

# THE IMPACT OF TEACHER PROFESSIONAL DEVELOPMENT ON STUDENT ACHIEVEMENT

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The Greater Birmingham Mathematics Partnership is funded by NSF awards DUE-0632522 and DUE-0928665. The opinions expressed herein are those of the authors, and not necessarily those of the NSF.

## Does Professional Development Matter?

## Professional Development

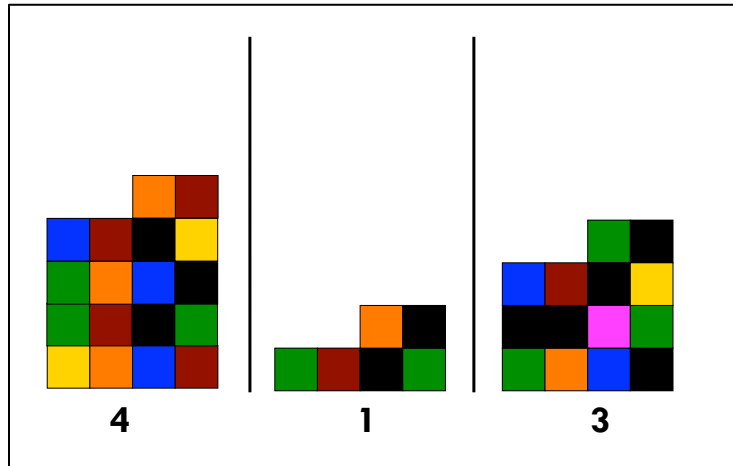
- Challenging nine-day mathematics content courses
- Inquiry-based
- Expandable tasks
- Whole class processing
- Menu
- Multiple representations
- Group tasks
- Portfolios



## Challenging Mathematics Courses

- Big mathematical ideas
- Productive disposition
- Inquiry and reflection
- Communication

## Sample Task: Tile Stacks



## Whole Class Processing

- Work to bring out multiple solution paths

## Menu

- A coherent collection of tasks
- Organized around a big mathematical idea (e.g. linear patterns)
- Surrounds students with a mathematical concept
- Allows them to encounter ideas in multiple contexts
- Students choose who to work with or to work alone
- Students choose how long to work on a task
- Meets a range of learner needs
- Includes core tasks and dessert tasks

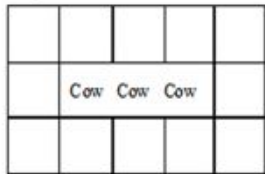
## Menu

- Cowpens and Bullpens
- Tile Stacks #2
- Polygon Perimeters
- Increasing Pattern #1
- Increasing Pattern #2
- Increasing Pattern #3
- Increasing Pattern #4
- Increasing Pattern #5
- Robbie the Robot

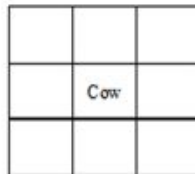
## Cowpens

- The High Mountain Fencing Company is in the business of building cow pens. The company ships cow pens to all parts of the United States.
- To cut costs they have found a way to build pens using fencing sections.

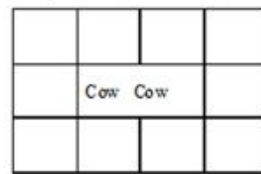
A pen for 3 cows looks like this:



A pen for 1 cow looks like this:



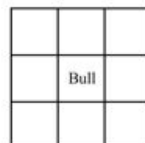
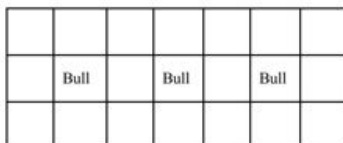
A pen for 2 cows looks like this:



- How many sections of fence would it take to hold 100 cows? 1,000? Any number?

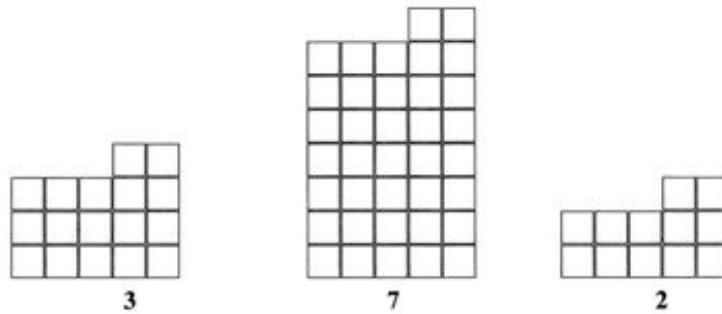
## Bullpens

The High Mountain Fencing Company is also in the business of building bull pens. However pens to hold more than one bull are constructed differently than cow pens.



How many sections of fence would it take to hold 100 bulls? 1,000? Any number?

