

Math Pathways & Pitfalls: Jump-Starting Effective & Equitable Instruction

WestEd 



Welcome and Introductions

- **Carne Barnett-Clarke**
Director, Math Pathways & Pitfalls
cbarnet@WestEd.org

- **Alma B. Ramírez**
Co-Director, Math Pathways & Pitfalls
aramire@WestEd.org

www.WestEd.org/mpp

Housekeeping

Discussion / Interactive Format

- Quick Polling
- Open Response
- Breaks for responding to chat questions/comments
*Those on just teleconference can email questions to:
eventquestion@wested.org*

Poll: Who is in the audience?

- Site or District administrator
- Teacher (classroom or resource)
- Mathematics teacher or coordinator
- EL coordinator
- Higher education staff
- Technical Assistance provider
- SEA staff
- Other (type into the chat area)

Context

Challenges

- Pressure to increase scores
- Assessments difficult mathematically & linguistically

Needs

- Mathematical understanding that does not cave in to pitfalls
- Support to develop mathematical language

Grade 2, CST released item, 2008

Which number sentence is an opposite number sentence for eight plus six equals fourteen?

$$8 + 6 = 14$$

- A. $2 + 12 = 14$
- B. $7 + 7 = 14$
- C. $8 - 2 = 6$
- D. $14 - 8 = 6$

Grade 2, CST released item, 2008

A teacher divides a whole class into groups to work on a class project. Each group has one-sixth of all the children in the class. How many groups are there?

- A. 2
- B. 6
- C. 7
- D. 12

Grade 4, CST released item, 2008

Kira owes Mark \$5, and Mark owes Kira \$7.
Which statement means the same thing?

- A. Kira owes Mark \$2.
- B. Kira owes Mark \$12.
- C. Mark owes Kira \$2.
- D. Mark owes Kira \$12.

Grade 4, CST released item, 2008

The sales tax for an item is \$0.47. What is the amount of tax rounded to the nearest dime?

- A. \$0.40
- B. \$0.45
- C. \$0.47
- D. \$0.50

Poll: What makes these items difficult?

- The mathematics
- The language
- Both the mathematics and the language
- Neither – the items are easy

Goal of this presentation

Share strategies to help teachers:

- Turn Pitfalls into Pathways for Learning
- Develop Mathematical Language
- Address Multiple Modalities
- Develop a Community of Learners

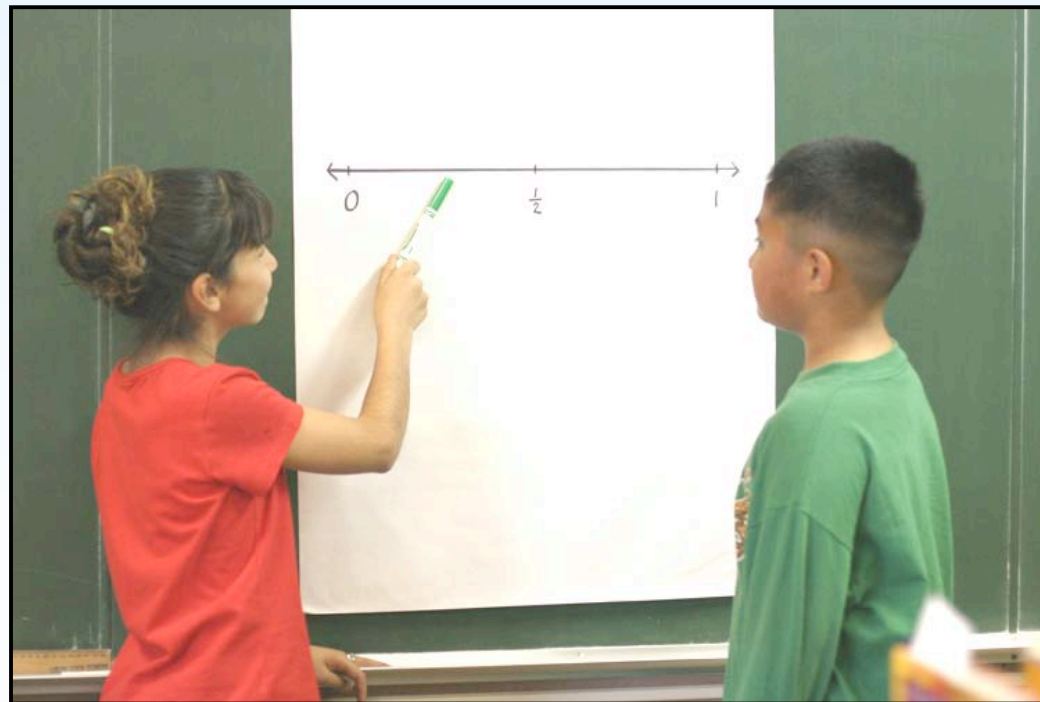
Format of Presentation

- Research basis for strategies
- What teachers can do to embed strategies in their own lessons
- Examples of the strategies within a curriculum
- Results from embedding the strategies in a curriculum

