

# Building Partnerships and Resources to Support Mathematical Argumentation

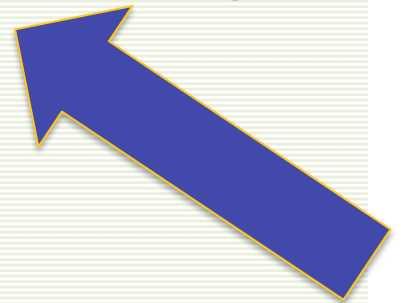
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# Standards of Mathematical Practice

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.



# Bridging Math Practices

## Math-Science Partnership Grant

2014-2015: Phase I of Grant (40 teachers)

2016: Continuation Grant (30 teachers)



## Partnership

- UConn – Neag School of Education
- UConn – Math Department
- Manchester Public Schools
- Mansfield Public Schools
- Hartford Public Schools

## Overarching Goal

- Build the capacity of math teachers and coaches (grades 3 – 12) to support students' mathematical reasoning and argumentation

# Highlights of Results: Phase I

- Significant changes ( $p < .01$ ) in teachers' **confidence** in their *knowledge* of argumentation and *abilities to develop students' capacity* with argumentation
- Levels-of-Use questionnaire indicated high degrees of **integration with practice** (60 – 70% reported at top 2 levels)
- Teachers reported high **value of the experience**.
  - *Gaining a better understanding of the argumentation process*
  - *Collaboration with other teachers from other districts and sharing ideas*
- Medium to large effect sizes in gains of **teachers' math content knowledge** for teaching

# Bridging Math Practices Products

<http://bridges.education.uconn.edu>

## Task Repository

Name: \_\_\_\_\_ Date: \_\_\_\_\_

**Think**

Little Land Kennel charges a fixed rate of \$25.00 and an extra \$40.00 for each night that you board your dog. Bark and Wag Kennel charges a fixed rate of \$40.00 and an extra \$35.00 for each night that you board your dog. How many nights would you have to board your dog for the cost of each kennel to be equal?

**Anticipated Student Responses**

**Talk**

Algebraic Equations

- $C=25+40x$
- $C=40+35x$
- $25+40x=40+35x$

Make a table for each Kennel and find out how much each day costs at each kennel until you find a day where they cost the same.

Guess and check. Substitute numbers in until you find an answer.

(table also a graphing response-but I don't foresee that with the numbers given)

Argument Rubric					
Argument Component	1 Does not meet expectations	2 Needs improvement	3 Approaching expectations	4 Meets expectations	5 Exceeds expectations
Claim (x2)	I did not state a claim or take a stance, nor did I imply agreement or disagreement.	I implied agreement or disagreement but I don't clearly state a claim.	I stated a claim, but did not clearly agree or disagree.	I stated a claim and took a stance in agreement or disagreement.	I stated a claim and took a stance that agrees with my arguments.
Basic of Argument (x4)	Does not state a principle or definition.	Implies a principle or definition.	States a principle or definition.	Clearly states a principle or definition that is widely agreed as valid.	Clearly states a principle or definition and cites the source.
Evidence (Grounds) (x3)	I did not use any evidence to support my claim.	I used limited evidence and it does not clearly or fully support my claim.	I used some evidence but it is not detailed enough to fully support my claim.	I used appropriate and detailed evidence to fully support my claim. - Expressions - Equations - Pictures - Graphs.	I used appropriate and detailed evidence to fully support my claim. Varied solution with 2+ strategy from previous column.

## Self-paced Learning Modules



## Argumentation Resource Packets

### Student A

Javier claims  $\frac{1}{2} < \frac{3}{8}$ . Do you agree or disagree and why?

We disagree because if you look at our picture it shows  $\frac{3}{8}$  is less than  $\frac{1}{2}$ . If you add one more  $\frac{1}{8}$  then it will be equal.  $\frac{1}{2} = \frac{4}{8}$

If you add 1 more  $\frac{1}{8}$  to  $\frac{3}{8}$  then it would be the same as  $\frac{4}{8}$ .