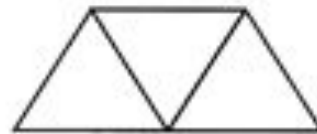
## Tile Stacks #2



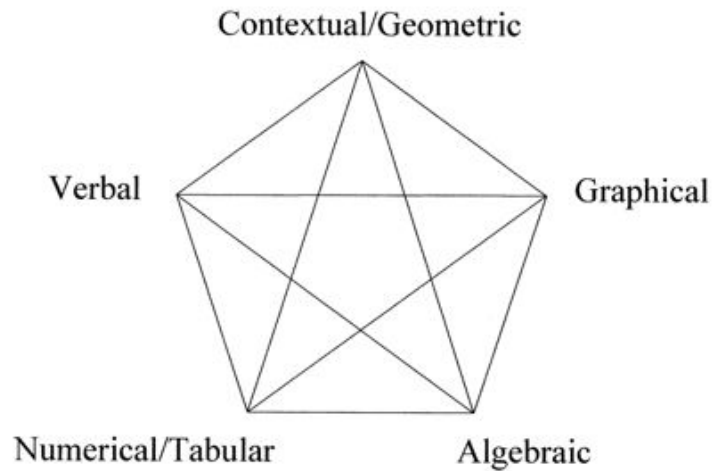
- Build two more structures. How many cubes will each take? How many cubes for the 10th structure?
- Write an algebraic rule to find the number for any stage of growth. Define your variables.
- Show geometrically why your rule makes sense.

## Polygon Perimeters

- If you lined up 100 triangles like this, what would the perimeter be?
- Assume that the length of one side of a triangle equals 1 unit.
- If you did the same for 100 squares, what would the perimeter be?
- For  $n$  squares?
- What about 100 hexagons lined up? What about  $n$  hexagons?
- **Challenge:** Can you find and describe the pattern (or function) for any regular polygon?



## Multiple Representations



## Group Tasks

- Leverage the value of social interaction (Piaget)
- Are carefully selected to be worth working on collaboratively (filters)
- Participants follow “Groups of Four Rules”
- Example: Cuisenaire Rod Trains

## Cuisenaire Rod Trains

A train is any collection of Cuisenaire rods placed end to end: 

Any train that looks different *is* different: 

### **Task:**

As a group, pick three rods and make all of the possible trains that are the length of each rod.

Record your results on chart paper or newsprint.

\*Can you find a way to determine all the possible trains for a rod of any length “ $n$ ”?

## Portfolios

- Participant-selected pieces
- Instructor-selected pieces
- Reflective writing
- Pre- and post-assessment tasks

## Challenging Mathematics Courses

- Big mathematics ideas
- Productive disposition
- Inquiry and reflection
- Communication

## Repeated Observations of Participants

- Center for Educational Accountability developed observation protocol based on challenging courses

<i>Patterns (N = 30)</i>	Day 1	Day 4	Day 8
<b>Understanding of Mathematical Ideas</b>			
uses variables to describe unknowns	13%	40%	97%
explains why equations make sense geometrically	7%	30%	77%
represents linear and quadratic equations in variety of ways	0%	17%	63%
<b>Productive Disposition</b>			
persists when answer is not known	0%	43%	93%
asks for guidance but not answers	10%	30%	87%
tries variety of strategies for approaching problem	10%	67%	93%

## Repeated Observations of Participants

<i>Patterns</i> (N = 30)	Day 1	Day 4	Day 8
<b>Inquiry and Reflection</b>			
makes extensions, connections beyond immediate problem	0%	17%	73%
explores why it works and whether it will always work	0%	7%	53%
confusion and mistakes lead to further exploration	20%	67%	100%
<b>Communication</b>			
explains reasoning fluently	0%	17%	80%
asks probing questions	20%	37%	93%
shares ideas with class	40%	57%	97%

## Participant Surveys

- This course improved my mathematical skills and understanding.  
 88% strongly agree; 11% agree
  
- "I have been teaching public school for 25 consecutive years now. Taking the GBMP/MEC classes has completely changed for the better my own conceptual mathematical abilities and these courses have completely transformed how I teach math to my students. I am so much more of a confident, knowledgeable, and effective problem solver and teacher now than I have ever been before in my life!"*
  
- "These courses are incredibly important! They provide me and other teachers with a way of deepening true understanding of mathematics, developing a positive disposition toward mathematical learning, and creating networks of support that will help as we begin to implement changes in instruction during the next school year."*

## Portfolios: *Patterns*

- Participant-selected pieces, instructor-selected pieces, reflective writing
- Scored with CEA-developed rubric (based on CCC)
- Three raters; consensus-reaching

<i>Patterns</i> (N = 20)	Median Score	Incomplete Score = 1	Emerging Score = 2	Proficient Score = 3	Expert Score = 4
Problem Translation	3	0	1	12	7
Mathematical Procedures	3	0	1	13	6
Productive Disposition	3	0	1	11	8
Inquiry and Reflection	3	0	2	11	7
Justification and Communication	3	0	2	11	7

