# One Urban District's Journey to Empower Teachers and their Students

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# Milwaukee Master Teacher Project


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# Agenda for the session

- Overview of the Milwaukee Master Teacher Project
  - uwm.edu/mmtp
- Four examples of classroom activities
- Results of action research and its impact on teaching and learning
- Discussion

# The Milwaukee Master Teacher Project

- Five-Year Noyce Track 3 project
- 24 high school math and science teachers in Milwaukee Public Schools (7 math, 1 computer science, 16 science)
- Four action research-based microcredentials “badges” per year
- Anticipating change in:
  - Teacher capacity for action research
  - Instructional practices related to focus of microcredentials
  - Quality of instructional practice overall

# MILWAUKEE MASTER TEACHER PARTNERSHIP

## Foundations



Action Research I & II

## Leadership



Designing & Supporting Teacher Learning



Instructional Design

## Content Focused


CCSSM & NGSS



Mathematical Modeling



Teaching Math with Technology

## Pedagogy Focused


Student Engagement & Motivation


Cognitively Demanding Tasks


Productive Struggle


Questioning & Discourse


Assessment


Orchestrating Productive Discussions

# Structure of a microcredential

- Opening activity to orient to the construct under study
  - Do a math task, discuss experience with a pedagogical topic
- Engage in selected research-based readings and discussions
- Use research-based ideas to plan a lesson or series of lessons around the topic
- Collect data from implementation
  - Extent to which students met learning goals, with artifacts
  - Teacher reflection
  - Student reflection

**Structure of a Microcredential**
**Example: Modeling I**


Engage in math modeling task together as learners → Read parts of the GAIMME report and discuss the key components of modeling → Identify aspects of the modeling cycle that are currently in practice and others that are challenging → Design and implement a modeling lesson → Collect and analyze data from the lesson → Present data for peer feedback

# Teachers' Action Research Stories

# Teacher Action Research

- Michael Moore: Picking Good Tasks
- Joan Masek: Mathematical Modeling
- Mary Zietlow: 5 Practices and Mathematical Modeling
- Erin McReynolds: Action Research Leading to Teacher Leadership

# Picking Good Tasks

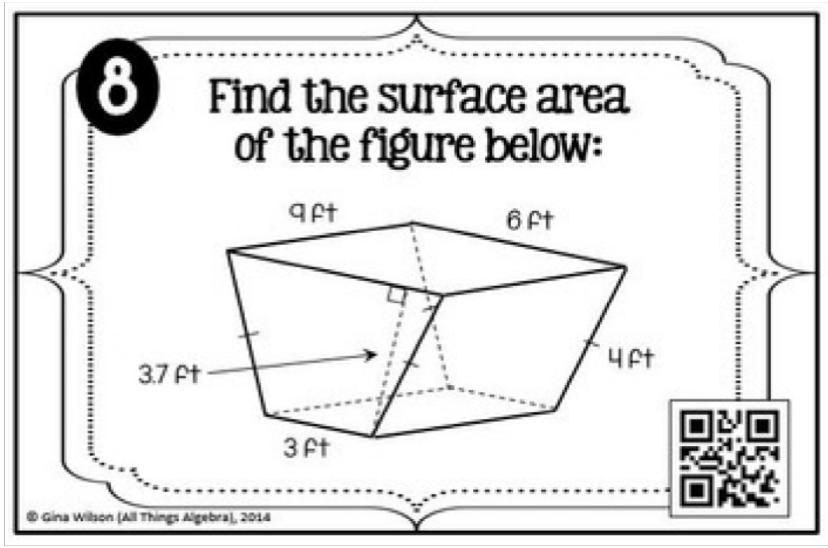
Michael Moore

Ronald Reagan IB High School

Milwaukee Public Schools

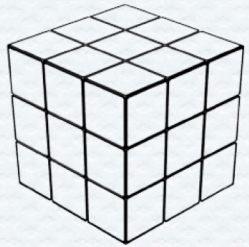
# Different Level Demand Tasks

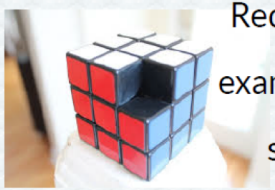
# Surface Area




vs

**Directions: The following prism is made up of 27 identical cubes. What is the greatest possible surface area the prism can have after removing 1 or more cubes from the outside?**





Doing Mathematics Tasks

Require students to analyze the task and actively examine task constraints that may limit possible solution strategies and solutions.