### Commentary

This argument is considered **High**. The students' claim is that they disagree with Javier. They use a pictorial representation to show that  $\frac{3}{8}$  is less than  $\frac{1}{2}$ . They explain in words that if they add  $\frac{1}{8}$  to  $\frac{3}{8}$  it would equal  $\frac{1}{2}$ . The response could be extended by including a statement explaining in words that  $\frac{1}{2}$  and  $\frac{4}{8}$  are equivalent fractions. The pictorial representation that compares  $\frac{1}{2}$  and  $\frac{5}{8}$  could be elaborated on to show the relationship comparing  $\frac{1}{2}$  and  $\frac{3}{8}$ .

### Argumentation Components

<b>Claim</b>	<b>Evidence</b>
The claim is clearly stated: "We disagree."	The students drew a pictorial representation of $\frac{1}{2}$ and $\frac{3}{8}$ and it clearly shows that $\frac{1}{2}$ has more shaded. They also included a pictorial representation of $\frac{1}{2}$ and $\frac{4}{8}$ to show equivalence. They then state that $\frac{3}{8}$ is $\frac{1}{8}$ less than $\frac{1}{2}$ .
<b>Warrants</b>	<b>Language &amp; Computation</b>
The students explicitly state that "if you add one more $\frac{1}{8}$ to $\frac{3}{8}$ then it will equal $\frac{1}{2}$ ."	All mathematical computations and statements are true.

## 5-Module Sequence "Course" Materials

- 1 What is an argument?
- 2 Tasks to support argumentation
- 3 Norms and Routines
- 4 Classroom Discourse
- 5 Providing feedback on student work

# Other Project Products

- Expanded capacity
  - Districts, schools
  - Teacher prep, partnerships
- New knowledge
- New materials and tools



# Building Capacity-Manchester



What happened to advance the practices, and to improve student engagement and learning outcomes?

With what impact?

# Building Capacity-Manchester

## **District-level**

- Shared rubrics for written work
- Inclusion of MP3 on K-5 report card
- Task Repository part of online curriculum materials

## **Building-level**

- PD sessions for MS & HS math department (argumentation resource packets)
- Argumentation-related SLOs (at MHS)
- PLC work
- Internship to support argumentation (HS, elem)

## **Classroom-level**

- Using rubrics, tasks/tools from repository
- Teaching with argumentation
- Coaching cycles that focus on argumentation (elem)



# Impact

## Teachers

- Attention to own language, how they explain things
- Shift from “what’s easy for them” and “shortcuts” to “how do we wrestle with this?”
- Focus on “unifying ideas;” must incorporate conceptual
- Assuming less – asking that follow up

## Students

- Changes in orientation and disposition (changes in classroom culture)
- Willingness to try (not one right way)
- Asking different kinds of questions. “This doesn’t make sense”
- Valuable for all students
- Student work samples

# Algebra II – graduation requirement

Beginning of Year

• **IDK**



End of Year

Algebra 2 PSP - Argumentation Task: Quadratics

Which of these functions represents the graph above? Write an argument to explain your choice(s).

$f(x) = (x - 4)(x - 2)$        $f(x) = x^2 + 6x + 8$        $f(x) = (x - 3)^2 - 1$

~~$x^2 - 2x - 4x + 8$~~   
 $x^2 + 2x + 8$

I believe the first<sup>and last</sup> equation represents the graph, because when you solve the other equations you won't get the right points that's on the graph. 4 and 2 are both points on the graph that follows the "intercept form" and it represents  $x$ . -3 and -1 are both on the graph and they represent the vertex function. -3 is actually 3 but is turned into a negative number to follow the vertex function.