## Performance Assessment: *Patterns*

- MEC-developed assessment pre- and post-
- Scored with OR Department of Education Rubric
- Two raters; high inter-rater reliability
- A Wilcoxon signed ranked test showed statistically significant improvement

<i>Patterns</i> N = 70	Conceptual Understanding		Processes and Strategies		Communication		Accuracy	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Median	2.0	4.0	2.0	4.0	2.0	4.0	4.0	5.0

## Objective Test of Content Knowledge

- Content Knowledge for Teaching Mathematics (CKTM)
  - Learning Mathematics for Teaching Project (ML), Ball, et. al.
  - Added items developed by Nanette Seago
  - 31 items pre and post
- Pre-Post Results for *Patterns* ( $N = 314$ )
  - 3-point increase in mean
  - Effect size = .484; medium effect
- Longitudinal Results for *Patterns* ( $N = 35$ )
  - Gains maintained and even increased over time

## Reformed Teaching Observation Protocol

- **Lesson Design and Implementation**
  - The instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein
  - This lesson encouraged students to seek and value alternative modes of investigation or of problem solving
- **Propositional Knowledge**
  - The lesson involved fundamental concepts of the subject
  - The lesson promoted strongly coherent conceptual understanding

## Reformed Teaching Observation Protocol

### □ **Procedural Knowledge**

- Students used a variety of mean to represent phenomena
- Students made predictions, estimations and/or hypotheses and devised means for testing them
- Students were actively engaged in thought-provoking activity that often involved the critical assessment of procedures
- Students were reflective about their learning
- Intellectual rigor, constructive criticism, and the challenging of ideas were valued

## Reformed Teaching Observation Protocol

### □ **Communicative Interactions**

- Students were involved in the communication of their ideas to others using a variety of means and media
- The teacher's questions triggered divergent modes of thinking

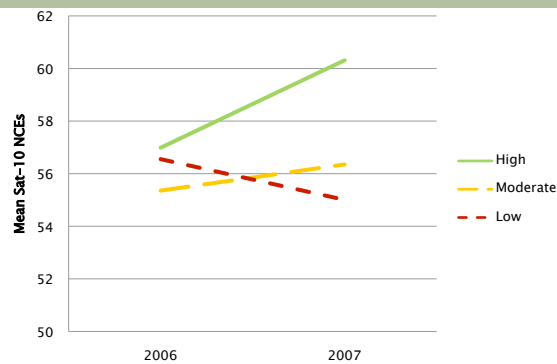
### □ **Student/Teacher Relationships**

- The teacher acted as a resource person, working to support and enhance student investigations
- The metaphor "teacher as listener" was very characteristic of this classroom

## Reformed Teaching Observation Protocol

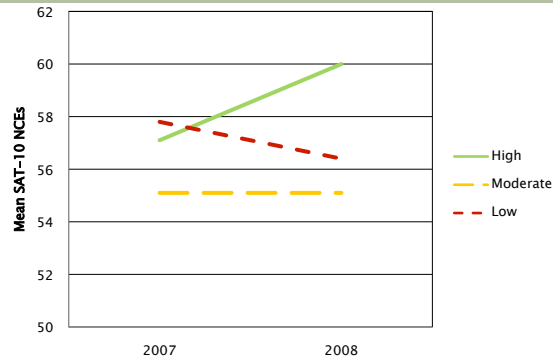
RTOP Subscales (maximum of 20; two raters; N = 265)	Courses	Median
Lesson Design and Implementation	0	0
	1	8
	2	12.5
	3+	8.75
Propositional Knowledge	0	0
	1	9.75
	2	13
	3+	11
Procedural Knowledge	0	0.5
	1	8.25
	2	12
	3+	8.25
Communicative Interaction	0	1
	1	7
	2	11.75
	3+	8
Student/Teacher Relationships	0	1
	1	8.75
	2	13.75
	3+	9

## Student Achievement by Implementation Level 2006-2007



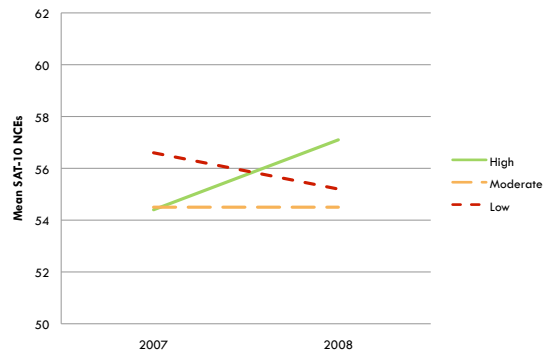
Implementation Level	2006 Mean	Std Dev	2007 Mean	Std Dev	N
High	57.0	21.4	60.3	22.2	1097
Moderate	55.4	21.2	56.4	21.6	6704
Low	56.6	20.8	55.0	21.3	15022
<b>Total</b>	<b>56.2</b>	<b>20.9</b>	<b>55.7</b>	<b>21.4</b>	<b>22823</b>