Procedures without Connections Tasks

**Students work in pairs to solve surface area problems. Can scan QR code to find out if they are correct. Rotate to new problem.**

"All Things Algebra." Teachers Pay Teacher www.teacherspayteachers.com/Store/All-Things-Algebra
"Open Middle." Open Middle, www.openmiddle.com/

What activity was more challenging?

What activity was more interesting?

Which activity better helped you understand today's learning intention?

- Memorization tasks, procedures without connection, procedures with connections, and doing mathematics.
- "Doing Mathematics" tasks may have multiple entry points and oftentimes multiple pathways to a solution.
- These tasks encourage creativity, are centered around thinking more than answers, and help develop critical thinking skills.

Stein, Mary Kay; Smith, Margaret; Henningsen, Marjorie; Silver, Edward. (2009). *Implementing Standard-based Mathematics Instruction.* New York, NY: Teacher College Press

# Mathematical Modeling: Gaimme Report and Common Core State Standards

Joan Masek

Alexander Hamilton High School

Milwaukee Public Schools

FIGURE 3.1: A SINGLE LOOP BACK AS ONE EXAMPLE OF A NON-LINEAR PASS THROUGH A MODELING PROCESS.

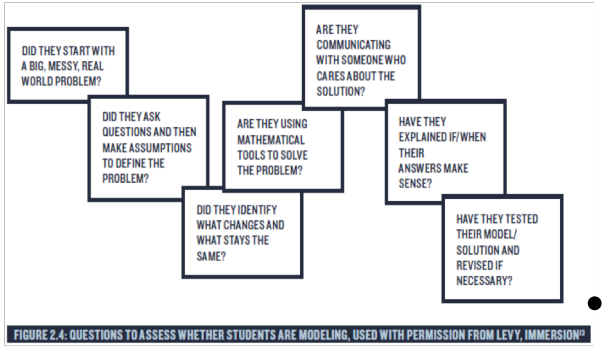


FIGURE 2.4: QUESTIONS TO ASSESS WHETHER STUDENTS ARE MODELING, USED WITH PERMISSION FROM LEVY, IMMERSION[3]

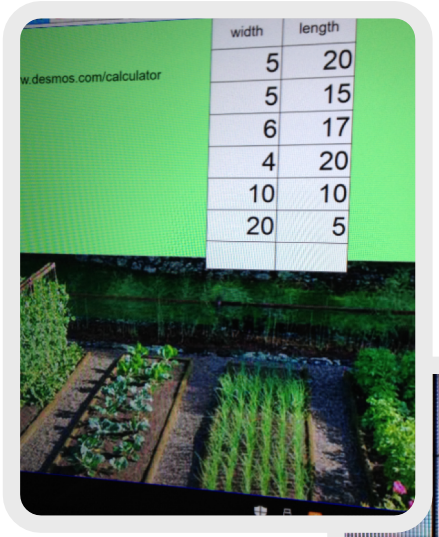
# Emphasis is on the process

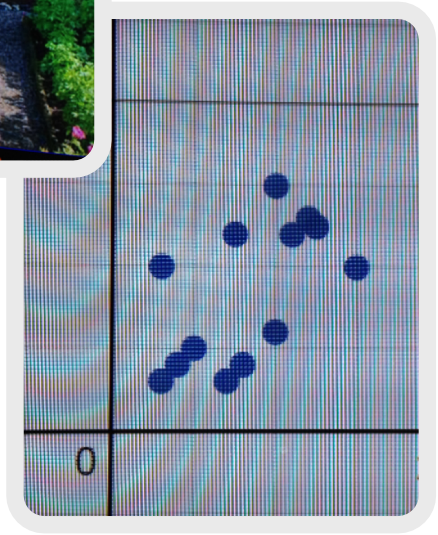
- Initial question has multiple entry points
- Make assumptions and choices
- Do the math!
- Analyze the solution
- Iterate