Strategy

For Jump-Starting Effective & Equitable Instruction:

>>> Turn Pitfalls into Pathways for Learning



Grade 8, NAEP 2007

Tammy scored 52 out of 57 possible points on a quiz. Which of the following is closest to the percent of the total number of points that Tammy scored?

- A. 0.91%
- B. 1.10%
- C. 52%
- D. 91% (correct response)
- E. 95%

62% correct

Poll

Select a choice that can be easily eliminated if you have a fundamental understanding of percent.

Tammy scored 52 out of 57 possible points on a quiz. Which of the following is closest to the percent of the total number of points that Tammy scored?

- 0.91%
- 1.10%
- 52%
- 91%
- 95%

Incorrect solutions are symptomatic of:

- Fundamental misunderstandings
- Faulty reasoning
- Lack of metacognitive awareness

Using Pitfalls as Pathways for Learning

Tammy scored 52 out of 57 possible points on a quiz. Which of the following is closest to the percent of the total number of points that Tammy scored?

Pitfalls

- Produce cognitive dissonance
- Stimulate inquiry
- Motivate metacognitive awareness

(Festinger, 1957; Borasi, 1994)

Contrasting Examples: Correct vs. Pitfall

- Facilitate transfer to new problems
- Promote inferences and abstractions
- Help memory retrieval

(Gentner, Loewenstein, and Thompson, 2004; Gentner & Medina, 1998)

Turning Pitfalls into Pathways for Learning *In Any Lesson*

Planning a Lesson:

- Purposely select examples or problems that elicit pitfalls
- Write down common pitfalls for the problems
- Write down possible reasons for the pitfalls
- Write down questions that will elicit understanding the meaning of the problem, not just how to solve it

Turning Pitfalls into Pathways for Learning *In Any Lesson*

During a Lesson:

- Discuss both correct and incorrect solutions
- Ask why a solution makes sense or doesn't make sense
- Foster an expectation that “we learn from our mistakes” and “we look out for pitfalls”

Turning Pitfalls into Pathways for Learning *In Any Lesson*

On Multiple Choice Assessments:

- Discuss why particular choices are pitfalls
- Discuss which choices might make sense, and which can be eliminated
- Look back to see if the choice selected makes sense

Poll

Based on your personal experience, estimate the percentage of teachers who anticipate common pitfalls and use this information to plan effective mathematics instruction.

- 0 to 25%
- 26 to 50%
- 51% to 75%
- 76% to 100%

Poll

Do you have any questions or comments on the information just shared? Please type below.

Strategy

For Jump-Starting Effective & Equitable Instruction:

>>> Develop Mathematical Language



Researchers Describe Academic Language

- “The development of the spoken forms of language are essential for second language learners as a bridge to the more academic language associated with learning in school...”
– *Pauline Gibbons, Scaffolding Language, Scaffolding Learning, 2003*
- “...mathematics ...has its own academic register features, and a considerable amount of the knowledge required for success in higher levels of mathematics is construed through language.
– *Mary Schleppegrell, The Language of Schooling, 2004*
- “...for ...learning to occur, students need ample opportunities to hear math language and to speak and write mathematically.
– *Anstrom, 1999*
- “Mathematics language has particular semantic and syntactic features. – *Spanos, et.al. 1988*

A Framework for Looking at Academic Language

What do we want students to be able to do?

- **Translate** from one representational form - words, symbols, pictorial/concrete - to another
- Know the **meaning of math terms** and identify their definitions or synonyms
- **Distinguish between academic and informal** use of mathematical words, mathematical and nonmathematical use of words, and between words that sound similar, but have different meanings
- **Distill core mathematical meaning** from verbal math problems, questions, statements, or explanations even when the sentences are complex or different from everyday English
- Communicate using the **specialized academic language** of mathematics communities

Helping Students Develop Mathematical Language *In Any Lesson*

During a lesson

- Attend to key vocabulary or “math words” that will be used authentically in the lesson.
- Limit the number of words and definitions, and provide examples and words in context.
- Develop common norms for entering into classroom conversations.

