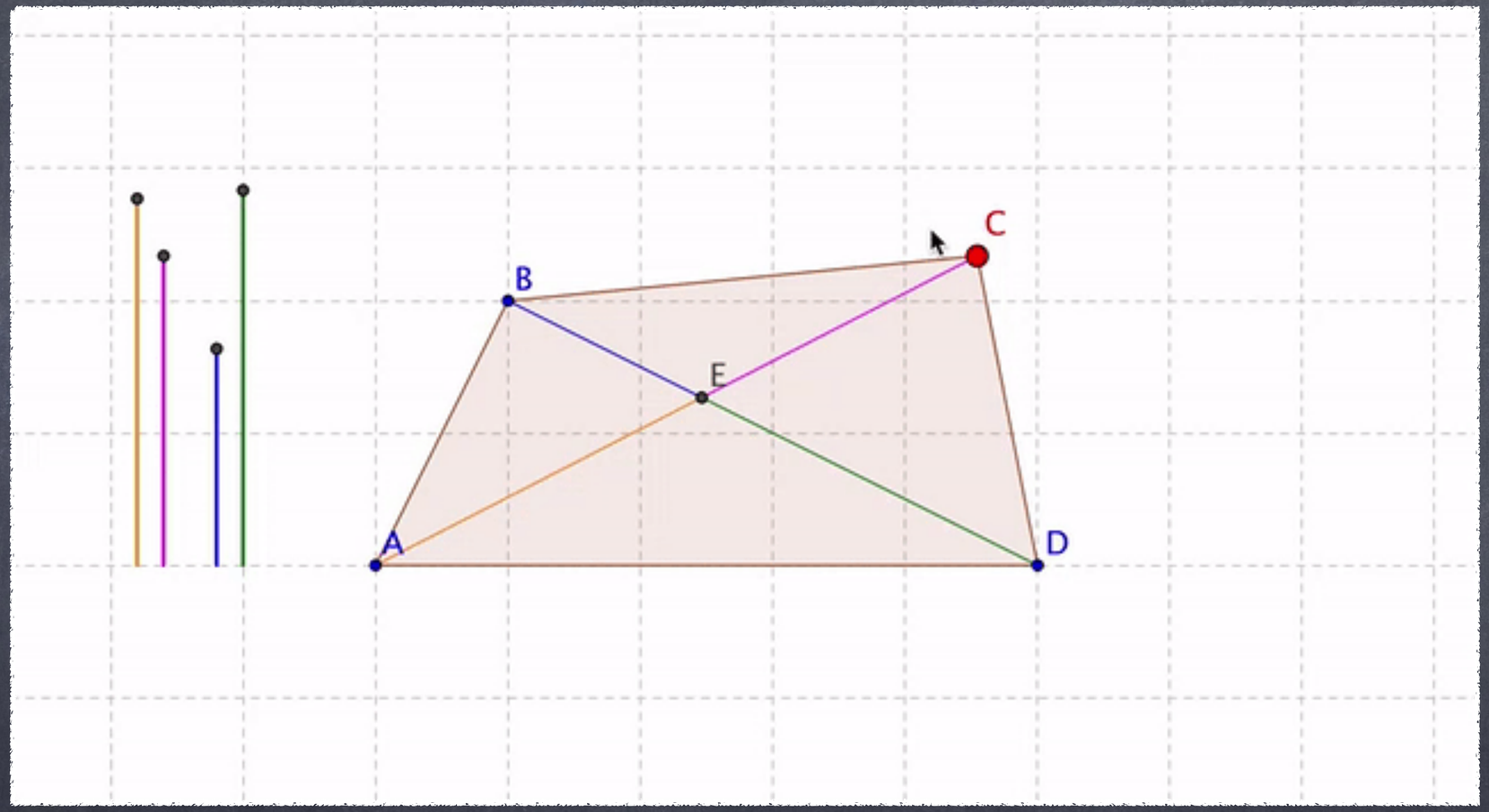

frequency (log scale)
1000
100
10
6
400
600
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
entry



Have your math department
(and your students!)
come up with **wrong** answers ... and justify them!

Constraints

695S7



GeoGebra

https://www.geogebra.org/m/WxhmrA3H

abstraction:

Theorems

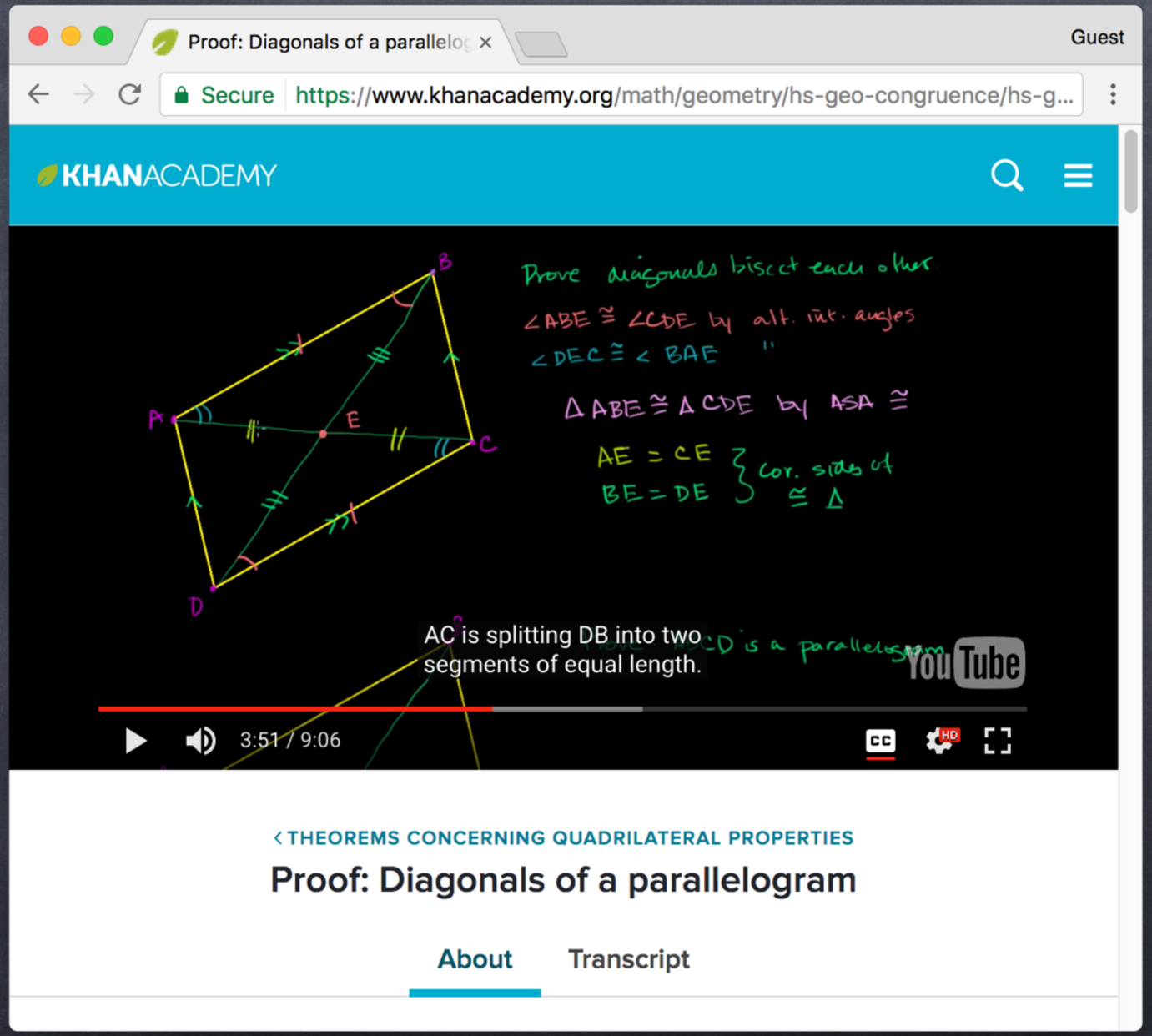
Theorem: The diagonals of a kite are perpendicular.

