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Session 107

A Model for Mathematical Argumentation

Making It Work in Your Classroom

NCTM 2017

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MATHEMATICS EDUCATION GROUP

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NSF

This presentation

- I'll give you a bit of background on our project
- We'll explore our model while doing math
- We'll do a table read of a vignette
- There'll be time for questions

CCSS-M:
"Construct viable arguments and critique the reasoning of others"

Most powerful mathematics practice

All students should have access

Aids in conceptual understanding

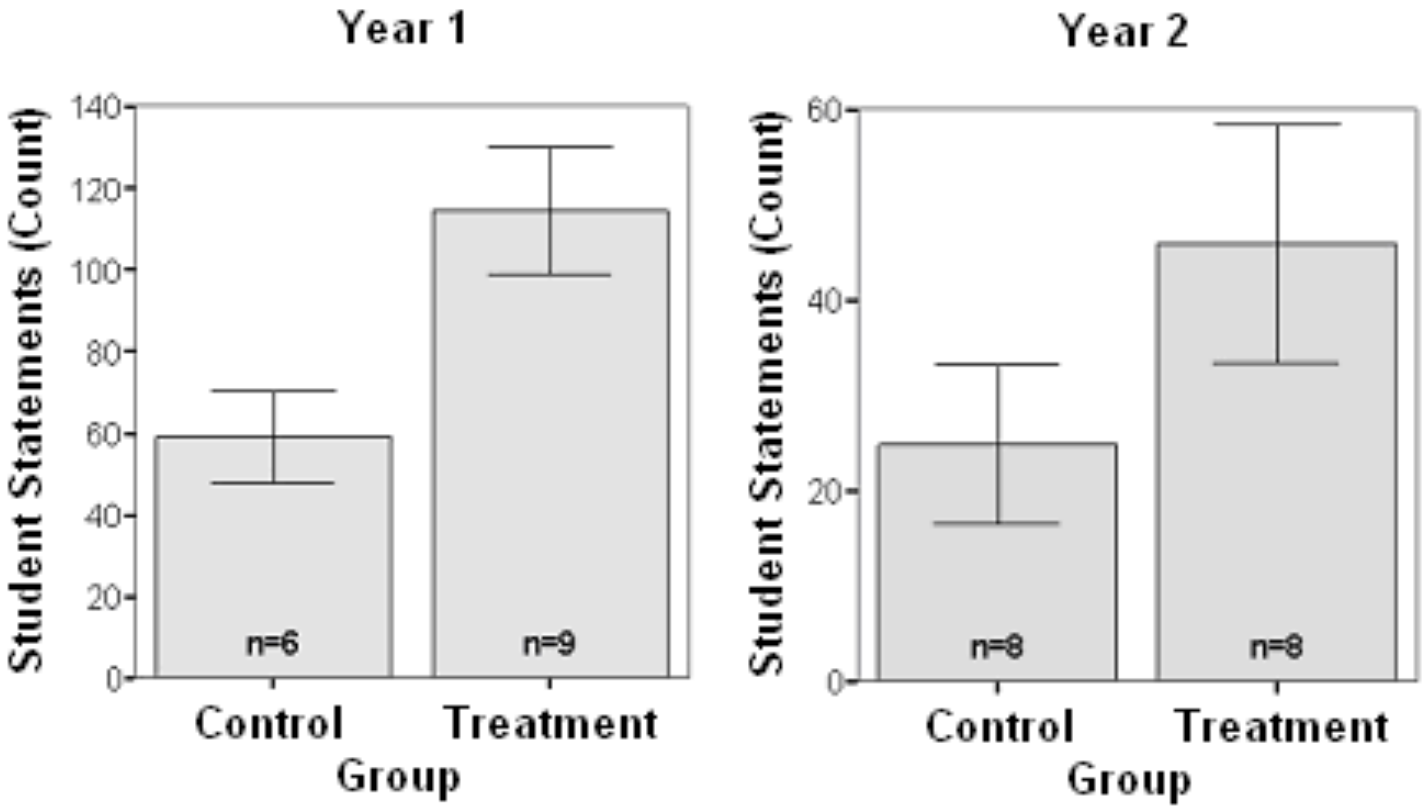
Bridging is professional development for mathematical argumentation in middle school.

Variety of school and district settings, with culturally and linguistically diverse student populations