Helping Students Develop Mathematical Language *In Any Lesson*

- When discussing problems, use contrasting examples and solutions, including correct and “pitfall” reasoning.
- Discuss examples thoroughly and make a record of the discussion that has occurred.
- Provide opportunities for students to enter into the discussion by varying the linguistic demands of questions and of required responses.

Poll

Which modality do think students in your district most often experience in the classroom?

- Visual or tactile
- Reading
- Writing
- Talking
- Listening

Poll

What is your least favorite modality for learning?

- Visual or tactile
- Reading
- Writing
- Talking
- Listening

Strategy

For Jump-Starting Effective & Equitable Instruction:

>>> Address Multiple Modalities



Why Multiple Modalities?

- Boosts learning
- Makes instruction more accessible to diverse learners

(Ginns, 2005; Short, 1991)

Missed Opportunities

- U.S. emphasis on recitation style teaching was documented in TIMSS (Trends in International Mathematics and Science Study)
- Classrooms, especially with English learners, often introduce mathematics concepts with little or no discussion

(Stigler & Heibert, 1997; Khisty, 1992)

Addressing Multiple Modalities

In Any Lesson

- Ask students to **explain** and **show** their ideas with drawings or materials
- Ask students to **label** their drawings
- Ask students to **discuss** mathematical ideas
- Have them **summarize** the ideas by writing and drawing

Strategy

For Jump-Starting Effective & Equitable Instruction:

>>> Develop a Community of Learners



Why a Community of Learners?

Support for risk-taking

- There is a correlation between intellectual risk-taking and higher achievement.
- For English learners, risks are based both on their content knowledge and linguistic ability in English.
- A supportive, collaborative environment must be established that supports risk-taking.

(Beghetto, 2004; Khisty, 1995; Secada, 1992; Cohen, 1982)

Developing a Community of Learners *In Any Lesson*

Vary participation structures from low to high risk

- Give students time to privately grapple with ideas.
- Allow time to work with a partner to flesh out ideas, without having to expose ideas to the class until more completely formed.
- Slowly invite students to share their thinking with the entire class.

Developing a Learning Community

In Any Lesson

Invite risk-taking within a respectful, cooperative learning environment

- Errors are explored for the benefit of the class, not put down or hidden.
- The entire group can collaborate to fully understand a concept by adding to or questioning others' ideas.

Poll

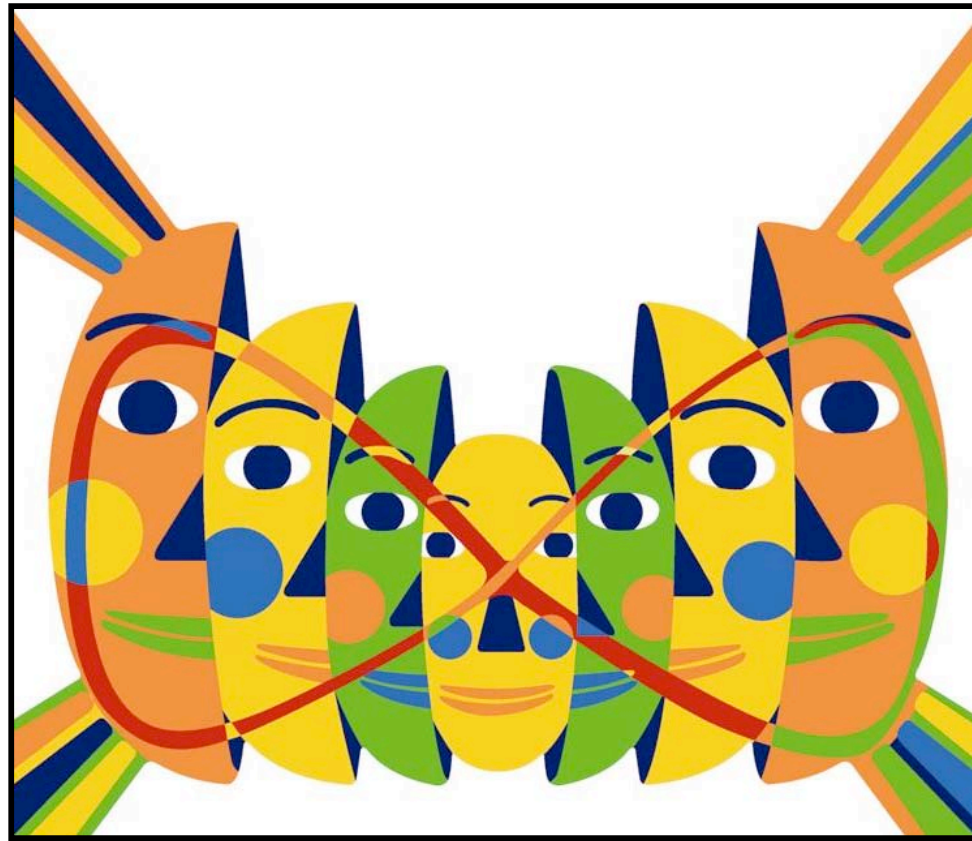
Do you have any questions or comments on the information just shared? Please type below.