GAIMME

# PROBLEM: One member of your group is a zombie. How long before the zombie apocalypse destroys Milwaukee?

# PROBLEM: Build a rectangle garden using 50 feet of fencing

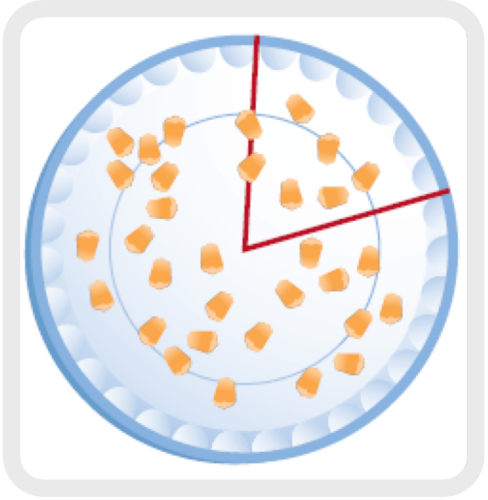


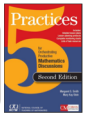

| MISCONCEPTIONS / LACK OF UNDERSTANDING | TYPE | % |
|---|---|---|
| Use of terms "more" "less" "<" or ">" inequality symbols | terminology | 30% |
| Confusion of equality and inequality --- including solution represented as an equality | conceptual | 15% |
| Errors in solving or graphing technique | procedural | 30% |
| Incorrect identification and/or interpretation of the solution of an inequality | conceptual | 65% |

*Conclusion – The "Garden Plot" modeling problem was designed to allow student misconceptions and incomplete reasoning to surface. Classroom discussions addressed student thinking.*

# PROBLEM:
# Create a model for radioactive decay

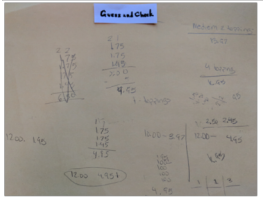


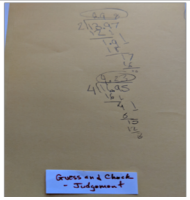
Practice 1: Anticipating → Practice 2: Monitoring → Practice 3: Selecting → Practice 4: Sequencing → Practice 5: Connecting

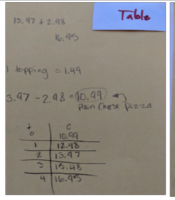


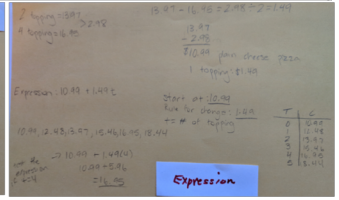

**MONITORING CHART**

| STRATEGY | ASSESSING QUESTIONS | ADVANCING QUESTIONS |
|---|---|---|
| Guess and Check | Can you tell me what you did?<br>How did you select your starting values?<br>How did you select the next values? | Is it possible the toppings cost $1 each?<br>Can you organize your data in a table or graph?<br>So, you are saying....<br>Is there another way.... |
| Table | Can you tell me what you did?<br>How did you select your starting values?<br>How did you select the next values? | How are the values changing in the table?<br>Is there another way to look at your data?<br>So, you are saying....<br>Can you see a pattern?<br>Can you predict the cost of 7 toppings? |
| Picture | Can you tell me what you did?<br>Tell me about your picture.<br>How did you get....? | Is there another way to look at your data?<br>So, you are saying....<br>Can you see a pattern? |
| Graph | Can you tell me what you did?<br>How did you select your starting values?<br>How did you get....?<br>Why did you....? | Is there another way to look at your data?<br>So, you are saying....<br>Can you see a pattern?<br>Can you predict the cost of 7 toppings? |
| Equation | Can you tell me what you did?<br>How did you select your starting values?<br>How did you get....? | So, you are saying....<br>Did you "check" this for other #s of toppings?<br>Can you predict the cost of 7 toppings?<br>Is there another way to look at your data?<br>Handout a graph. |
| OTHER | | |

