Teaching for Argumentation and Teaching for Content: Resolving a Tension

Jennifer Knudsen, Harriette S. Stevens, Teresa Lara--Meloy

SRI International and Mathematics Education Group

Presented at the meeting of the National Council of Supervisors of Mathematics
New Orleans, April 9, 2014

In this presentation, we'll…

1. Introduce you to the Bridging PD program,
   - Innovative professional development using improv for argumentation.
2. Show Bridging resources for teaching for argumentation.
3. Explain framework for case studies.
4. Present cases: video, transcript and analysis.
5. Invite you to discuss the cases.

Argumentation is a shared value.

- Long history of valuing the inclusion of mathematical argumentation in the K--12 mathematics classroom.

  e.g., Dewey, Fawcett, Yackel, Cobb, Krumhauer, Bieda…

- The Common Core State Standards are aligned with these values:

  "Construct viable arguments and critique the reasoning of others."

Fostering argumentation

Bridging from workshop to classroom

Bridging Fosters CMA

Shechtman & Knudsen, in press

Classroom mathematical argumentation (CMA) includes:

- Conjecturing—"conscious guessing" to create a mathematical statement.
- Justifying—process of explicating one's reasoning to establish validity.
- Concluding—process of coming to agreement of validity.

CMA is

- Fundamental disciplinary practice to which all students should have access.
- 21st Century skill.
- Complex integration of mathematical and social practices.

Bridging PD Resources

- Curriculum and software, rich with opportunities for argumentation.
- Time for teachers to learn to make arguments themselves.

- Time and structure for learning new teaching moves, to be used improvisationally.

Bridging treats teaching as "disciplined improvisation" (Sawyer, 2009)

Disciplined

- Framework for math argumentation.
- Structures through curriculum and pre--made software files.
- Structured planning process for creating argumentation--rich lessons.

Improvisation through "approximations of practice" (Grossman et al., 2009)

- Activities grow closer to practice.
  - Act out a script.
  - Make an argument.
  - Facilitate an argument.
- *Teaching games adapted from improvisational theater games.*

Bridging II: Design Study

How can teachers structure argumentation to support student learning?

- 4 teachers, 8 days together
- Co--designed curriculum
- Learned improv for classroom use
- Used improv to learn to teach argumentation
- Took away resources: curriculum, software, norms posters

