THE IMPACT OF CHALLENGING MATHEMATICS COURSES ON MIDDLE SCHOOL TEACHERS

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Greater Birmingham Mathematics Partnership

Partner	Students	Minority	Red. Lunch	MS	Gr. 6-8
Bessemer City Schools	4,087	97%	82%	1	962
Fairfield City Schools	2,323	100%	71%	1	585
Homewood City Schools	3,552	34%	22%	1	744
Hoover City Schools	11,141	22%	13%	3	2,537
Jefferson County Schools	32,553	28%	31%	7	8,713
Mt. Brook City Schools	4,150	1%	0%	1	1,016
Shelby County Schools	22,759	16%	24%	8	5,185
Trussville City Schools	4,100	8%	11%	1	970
Vestavia Hills City Schools	5,226	6%	4%	1	1,127
University of Alabama at Birmingham	17,584	31%			
Birmingham-Southern College	1,412	16%			
Mathematics Education Collaborative					

GBMP Activities

1. Summer Courses
2. Mathematics Support Teams
3. Administrator Sessions
4. Community Mathematics Nights
5. Middle School Mathematics Teaching Certificate
6. IHE Course Development
7. Engineering Application Tasks

Summer Courses

Existing Courses

- *Patterns: The Foundations of Algebraic Reasoning*
- *Numerical Reasoning*
- *Geometry and Proportional Reasoning*
- *Probability and Data Analysis*
- *Extending Algebraic Reasoning*

Under Development for Summer 2009

- *Patterns II: Further Explorations in the Foundations of Algebraic Reasoning*
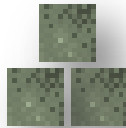- *Extending Algebraic Reasoning II*

Summer Courses

- Challenging nine-day mathematics content courses
- Inquiry-based
- Menu-driven
- Expandable tasks
- Multiple representations
- Group work
- Academic year sessions
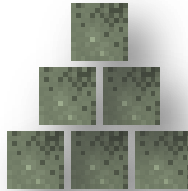
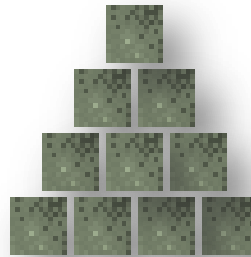# Sample *Patterns* Task

Step 1   Step 2   Step 3   Step 4

- Build the next two steps in this pattern.
- How many tiles are needed for the 10th step?
- How many tiles are needed for the nth step?

Challenging Courses and Curricula

- Deepening understanding of big mathematics ideas

- Productive disposition

- Inquiry and reflection

- Communication

Participant Surveys

□ *"This course improved my mathematical skills and understanding."*

86% strongly agree; 12% agree

□ *"The instructor was knowledgeable and effective."*

97% strongly agree; 3% agree

□ *"The Summer course has totally changed the way I feel about myself as a user of mathematics, and therefore, my ability to help my students develop a strong understanding of mathematical concepts."*

□ *"I have looked closely at my questioning techniques as a result of this class. Although I have been teaching for almost 30 years, this was the first model of great questions—set in a class setting so that I could see reactions and results."*

Objective Test of Content Knowledge

- Patterns
    - 31 items pre and post
    - Content Knowledge for Teaching Mathematics (CKTM) Learning Mathematics for Teaching (LMT) Project University of Michigan
    - Items developed by Nanette Seago
    - Test information value and internal consistency checked
- Geometry
    - All LMT CKTM-Geometry items used pre and post

Objective Test of Content Knowledge

- Patterns
  - 3-point increase in mean
  - Effect size = .496; medium effect
  - The upper half of the post-test score population exceeds 69% of the pre-test score population ($N = 76$)
  - Preliminary longitudinal data ($N=20$) indicates gains are maintained
- Geometry
  - 3-point increase in mean
  - Effect size = .588; medium effect
  - The upper half of the post-test score population exceeds 72% of the pre-test score population ($N = 51$)

Performance Assessment: Patterns

☐ MEC-developed assessment pre and post

☐ Scored with Oregon Department of Education Rubric

☐ Two raters; high inter-rater reliability

☐ A Wilcoxon signed ranked test showed statistically significant improvement

Patterns $N = 70$	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

Portfolios: Patterns

- Participant-selected pieces, instructor-selected pieces, reflective writing

- Scored with CEA-developed rubric (based on CCC)

- Three raters; consensus-reaching

Patterns (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

Behavioral Checklist: Patterns

□ CEA-developed checklist based on CCC dimensions

Patterns (*N* = 15)	Day 1	Day 4	Day 8
Mathematical Ideas			
uses variables to describe unknowns	7%	27%	93%
explains why equations make sense geometrically	7%	27%	73%
represents linear, quadratic functions in variety of ways	0%	13%	53%
Productive Disposition			
persists when answer is not known	0%	33%	87%
asks for guidance but not answers	13%	27%	80%
tries variety of strategies for approaching problems	13%	73%	93%

Behavioral Checklist: Patterns

Patterns (*N* = 15)	Day 1	Day 4	Day 8
Inquiry and Reflection			
makes extensions and connections beyond problem	0%	13%	67%
explores why it works, whether it will always work	0%	7%	53%
confusion and mistakes lead to further exploration	20%	73%	100%
Communication			
explains reasoning fluently	0%	13%	80%
asks probing questions	20%	33%	93%
shares ideas with class	27%	47%	93%

Classroom Observations

☐ Reformed Teaching Observation Protocol (RTOP)

