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Session 448

Mathematical Argumentation Lessons: Engaging All Students

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MATHEMATICS EDUCATION GROUP

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bridging
professional development

Bridging is professional development for mathematical argumentation in middle schools.

Urban schools 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

In this session

- Characteristics of learning environments supportive of diverse student groups, particularly in urban schools
- Improvisational activities that promote student identify and empower learners
- Mathematical argumentation and curricular activities that can enrich learning environments
- Discussion

Bridging PD: We work in partnership with large urban school districts.

- High proportions of under-served and economically disadvantaged students
  - African American/Black youth
  - Latin@ youth
  - English Language Learners
  - Over 50% free and reduced price lunch
- These youth often lack access to, or the opportunity to learn, higher-level mathematics.

Research informs our work and provides insight into characteristics of learning environments important to specific student groups common in urban settings, in particular:

Characteristics (among others) of learning environments important to African American/ Black youth

- High-energy classrooms
- Sustained interaction with others
- Majority of learning in communal, group settings

Characteristics (among others) of learning environments important to Latin@ youth

- Beliefs that one is competent and in control of one's own learning
- Perceptions of receiving support from others, including peers and teachers

Characteristics (among others) of learning environments important to English learners

- Recognition of all of the resources and experiences students bring to the classroom, including their first language
- Use of multiple representations for participation, including gesture

High expectations: Important for *all* students

- Academic rigor
- Use of high-level vocabulary
- Conceptually–rich mathematics content
- Focus on mathematical practices, not just practicing math skills

So why argumentation?

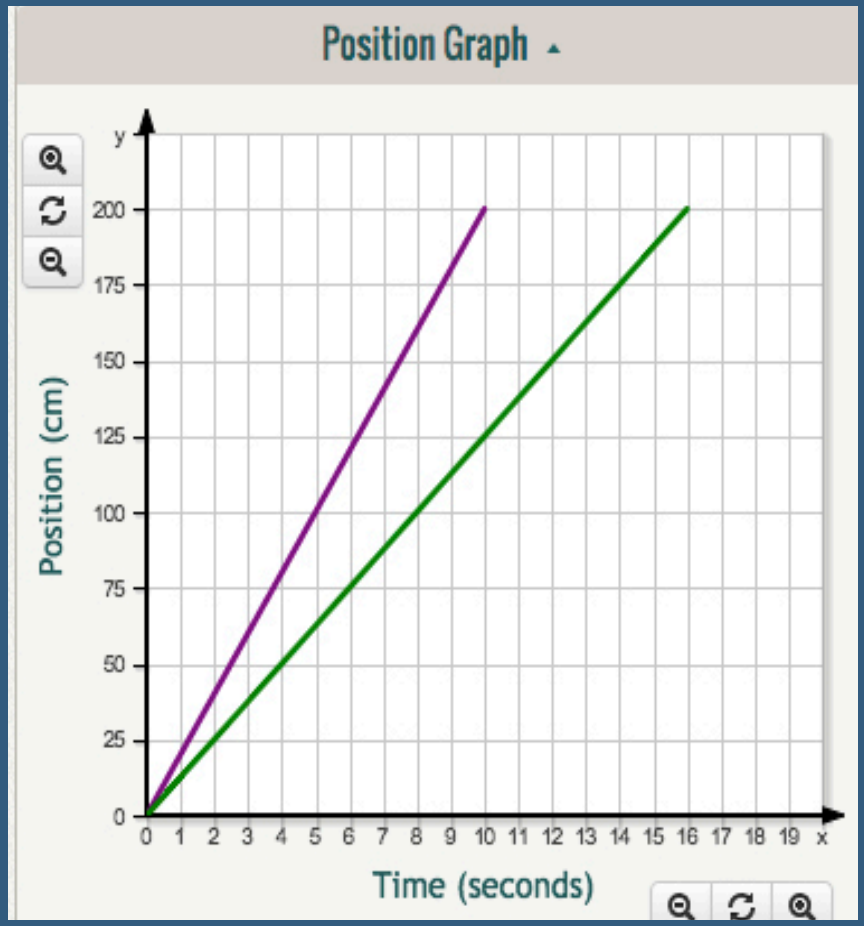
Common Core MP 3: *Construct viable arguments & critique the reasoning of others*.