Poll



Do you currently use any of these strategies in your curriculum or intervention program?

- Turn pitfalls into pathways for learning
- Develop mathematical language
- Address multiple modalities
- Develop a community of learners

Examples of these Strategies in a Math Curriculum



Embedding the Strategies Throughout a Lesson

- Math Words
- Starter Problem
- Student Thinking examples  
- Our Turn / My Turn
- Assess and Reinforce:
Multiple Choice and Guided Writing

Math Words, Grade 3

equation An equation like $5 + 30 = 35$ shows that $5 + 30$ and 35 are equal.

equals sign An equals sign means “is the same amount as.”

both sides The amounts on both sides of the equals sign in this equation are equal to 20.

$$10 + 10 = 19 + 1$$

Student Thinking, Grade 3

Starter Problem

Copy and complete this equation.
Think about the meaning.

$$20 + \underline{\hspace{2cm}} = 54$$

Student Thinking, Grade 3



Anita

I read it to myself: "20 plus a missing number is equal to 54." Both sides of the equals sign need to be the same amount. The left side needs 34 more. It checks.



$$20 + 34 = 54$$



Joel

It says to add, so 20 plus 54 is 74.



$$20 + 74 = 54$$

Starter Problem

This diagram shows that $\frac{1}{5}$ of a school is painted. What percent is painted?

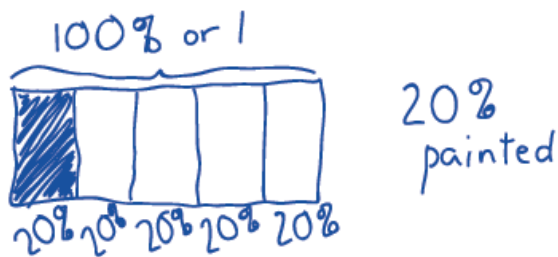


Student Thinking



Angela

If they painted the whole school it would be 100%. So $\frac{1}{5}$ is the same as 20% painted.



Martin

$\frac{1}{5}$ is 15%. That's simple!

$$\frac{1}{5} = 15\%$$



Developing a Community of Learners

- Sentence stems
- Classroom posters

Discussion Builders grades 4-8

Presenting Alternative Ideas

I have an idea...
I wonder what would happen if...
I have a counter-example...
I have a conjecture. What if we tried...?

The graphic features a yellow title box with a hand-drawn orange cloud above it. Below is a purple box with a lightbulb icon. The main text is in a yellow box with a green border.

Building a Community of Learners

Varying Risk Structures

Gradually increasing linguistic and mathematical risk structures increase intellectual risk-taking

- **Starter Problem**
private
- **Read/Listen to OK and Pitfall**
private
- **Discuss OK and Pitfall**
individual → partner → whole class

Poll

Do you have any questions or comments on the information just shared? Please type below.

What is the Impact of these Strategies?