Theorem: The diagonals of a square are congruent and are the perpendicular bisectors of each other.

“Naive conjecture and counterexamples do not appear in the fully fledged deductive system. The zig-zag of discovery cannot be discerned in the end product.”

Lakatos, Proofs and Refutations 1976

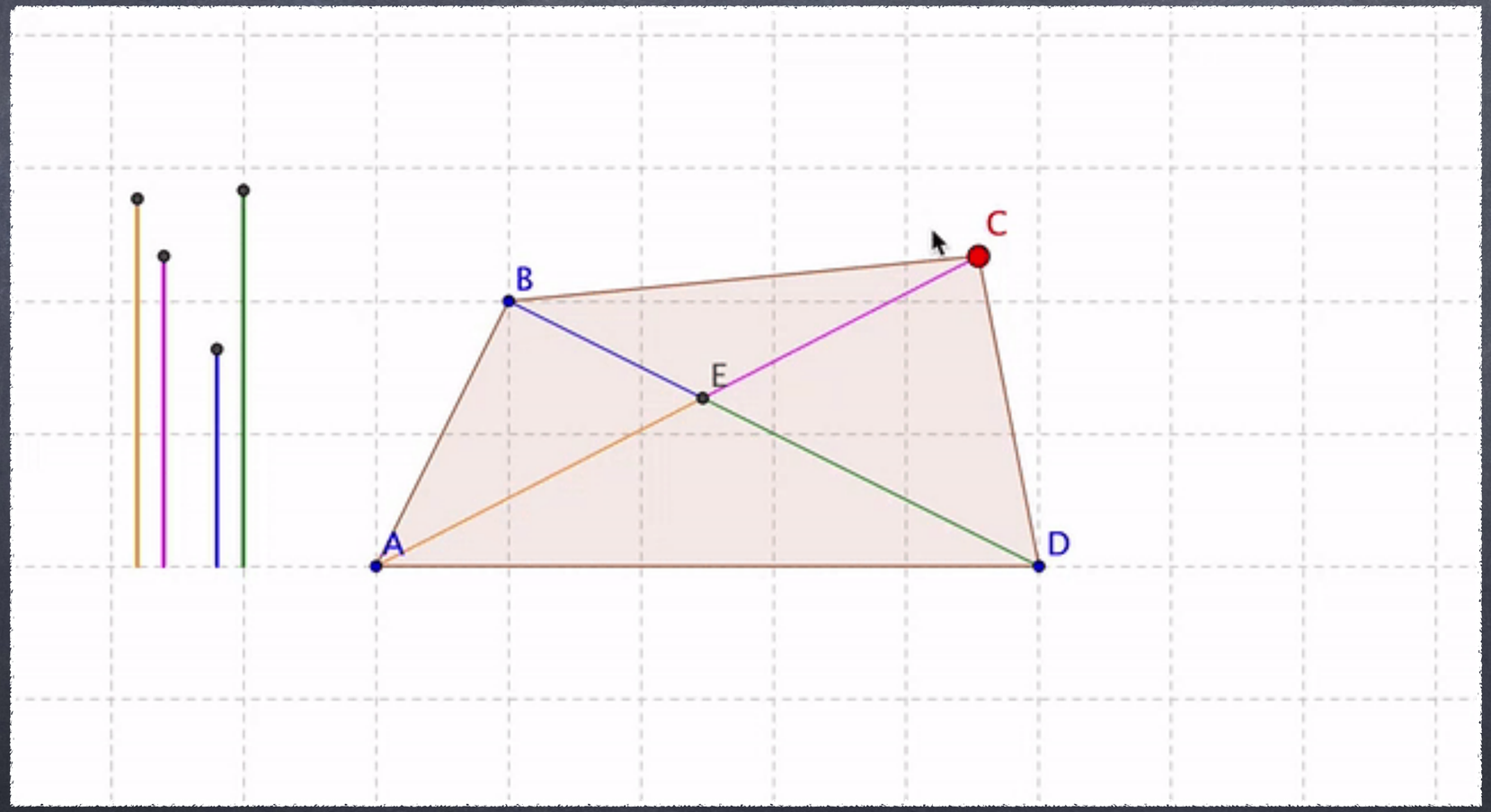
deduction:

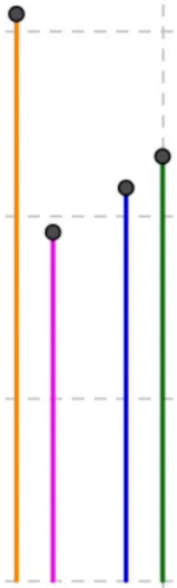

Proof: Diagonals of a parallelo
Guest
Secure
https://www.khanacademy.org/math/geometry/hs-geo-congruence/hs-g...
KHANACADEMY
Prove diagonals bisect each other
∠ABE ≅ ∠CDE by alt. int. angles
∠DEC ≅ ∠BAE "
△ABE ≅ △CDE by ASA ≅
AE = CE
BE = DE
} Cor. sides of ≅ △
A
B
C
D
E
AC is splitting DB into two segments of equal length.
3:51 / 9:06
THEOREMS CONCERNING QUADRILATERAL PROPERTIES
Proof: Diagonals of a parallelogram
About
Transcript

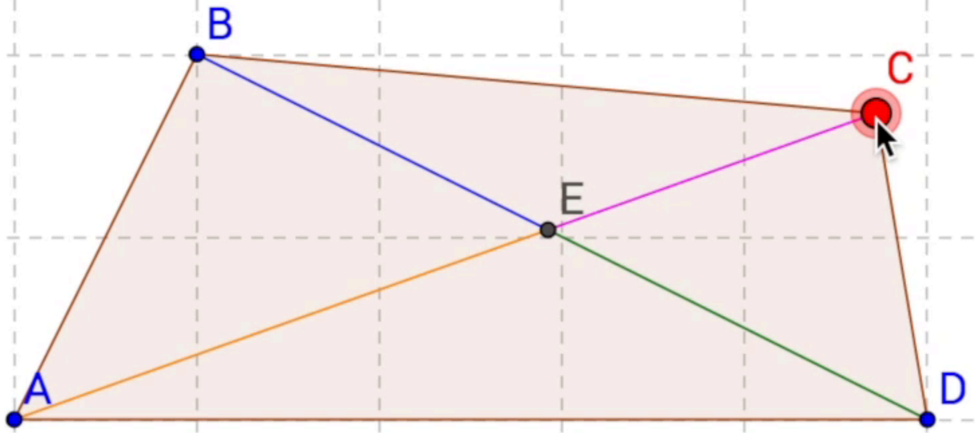
“The product of mathematical activity might be justified with a deductive proof, but the **product** does not represent the **process** of coming to know.”