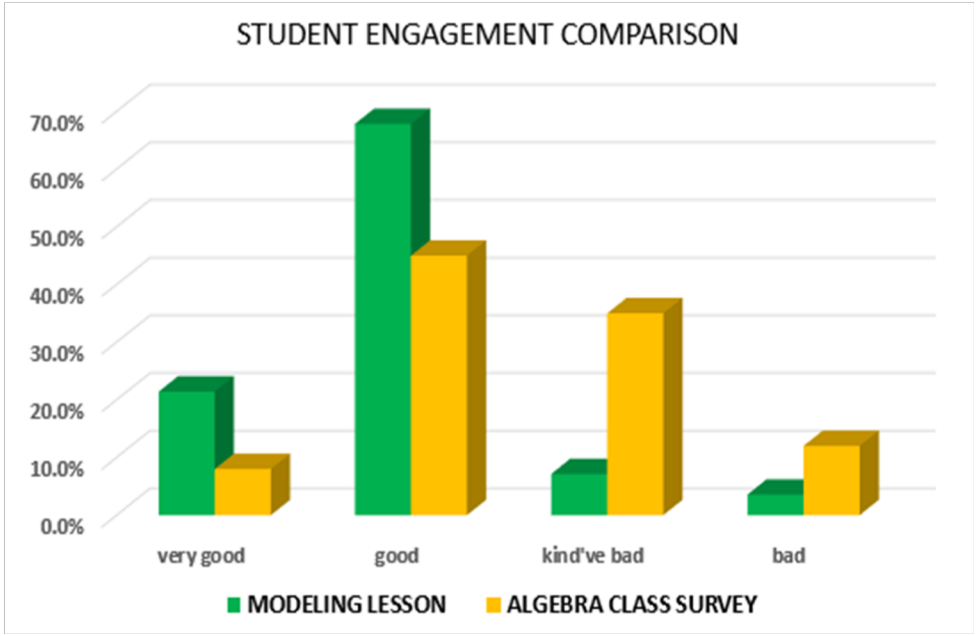


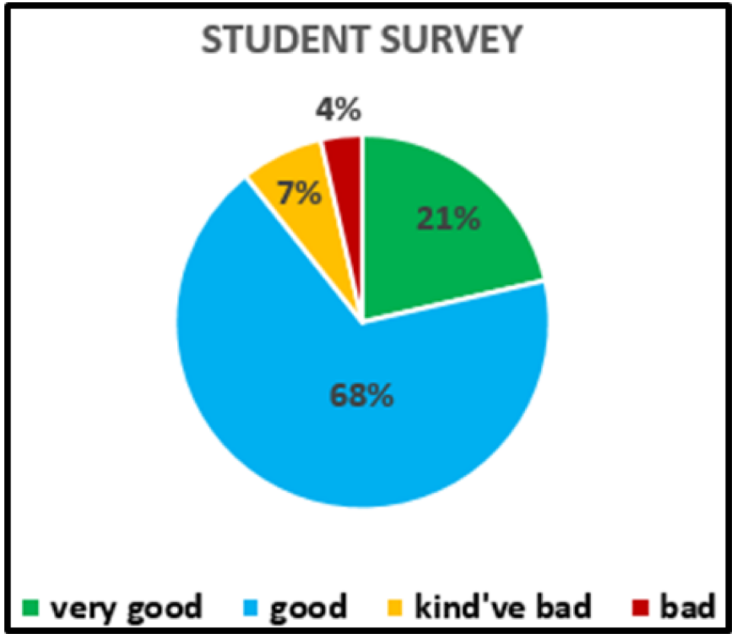



# STUDENT FEEDBACK



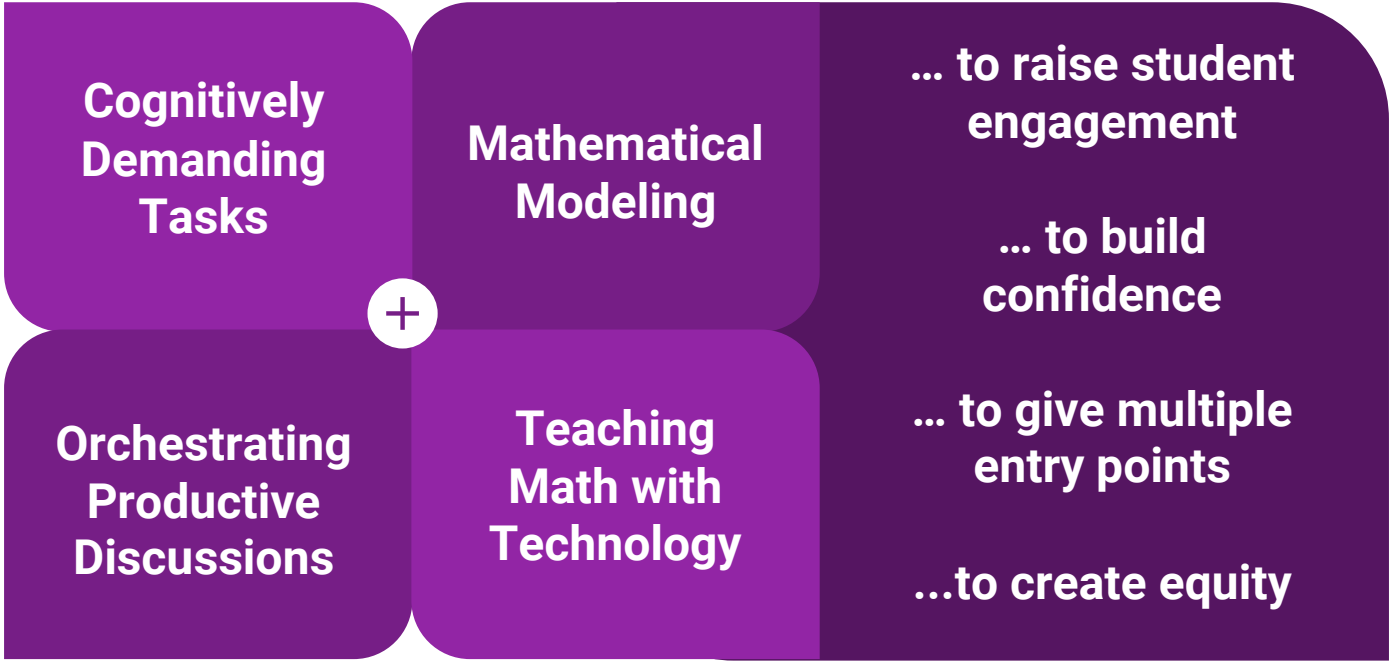
# 5 Practices and Mathematical Modeling: The Freeze

Mary Zietlow

Riverside University High School

Milwaukee Public Schools

# Microcredentials build on each other...



# Meet “The Freeze”

https://www.sbnation.com/lookit/2017/6/12/15781812/who-is-the-freeze-atlanta-braves-fan-races-baseball-mlb

https://youtu.be/O-GYh7cQQeY

# Mathematical Task

How much of a head start should The Freeze give?

For the next 2 days, you will:

- analyze the graph for The Freeze and the Atlanta fan and interpret their equations
- simulate the "race" using the motion sensors
- present your "race" analysis to the class
- complete a survey of this activity
- The groups should have 3-4 students.