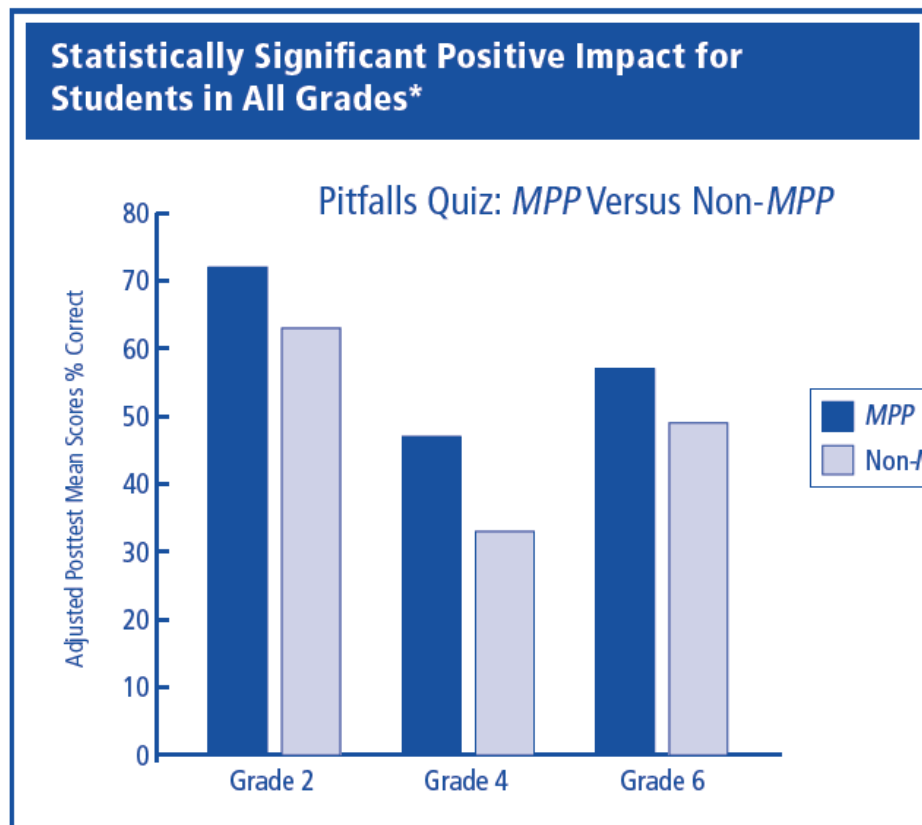
There have been two randomized trial studies conducted on the use of *MPP* lessons.

- The first study was funded by the National Science Foundation.
- The second was funded by the Institute of Education Sciences, U.S. Department of Education.

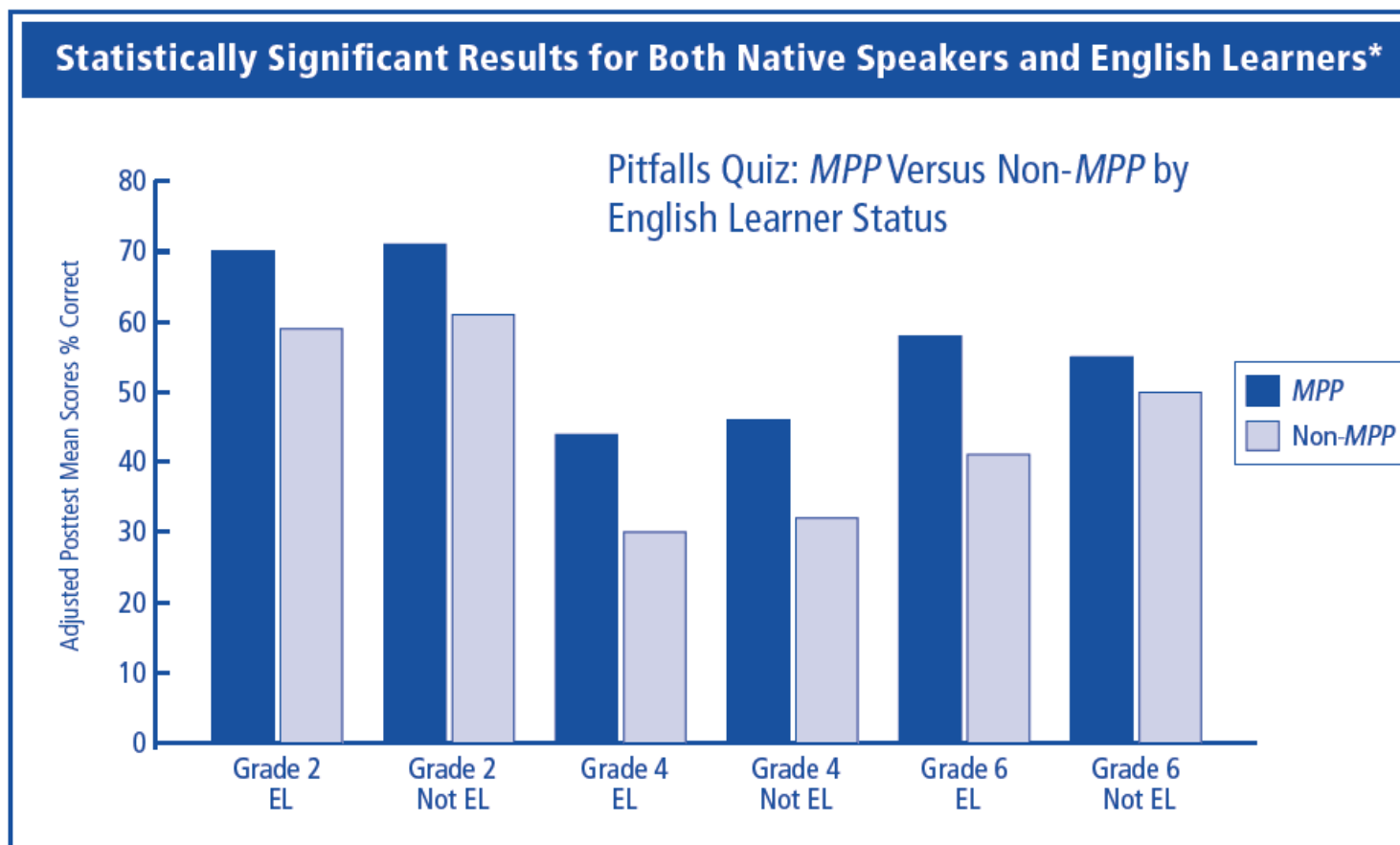
NSF Research Results on the Impact of *MPP*