Lampert, When the Problem is Not the Question and the Solution is Not the Answer: Mathematical Knowing and Teaching 1990

Put abstraction and deduction **after** constrained exploration

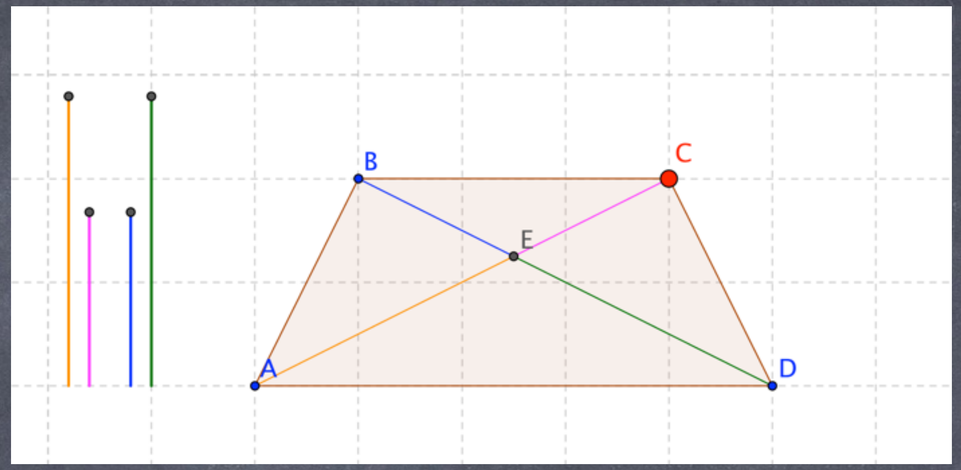


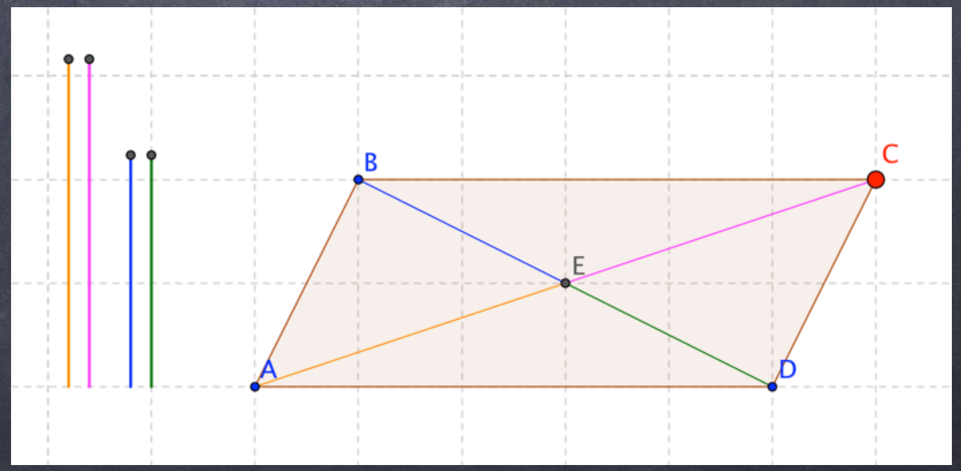




@farrarscott

Alex: **two the same and two the same** [gestures at screen]
T: wow
Bob: heh
T2: what shape is that?
Bob: it's a-- um-- trapezoid
Alex: trapezoid
now almost
Bob: I think I know how to make…
ah how do you make a parallelogram? Ah ah ah [Bob has the mouse]
Alex: me! Me me me me
Bob: no no, no you.
Alex: I know I know… can I just try? [Bob continues dragging]
nooo
T: ok let's trade turns
Bob: ok [passes control to A]
Alex: like um …. A parallelogram.
Bob: yaaaay!
Alex: oh it turns into the same…
Bob: no put that down here [points at screen]
T: ---So you found that shape, and the other shape...
Alex: ---but that's **two the same two the same**





Goals:

1. Understand what can tech can/should support

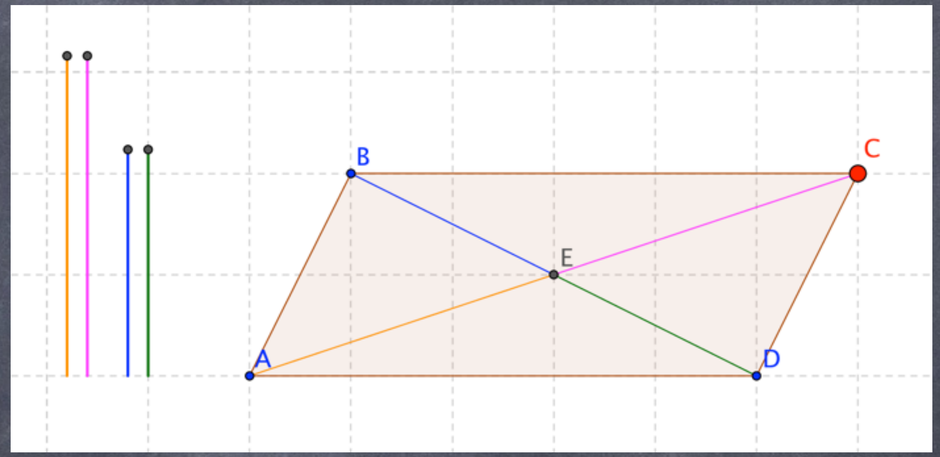
aggregate student open work

constrain student exploration

2. Have teachers leverage that support

Constrained Exploration

- Focus interaction by limiting it.
  (point C only)
- Students “breaking it” still has meaning.
  (triangle)
- No rules. Instead: signals
  (segments disappear for non-polygon)
- properties are apparent without words
  (congruent segments more apparent)



Goals:

1. Understand what can tech can/should support

aggregate student open work

constrain student exploration

2. Have teachers leverage that support

match constraints to mathematics

Understand

PtA : Tech

- visualizing mathemati
- effective teaching
- concretizing abstractions
- meaningful learning

constraints

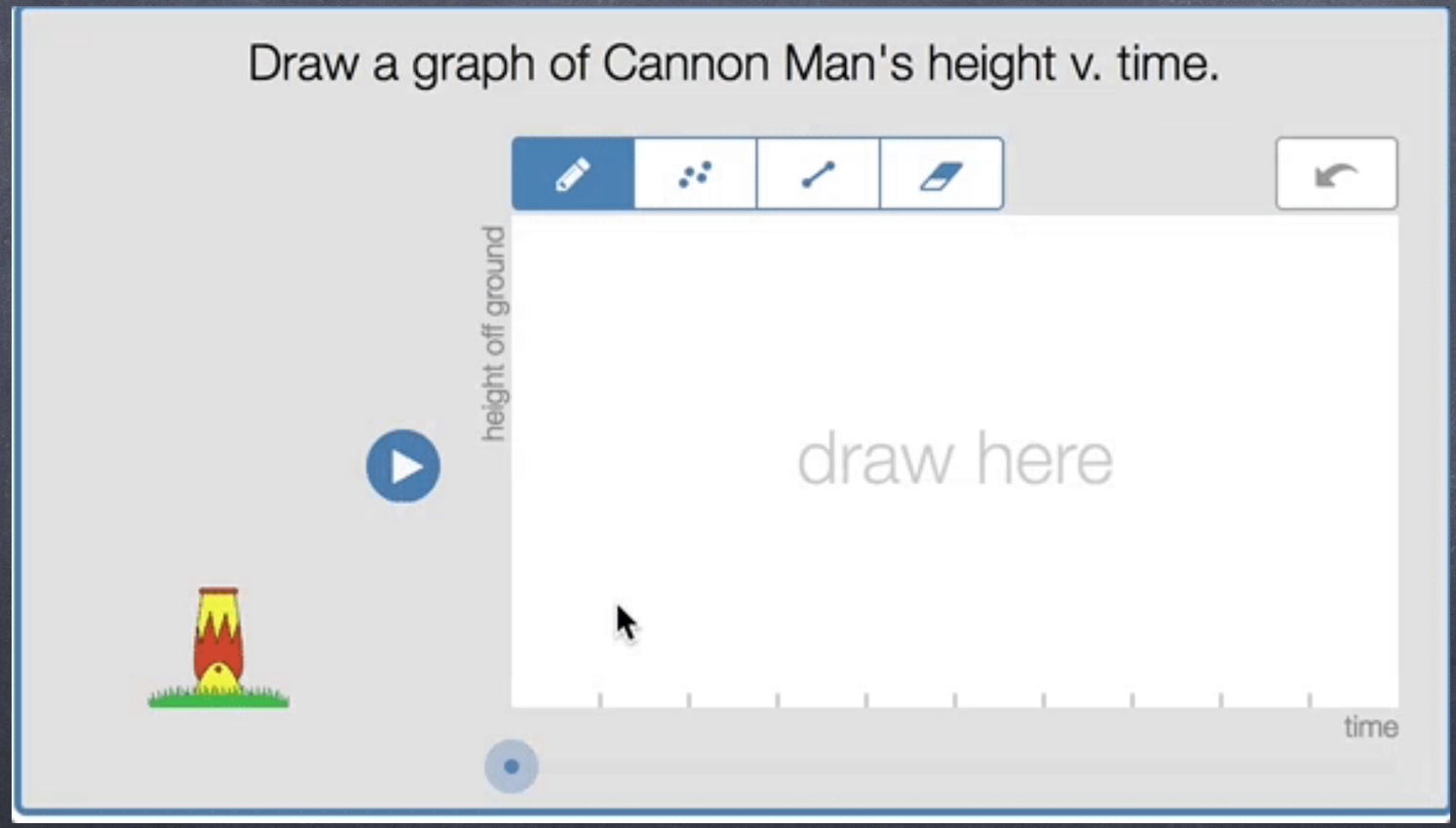
aggregation

constraints

?