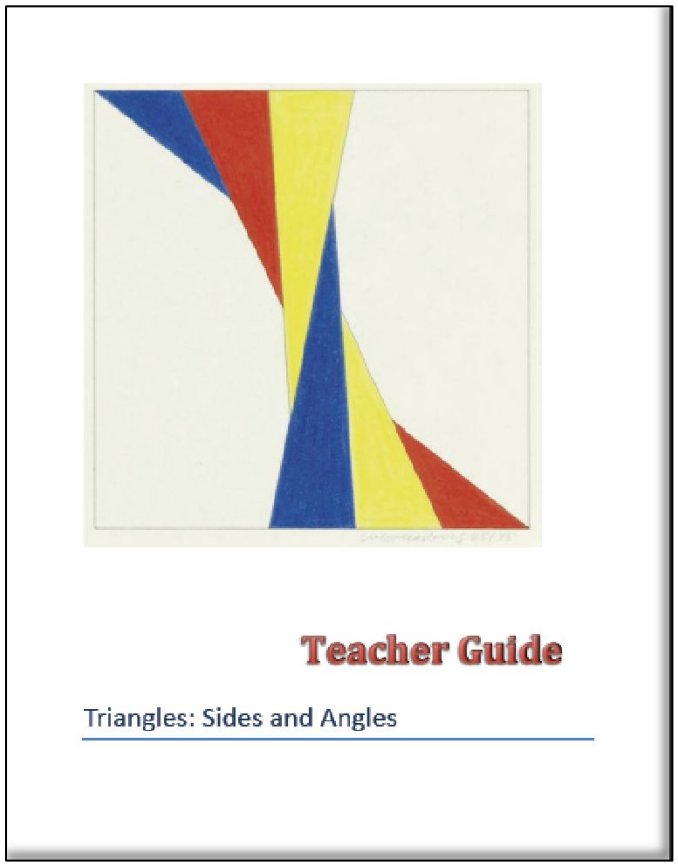
SRI International

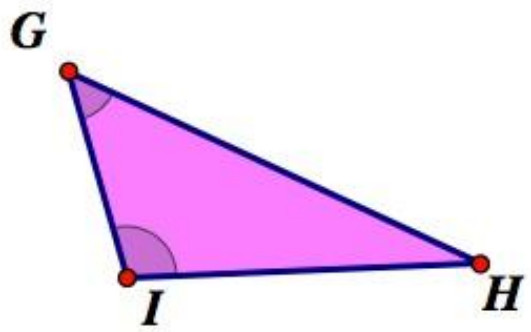
Bridging II Classroom Resources for CMA

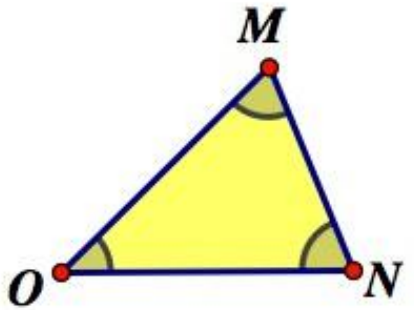
Set of teaching moves, among them…

- Questioning
- Structuring CMA
  - Making it clear when conjecturing vs justifying.
  - Setting norms for concluding.
- Giving advice on "how argumentation goes."
- Connecting to a larger community of mathematicians.