- Experimental research study with randomized groups
- Conducted with ethnically, linguistically, and geographically diverse student populations
- Outcome measure: mathematics learning
- Significant positive effects
(ESS = 0.43 to 0.66)

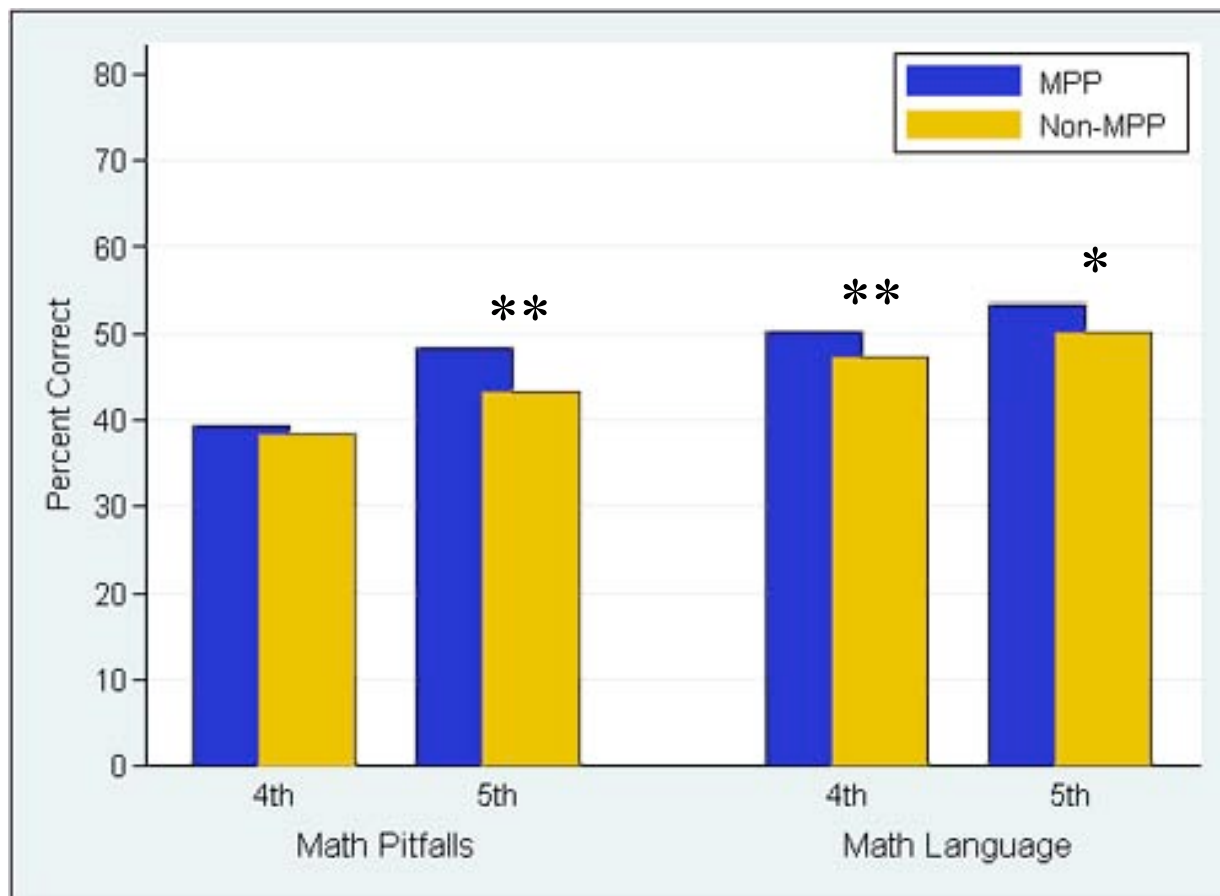
NSF Research Results: Math Learning



NSF Research Results: English Learners

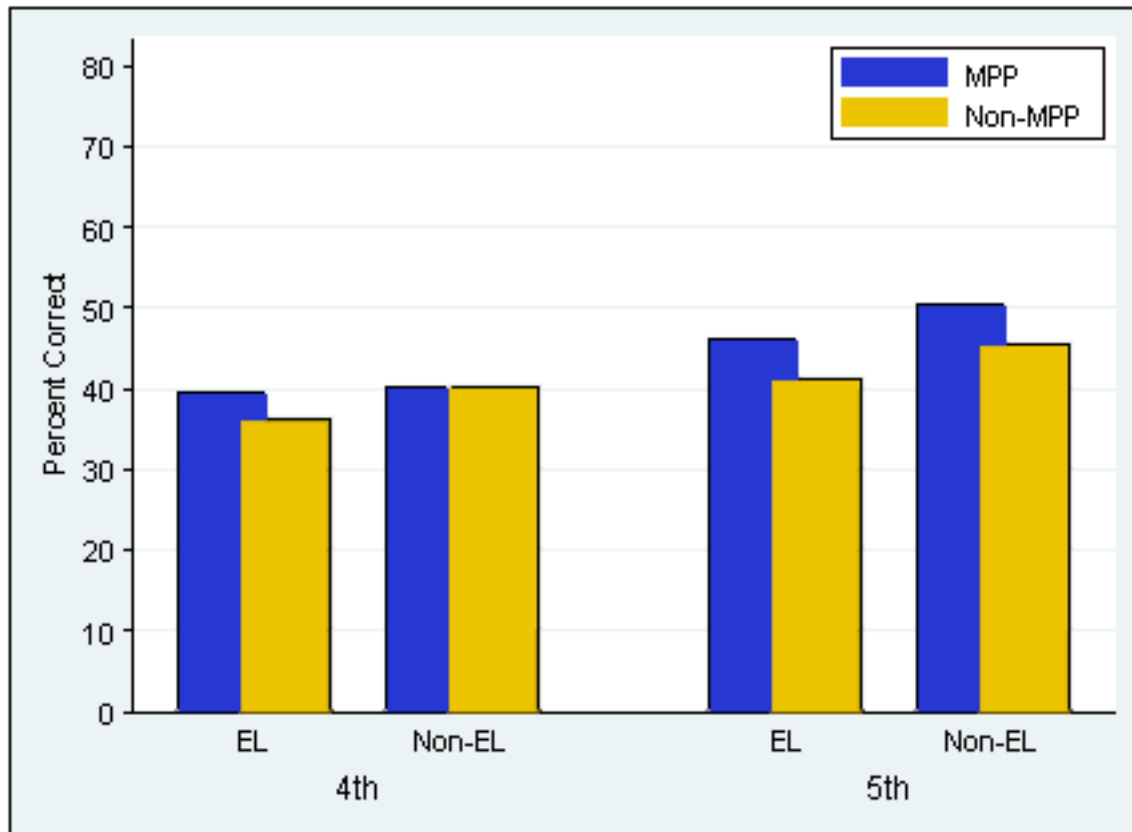


MPP: Positive Effects on Math & Language



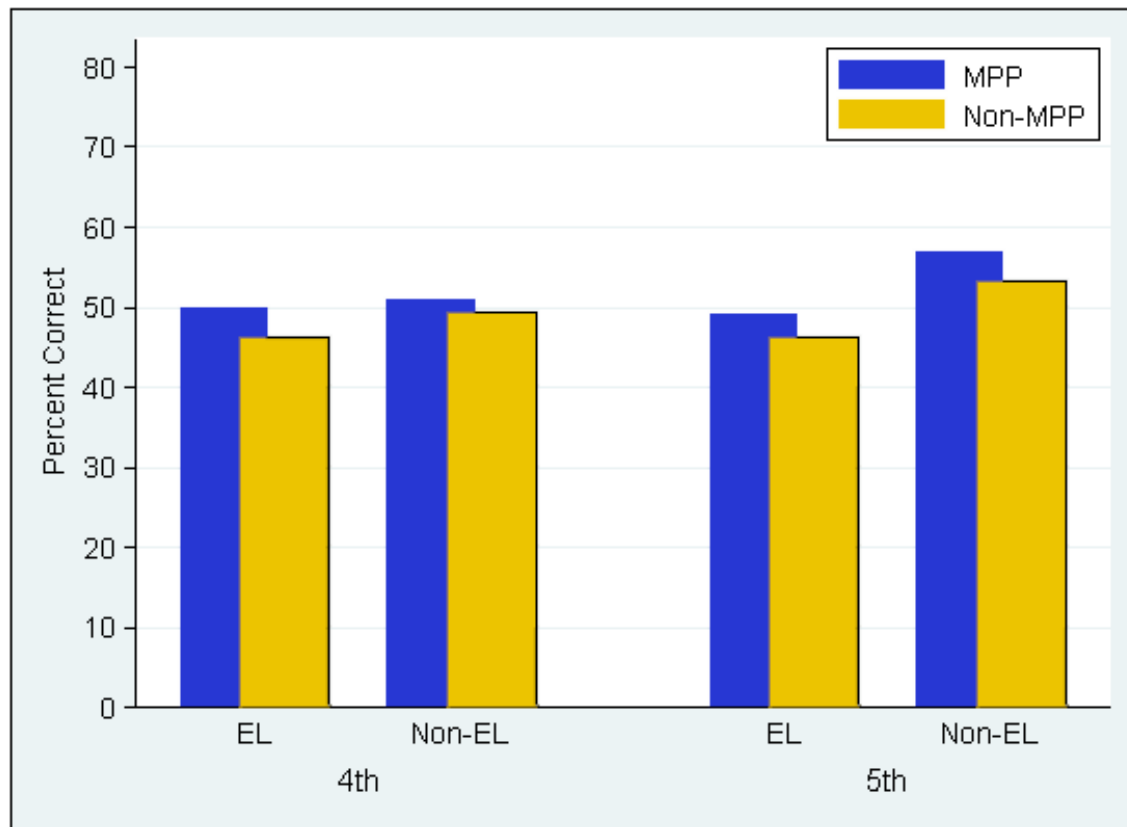
Math Quiz

Impact of *MPP* for English Learners and Native English Speakers was **statistically equivalent**



Language Quiz

Impact of *MPP* for English Learners and Native English Speakers was **statistically equivalent**