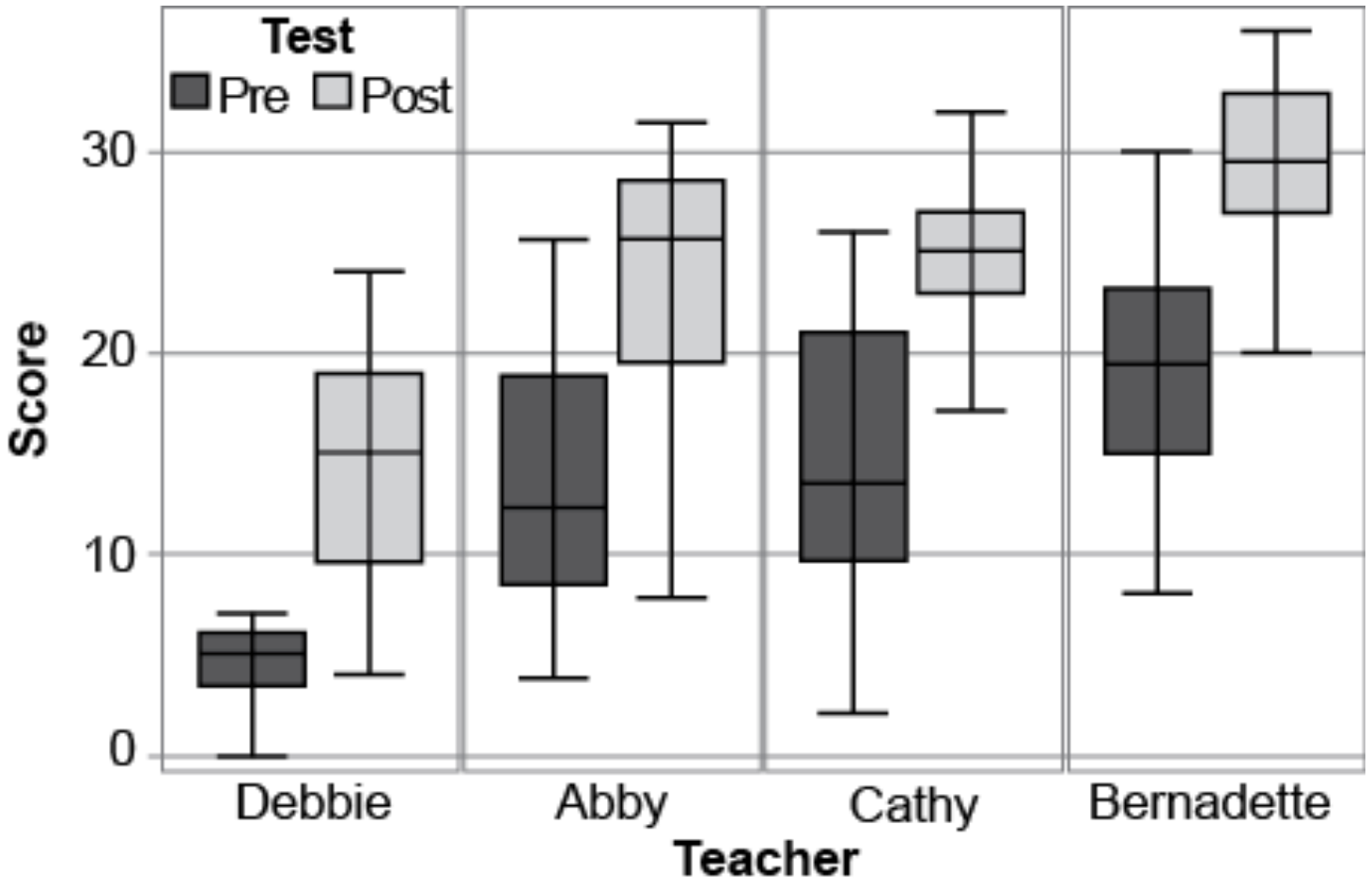
Summer institutes and
School year:
3 hrs/month alternating virtual and face to face

Interactive digital curriculum units AND adaptations of adopted curriculum

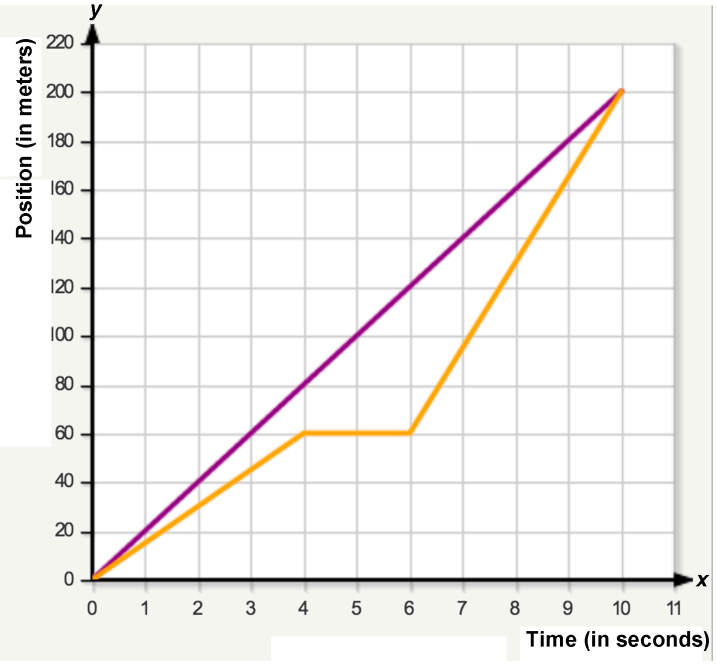
Results: twice as much classroom argumentation



Results: gain of 10 pts in student learning



One situation, four practice standards



We focus here

Problem Solving	Create a trip with 3 segments that ends at 200 feet.
Modeling	The bus travels at 3 different speeds for city, country and highway. Design a route to get home in less than 3 hours.
Precision	An object's time and position are noted at (0,0) (2,3), (3,5) and (10,14). What line best fits this data?
Argumentation	**Raj says that if a line is steeper than another, then it represents a faster motion. Is this always true?**

What math argumentation is / is not

It is a social practice to establish the truth about a mathematical idea.