Workbook and dynamic geometry software

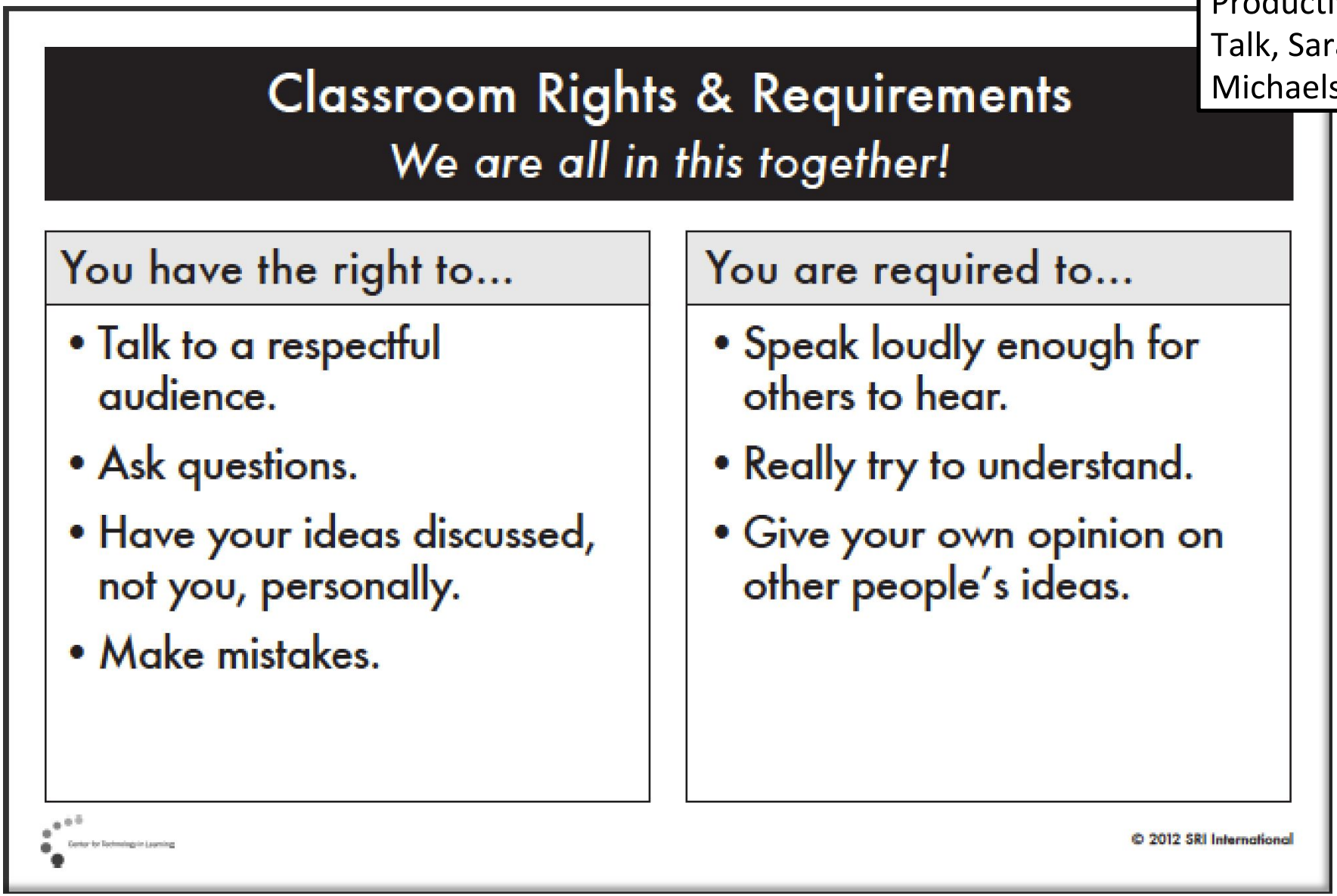






Classroom poster: general norms

Inspired by Productive Talk, Sarah Michaels



Classroom poster: how--tos for argumentation

See Knudsen, et al, this month's MTMS

How to Do Math Argumentation

Conjecturing

- Look for math patterns that make sense to you
- Think about more than just one case
- Be creative
- Don't judge other people's conjectures

Justifying

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

Concluding

- Stop the argument when your class agrees that it is true

Center for Technology in Learning

Improv games support norms, how--tos

Gift Giving

1. *Partners face each other—huge imaginary closet gifts behind them.*
2. *One player offers a gift from closet—any size, weight or shape (indicate by how you give.)*
3. *Other player unwraps gift, names the present by thanking the giver as they handle the gift.*
4. *First player explains why they picked gift specially the partner.*
5. *Switch roles.*

Let's play! Experience this resource.

What did the game have to do with…

- Conjecturing
- Justifying
- Concluding

SRI International

Case Studies

Methods

Data collection:

- Video and written observations of all instruction during the *Triangles* unit.

Analysis:

- Using video and protocol, constructed narratives of two classroom implementations *of the same lesson*.
- *Identified teaching moves* in terms of form, content and purpose, classified by types of scaffolding.
- *Compared* types of teaching moves across classrooms.

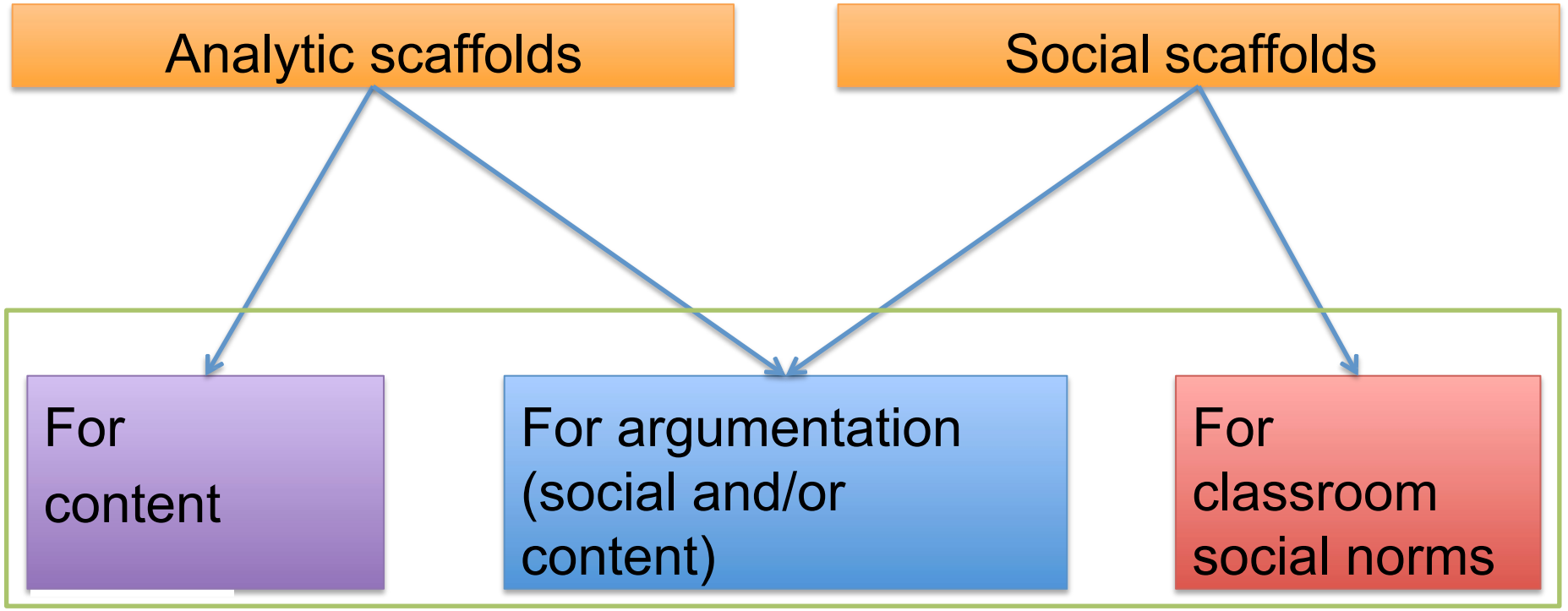
Viewed what teachers did as moves.