Transfer Study: Classroom Observations

Classrooms implementing *MPP* were more likely to exhibit the following kinds of patterns and practices in post observations than pre observations during their regular (non-*MPP*) math lessons.

Mean total scores for the post-*MPP* implementation data were significantly greater than pre-implementation (Wilcoxon $T^+ = 36$, $p < .005$, $n = 8$).

Transfer Study: Classroom Observations

Math

- More challenging and difficult problems
- Students expected to make sense of the math by sharing, showing, or explaining ideas
- Pitfalls noticed and viewed as an opportunity to learn
- Deeper understanding of the mathematical topics lesson over all

Transfer Study: Classroom Observations

Language / Discourse

- Greater variety of speaker roles and participant structures for students
- More opportunities for students to explain and justify reasoning
- Extended discussions with fellow students about mathematical ideas
- Mathematical vocabulary used with greater confidence
- Greater level of engagement in the lesson over all

Poll

Do you have any additional questions or comments on the information we have presented today?
Please type below.

For Additional Information

- Visit the *Math Pathways & Pitfalls* website, www.WestEd.org/mpp
- Or email kdarlin@WestEd.org

Next Steps

Archive

- www.schoolsmovingup/webinars.mpp

Feedback

www.surveymonkey.com/s.aspx?sm=jj0ICOMhrqdCodCQahxw0g_3d_3d