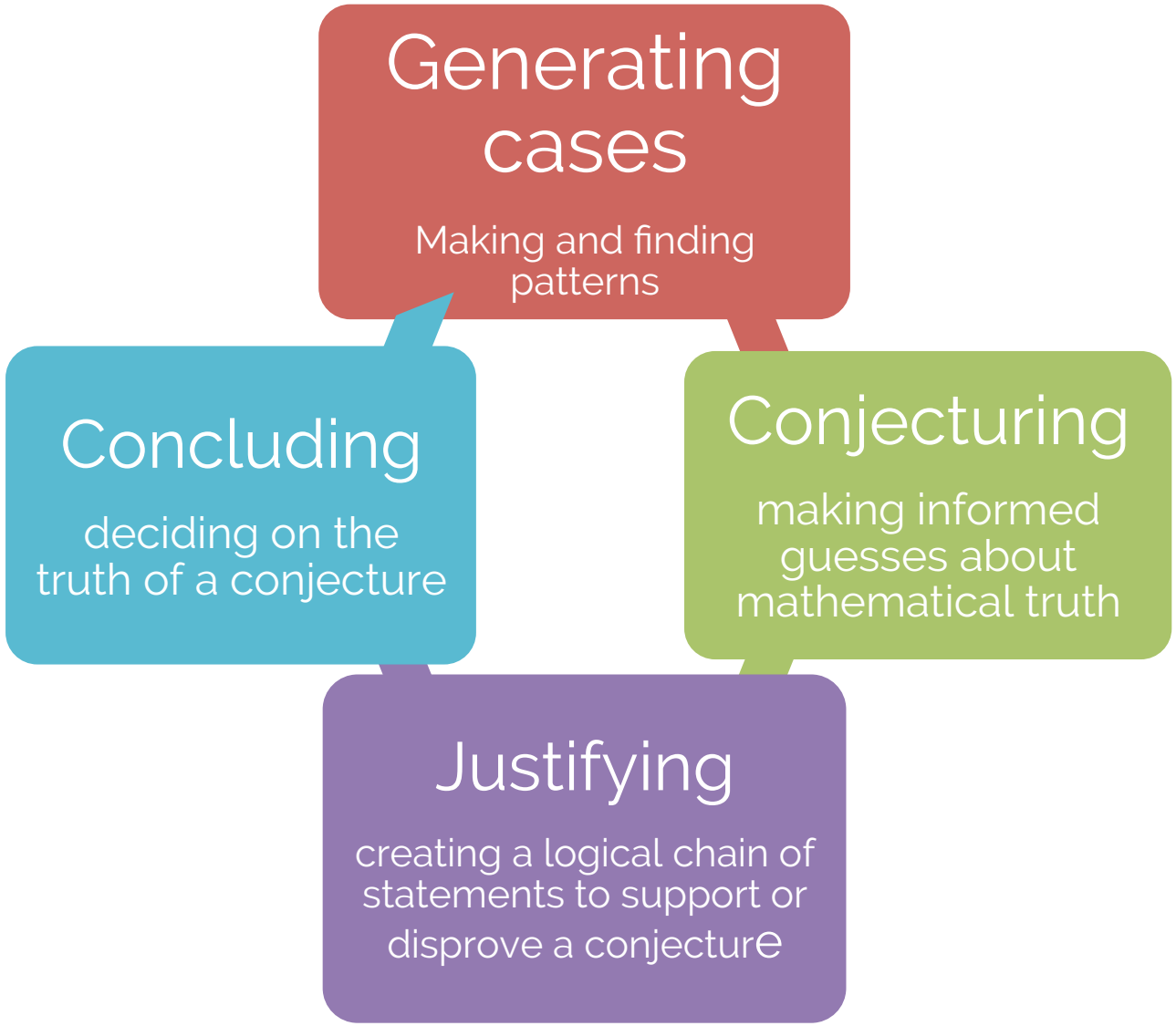
(Thurston, 1998)