☐ Two raters; consensus-reaching

| RTOP Subscale (maximum of 20)	Courses	Median
Lesson Design/Implementation	0	5
	1	12
	2	13.75
	3+	13
Propositional Knowledge	0	6.5
	1	12
	2	14
	3+	14.5

Sample ($N = 116$); 0 courses ($N=17$); 1 course ($N=35$); 2 courses ($N=38$); 3+ courses ($N=26$)

Classroom Observations

| RTOP Subscale (maximum of 20)	Courses	Median
Procedural Knowledge	0	6.5
	1	11
	2	14
	3	12.5
Communicative Interaction	0	4
	1	10.5
	2	13
	3	13
Student/Teacher Relationships	0	6.5
	1	13.5
	2	15
	3	14.5

Student Achievement Grades 5-8

SAT-10 over Time by Implementation Level
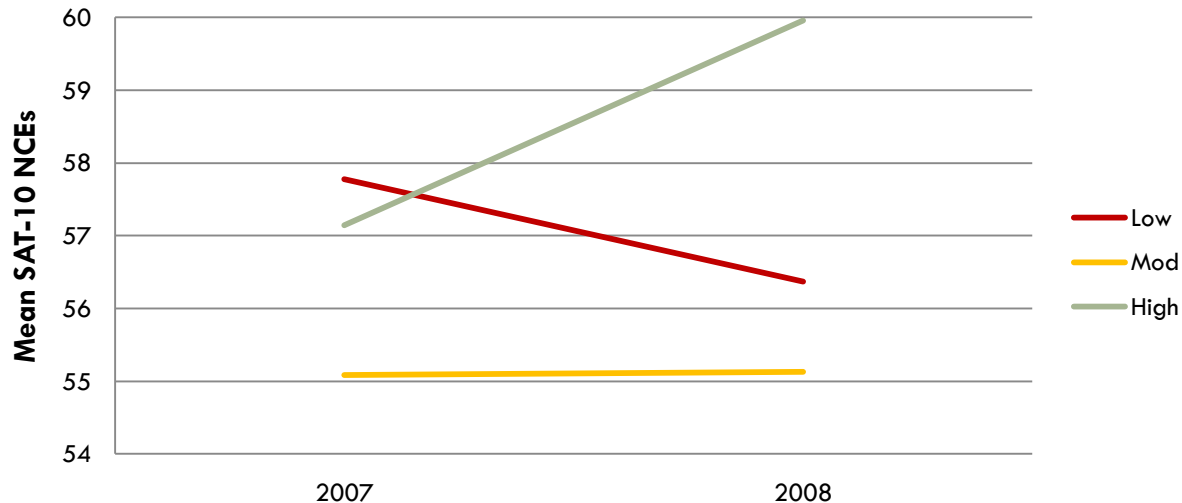
Implementation Level	2007 Mean	Std Dev	2008 Mean	Std Dev	N
Low	57.8	20.8	56.4	20.9	14506
Moderate	55.1	20.8	55.1	20.9	6215
High	57.1	21.1	60.0	21.0	3305
Total (6 systems)	57.0	20.9	56.5	21.0	24026

SAT-10 Excluding High SES System

SAT-10 over Time by Implementation Level
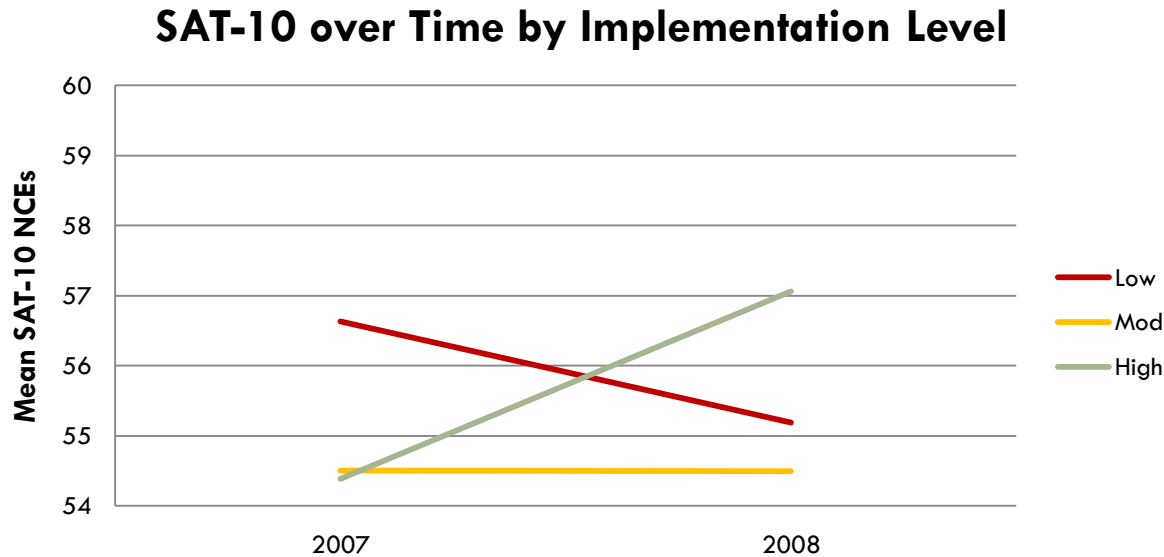
Implementation Level	2007 Mean	Std Dev	2008 Mean	Std Dev	*N*
Low	56.6	20.4	55.2	20.4	13811
Moderate	54.5	20.6	54.5	20.6	6070
High	54.4	20.4	57.1	20.2	2886
Total (5 systems)	55.8	20.5	55.3	20.4	22767