- Teaching moves using in PD and research.
- Smallest chunk of behavior that can be aimed at a *purpose*.
- We consider form, *purpose* and consequences of moves. (Krunkle et al, 2004)

e.g., this tool served the purpose of a hammer when I drove a nail with it.

Conceptual framework for purposes of teaching moves

Nathan and Knuth (2003)



Teaching moves to scaffold…

Content	Social norms
Showing students that triangles can be classified by side or by angle.	Reminding students to build off each others' ideas.
Argumentation Asking for a counterexample. Explaining how a diagram can be used, mathematically, to support an argument.	*Argumentation* Reminding students to stay open to new ideas during conjecturing.

Cases of two teachers, both using Activity 3

Bernie

- 10 years in classroom
- Teaching geometry to 8th graders
- Mixed SES school
- Double periods (110 minutes)

Cathy

- 10 years in classroom
- Teaching lower-- achieving 7th graders
- High SES school
- Single period (50 minutes)

Both teachers did same three sub-activites

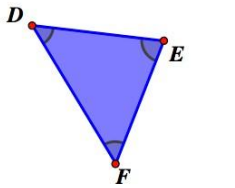
- Used the improv game, Gia Giving.
- Facilitated group work: students using the software and written material.
- Led a whole--class discussion.

(in Activity 3 out of 9)

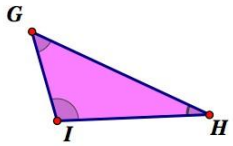
Both teachers drew on the same resources.

1. Warm up game: *Gift Giving*

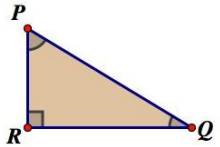
2. Drag the vertices of each triangle to figure out what kind of triangle it is. Label each triangle.



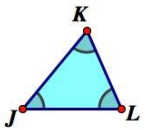
△*DEF* is _____



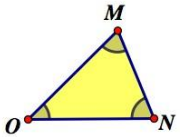
△*GIH* is _____



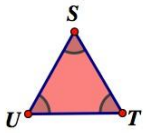
△*QRP* is _____



△*KJL* is _____



△*OMN* is _____



△*STU* is _____

3. Possible or impossible?

	Scalene	Equilateral	Isosceles
Acute			
Right			
Obtuse			

4. For each, write:

It is impossible to make____ from ____.
Some ____ are also _____.
All ____ are ____.

5. Select a statement as a conjecture and justify it.

SRI International

Case I: Bernie

Overview of Bernie's Activity 3

- Lots of Social scaffolding for argumentation. Improv games afford "mini-speeches" in which she addresses argumentation practices.
- Content often scaffolded through argumentation.
- Students have many opportunities to make arguments.