High-level disciplinary practice: what mathematicians do

Fosters conceptual understanding

Advances 21st century workplace skills

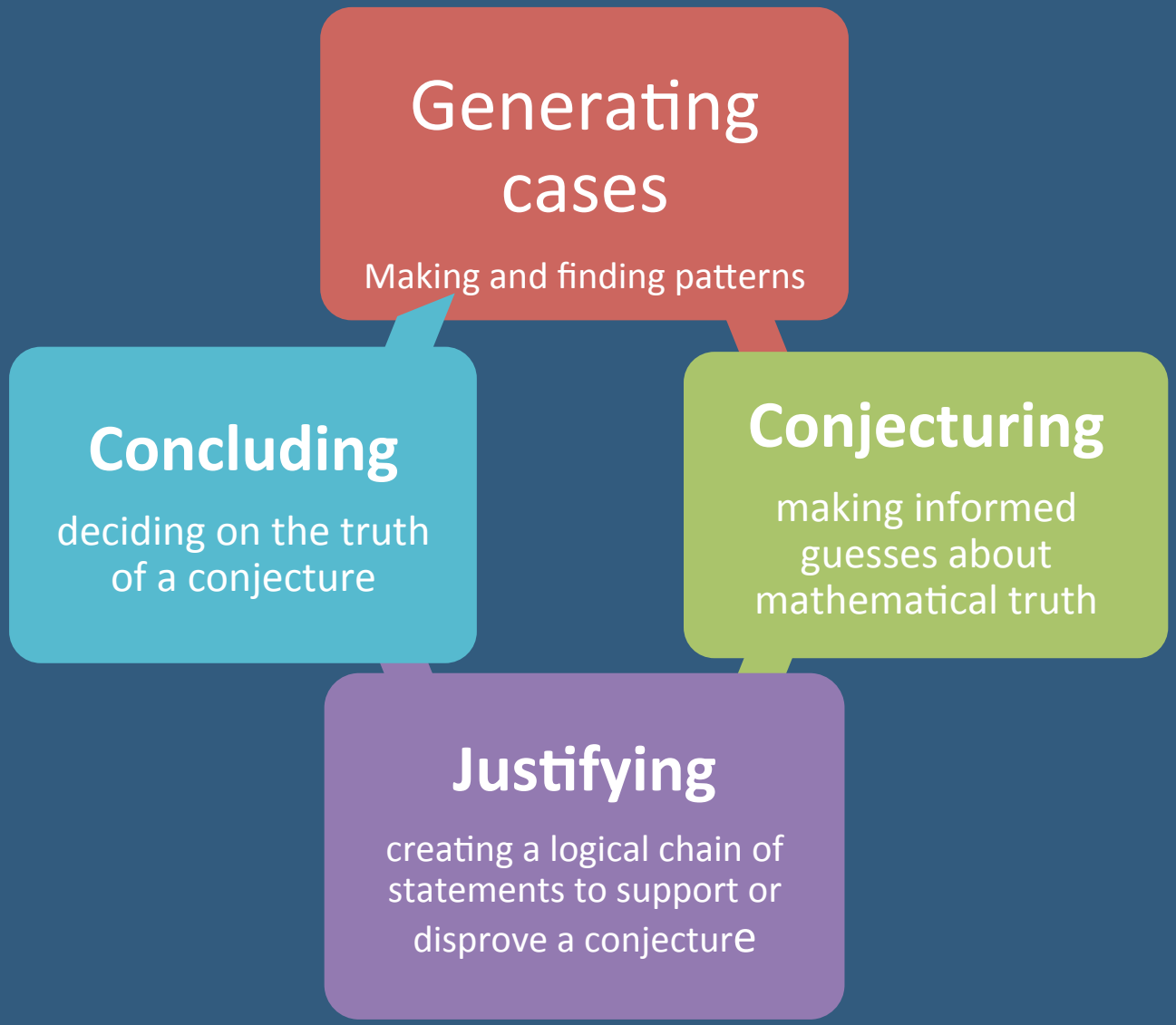
Argumentation is about deciding what's true or false in a mathematical situation.



Amani says: "If a line is steeper than another, then it represents a faster motion."

Is this always true?