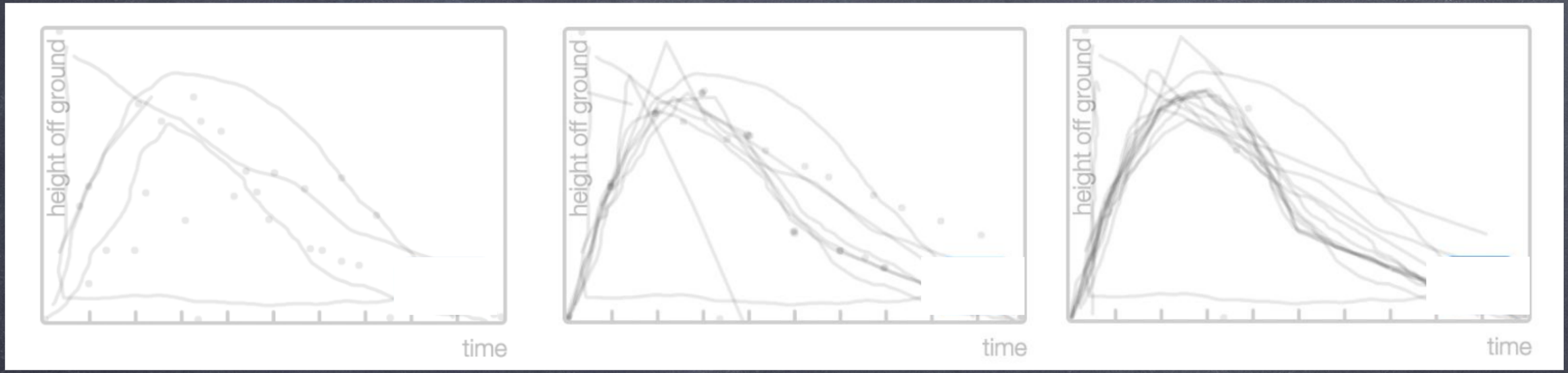
Constraints + Aggregation

concretizing a graph

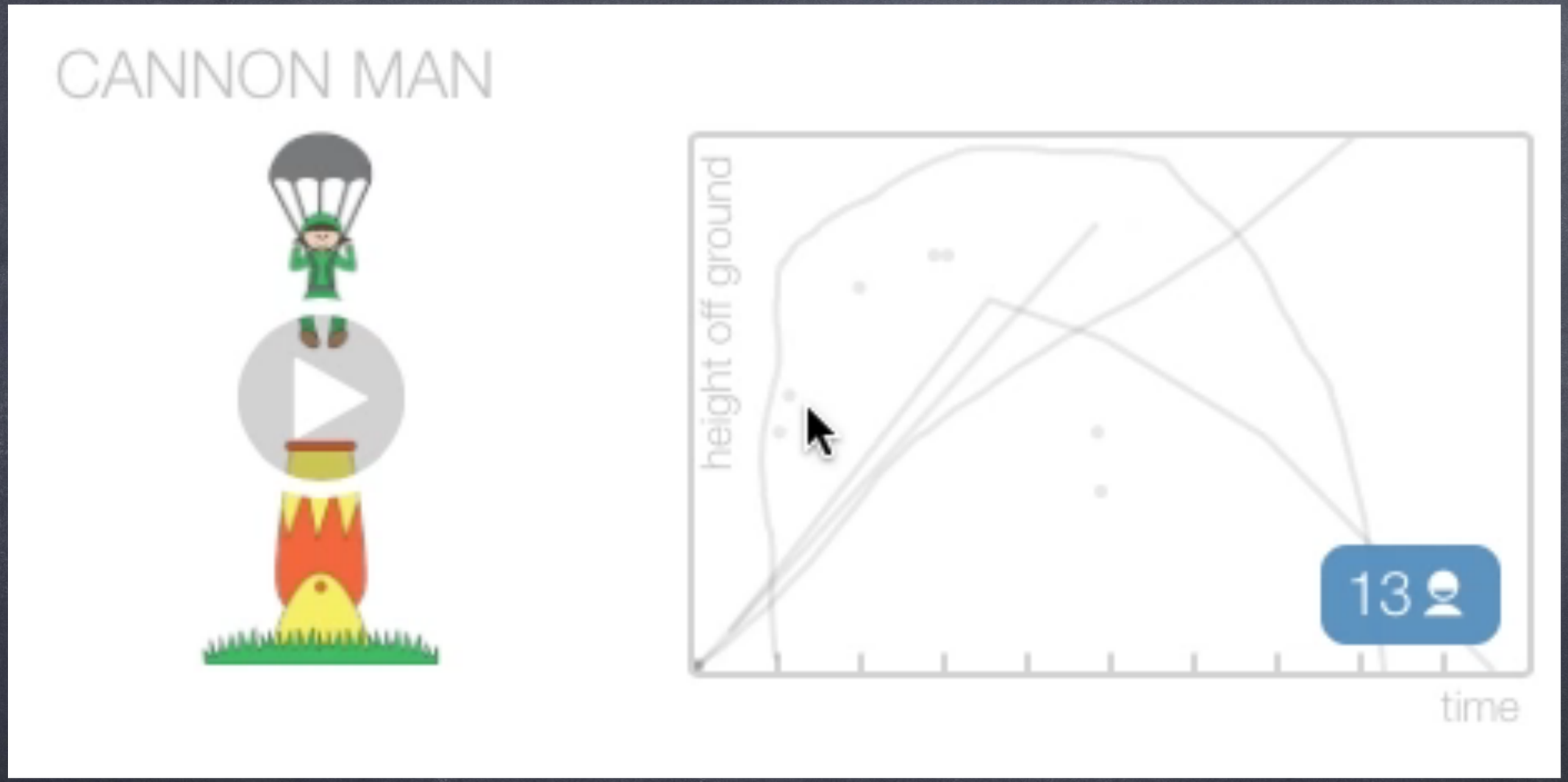


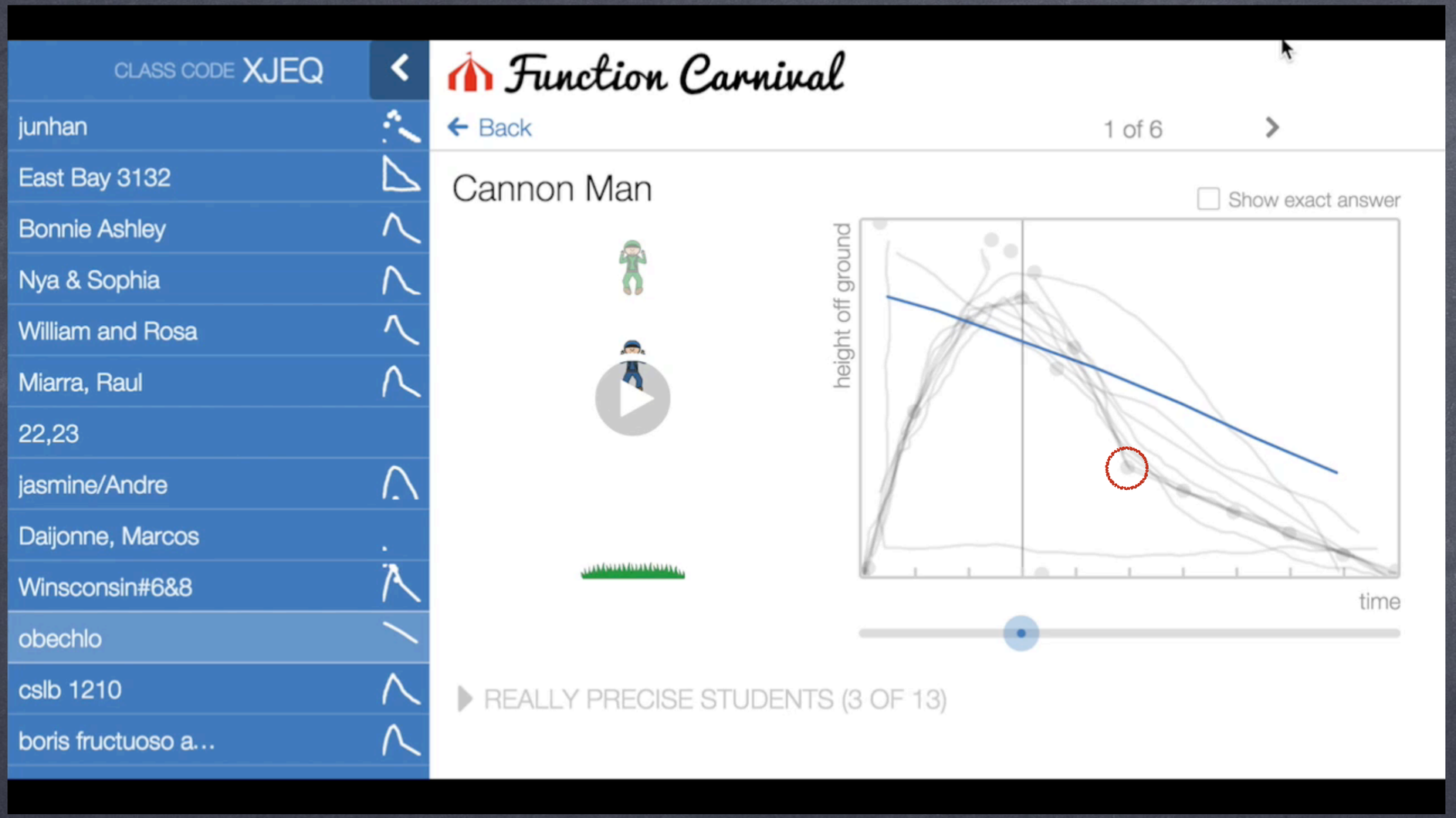
aggregation of 15 student pairs

at 3 minutes, 6 minutes, 10 minutes.