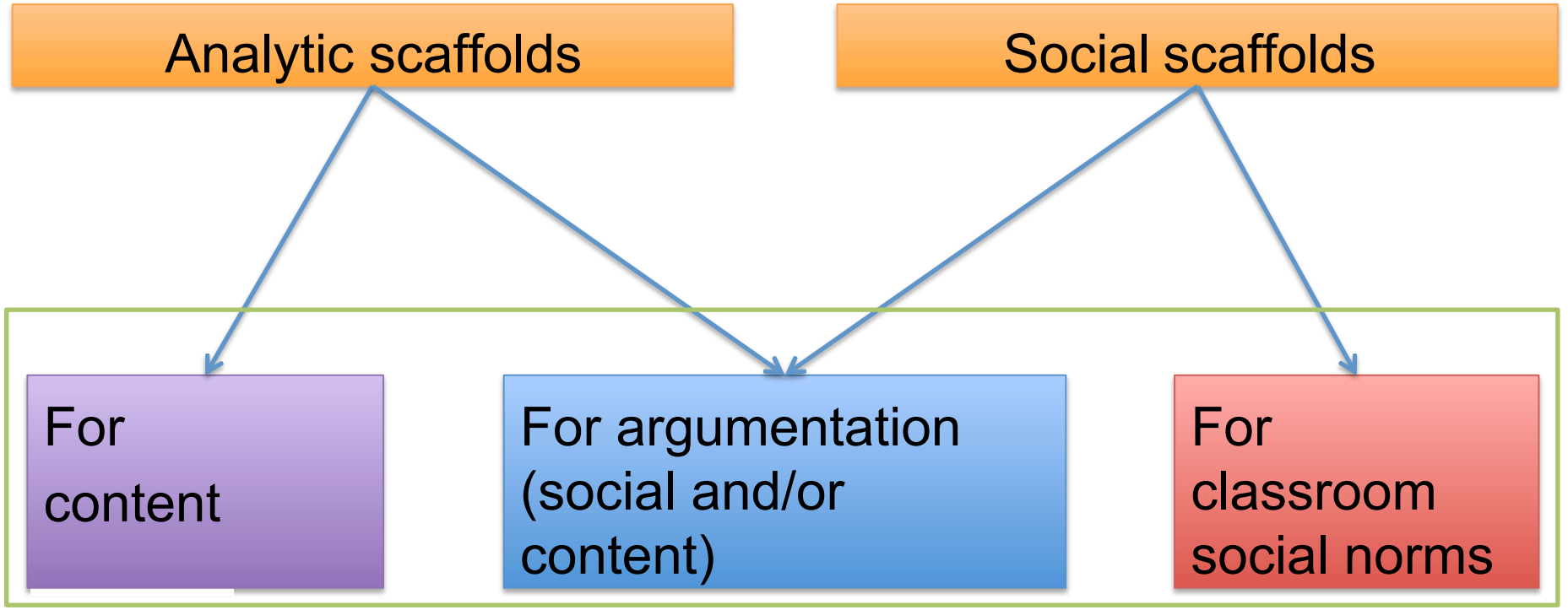
How do Bernie's mini--speeches relate to your own gift giving game?

Bernie’s Mini-Speeches

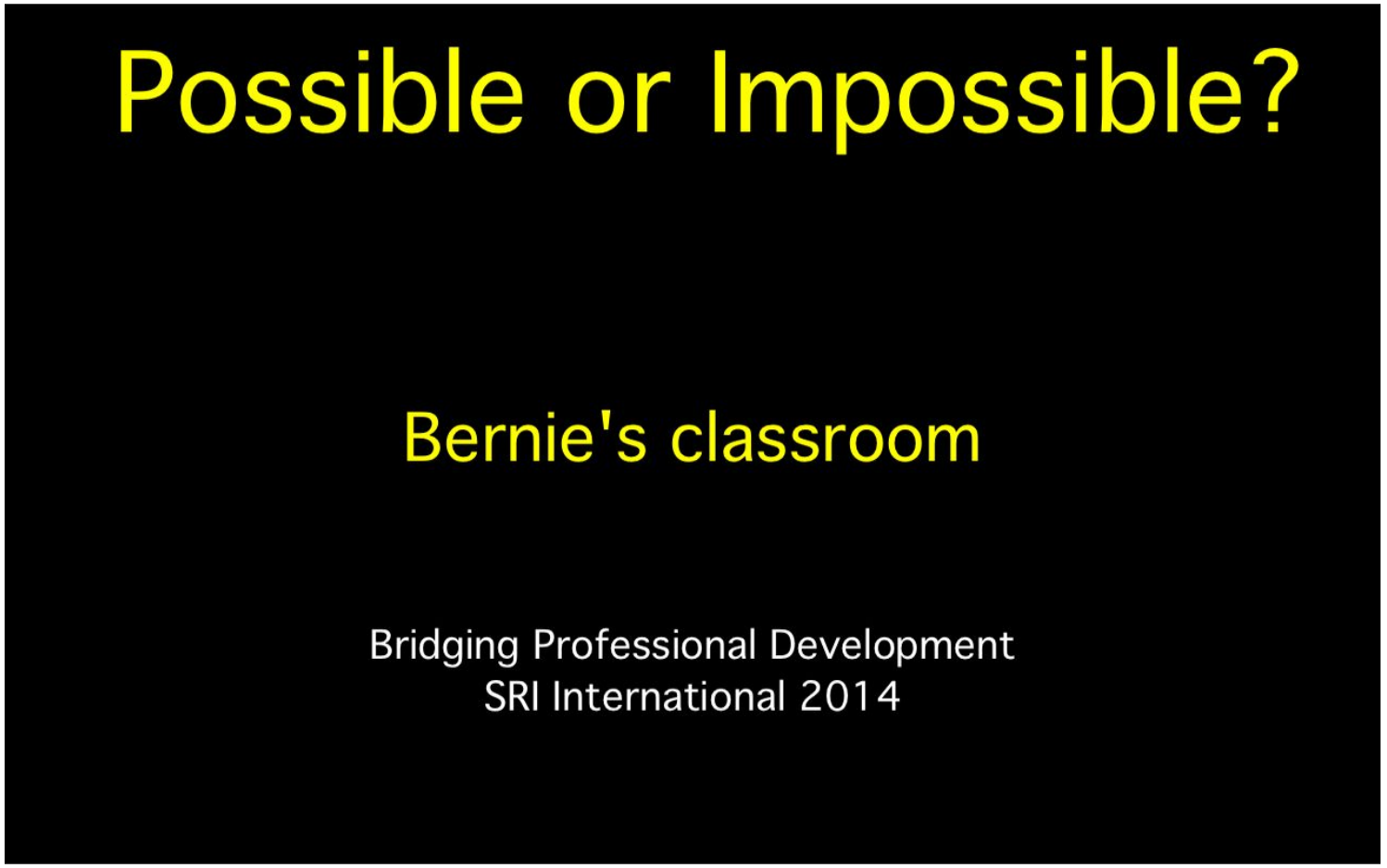
How do Bernie's mini-speeches relate to your own gift giving game?