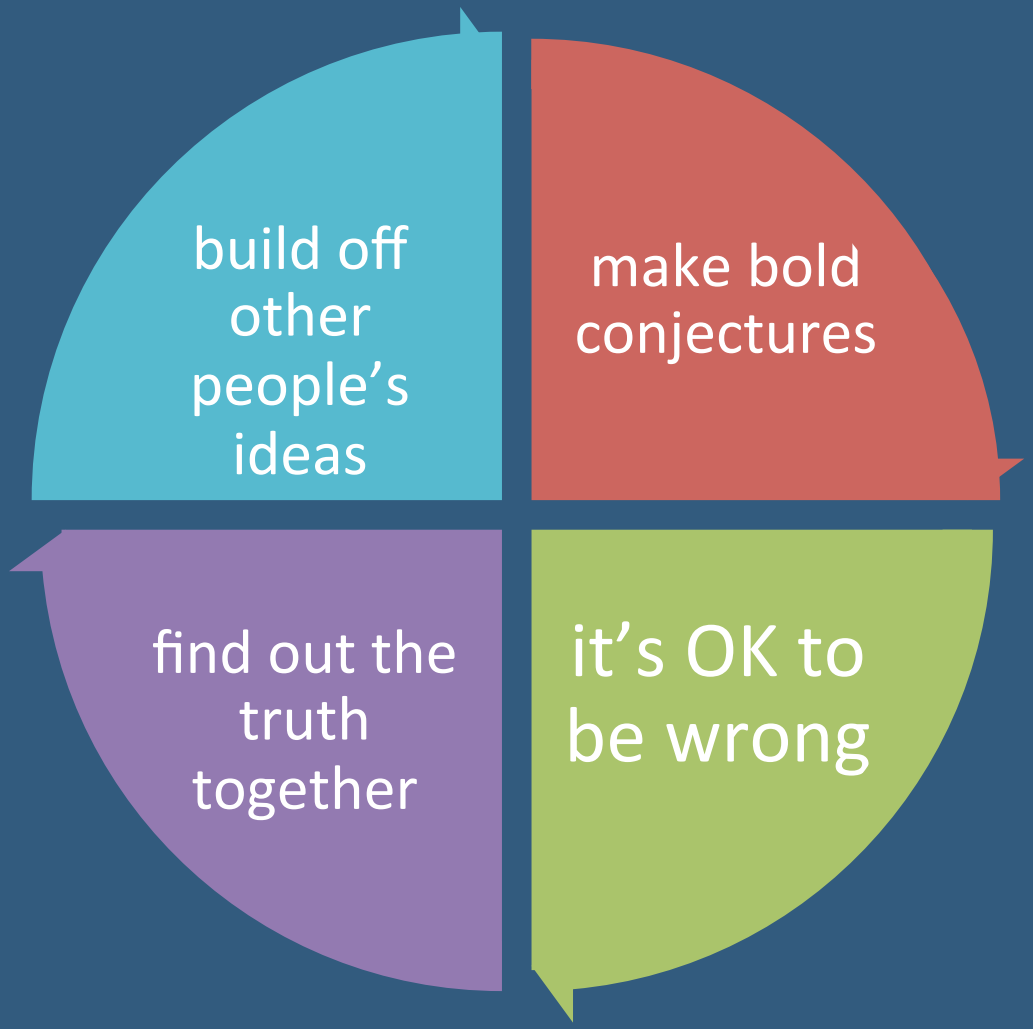
Our view of argumentation in four parts



Students become mathematical truth seekers.

- Argumentation is a social practice.
- Class becomes a community of mathematicians deciding together on what is true.
- Students move beyond "Level 0"— *the book says so; my teacher told me.*
- This approach requires a shift as students start viewing themselves as mathematical thinkers and doers.

Math argumentation requires new norms



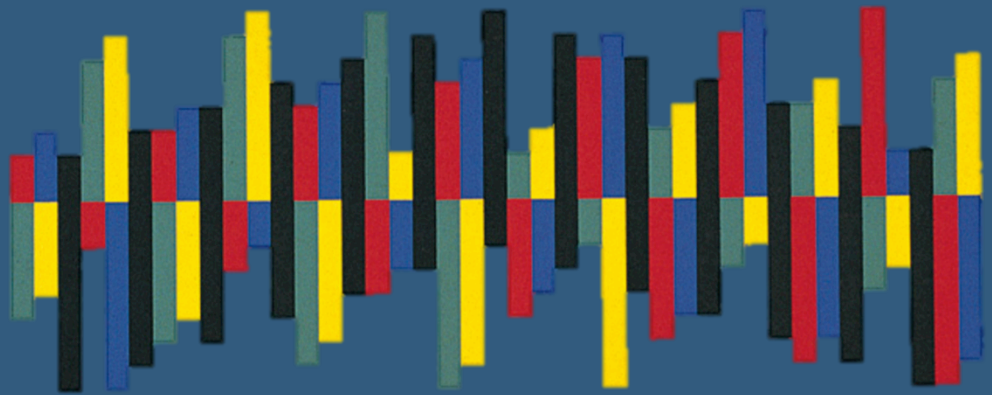
Challenge:

How do we engage students whose home and prior school norms may not be perceived as aligning with norms for mathematical argumentation?

Insight: engaging in mathematical argumentation is improvisational!

Effective classroom discussion is *improvisational*, because the flow of the class is unpredictable and emerges from the actions of all participants, both teachers and students.

—Dr. Keith Sawyer, 2004



Teachers use improv games with students.

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

In movies

Lin-Manuel Miranda at the White House

Qualities of improv games

- Provide high-energy modalities
- Foster sense of belonging
- Kinetically rich experiences bridge everyday experiences and academic content
- Make norms explicit for argumentation

