



Bridging.sri.com

Session 696

Learning to Teach for Argumentation through Successive Approximations of Practice

NCTM 2017

Jennifer Knudsen | Harriette Stevens

SRI Education



Images by:
Verena Loewensberg



Successive approximations of practice...



As a lens for PD activities

How we use the idea in our Bridging PD

How you can use the idea in designing your own PD activities



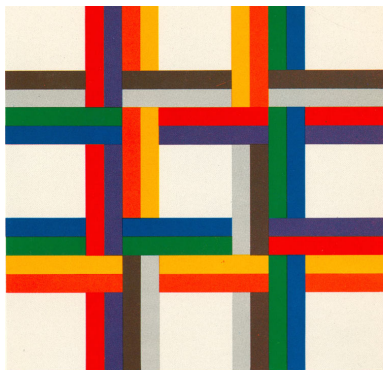
A little context: Bridging is professional development for mathematical argumentation in middle school.

Urban districts
with culturally
and linguistically
diverse student
populations

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

New book for teachers
is based on Bridging.

Coming
September
2017



Includes PD guide
with PD activities
from this
presentation

Jennifer Knudsen
Harriette S. Stevens
Teresa Lara-Meloy
Hee-Joon Kim
Nicole Shechtman

Mathematical Argumentation in Middle School

The What, Why, and How

A Step-by-Step Guide with
Activities, Games, and
Lesson Planning Tools

CM CORWIN
MATHEMATICS

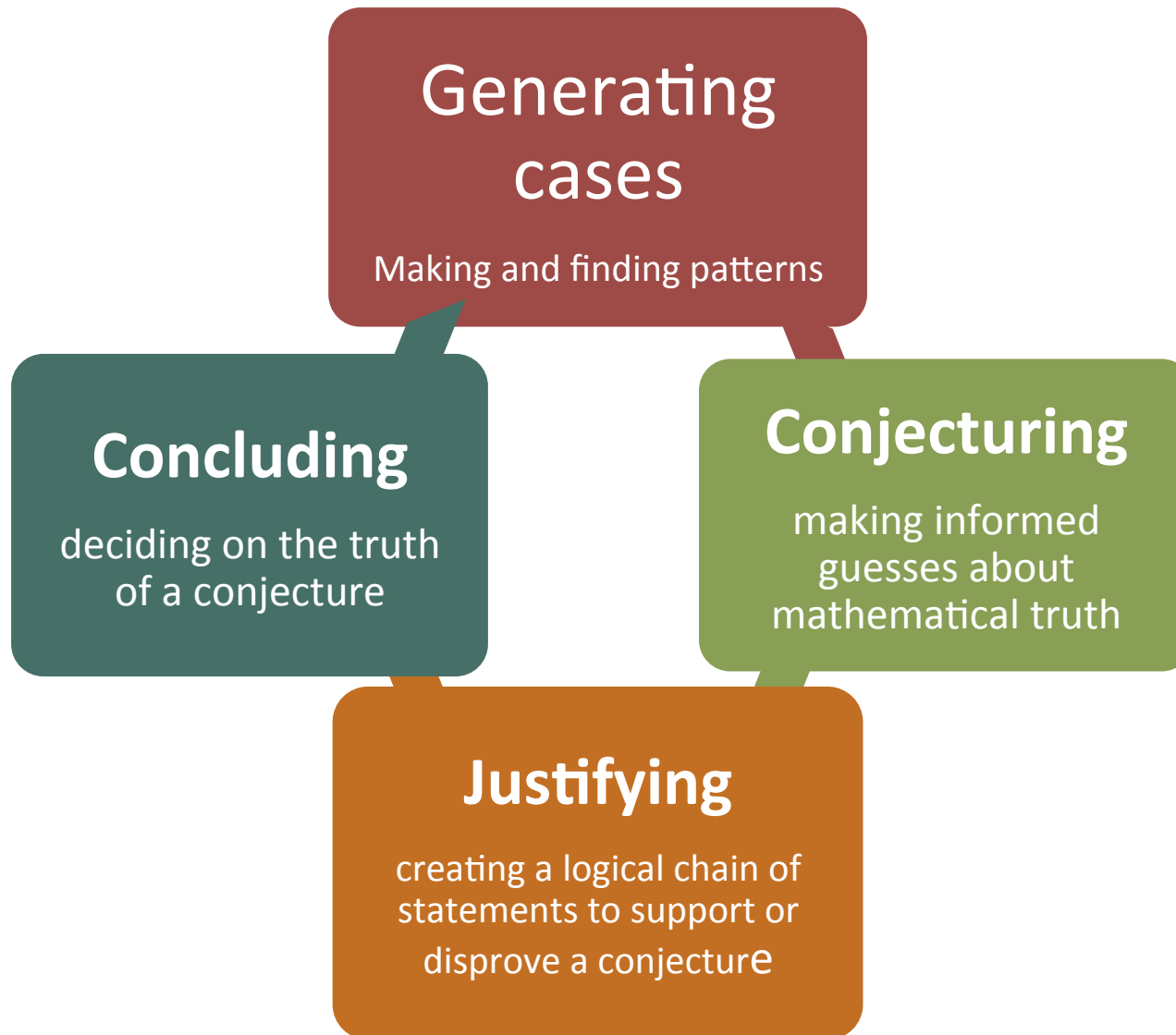
Foundational principle for Bridging:
Teaching is disciplined improvisation!