# Why Mathematical Argumentation?

- Because argumentation is the essence of mathematics
- Because more students become better math thinkers
- Because this is what the world now demands



# Deeper conceptual understanding

## Students

- Builds on *their specific* prior knowledge
- Make connections
- Reflect, communicate, explain to others

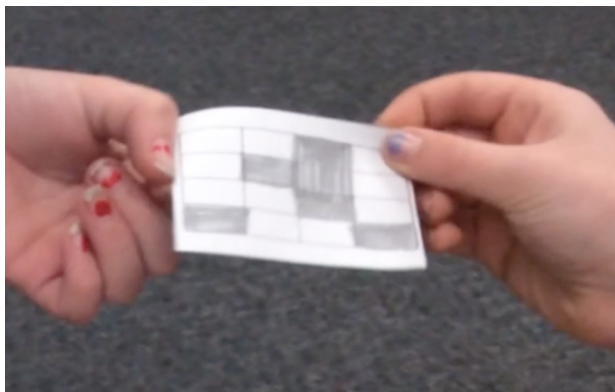
## Teachers

- Learn what students know, how reasoning
- Targeted, efficient instruction

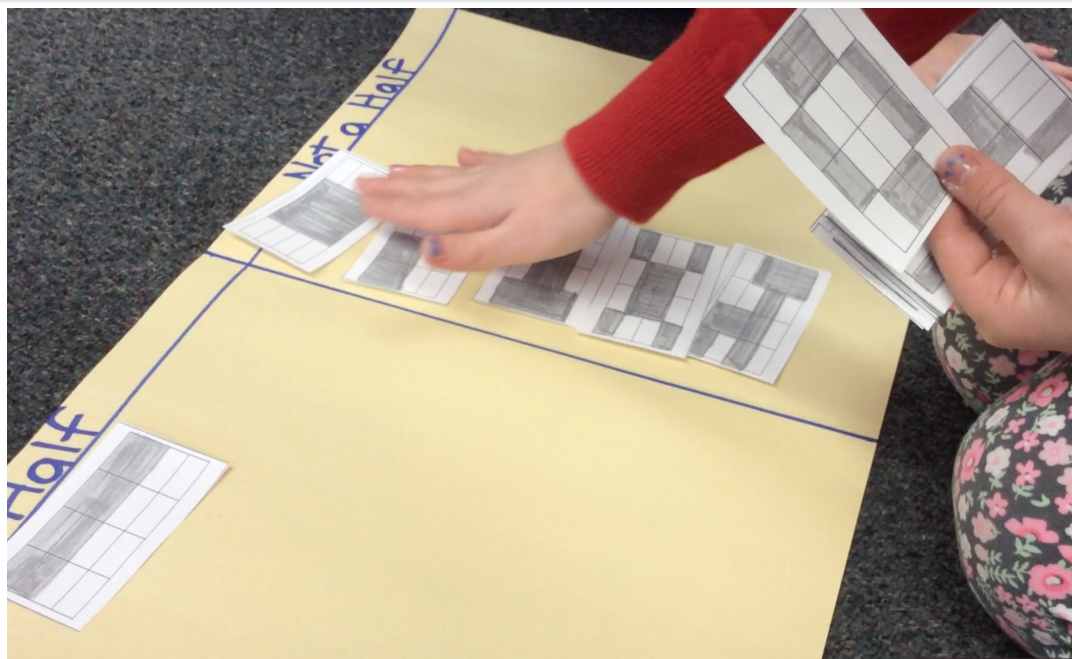
*Overall, builds a connected body of knowledge*

# Is It a Half?

## Sorting task



Half	Not a Half



3<sup>rd</sup> grade – Manchester school  
Teacher Bridges Participant 2014-2015

# Questions about “Is it a Half?” Video

- What kinds of questions are being asked?
- How is argumentation being supported?
  
- As a teacher what would you do next to continue supporting these students to develop argumentation?

# Questions for Discussion

- What kind of professional development and/or supports might teachers need to engage students in the Common Core Math Practices?
  - Construct viable arguments and critique the reasoning of others
- What is already happening in classrooms that could be modified to promote argumentation?
- Other questions or comments?

# Thank You

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