Collaborative

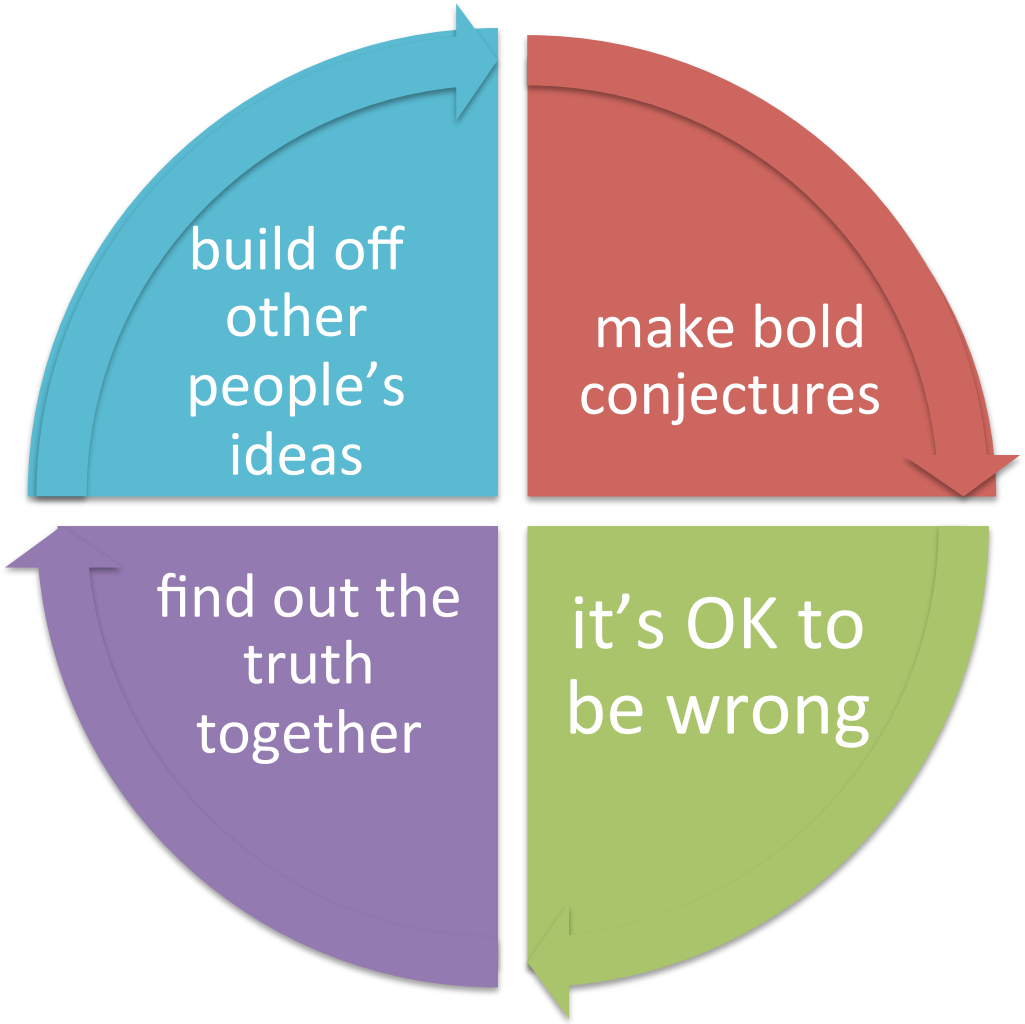
Not the use of mathematics to justify a non-mathematical claim:

i.e., which team is going to win the game.

Argumentation in four parts



Argumentation requires new norms



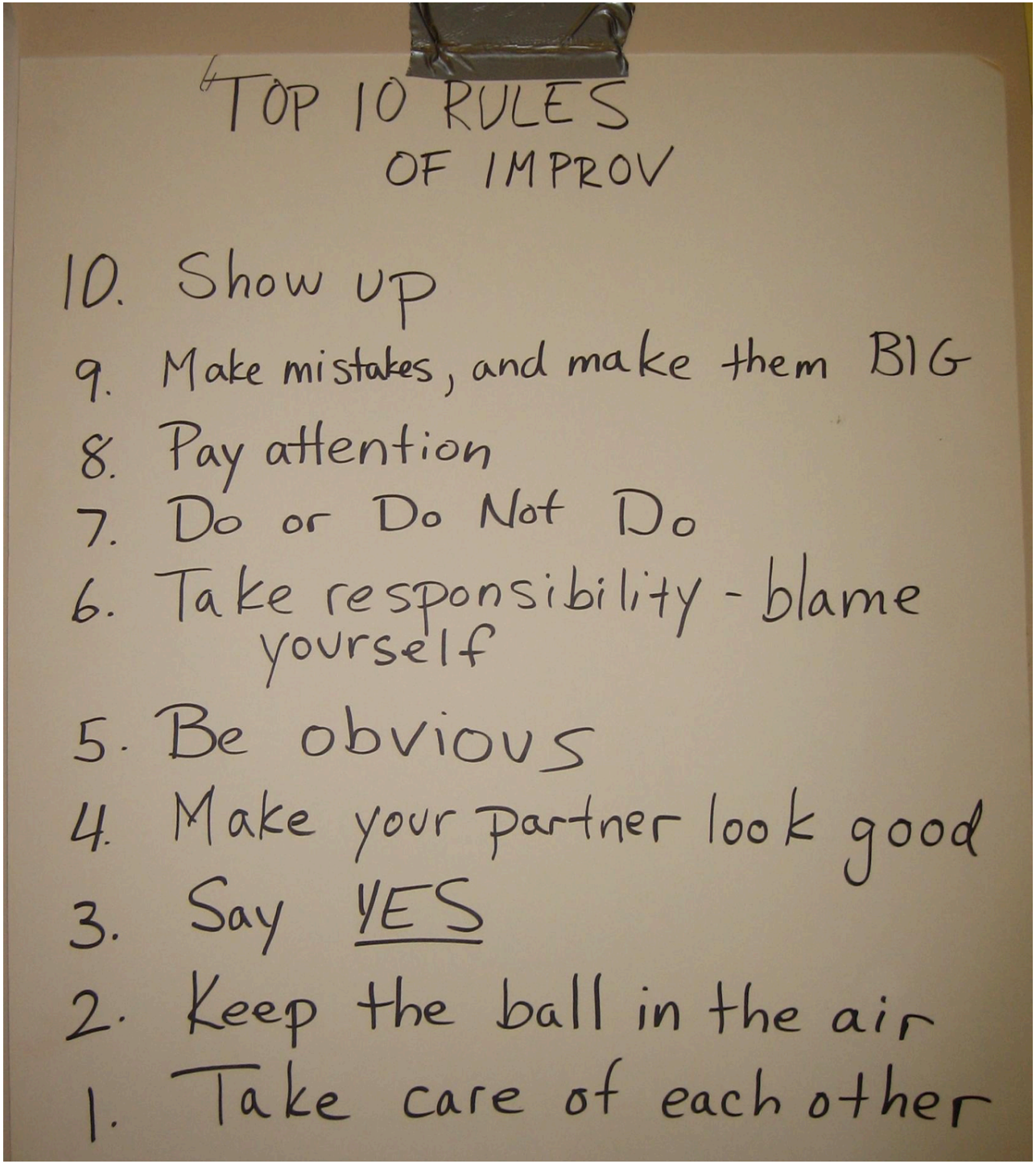
We use improv games to help students learn norms.