“Good teaching is always improvisational... Teacher improvisations are always guided by structures that are important to effective teaching.”

—Sawyer, 2015

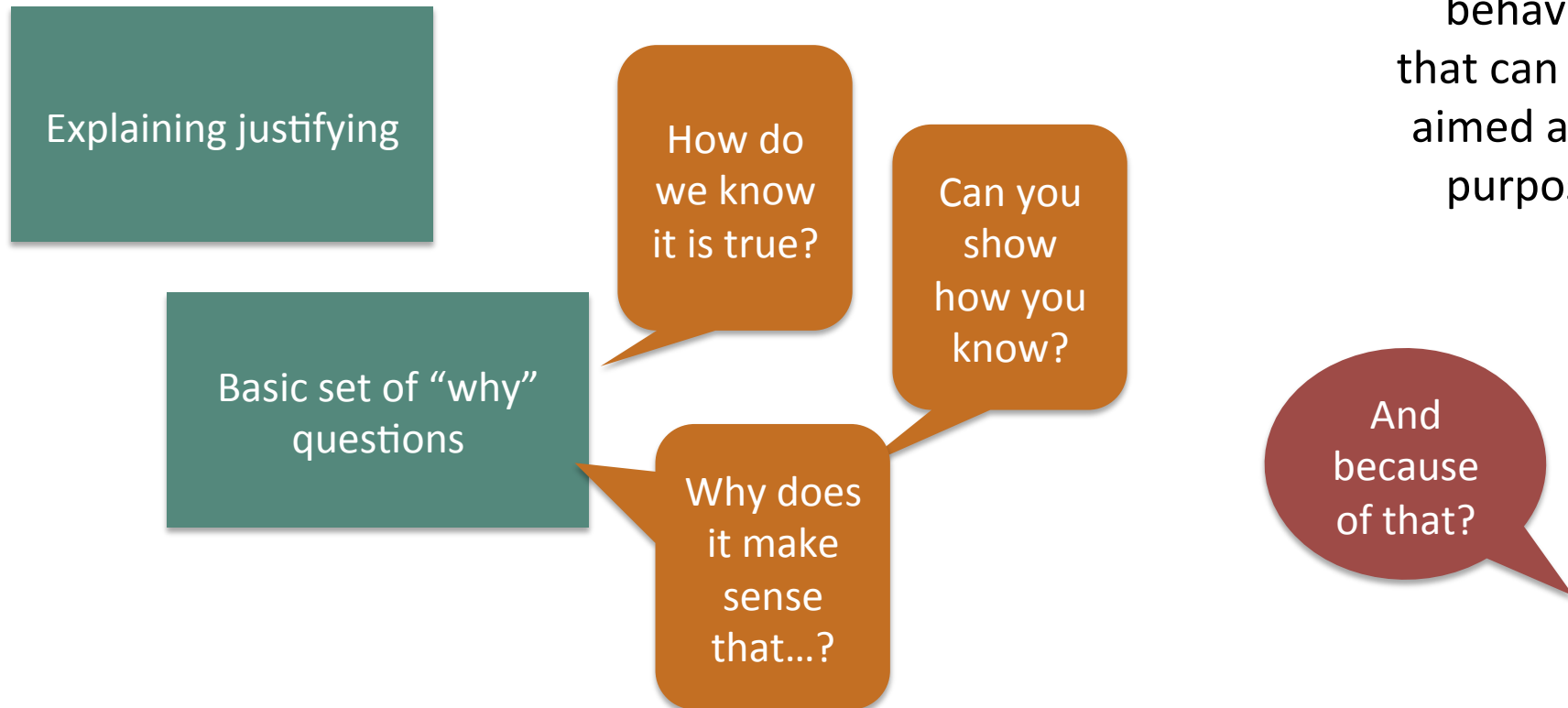


The *discipline* includes knowledge of the structure and nature of argumentation.



Improvisation is drawing on a set of teaching moves in the moment to support students' arguments.

Moves—the smallest piece of behavior that can be aimed at a purpose.



Our PD design problem:

If teaching is disciplined improvisation, how do we help teachers learn to **improvise** in the classroom, calling on their **knowledge** of argumentation?

We came to view PD activities through these lenses:

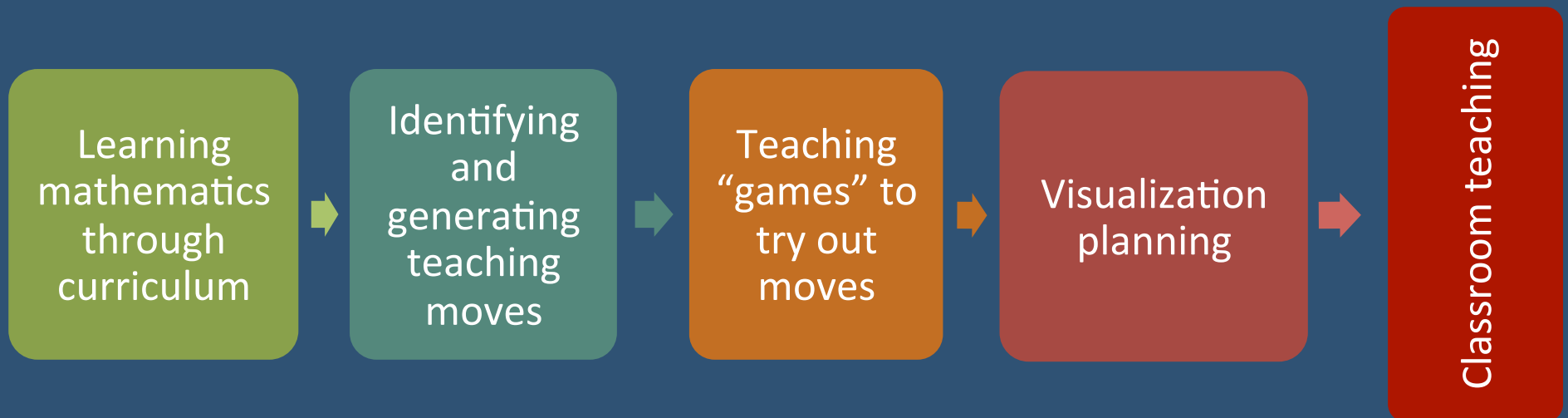


“A representation illustrates a facet of practice.”

“An approximation engages [teachers] in that practice.”

—Grossman, et al., 2009

Bridging activities that are **successive approximations of practice** get ever closer to improvisation in the classroom.



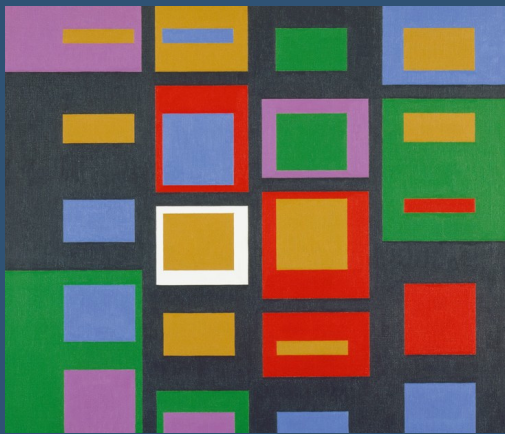
Learning
mathematics
through
curriculum

Identifying
and
generating
teaching
moves

Teaching
“games”
to try
out
moves

Visualization
planning

Classroom teaching



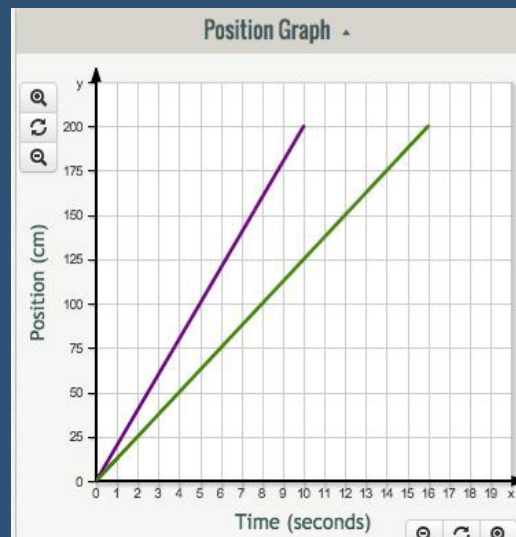
In learning math through curriculum, teachers experience...

making bold
conjectures

constructing
justifications
with others

exercising
math
authority

*Raj says that if a
line is steeper
than another,
then it represents
a faster motion.
Is this always
true?*



Learning
mathematics
through
curriculum

allows...

