Using Public Records to Support the Productive Use of Student Mathematical Thinking

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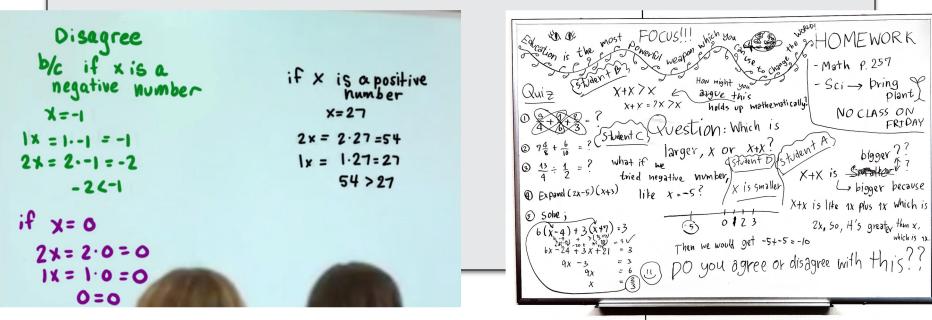


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### A public record is ...



- A visual representation of mathematical thinking
- Publicly accessible to all participants within the classroom



### **Related Research**



- Teachers' use of publicly accessible media (e.g., blackboards, whiteboards, etc.) is a widely accepted practice (Villareal & Borba, 2010).
  - O Support student mathematical activity (Koehne et al., 2020; TIMSS 1995 Video Study)
  - Maintain continuity during collaborative inquiry (Staples, 2007)
  - Engaging with each others' ideas (Webb et al., 2014)
- Teaching practices that use student thinking can be challenging to enact (e.g., Simpson & Haltiwanger, 2017; Peterson & Leatham, 2009).



• How can teachers use public records to support productive use of student mathematical thinking?

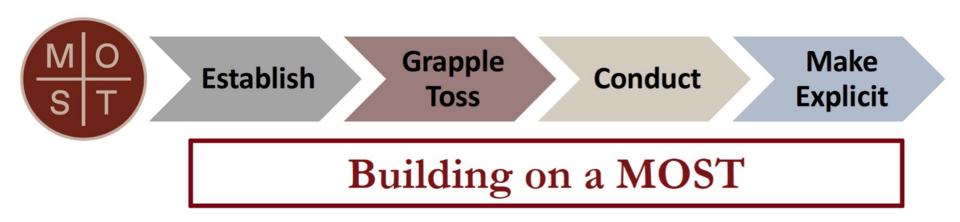


• How can teachers use public records to support productive use of student mathematical thinking?



- How can teachers use public records to support productive use of student mathematical thinking?
- How can teachers use public records to support the teaching practice of *building on MOSTs*?

A MOST is a Mathematical Opportunity in Student Thinking



Building on a MOST is engaging the class in making sense of the MOST to better understand the mathematics of the MOST.



- How can teachers use public records to support productive use of student mathematical thinking?
- How can teachers use public records to support the teaching practice of *building on MOSTs*?
- How can teachers use public records to support the elements of the teaching practice of building on MOSTs?

### Framing the Use of Public Records

- Cognitive Load Theory (Swellers 1988; Swellers et al., 2011)
  - Long Term Memory & Working Memory
  - O Extraneous Load & Intrinsic Load
- Ways instruction can reduce cognitive load
  - Integrating sources of information
  - Pairing visual display with speech



### Methods



- Study is part of a larger project conceptualizing the building teaching practice
- Participants are grades 6-12 teacher researchers (*n*=14) who were enacting our conceptualized building practice and helping us to refine it
- Video-recordings of classroom enactments of four mini-tasks (n=27)
  - Percent Discount task "The price of a necklace was first increased 50% and later decreased 50%. Is the final price the same as the original price? Why or why not?"
- We examined collections of *manipulating* and *referencing* across the enactments for of the four elements of building

### Using a Public Record to Support the Establish Element



#### Manipulating

- Hone to clarify a MOST
- Placement to setup the public record for additional ideas
- Name or label the MOST helps make it an object

#### Referencing

• Minimal

The price of a necklace was first increased 50% and later decreased 50%. Is the final price the same as the original price? Why or why not?

Claim

The price will increase and decrease by the same amount.

I said yes, because, you know, the price of a necklace that you buy at a store that has that 50% deal in the problem will get increased and decreased by the same amount.

### Using a Public Record to Support the Grapple Toss Element

#### Manipulating

- Minimize manipulating during Grapple Toss
- Emphasize/Highlight the MOST

#### Referencing

• Orient students to the details of the MOST

The price of a necklace was first increased 50% How might you Is the final price the same as the original price argue whether Claim this claim The price will increase holds up and decrease by the mathematically? same amount. VS. How might you argue whether the price will increase and decrease by the same amount holds up mathematically?



#### Manipulating

- Similar actions as Establish
- Purposefully Organize

The price of a necklace was first increased 50% and later decreased 50%. Is the final price the same as the original price? Why or why not?

Claim:

```
The price will increase
and decrease by the
 same amount
necklace = $100
    Inc by 50% = 50% of 100 = 50
          100 + 50 = $150
           50% of 150 = $75
necklace = $20 + 10 = 30
           $ 30 - 10 = 20
50% of $20 = 10
     $ 20 + 10 = 30
50% of 30 = $15
     30 - 15: $15
```



#### Manipulating

- Similar actions as Establish
- Purposefully Organize

The price of a necklace was first increased 50% and later decreased 50%. Is the final price the same as the original price? Why or why not?