timelapse of teacher's view

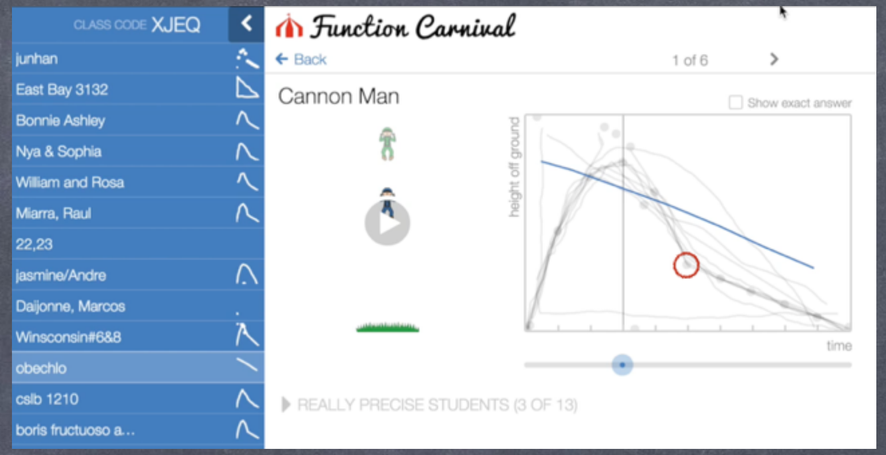




- visualizing mathematics
- concretizing abstractions
- effective teaching
- meaningful learning

A/V

T: most of you put this little-- I dunno-- can someone talk about this right here?
S: that dent?
T: yeah [waits] oh, did you want to talk about it?
Ss: [murmurs]
S: that's when he pulled the parachute
T: ok what happens when he pulls the parachute?
Ss: slowed down
S1: he hit a constant
T: ok I'm following, but how does this [linear part of graph] represent him slowing down?
S1: cause he was going fast and then, and then he kinda -- he doesn't stop but like it all goes in like slow down
T: slow down from what?
S2: going really fast
S3: its his distance back to the ground... its taking him longer to get back down to the ground
T: so its taking him longer to get closer to the ground
S3: yeah

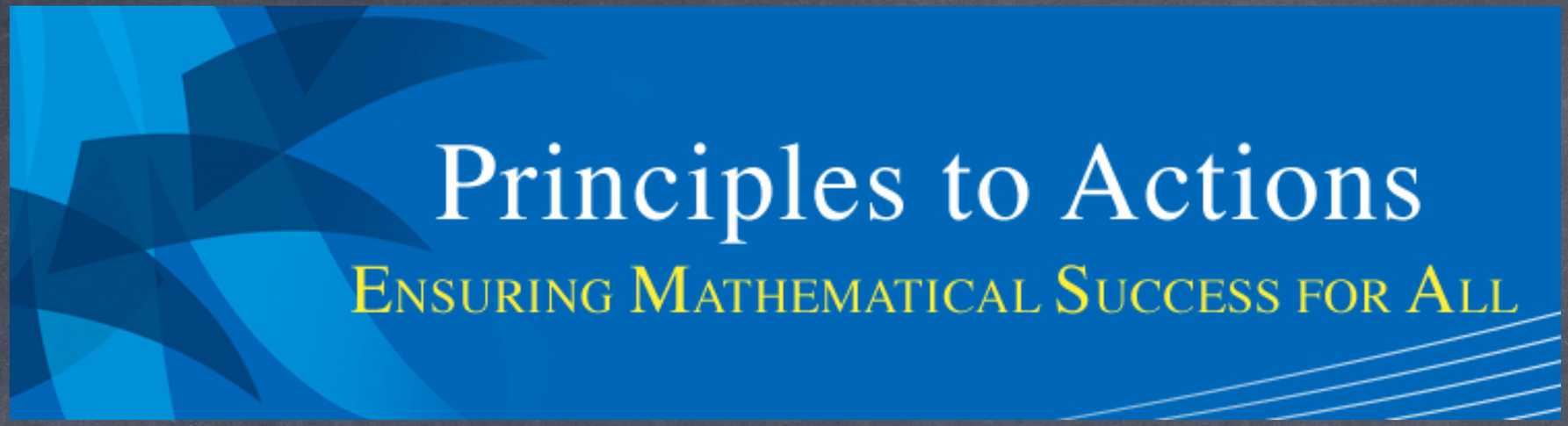


Understand

Final Tech Principle:

- let students play within purposeful constraints
- collect aggregation of their play / informal work
- socially negotiate the formal knowledge as a class

- meaningful learning



Tools and Technology.

1. Tech should help teachers and students **visualize** and **concretize** mathematics abstractions.

2. Tech should support **effective teaching** and **meaningful learning**.

Goals:

1. Understand what can tech can/should support

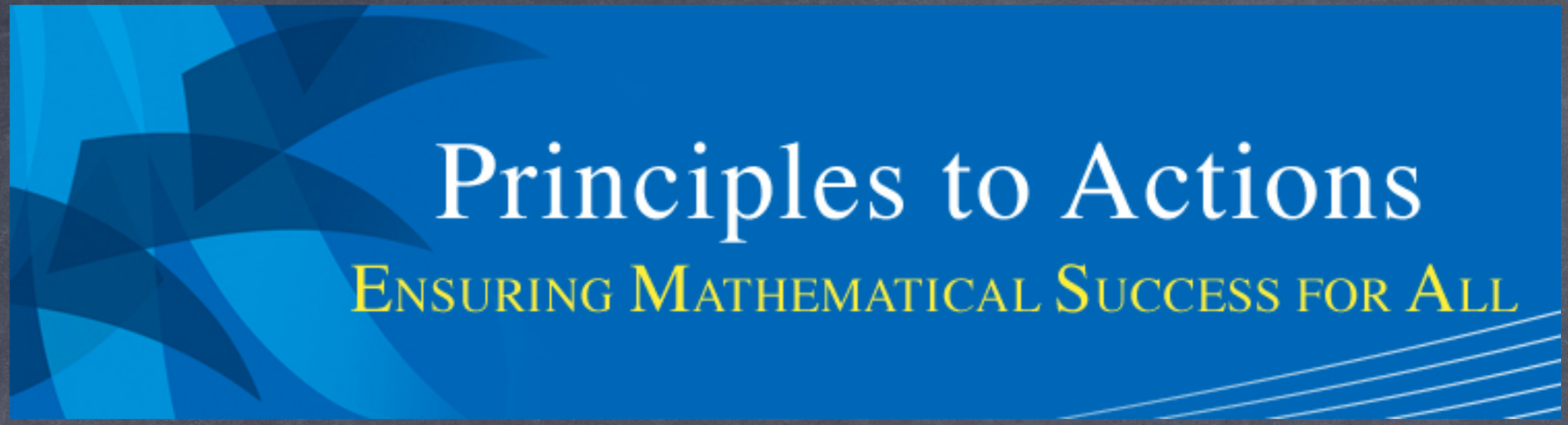
aggregate student open work

constrain student exploration

2. Have teachers leverage that support

connect student work to their understandings

match constraints to mathematics



Is your tech Principled?