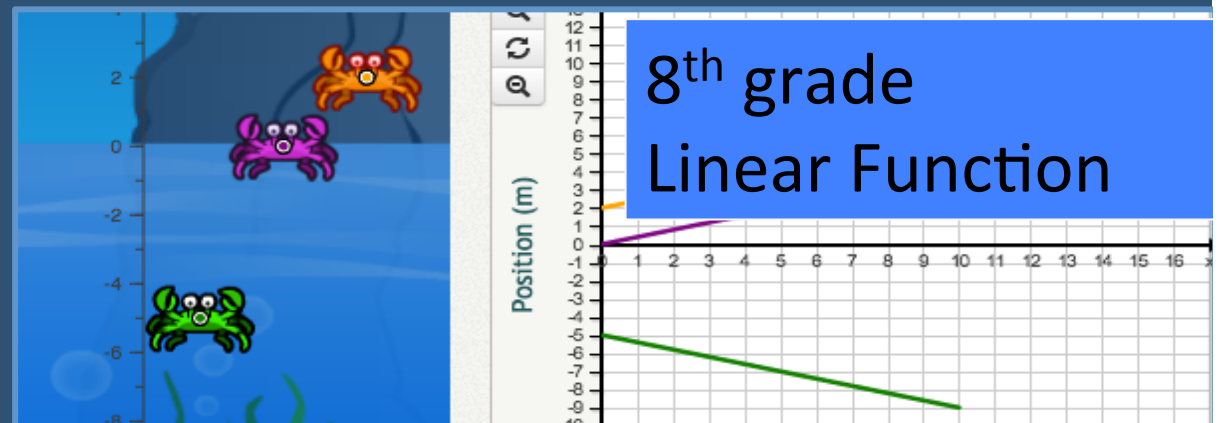
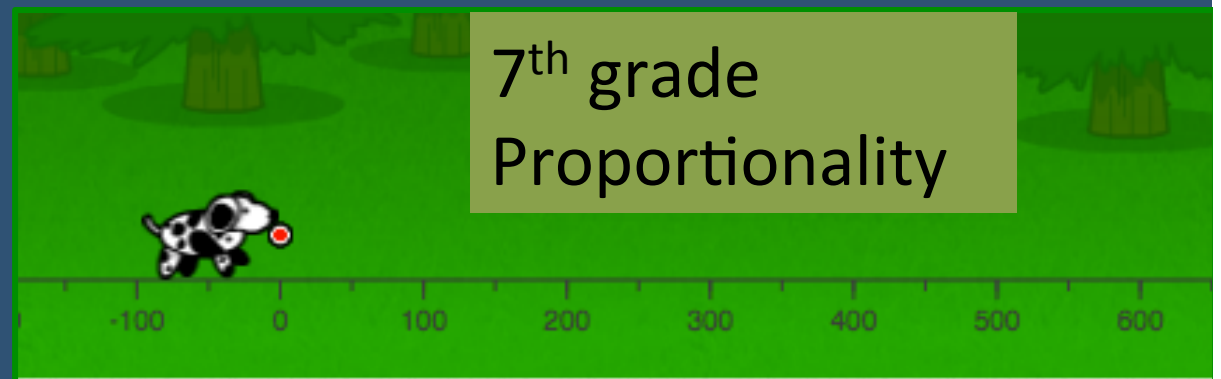
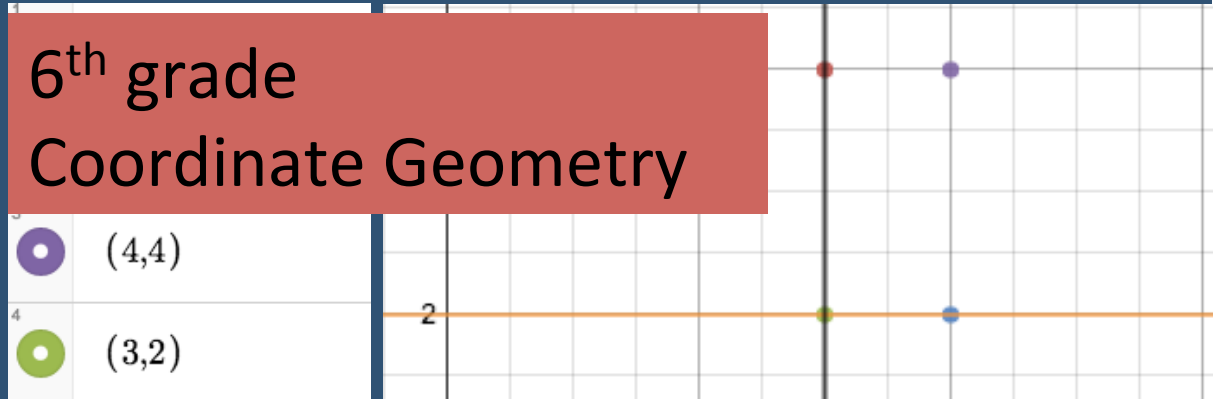
- teachers to experience argumentation
- leaders to model teaching argumentation

It provides a representation of practice.

Digital tools support argumentation.

Important: Teachers use with students.

See Resources on bridging.sri.com example in GeoGebra.

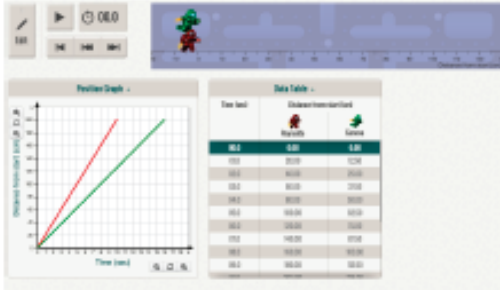


Main Activity

30 min

Activity 2.1

...for use
back in the
classroom.

		
Generating Cases	<p>A. Predict which robot will finish the race first. Press Play to check if you were right. Explain how you know.</p>	<p>Possible student answers: The red robot will finish first, because it arrives before the green robot; the red robot takes less time. In the explanation, elicit connections with the different representations.</p>
	<p>B. Which robot is going faster? Change the speed of the green robot. How did you do it?</p>	<p>Focus is on speed: Students can change the steepness of the graph to change the speed. They may also edit the starting position of the robot in the graph but this does not change the speed. And they can change the coefficient of x in the equation.</p>
	<p>C. Make one robot go really fast and the other robot go really slow. Press Play to observe the relationship between the robots' motions and their graphs.</p>	<p>Have students focus on what aspect of the graphs they have to change to modify the speed.</p>
Conjecturing	<p>D. Make a conjecture about what's always true about how the graph shows the speed of the robot.</p>	<p>Have students make conjectures in small groups. You may want to provide sentence starters to scaffold conjecturing. For example: If the green robot moves faster, then its graph....</p>

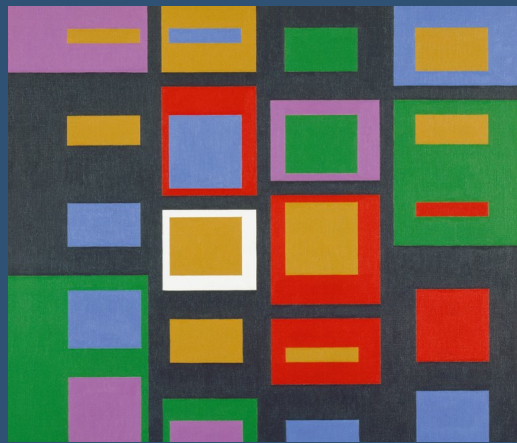
Learning
mathematics
through
curriculum

Identifying and
generating
teaching
moves

Teaching
“games”
to try out
moves

Visualization
planning

Classroom
teaching



Enacting vignettes helps teachers *Identify* teaching moves—and purposes.