# A Modeling Lesson that uses Technology and the 5 Practices to Create Discourse Opportunities

Mary Zietlow, Riverside High School, Milwaukee Public Schools

**Do you use any of these tools in your classes?**

- *Desmos*
- *Graphing Calculators*
- *Geogebra*
- *Sensors/lab equipment*
- *Shodor Interactive*

**T**wo **E**ssential **C**oncepts in **H**igh **S**chool **M**athematics :

- ❖ Technology as a driver of change in student engagement
- ❖ Mathematical modeling and the Modeling Cycle

From Catalyzing Change in High School Mathematics: Initiating Critical Conversations, Graham et al, NCTM, 2018

**The 5 Practices are:**

**Anticipating** likely student responses
**Monitoring** students' responses in real-time
**Selecting** who will present their methods
**Sequencing** a purposeful order for students to present
**Connecting** different responses to key ideas

From 5 Practices for Orchestrating Productive Mathematical Discussions, Smith and Stein, NCTM, 2011

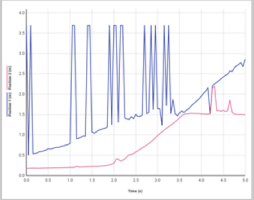
**Does the use of technology in a 5-Practice lesson help to make more productive class discussions?**

## The Task: The Freeze

**How much head start should The Freeze give to pass the fan with 2 seconds left in the race?**

## A Monitoring Tool

| Strategy | Assessing Questions | Advancing Questions | Who and What | Order |
|---|---|---|---|---|
| Finding the y-coordinate of the 1st when the 2nd starts | Why did you choose that y-value? How did you estimate? | Are the y-intercepts significant? What would you expect they are? | IM<br>GM | 2 |
| Multiply the time waited by the speed of the 1st | Why did you multiply? What is the formula this relates to? | How can you calculate that the passing is 2 secs from the end? | JV<br>ST | 1 |
| Students will guess a random time or distance. | Why did you choose that number? | What is the x-axis?<br>Y-axis?<br>Which line is for the Freeze? | MFA | 3 |
| Students will say that he start after a fixed distance every time. | How do you know that distance is enough? | | | |



**Grade Results of Student Handout:**

| AD | PR | BA | MI |
|---|---|---|---|
| 0 | 8 | 15 | 13 |

**Grade Results of Student Presentations:**

| AD | PR | BA | MI |
|---|---|---|---|
| 0 | 9 | 20 | 12 |

**Student Self-evaluations:**

| Got It | Starting to get it | Don't understand | Did not try |
|---|---|---|---|
| 3 | 8 | 0 | 2 |

## Student Voice:

**Describe the methods you used:**

- *I wasn't fully sure if I got the right speed or how much of a time the person had with a head start, but it looks like we did good so far.*
- *We just decided to give a 2-tile head start.*

**Describe how the class discussion and presentations benefitted you?**

- *I don't know. Most people wasn't done and most didn't know what to do or they was playing around.*
- *The class discussion benefitted me because it helped me learn how to do the problem.*

**What did you like/dislike about this activity?**

- *How we got to get out of our seats and actually experience it ourselves.*
- *I like when the line is (a sketch)*

**What was one thing you learned while doing this activity?**

- *I learned how to show distance.*
- *That you can do something if you try.*

**Next Steps:**

**If technology helps students engage in the activity, could it help students lead the discussion?**

# Action Research Leading to Teacher Leadership

Erin McReynolds

Alexander Hamilton High School

Milwaukee Public Schools

# Action Research 1 & 2

I was looking for ways to improve my intervention classes and that informed my choice of additional research and eventually my action research project for the first couple of microcredentials.

My changes in approach of intervention were wildly effective.

# Improving Conceptual Understanding of Arithmetic

**Problem:** Intervention students lack conceptual understanding of arithmetic, and therefore perform poorly in Algebra.

**Research question:** Can I improve my students' understanding of arithmetic by focusing on conceptual understanding and precise vocabulary?