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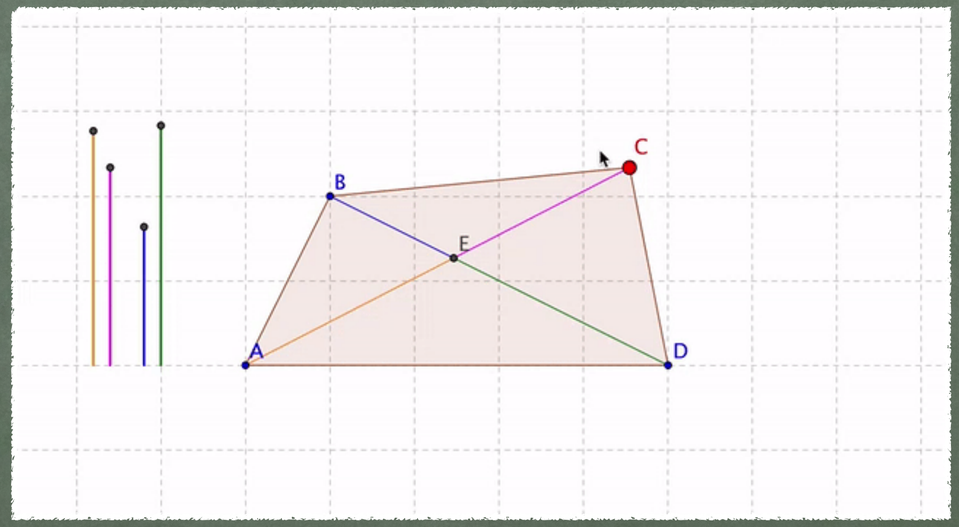
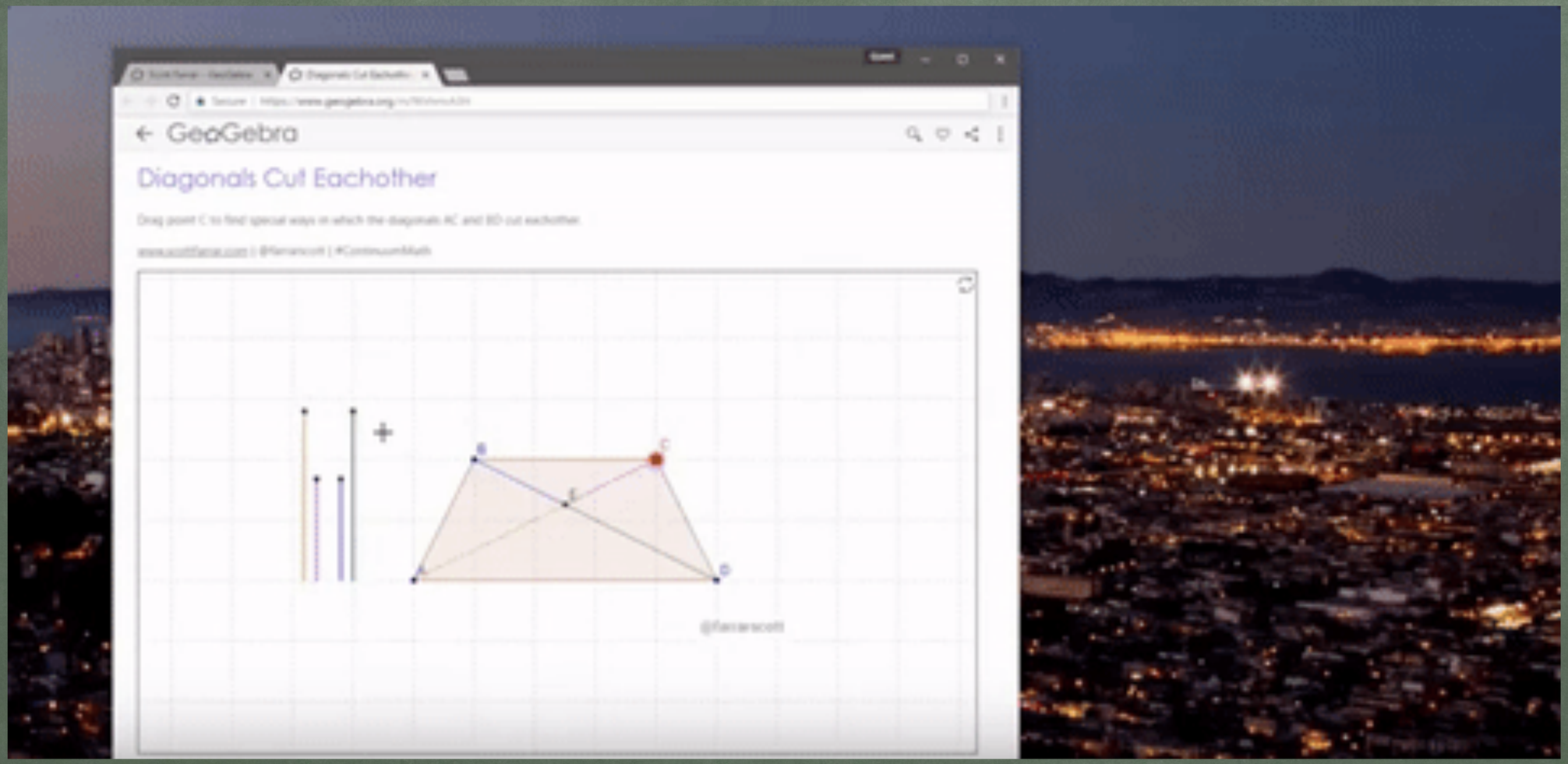
Extensions!

- In Function Carnival, the abstraction drives the concrete example.
  - Graph drives Situation



- Make a version of Diagonals in GeoGebra that does this.
  - What should drive What?

See how I did mine: https://www.youtube.com/watch?v=CNfdOcyEYUA



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695S7

your birth month

28

Each TreeTown citizen is gi n a crane of equal length. But e first section must be equal to ir birth month.

29

Set a = to your birth onth to find your crane. Then, g the crane to GrumpyCat to re e it.