Reminder: purposes of teaching moves

Nathan and Knuth (2003)



Bernie’s whole class discussion



SRI International

Case 2: Cathy

Overview: Characterizing Cathy's teaching in Activity 3

- Improv game used as warm up today's lesson.
- Content is often delivered by Cathy, particularly in the whole class format. Cathy made connections between topics.
- Students have few opportunities to make arguments:

e.g., in whole class discussion, arguments were often cut off, completed by Cathy.

Cathy's whole class discussion

SRI International

Comparing Moves: Homing In

Bernie connects specific to general

T: How about an obtuse equilateral triangle?

S: Not possible.

T: Not possible. Who can tell me why? Who can tell me why? Marcela? [argumentation, content]

S: …the angles always equal 60.

T: The angles in an equilateral triangle equal 60. You guys have been saying that. We haven't officially proven it yet. [argumentation] How does that contradict obtuse? [argumentation, content]

S: more than 90 degrees

T: Very good. If you find some kind of contradiction, that's a good way to justify why something's impossible. [argumentation, content]

Cathy connects new content to previous

T: Ah, right there. Let's kind of highlight that. That's an interesting statement for us: all equilateral triangles are acute. How can you justify that? [argumentation, content]

S: Because equilateral triangles have three equal angles and 180 divided by three is 60, and that's acute.

T: Do you guys buy what he's saying that equilateral triangles have three equal angles and that there probably about 60 degrees? [argumentation, content, cut---off] We haven't fully supported that yet but I think you're onto something. [argumentation] We're gonna make some observations about triangles today and the sum of the angles to confirm that. [content] Yes?

S: For the right scalene thingy, how do you make a right scalene?

S: You can just make a scalene triangle. Then you can make one side really long *[inaudible 00:09:26]*.

T: We actually drew a right scalene. What is the definition of "scalene triangle?" [content]

S: All the sides aren't the same.