## Student Achievement by Implementation Level 2007-2008



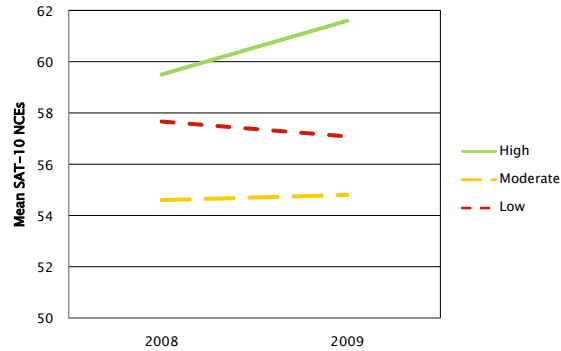
Implementation Level	2007 Mean	Std Dev	2008 Mean	Std Dev	N
High	57.1	21.1	60.0	21.0	3305
Moderate	55.1	20.8	55.1	20.9	6215
Low	57.8	20.8	56.4	20.9	14506
<b>Total</b>	<b>57.0</b>	<b>20.9</b>	<b>56.5</b>	<b>21.0</b>	<b>24026</b>

## Student Achievement w/o High SES



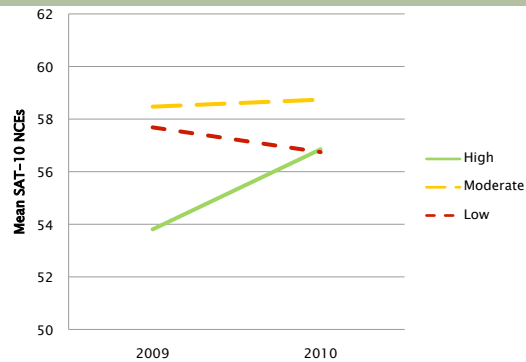
Implementation Level	2007 Mean	Std Dev	2008 Mean	Std Dev	N
High	54.4	20.4	57.1	20.2	2886
Moderate	54.5	20.6	54.5	20.6	6070
Low	56.6	20.4	55.2	20.4	13811
<b>Total</b>	<b>55.8</b>	<b>20.5</b>	<b>55.3</b>	<b>20.4</b>	<b>22767</b>

## Student Achievement by Implementation Level 2008-2009



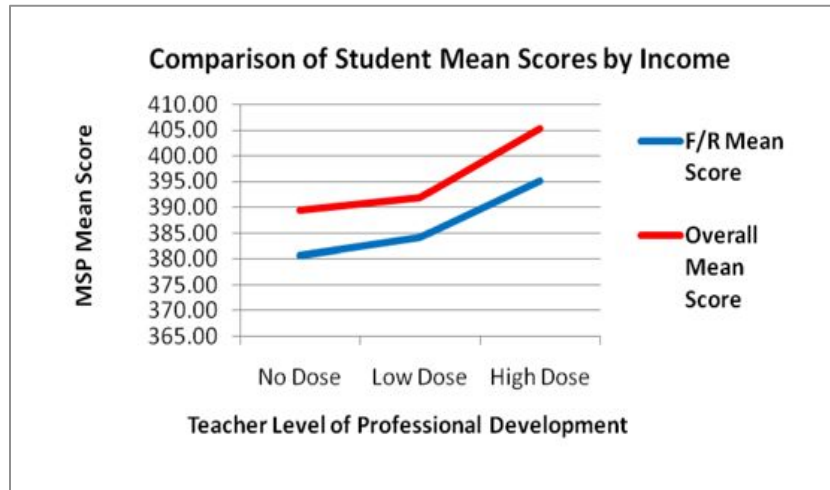
Implementation Level	2008 Mean	Std Dev	2009 Mean	Std Dev	N
High	59.5	20.7	61.6	21.3	3620
Moderate	54.6	20.2	54.8	20.4	7217
Low	57.7	20.4	57.1	20.7	8537
<b>Total</b>	<b>57.1</b>	<b>20.5</b>	<b>57.1</b>	<b>20.8</b>	<b>24872</b>

## Phase II Student Achievement by Implementation Level 2009-2010



Implementation Level	2009 Mean	Std Dev	2010 Mean	Std Dev	N
High	53.8	19.6	56.9	19.9	1221
Moderate	58.5	20.9	58.7	21.1	2441
Low	57.7	20.4	56.7	20.2	4255
<b>Total</b>	<b>57.3</b>	<b>20.5</b>	<b>57.4</b>	<b>20.5</b>	<b>7917</b>

## Washington State OSPI Data



## Contact Information

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