30

$a = 4$

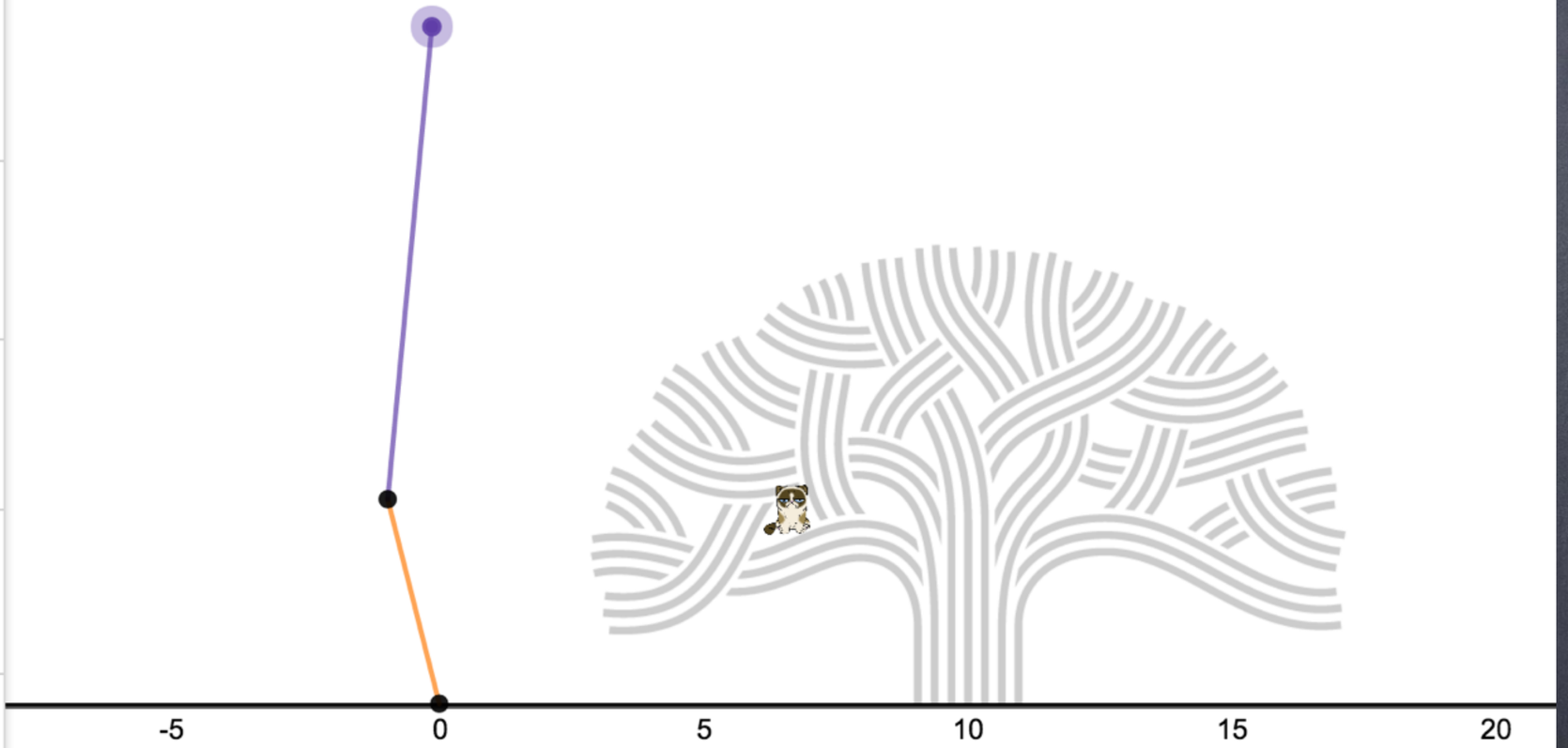
1 — 12

31

b

= 9

32



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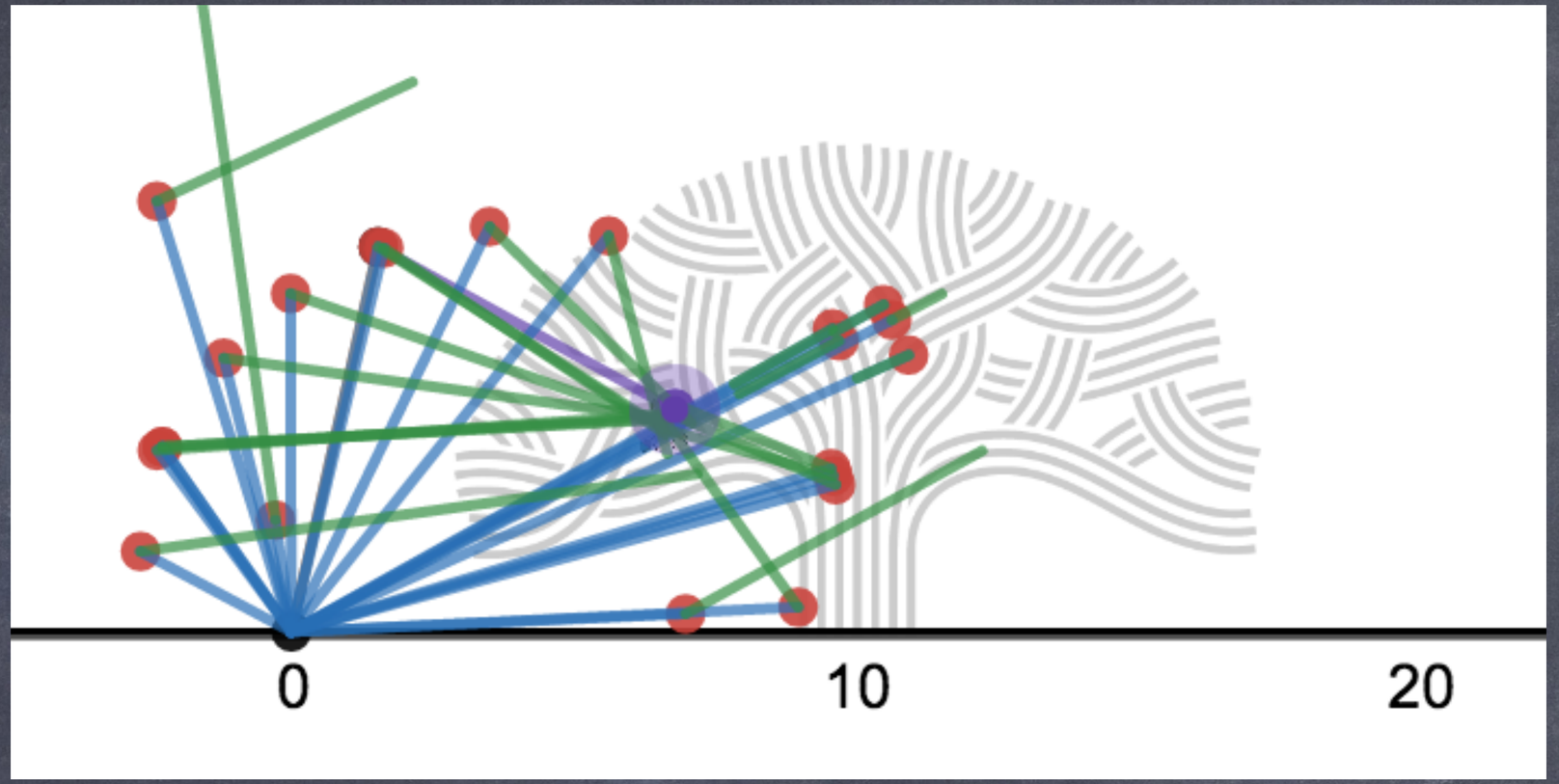

aggregation and constraints

[grumpy cat aggregate]