In movies

- Games come from improvisational theater
- Rules structure freedom to participate
- Freestyling as improv

Lin-Manuel Miranda at the White House

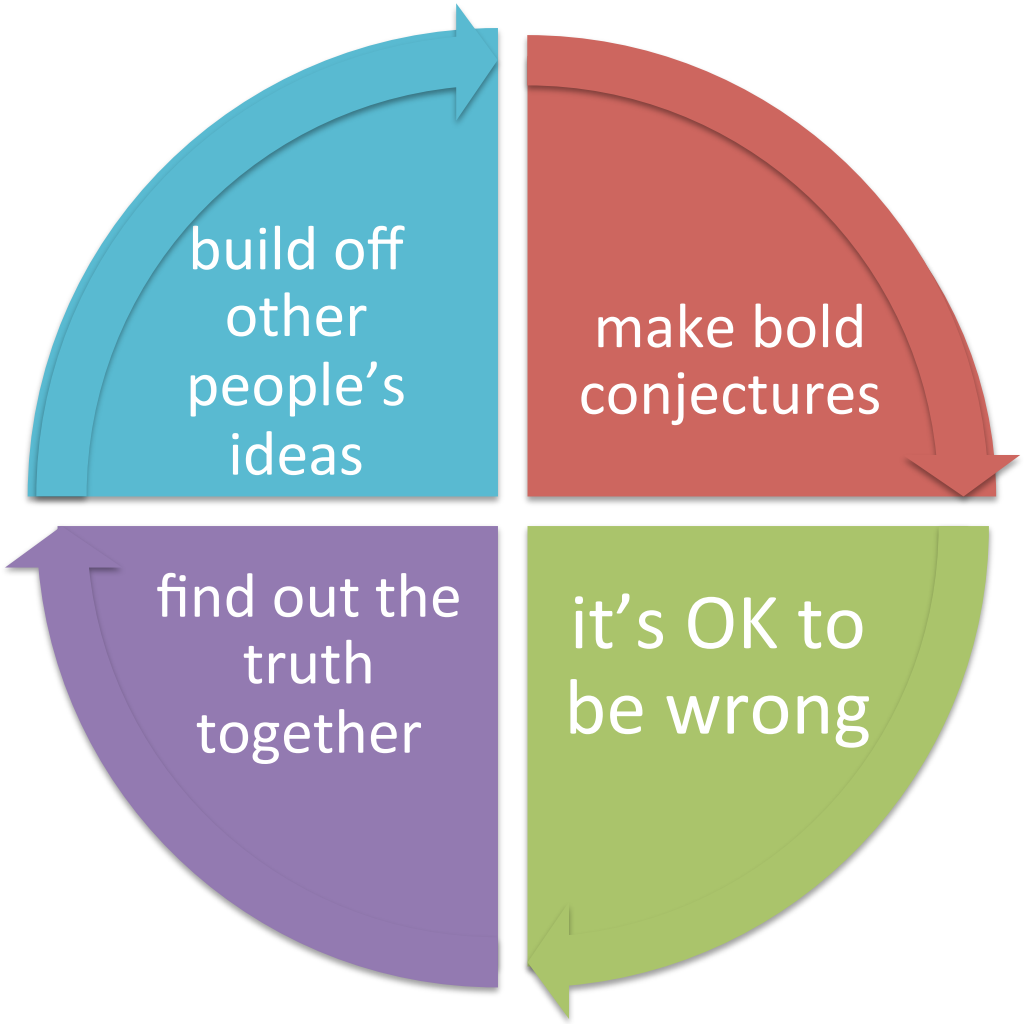
Let's play: *Gift Giving*


TOP 10 RULES
OF IMPROV
10. Show up
9. Make mistakes, and make them BIG
8. Pay attention
7. Do or Do Not Do
6. Take responsibility - blame yourself
5. Be obvious
4. Make your partner look good
3. Say YES
2. Keep the ball in the air
1. Take care of each other

Let's play: *Gift Giving*

- Stand facing your partner.
- There's a huge closet of unlimited gifts behind you.
- One person is the giver, another person is the receiver.
- The giver offers the receiver a wrapped gift from the closet.
- The receiver opens the gift and gratefully describes (and names) the gift.
- The giver responds with an explanation of how and why the gift was selected and why it would be enjoyed.
- Then switch roles.