#### Claim

The price will increase

and decrease by the

Same amount neck-lace = \$100 Inc by 50% = 50% of 100 = 50 100 + 50 = \$150 50% of 150 = \$75

Necklace = \$20 + 10 = 30 \$30 - 10 = 20

50% of \$20 = 10

\$ 20 + 10 = 30

507. of 30 = \$15 30 - 15 = \$15

# BUILDING

#### Manipulating

- Similar actions as Establish
- Purposefully Organize
  - Distinguish among ideas

The price of a necklace was first increased 50% and later decreased 50%. Is the final price the same as the original price? Why or why not?

```
and decrease by the
 Same amount
necklace = $100
   inc. by 50% = 50% of 100 = 50
          100 + 50 = $150
          50% of 150 = $75
Necklace = $20 + 10 = 30
           $ 30 - 10 = 20
50% of $20 = 10
      $20 +10 = $30
50% of 30 = 15
        30-15:$15
```



#### Manipulating The price of a necklace was first increased 50% and later decreased 50%. Is the final price the same as the original price? Why or why not? Similar actions as Establish Purposefully Organize les Distinguish among ideas 0 0 Consider the placement of ideas Claim The price will increase necklace = \$100 and decrease by the inc. by 50% = 50% of 100 = 50 100 + 50 = \$150 same amount. 50% of 150 = \$75 50% of \$20 = 10 \$20 +10 = \$30 Necklace = \$20 + 10 = 30\$ 30 - 10 = 20 50% of 30 = 15 30-15=\$15



#### Manipulating

- Similar actions as Establish
- Purposefully Organize
  - Distinguish among ideas 0
  - Consider the placement of ideas 0
  - Seek parallelism of ideas 0

The price of a necklace was first increased 50% and later decreased 50%. Is the final price the same as the original price? Why or why not?

es Claim: The price will increase and decrease by the same amount necklace : \$20 necklace = \$20 50% of \$20 is \$10 inc. by 50%: \$20 + \$10 = \$30 dec. by 507.: \$30 - \$10 = \$20

necklace = \$100 50% of \$100 is \$50 Inc. by 50%: \$100 + \$50 = \$150 50% of \$150 is \$75 dec by 50%: \$150-\$75=\$75

50% of \$20 is \$10 Inc. by 501: \$20 + \$10 = \$30 50% of \$ 30 is \$15 dec. by 50%: \$30 - \$15 = \$15



#### Manipulating

- Similar actions as Establish
- Purposefully Organize
  - Distinguish among ideas
  - o Consider the placement of ideas
  - Seek parallelism of ideas

#### Referencing

- Orient students to ideas that are being connected and synthesized
- Recenter student(s) on the MOST

The price of a necklace was first increased 50% and later decreased 50%. Is the final price the same as the original price? Why or why not?

Claim: The price will increase in and decrease by the same amount.

es

### No

Necklace = \$100 507. of \$100 is \$50 INC. by 507. : \$100 + \$50 = \$150 507. of \$150 is \$75 dec. by 507. : \$150 - \$75 = \$75

```
Necklace = $20
507. of $20 is $10
inc. by 507.: $20 + $10 = $30
dec. by 507.: $30 - $10 = $20
```

Necklace : \$20 50% of \$20 is \$10 INC. by 50%: \$20 + \$10 = \$30 50% of \$30 is \$15 dec. by 50%: \$30 - \$15 = \$15

### Using a Public Record to Support the Make Explicit Element



#### Manipulating

• Edit the initial idea to help resolve the MOST

#### Referencing

- Emphasize the MOST as the object of a checkin question
- Orient students to the details of ideas and connections to help resolve the MOST

The price of a necklace was first increased 50% and later decreased 50%. Is the final price the same as the original price? Why or why not?

<u>Claim</u>: The price will increase and decrease by the same amount.

es

### No

Necklace = \$100 507. of \$100 is \$50 INC. by 507. : \$100 + \$50 = \$150 507. of \$150 is \$75 dec. by 507. : \$150 - \$75 = \$75

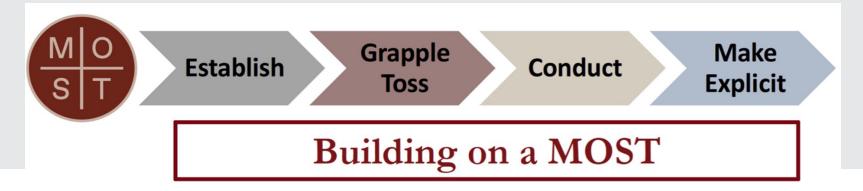
```
Necklace = $20
507. of $20 is $10
inc. by 507.: $20 + $10 = $30
dec. by 507.: $30 - $10 = $20
```

Necklace:  $\frac{$20}{507.05}$  is \$10 Inc. by 507.:  $\frac{$20}{507.05}$  is \$10 507. of \$30 is \$15 dec. by 507.: \$30 - \$15 = \$15

### Conclusion



- Purposefully organizing (*distinguishing, placement, parallelism*) the public record can help establish and sustain a common ground (Staples, 2007)
- Teacher use of public records can reduce extraneous cognitive load (Sweller et al., 2011)
- Referencing the public record helps orients students to details of each other's thinking, which can be key for learning (Webb et al., 2014)



### **Discussion Questions**



- Questions for us?
- How might these uses of public records to support the building practice support other teaching practices?
- How might uses of public records differ depending on the teaching practice in which a teacher is engaged?

### Thank you!



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