Let's play: *Gift Giving*

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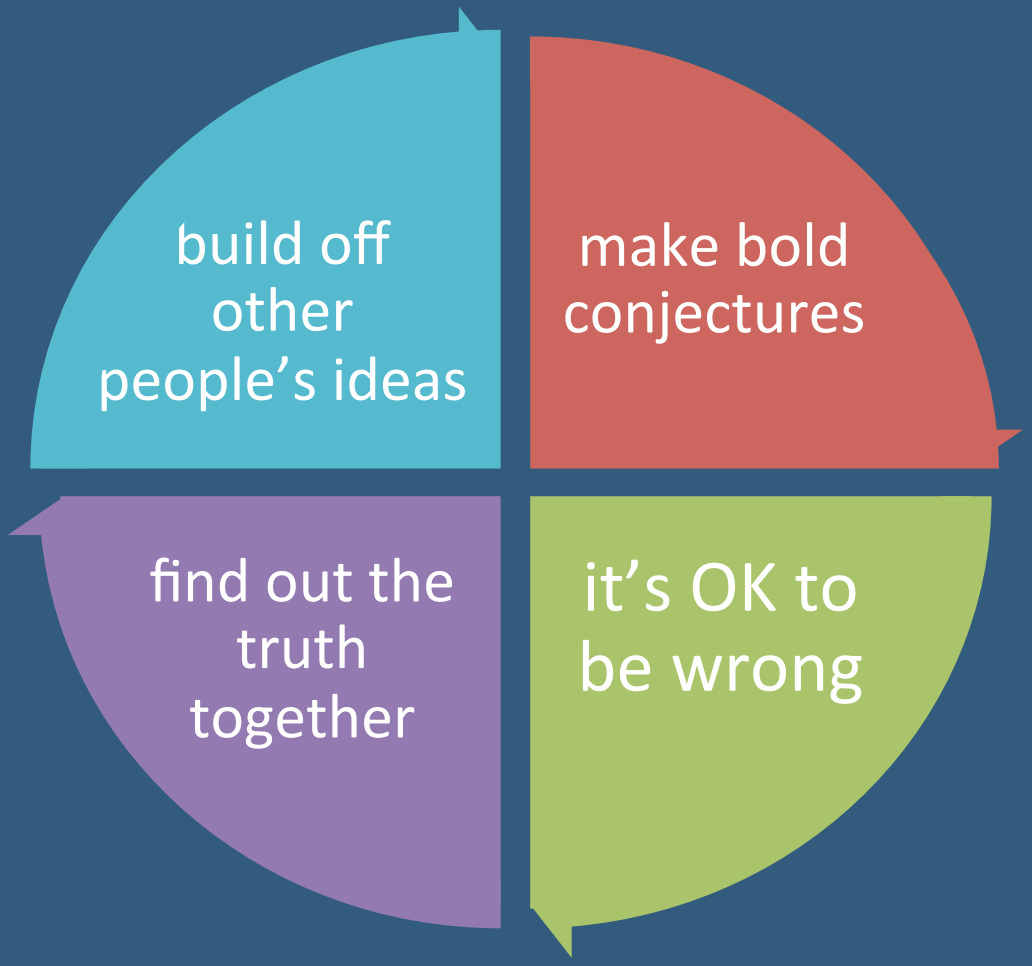
- Stand facing your partner.
- There's a huge closet of unlimited gifts behind you.
- One person is the giver, another person is the receiver.
- The giver offers the receiver a wrapped gift from the closet.
- The receiver opens the gift and gratefully describes (and names) the gift.
- The giver responds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

What does the game have to do with norms for argumentation?



Improv games . . .

are used for making classroom norms explicit for argumentation

Teacher M's students connected the game to argumentation norms.

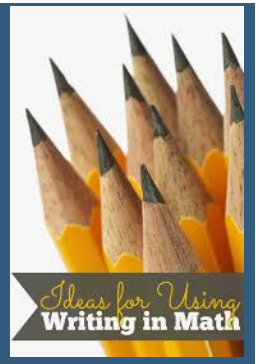
Because like, if discussion takes time, one person's doing at a time and nobody's talking over each other.

It connects because when we were doing zip, zap, zop, we were going back and forth and it's like speaking, but actually a game. And when we were doing the argument we are also doing the same with ideas instead of using zip zop zap.

When we were making our conjectures, it's okay if we are not right the first time as long as you try.

We was speaking loudly enough so everyone can hear.

Curriculum



Paper-and-pencil and online instructional activities can enrich the learning environment for culturally and linguistically diverse students engaged in argumentation.

Task: Operations on Signed Numbers

You know how to add signed numbers using the number line.

Find the sums of different combinations of positive and negative numbers and notice whether the sum is positive or negative.

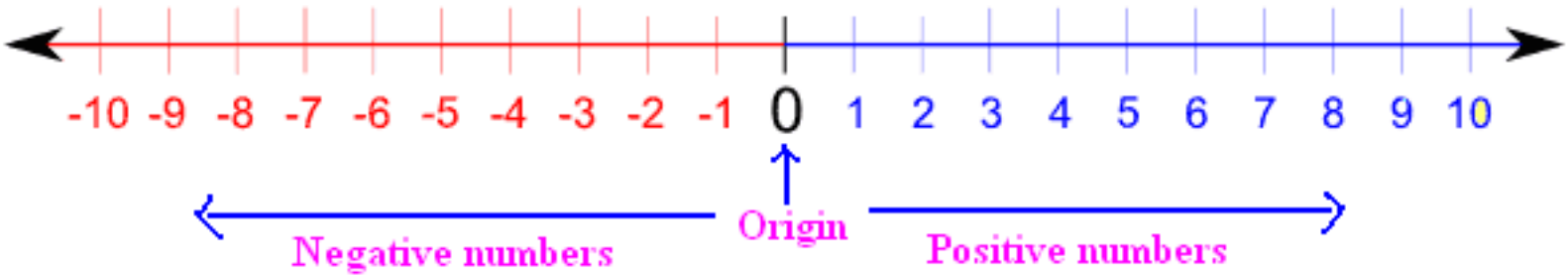
1. What patterns do you see?

2. Make conjectures about a shortcut for adding signed numbers without using the number line.

3. Justify one conjecture based on what you know about signed numbers and addition. (Remember, your conjecture may turn out to be true or false.)