How did we do with the norms?



Generating Cases

- Think about more than just one case
- Be creative
  - Try simple numbers or shapes.
  - Try hard numbers or shapes.
  - Try "weird" numbers or shapes.

Conjecturing

- Use patterns to make statements about what will always be true.
- Make bold conjectures about what might be true.
- Don't judge other people's conjectures.

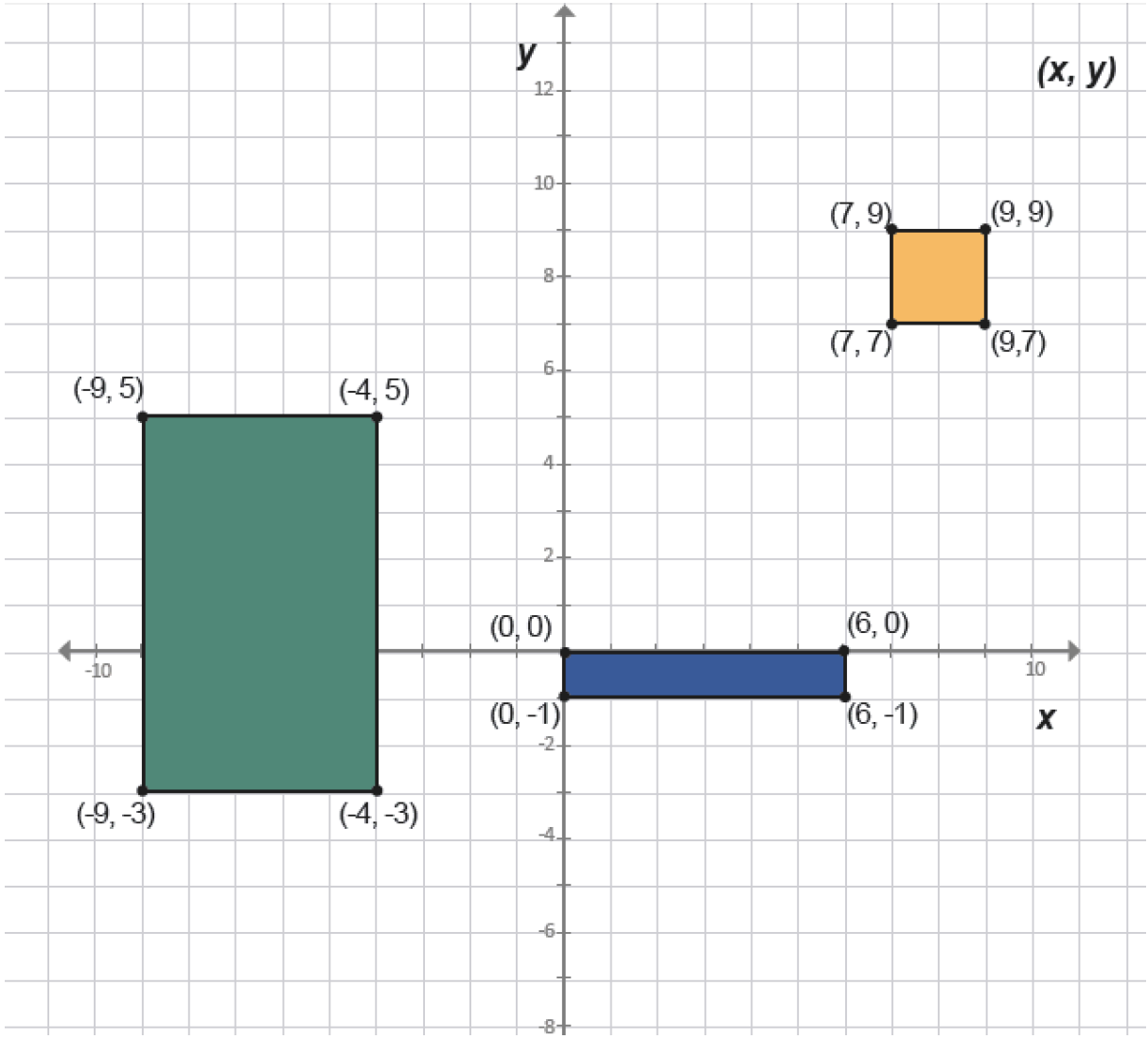
Justifying

- Look for reasons why a conjecture is true or false
- Build off of other people's ideas
- Try to convince others of your ideas, but keep in mind that you could be wrong—which is OK.
- Show it a different way. Make a drawing, a table, or a graph.
- Be obvious.

Concluding

- Know when to stop.
- Retell the argument from beginning to end.
- Base your conclusions on what is said, not who said it.