Teachers take parts and read aloud the classroom vignettes.

Leader asks

- **What move** did this teacher make in this line?
- What could have been her **purpose**?
- What was this vignette an example of?

Moves
and
purposes
go
together

Sample from vignette

Ms. Cooper: So to say it a little more precisely: in the rectangle, the x-coordinates of the vertices on one of the vertical sides are both 4. Is that what you mean?

Ying: Yes, I think so.

Ms. Cooper: OK are we done? Have we justified the conjecture?

Bailey (pointing to all four rectangles): Yes, we see it right there.

Camden: The conjecture is supposed to work for *all* vertical sides. Maybe there could be one where it doesn't work.

Ms. Cooper: That's a good insight, Camden, that we need a justification that works for *any* vertical side of a rectangle. Who thinks they know?

Based on curriculum experience, identify and *generate* moves good for...



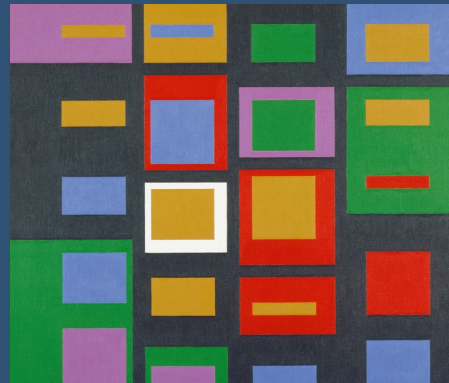
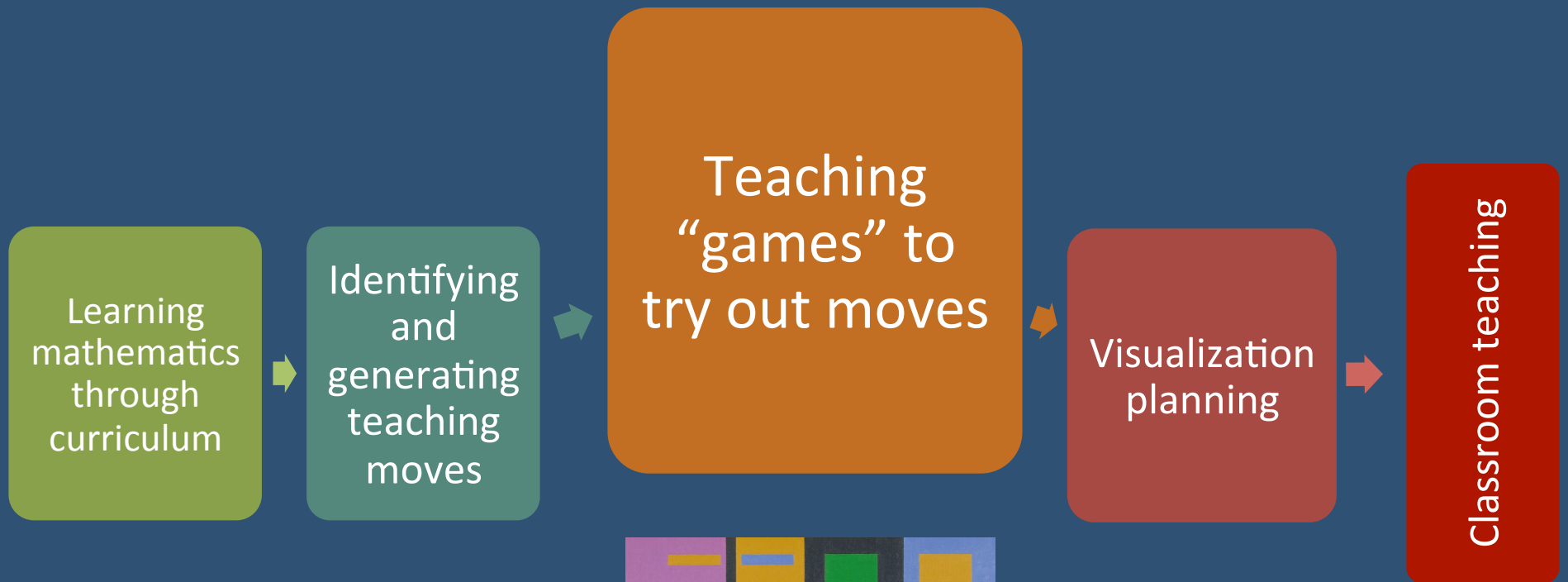
Teachers generate moves in a Google doc where they can share and organize them.

Identifying and generating teaching moves...

gets closer to practice because teachers *begin* to envision themselves as users of the moves.

Could you use these activities?
What would they be like?
What else could you design, based on these ideas?





Teaching games are based on improv games.

How improvisational actors learn their craft

NOT “anything goes”
—rules structure
open-ended participation

Freestyling is a kind of improv

Film all about improv



Lin-Manuel Miranda at the White House

Applied improv is used in other fields.

Alan Alda Center for Communicating Science



AT STONY BROOK UNIVERSITY

Improvisation for Scientists

This innovative program is shepherded by Alan Alda, a founding member of the Alan Alda Center for Communicating Science. Joining Mr. Alda are Valeri Lantz-Gefroh, lead improv teacher for the Alda Center, Louisa Johnson, M.F.A. from NYU, and three members of Stony Brook University's Theatre Arts faculty, Lydia Franco-Hodges, Deborah Mayo and Steve Marsh.