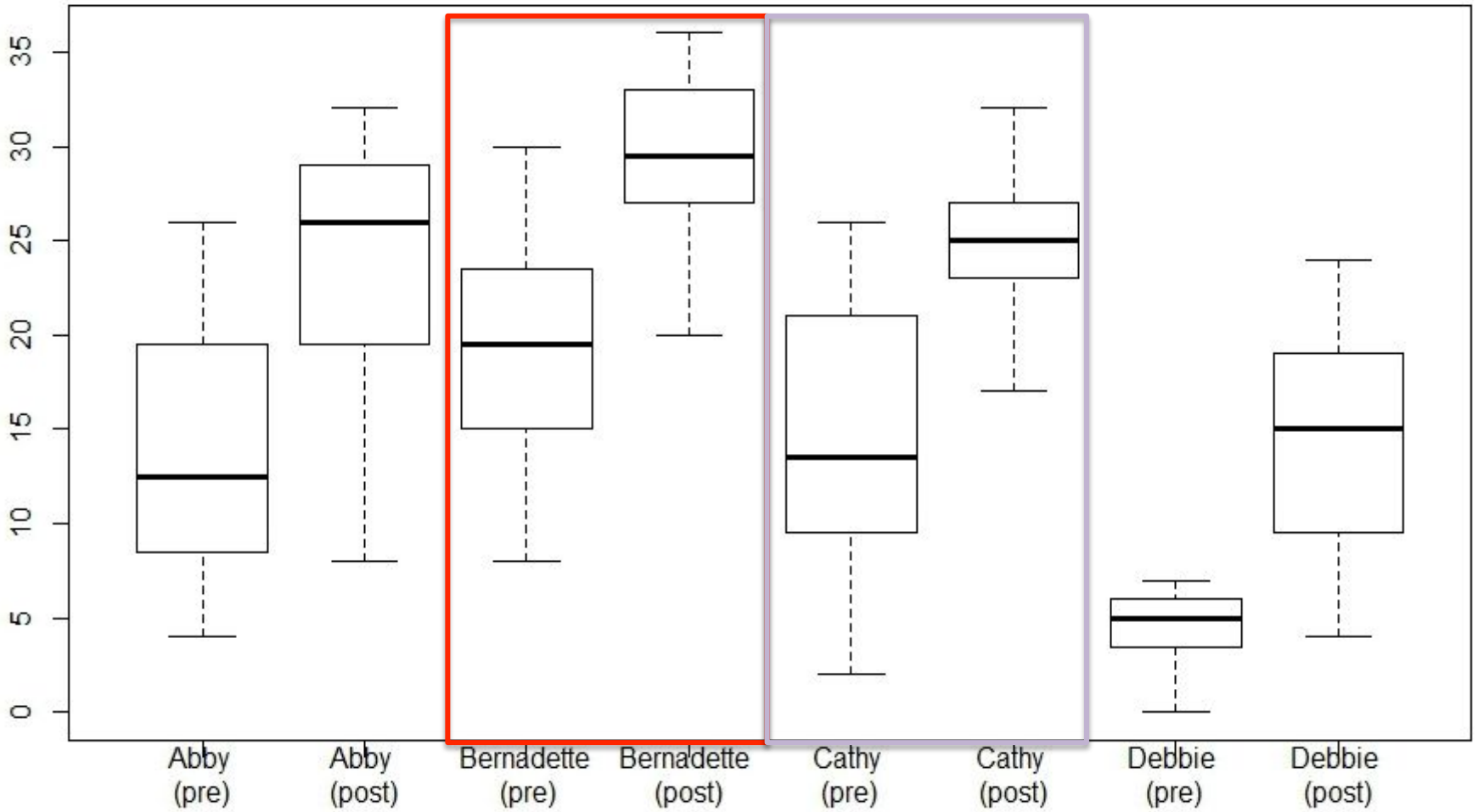
T: Do you remember studying triangles like this? Remember when we did the Pythagorean Theorem in seventh grade? Didn't we find out that three squared plus four squared is equal to five squared? Is this a rectangle with three different side lengths? It's a scalene and it's a right triangle. [content]

Moving back up a level…

- Cathy and Bernie's patterns of instruction remained in line with what we've shown.

- We have evidence that instruction makes a difference,
  - **in the quality of classroom argumentation (video)**
  - **with the following suggestive set of test scores.**

Four classes' pre-- and post--tests similar gains for Cathy and Bernie results:



But…

- Test blend of content only and argumentation questions.
- On items requiring argumentation, Bernie's students did better.

And so…

Every move matters!

In the same lesson, around related mathematics statements,

one teacher moves into argumentation,

the other away from it.

This is about teaching, not teachers. We know that teachers learn and practices evolve.

Discussion questions

1. What opportunities for student argumentation are afforded by each teacher's moves?
2. What could account for the differences in the teachers' moves? (We can only speculate.)
3. What (other) tensions might occur between teaching for content and teaching for argumentation?
4. What equity issues are potentially at play?
5. Given the PD context in which they developed their teaching moves for argumentation, what would you provide next for each teacher, if "personalized PD" were available?