## Literature Review:


- Rote memorization is difficult
- Students don't learn relationships
- Timed tests and memorization increase students' math anxiety
- Teaching facts in isolation limits students' number sense
- Traditional math teaching stifles students' natural mathematical intuition

- Focus on relationships
- Avoid teaching tricks
- Make sure reason underlies all math instruction
- Students need to discuss math to solidify understanding
- Activate natural mathematical intuition
- Ask open ended questions
- Use precise vocabulary consistently

## Classroom Implementation

### Number Talks

- Show students an arithmetic fact, students indicate when they find an answer, wait until everyone is ready
- Together we discuss the various ways to arrive at the answer and evaluate errors
- We evaluate multiple methods for finding solutions

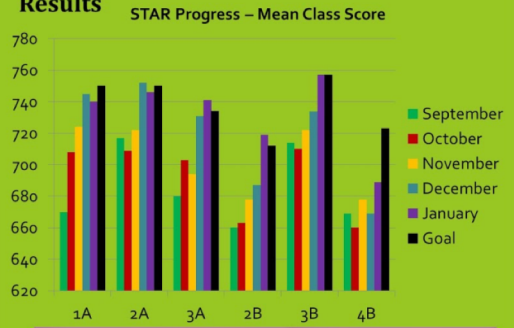
### Open Ended Questions

- Use a series of open ended questions that encourage students to explore mathematical relationships
- Students work cooperatively to work with the numbers and find the relationships

### Precise Vocabulary

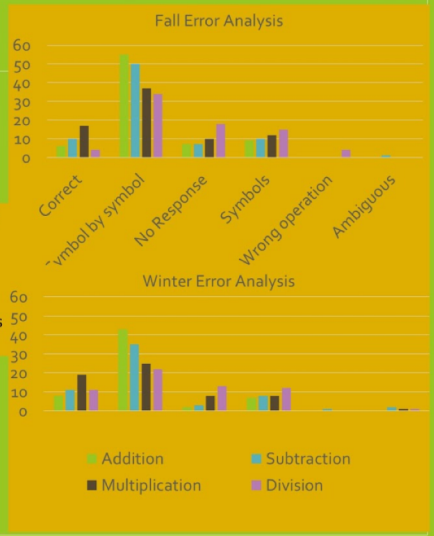
- Be consistent in vocabulary usage
- Use proper content vocabulary
- Avoid saying, "one point five", "three over five"

## Results




| Intervention & Algebra | Fall | Winter |
|---|---|---|
| Mean: | 682 | 724 |
| Median: | 705 | 743 |
| Std Dev: | 82 | 86 |
| t-test result: | | $3.31X10^{-8}$ |

| Algebra only | Fall | Winter |
|---|---|---|
| Mean: | 682 | 696 |
| Median: | 685 | 703 |
| Std Dev: | 88 | 76 |
| t-test result: | | 0.114 |




There was no significant improvement between Fall and Winter. Although students improved somewhat in symbolic representations of division.

## Class Resources:

*Creating A Language Rich Math Class by* Sandy Atkins

*Good Questions for Math Teaching* by Nancy Canavan Anderson and Lainie Schuster

*Mathematics for Elementary Teachers with Activities* by Sybilla Beckmann

*Mathematical Mindsets,* by Jo Boaler

*Making Number Talks Matter by* Cathy Humphreys & Ruth Parker

## Research

Comparing STAR score progression once a month over the course of the year

Data sources


Such as:

5+3

1. Write the expression as you would say it out loud
2. Write it a different way
3. Write it a third way
4. Draw a picture.

Collect student work and record student conversations to track for conceptual understanding

Samples to come

# Teacher Leadership 1 & 2

While at the NCTM regional conference in Chicago, I went to several talks that vindicated my findings from my action research microcredentials.

I decided to pursue an avenue to share the information that I had discovered on my own, even though others also knew of it.

I designed a PD that was effectively a short Q & A about what I had been doing in my classroom, sharing resources and the effects of my teaching on students.

# Bringing it all together: Project outcomes

# Questions and Discussion

# Personal and Project Outcomes

- Evidence of improved student outcomes
- Building teacher leadership
- What are some of your (un)anticipated outcomes?

# Contact Information

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