The goal of teaching scientists improv is not to turn them into actors, but to free them to talk about their work more spontaneously and directly, to pay dynamic attention to their listeners and to connect personally with their audience.



NY Times
March 29,
2017



Teaching “games” have a set of rules that focus on purpose.

Rules define...

- what the teacher should accomplish.
- the set of moves to use.

Teachers must play the game—a role play— not discuss it.

Post-game discussion: what moves worked for what purposes?

Example teaching game

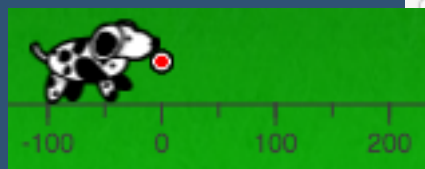
Round 1: closed-ended questions only

Round 2: open-ended questions only

1 teacher

2 students

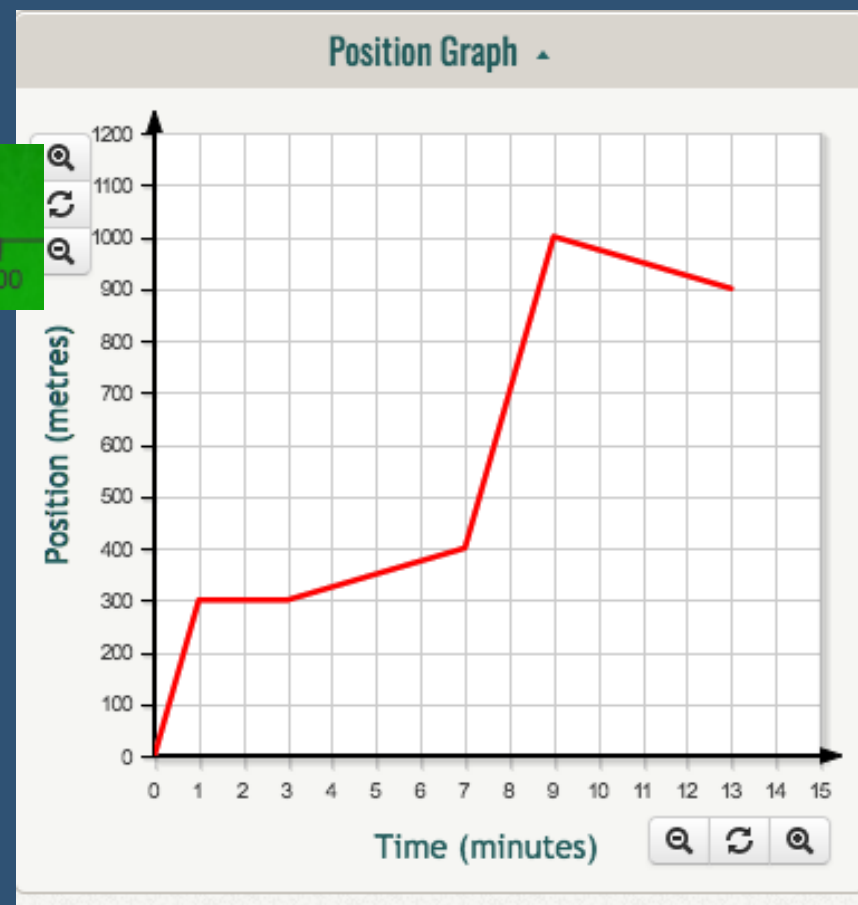
Facilitate justifying



Student conjecture

When the line is flat, the dog is not moving.

Reflect: What is each type of question good for?



Teaching games...

move closer to practice because actual moves are enacted, purpose analyzed.

The teacher can deploy these in the classroom in a similar situation.

Could you use teaching games?
What would they be like?
What else could you design, based on this?



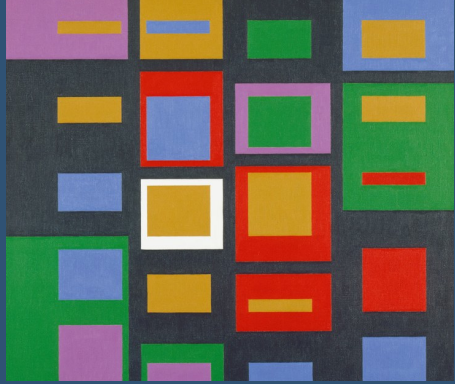
Learning mathematics through curriculum

Identifying and generating teaching moves

Teaching "games" to try out moves

Visualization planning

Classroom teaching



Visualization planning helps teachers imagine moves and responses.

1. Sit with another teacher.
2. Start with written lesson plan. Choose 10 min. segment.
3. Visualize:
 - One teacher **imagines the lesson outloud**, in detail, in order.
 - Listener records in the lesson plan, uses active listening.

- ✓ Focus on both moves and possible student responses.
- ✓ Follow possible paths.

Have also done between PD facilitator and teacher

Visualization planning...

helps teachers develop an effective lesson planning practice.

relies on research about expert vs novice teachers.

makes explicit the expert's planning practice.

Lesson plan form

Task: Students justify three conjectures

Time: 20 minutes

Grouping: Whole class

Teaching moves

Introduce the 1st conjecture. Elicit justification.