4. Write down your conclusion.

Adding Signed Numbers on the Number Line

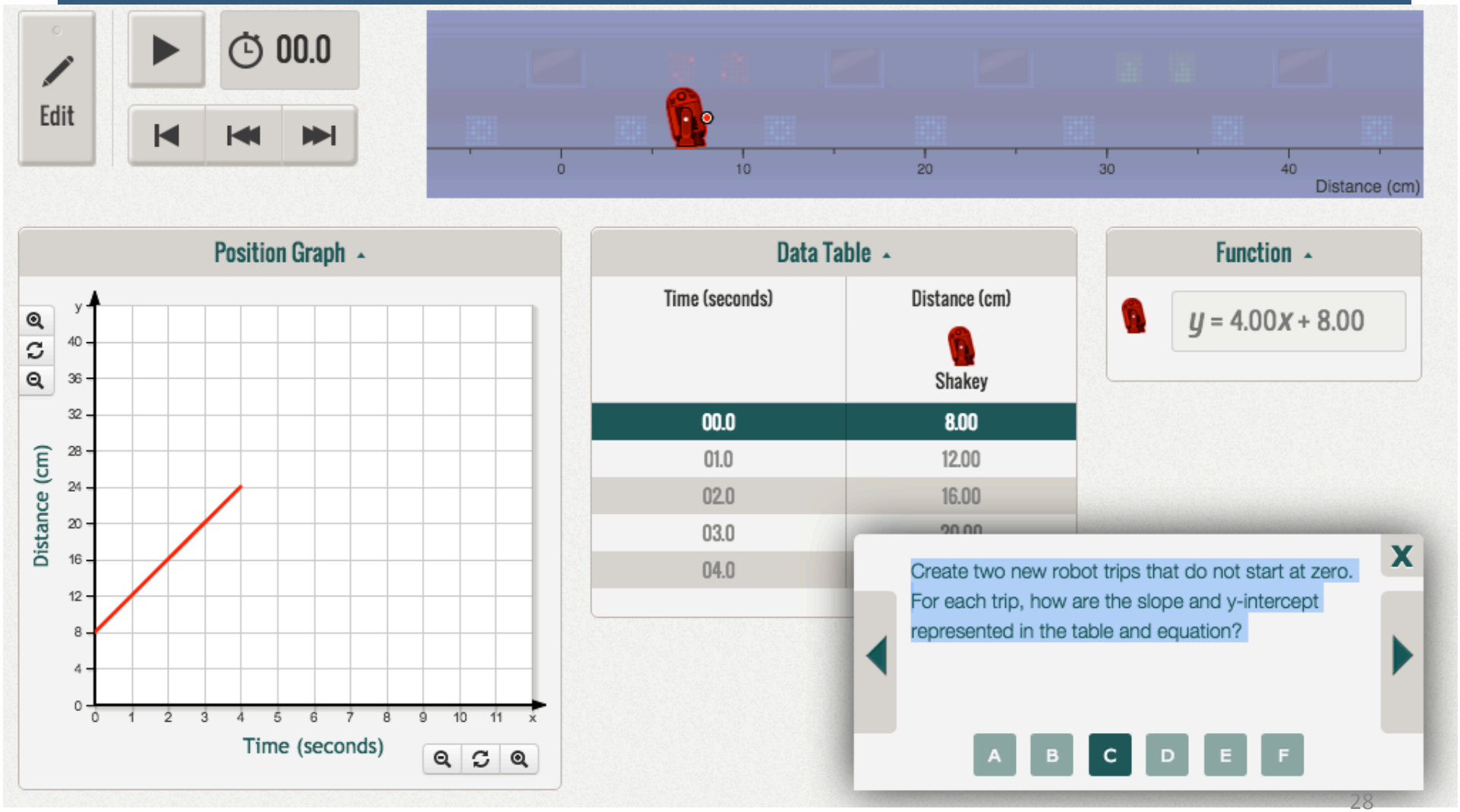


Online curriculum

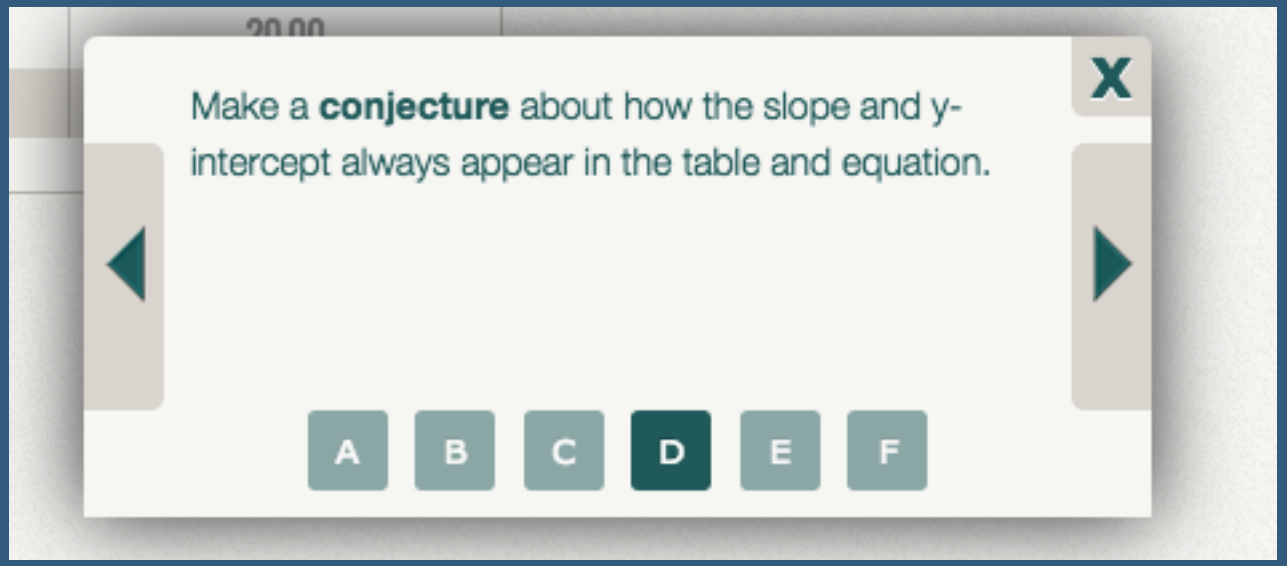
Students do not work in isolation:

- Students work in groups with individual and collective accountability.
- Teacher interaction is required.
- Online prompts are paired with interactive multiple representations.