Let's do argumentation together



Handout or online: http://www.geogebra.org/m/3141695

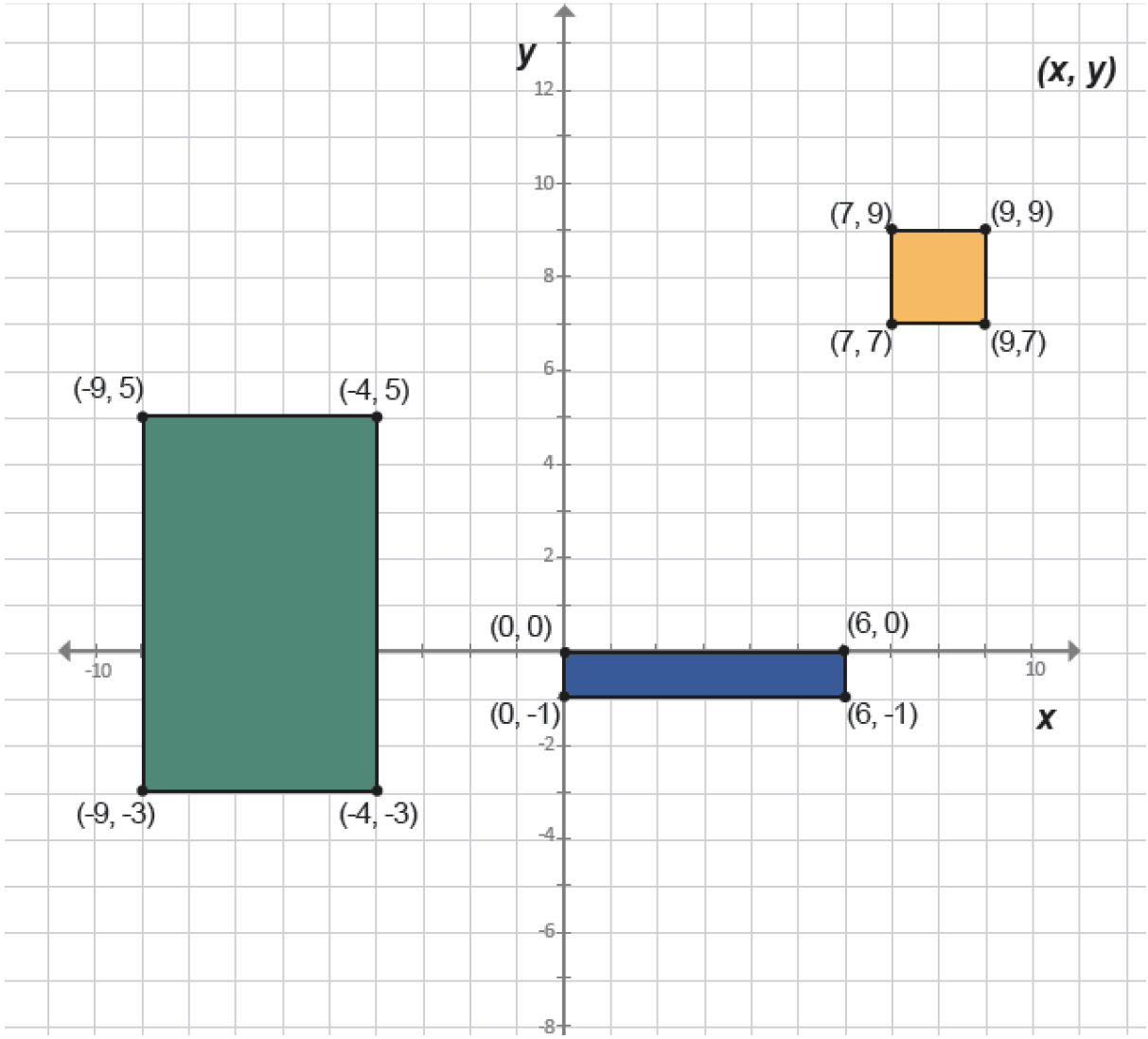
Generating Cases

Create examples (numeric expressions or geometric shapes) that you can use to look for and examine patterns.

Norms

- *Make multiple cases.*
- *Be creative: Try simple numbers or shapes. Try difficult numbers or shapes. Try "weird" numbers or shapes.*

Generate cases



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Conjecturing

A conjecture is a mathematical statement that you think might be true.

…in our case, *all* rectangles.

Norms:

- *Use patterns to make statements about what will always be true.*
- *Make bold conjectures about what might be true.*
- *Don't judge other people's conjectures.*

Does this relate to other MPs?

Your conjectures

All rectangles whose sides are parallel to the axis must have whole number coordinates.

The y-coordinates are the same, and the x-coordinates are the same.

The difference in the x-values represent the width, and the difference in the y-values represent the height.

All horizontal lines have the same y-coordinates.

All vertical lines have the same x-coordinates.