Show 4 rectangles on the display:

“typical”, square, pos and neg coordinates

“How do we know this *might* be true?”

Students may:

Use the typical rectangle as an example, stop there.

Do we know if it is always true based on that one example? How can we show it is true for all the rectangles?

use parallel and $x = 0$ on y -axis

Ask what parallel means

Say same distance apart

Never intersect

If needed:

What does that tell is about coordinates?

What does the x -coordinate mean?

Say x -coordinate tells distance from y -axis, so has to be the same on at the vertices of vertical lines

Visualization dialogue (fictionalized)

Ms. Cooper: Yesterday, students made about 10 conjectures. I picked three of them to justify tomorrow. There's one about coordinates on vertical lines, and a similar conjecture about horizontal lines, but that second one is false—they got the coordinates backward. Then I picked the conjecture that I thought was a bridge to where I want to get to—the students using algebra to name the pattern of coordinates in any rectangle. It just states that there is a pattern across the 4 vertices, but doesn't state what that pattern is.

Mr. Flores: So, three conjectures that build to your algebraic conjecture, your “secret mission”? I see them here in your plan.

Ms. Cooper: Yes, and I think I'll start out with the true conjecture, just to ease them into argumentation. They aren't that experienced yet.

Visualization planning...

moves closer to teaching practice as teachers engage in effective planning and envision their own classroom.

It provides a written record that teachers can use in the classroom.

Could you use
visualization?
What would it be like?
What else could you
design, based on this?





Classroom
teaching

Teacher OK. So why are you saying this has to be true?

Student1 Because these ones, whenever we did them and it was greater than 180, these two didn't meet.

Teacher OK, but how do you know besides what you just did for a couple? Because there's a bunch of combinations you didn't do, right?

Student2 Uhhh....You said it was.

Teacher Did I? But how do I know?

Student2 Because that's the answer.

Teacher But why?

Student1 Because...

Teacher Because you gotta be able to back it up.

Student1 Because it makes sense.

Student2 Because with triangles, the two angles let the lines come together.

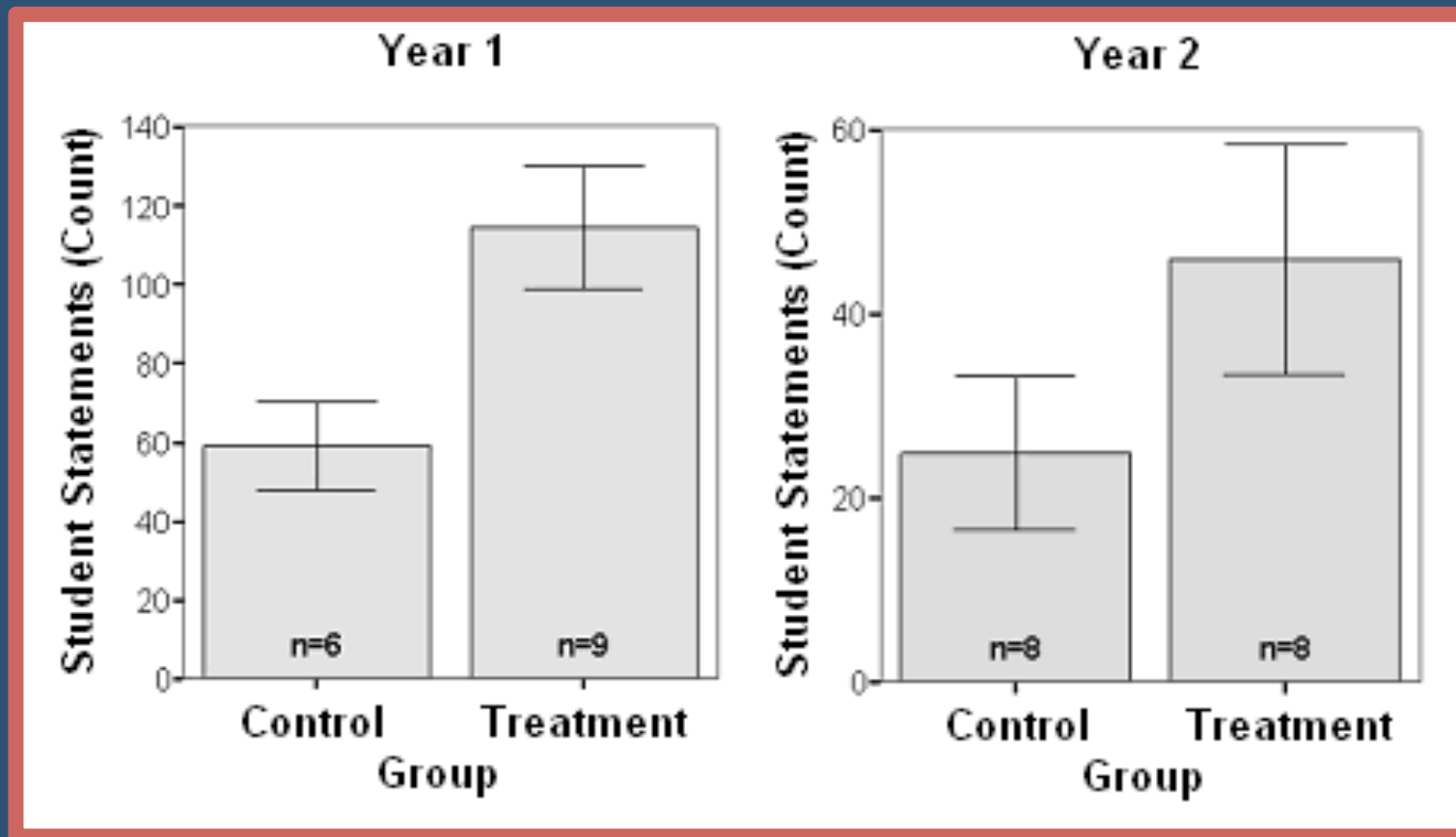
Teacher OK and if we use that logic, if 2 angles add up to more than 180, what would that mean?