Dynamically linked multiple representations and prompts provide opportunities for discourse and gesture



Vocabulary specific to argumentation and mathematics content

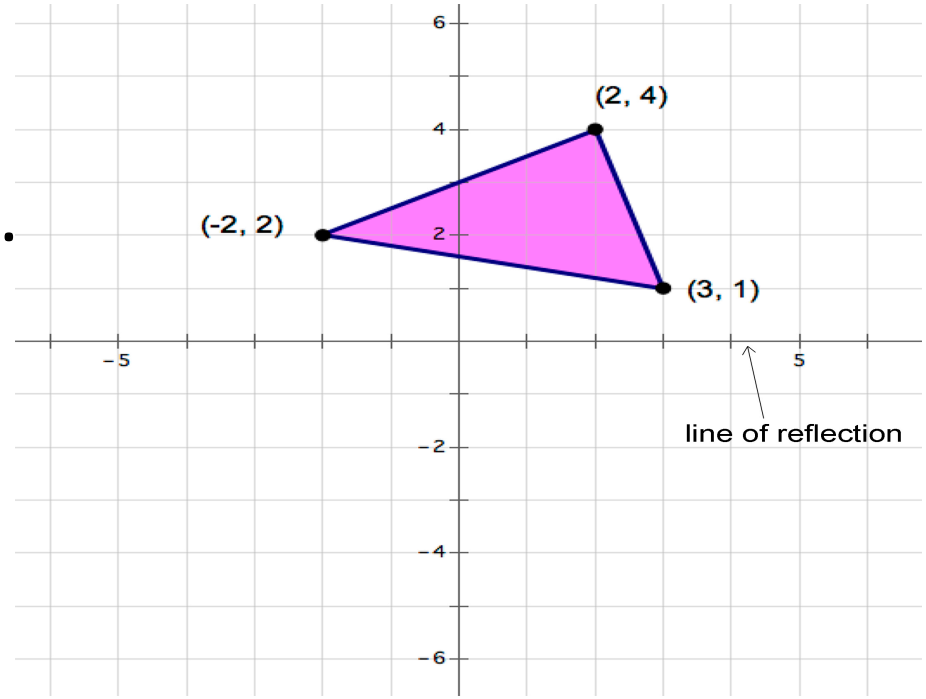


Teacher notes provide specific moves that challenge students to engage in argumentation.

Conjecturing	D. Make a **conjecture** about how the slope and *y*-intercept always appear in the table and equation.	This conjecture should go beyond specific quantities involved. Challenge students to make generalized statements by prompting them to look for patterns across cases that they explored. For example, if students said "increase by 2" in the previous activity, they might say here "increase by a constant" by recognizing the pattern across cases they created. Challenge students by asking, Would the tables all have to have *x* increase by 1? What would happen if that wasn't the case?

Task: Triangle Reflection

Reflect the triangle over the *x*-axis.



1. **What patterns do you see in the coordinates of the vertices of the triangle and its image?**

2. **Write a conjecture that describes what happens to the coordinates of the vertices of any triangle reflected over the *x*-axis.**