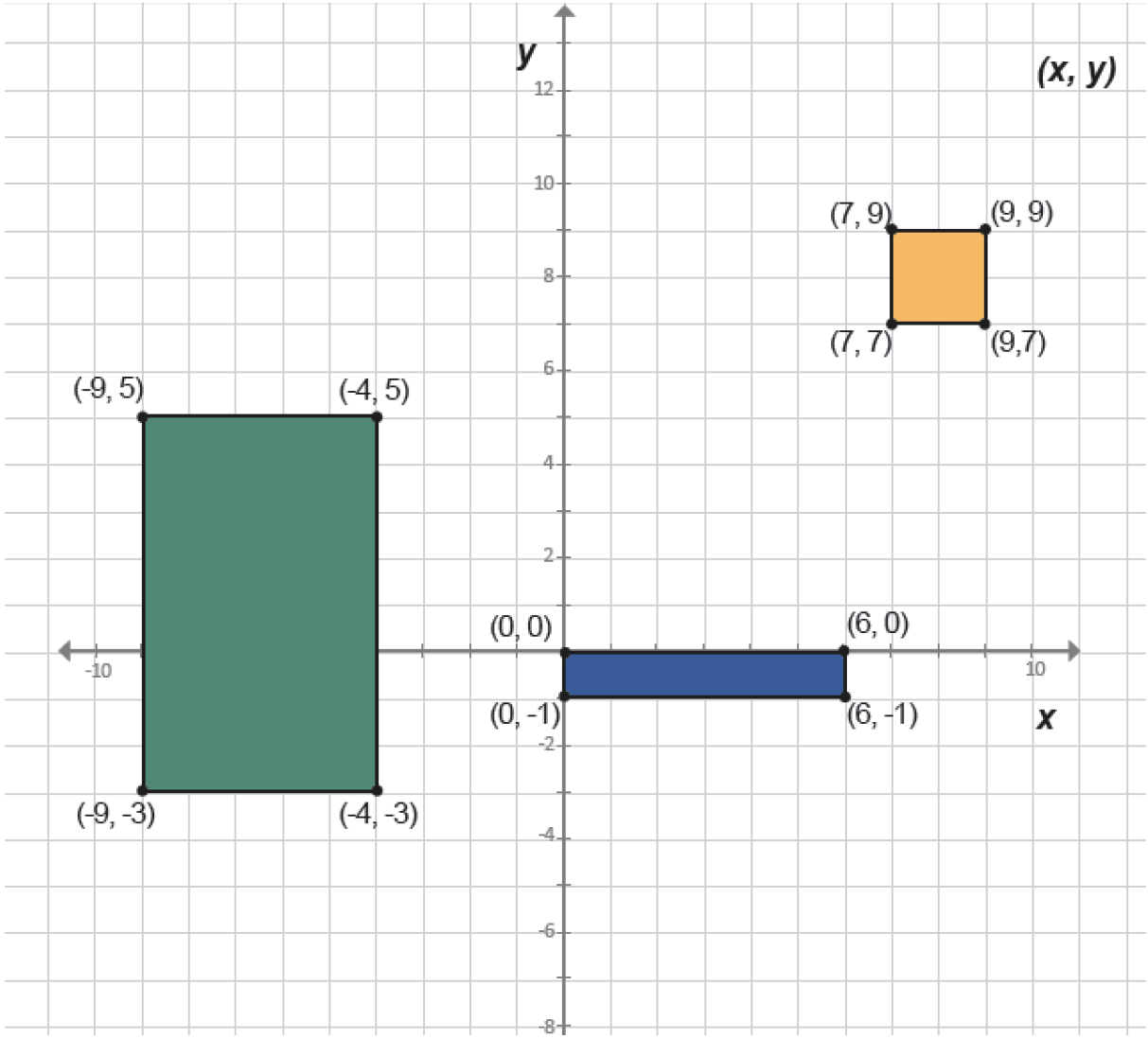
Justifying

A good justification is a connected chain of statements that convinces others of the truth or falsity of a statement; it goes beyond a personal exploration of an idea.

Norms:

- *Look for reasons why a conjecture is true or false.*
- *Build off of other people's ideas.*
- *Try to convince others of your ideas, but keep in mind that you could be wrong—which is OK.*

Conjecture:



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Concluding

Concluding means deciding whether a conjecture is true or false, based on a justification.

Norms

- *Know when to stop.*
- *Retell the argument from beginning to end.*
- *Base your conclusions on what is said, not who said it.*

Let's examine a classroom example

In groups of 3-4, enact this vignette
(i.e., do a table read)

As you do so, pay attention to the teaching moves.

- A *move* is the smallest piece of behavior that can be aimed at a purpose.

Teaching moves for argumentation

elicit conjectures

- *What patterns do you see? Describe the patterns in a sentence.*

ask why

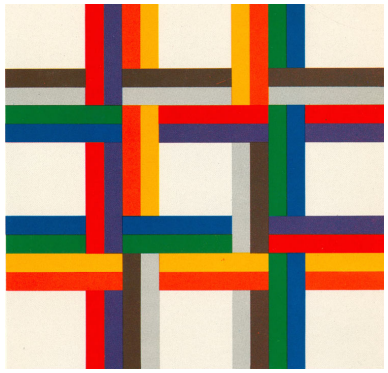
- *How do you know that?*
- *How do we know it is true?*
- *What makes you think so?*
- *Show how you know.*
- *Explain why this must be true.*
- *What's the mathematical reason it's true?*

explain to students

- *what conjecturing, justifying and concluding are.*

New book for teachers

September 2017



Includes 4-part model and activities from this presentation