Student1 That it won't meet with the other angle, it wouldn't be a triangle.

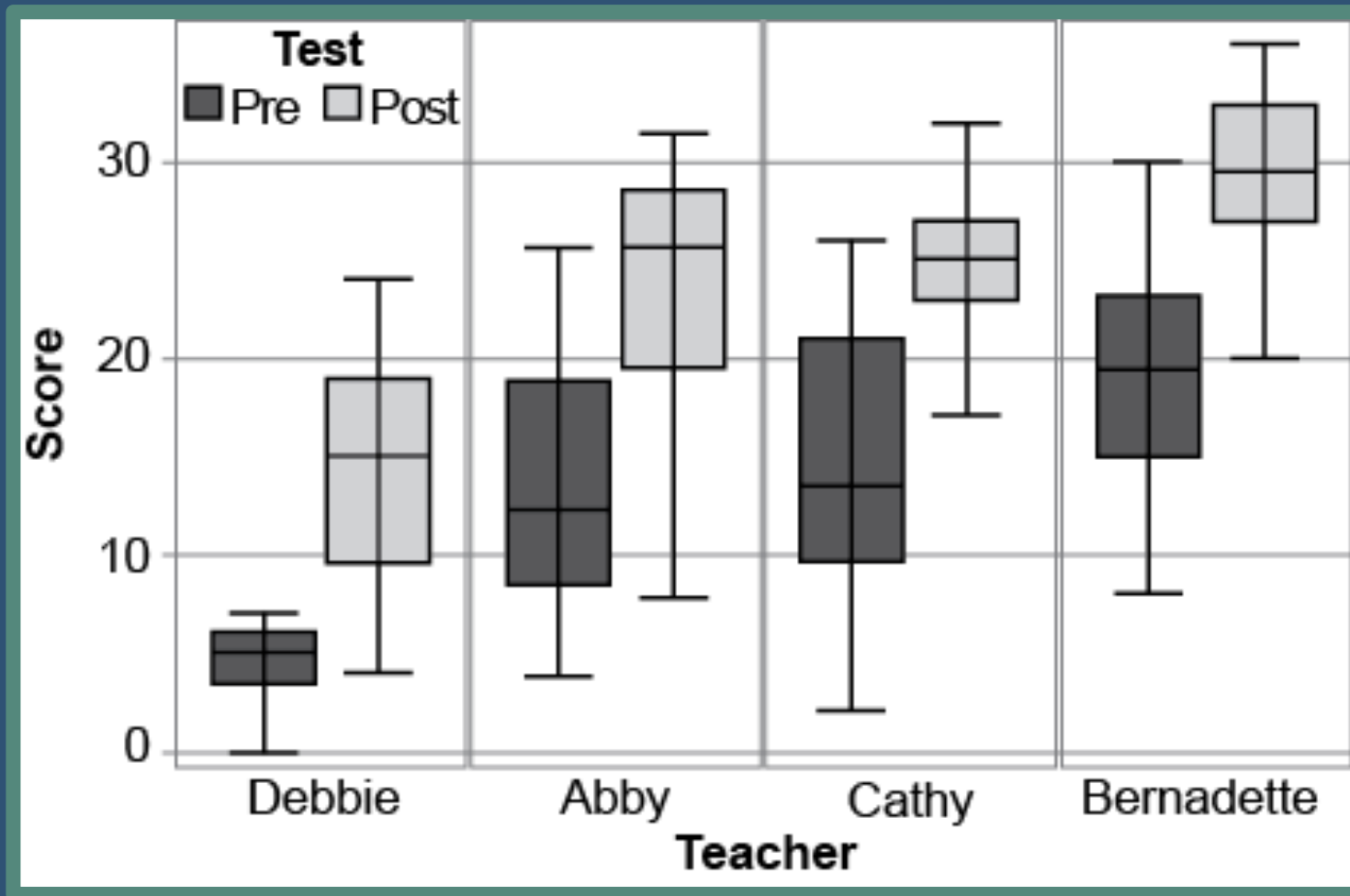
Teacher OK, write that down.

Using why questions repeatedly when students are beginning to argue

Study 1: twice as much classroom argumentation



Study 2: gain of 10 out of 36 pts in student learning



We've learned some lessons.

Don't skimp on the mathematics learning.

Providing structure all along the way enables exploration in the right territory.

Focus on moves, purposes AND possible student responses.

Designing approximations of practice

1. What are your PD goals?
2. How can we view your existing activities through the lenses of approximations and representations?
3. What would be a new activity, and how does it approximate and/or represent practice?
4. What two-way representations could bridge between PD and the classroom?

Thank you!

Bridging.sri.com

Jennifer.knudsen@sri.com



Learning
mathematics
through
curriculum

Identifying and
generating
teaching
moves

Teaching
“games” to
try out moves

Visualization
planning