3. **Justify your conjecture.**

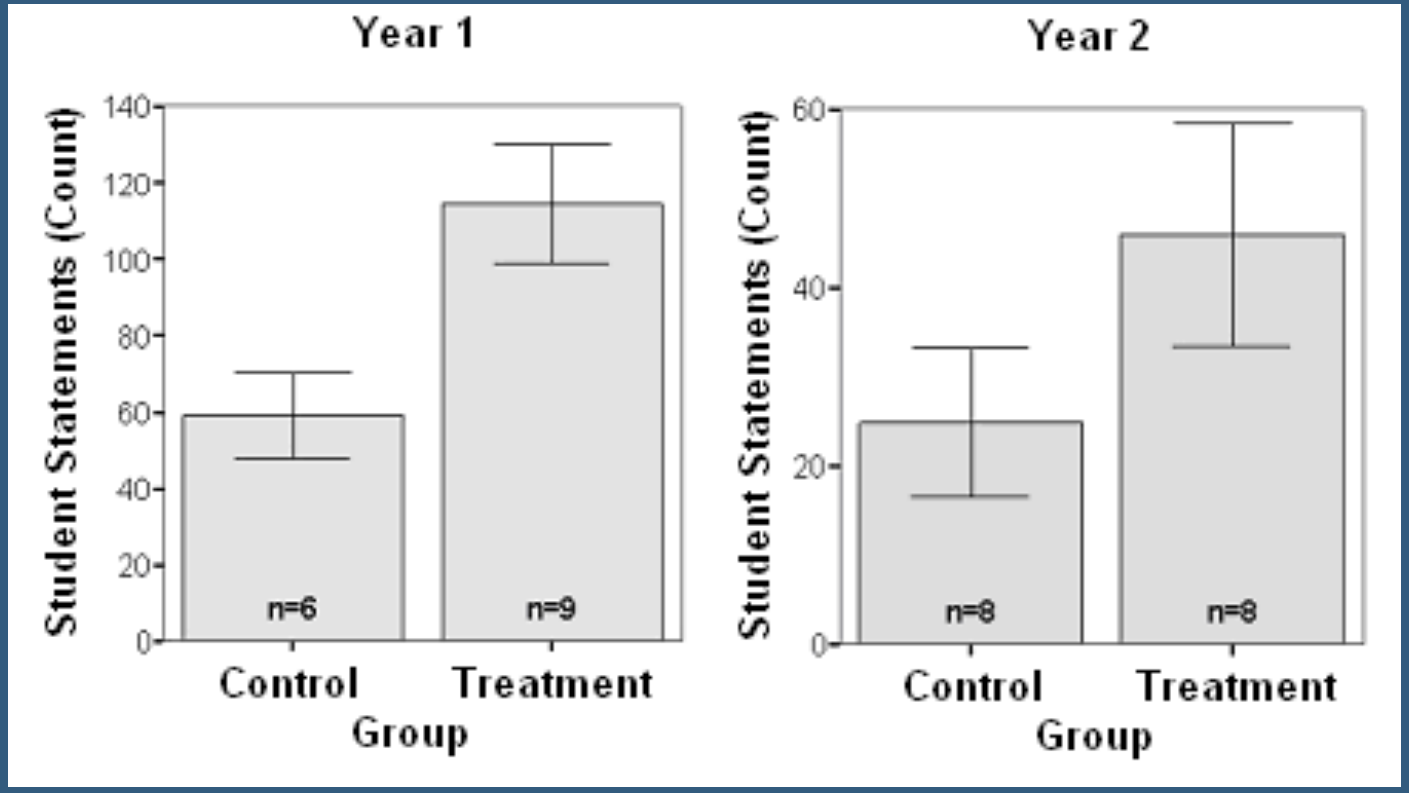
4. **Write down your conclusion.**

Evidence of effectiveness

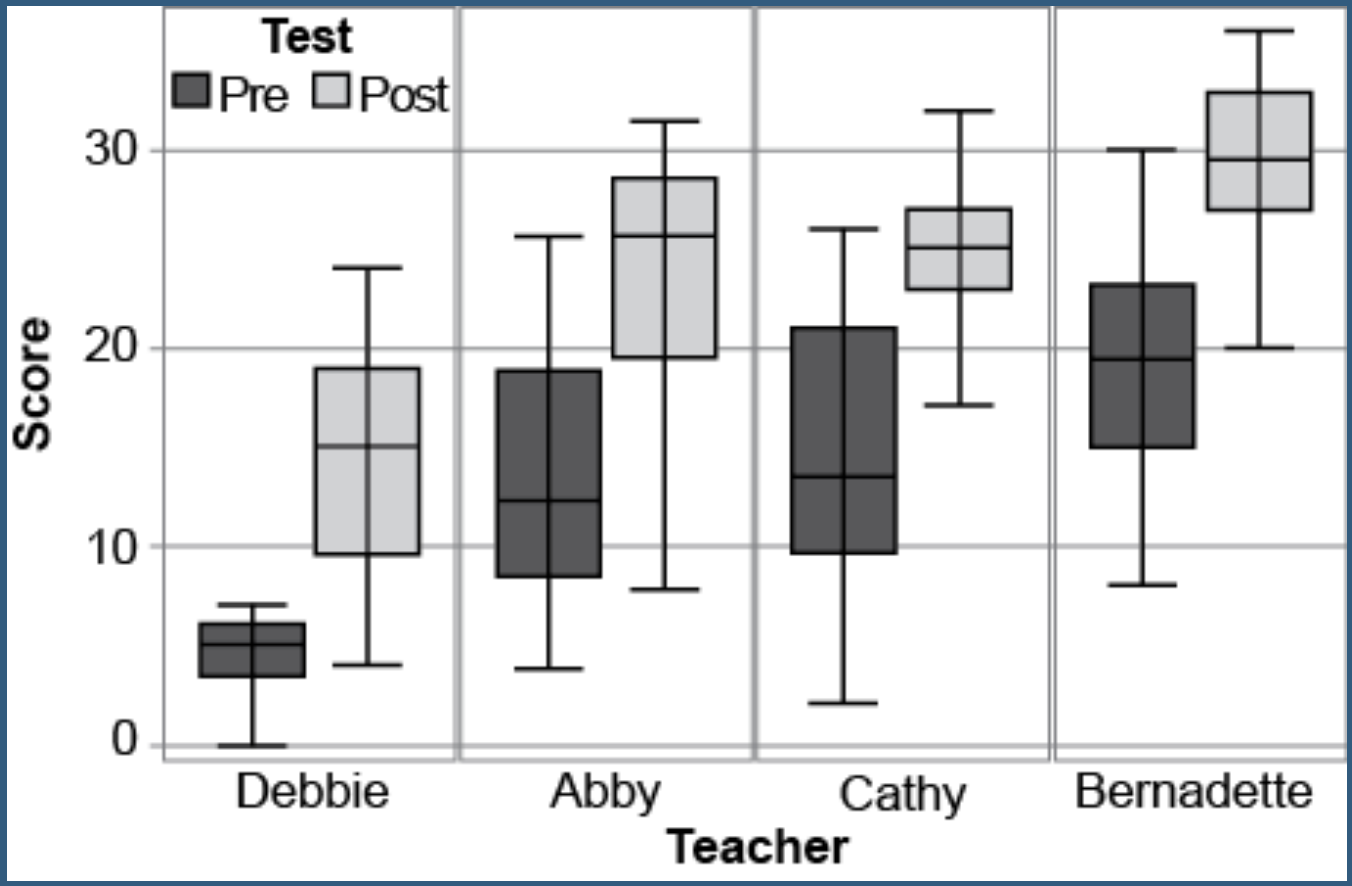
In an impact study, Bridging students engaged in twice as much argumentation as "control" students.

In a study of four diverse classrooms, students learned both content and argumentation skills in discourse and writing.

Study 1: Results show twice as much classroom argumentation



Study 2: Results show a gain of 10 pts in student learning



Discussion

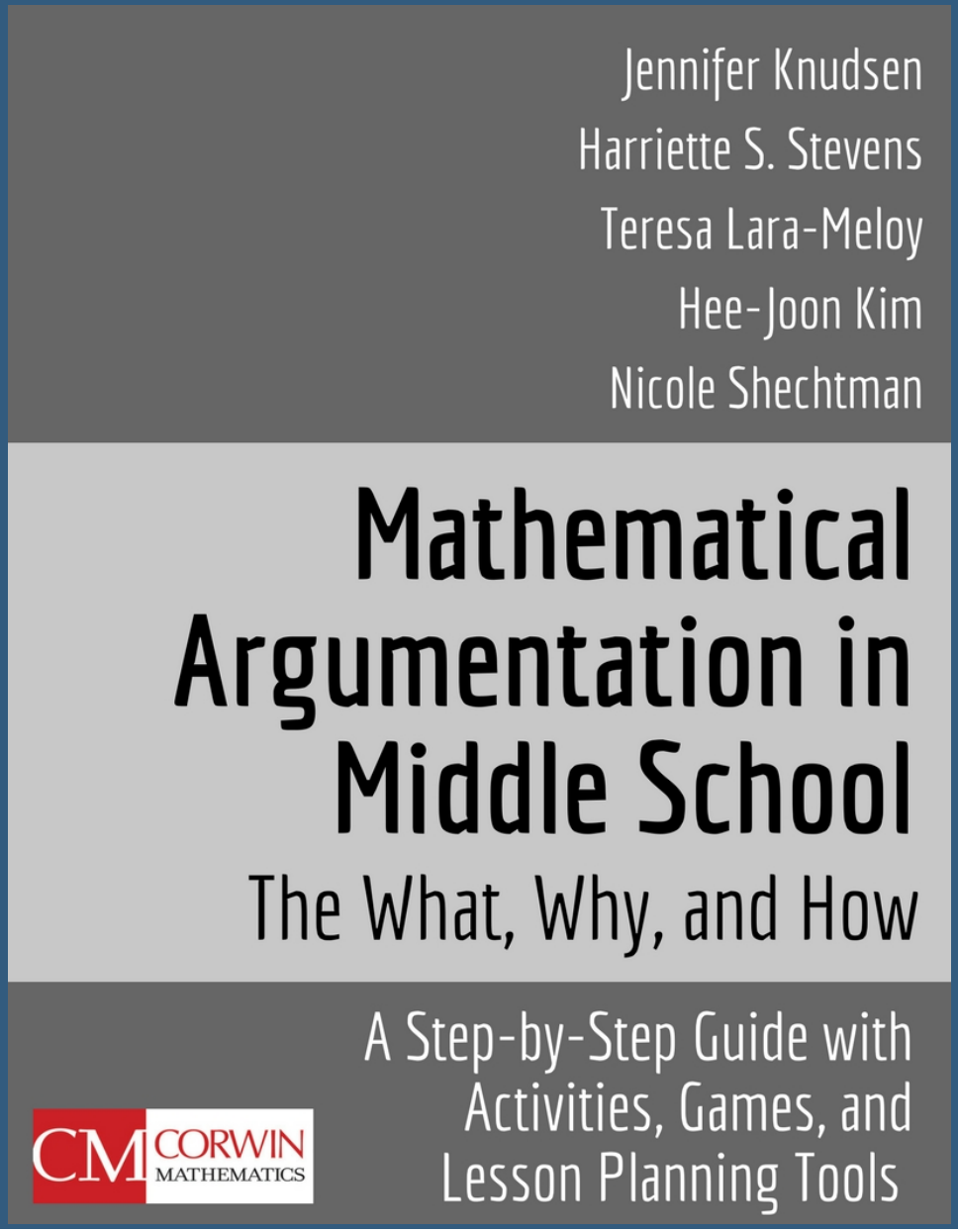
- In your view, how do these activities address the student needs we outlined?
- What is your own experience in supporting the needs of these student groups?
- What other needs should we consider?

Online Resources Demo

Bridgingmath.com

New book for teachers based on this work.

Coming
September,
2017



One more presentation

Session 696
Learning to Teach Mathematical Argumentation through Successive Approximations of Practice

Saturday 11:30am-12:00pm

THANK YOU!