

**Brookhill**  
Institute of Mathematics

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Using Depth of Knowledge to Add  
Rigor to the Mathematics Classroom

Wisconsin Mathematics Council  
Annual Conference  
May 5, 2016

# Vision Statement



The Brookhill Institute of Mathematics exists to raise the mathematical literacy of every learner.

# Introductions

Who we are:

- Paige Richards
- Jeff Ziegler

Who are you?

# Learning Intentions & Success Criteria

We are building a common language around rigor.

We will be successful when we can define and begin to quantify mathematical rigor using Webb's Depth of Knowledge.

What does **rigor**  
*look like* in mathematics  
classrooms?



# Why is Rigor Important?

“Student learning is greatest in classrooms where the tasks consistently encourage high-level student thinking and reasoning and least in classrooms where the tasks are routinely procedural in nature.”

Principles to Actions: Ensuring mathematical success for all (NCTM, 2014)



“The Common Core State Standards require **high-level cognitive demand**, such as asking students to demonstrate deeper conceptual understanding through the application of content knowledge and skills to new situations and sustained tasks.”

*Smarter Balanced Mathematics  
Item Specifications Appendix B*

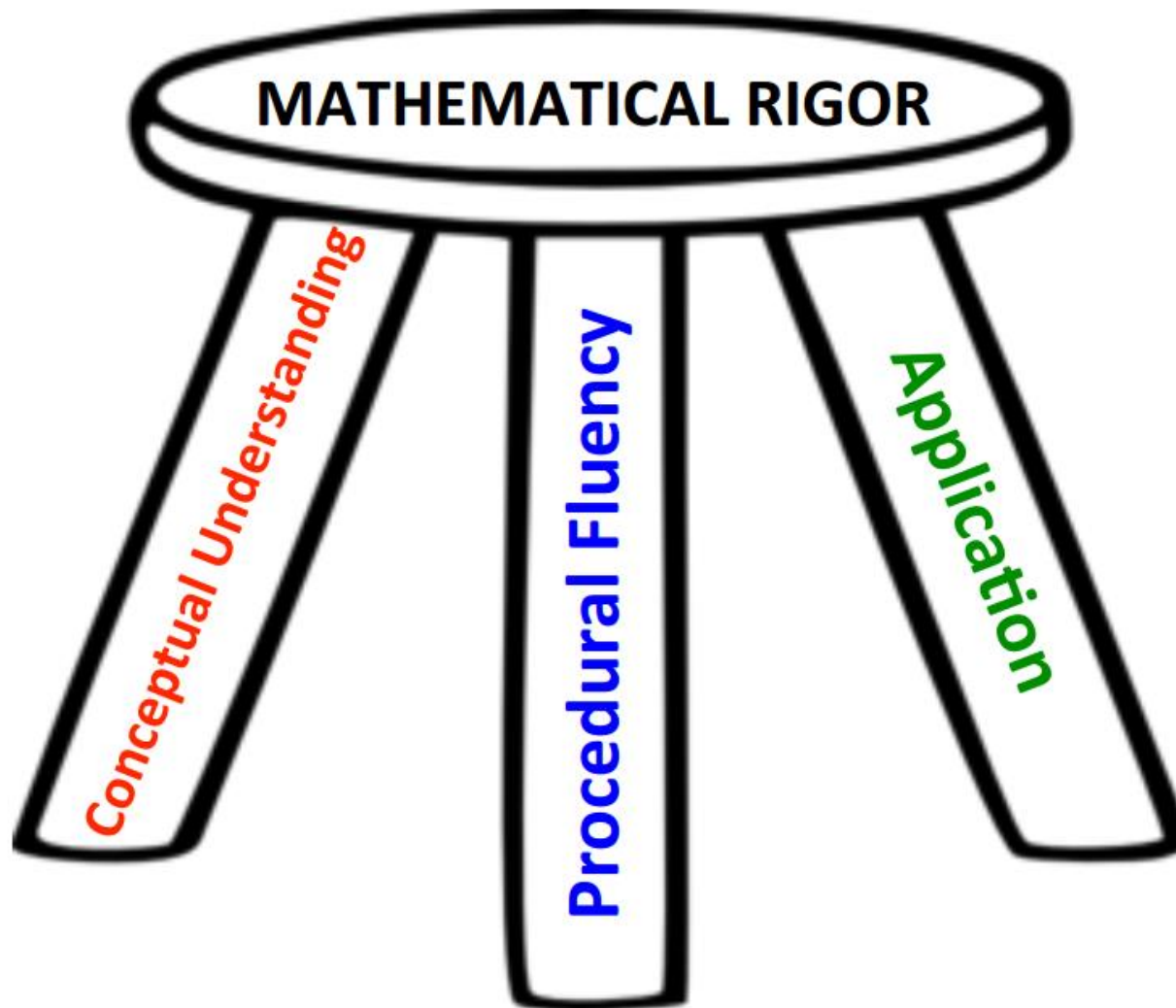


From WI DPI





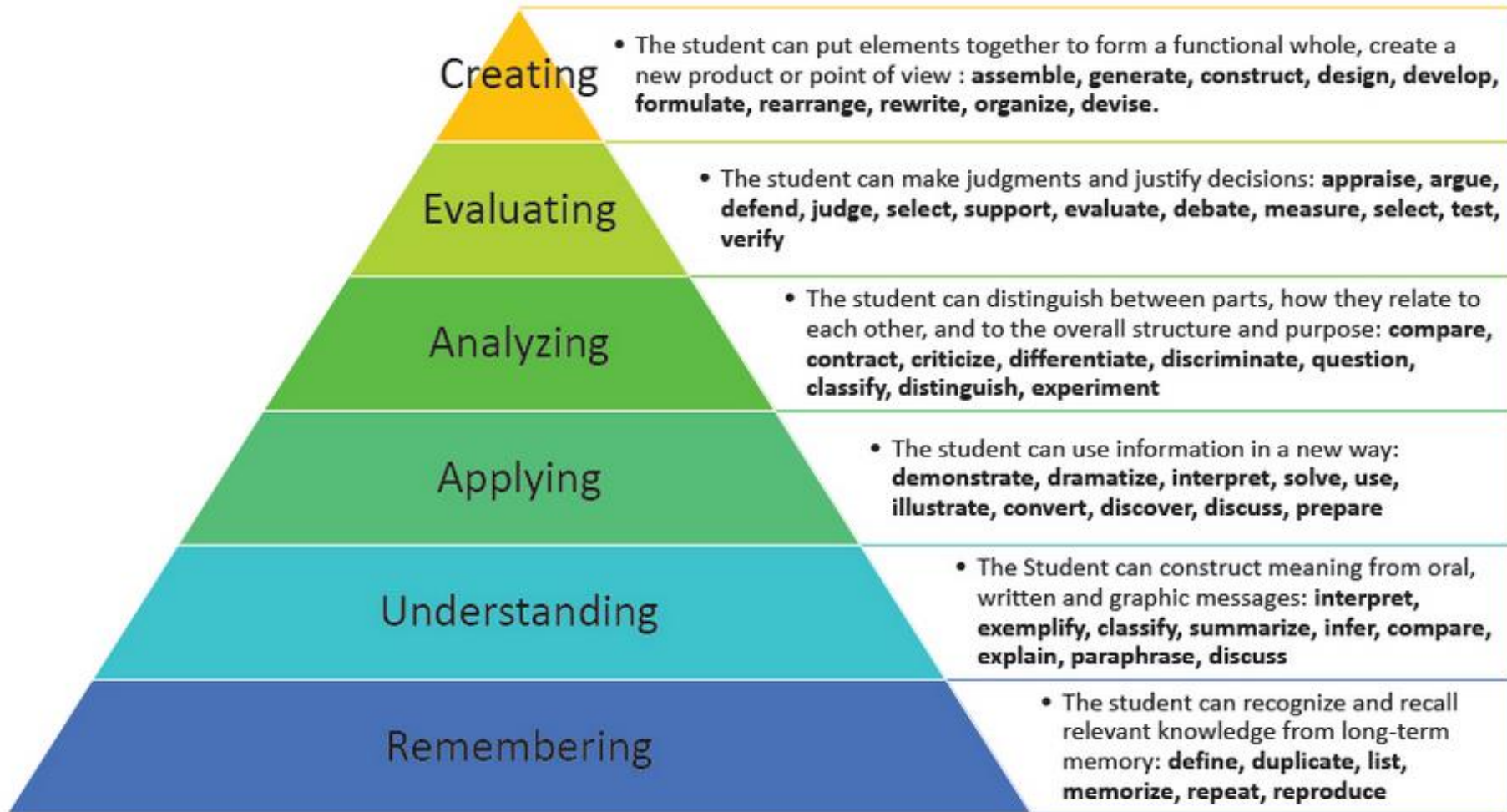
- Focus
- Coherence
- Rigor



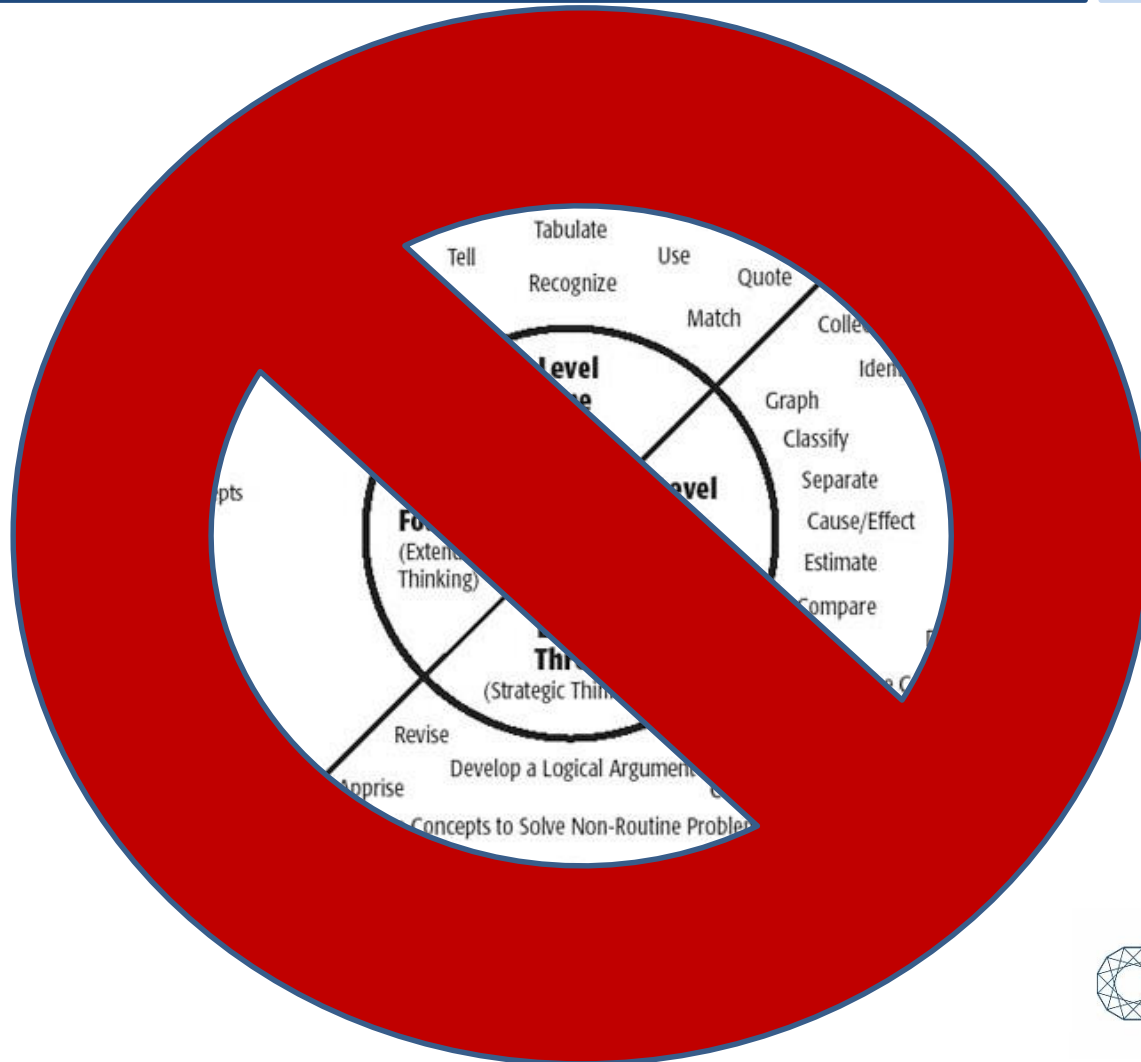
**MATHEMATICAL RIGOR - It's for ALL students**

# Building a Common Language

# Bloom's Revised Taxonomy



# DOK Wheel



# Webb's Depth of Knowledge (DOK)

*DOK categorizes tasks according to the complexity of thinking required to successfully complete them.*

**DOK Level 1:**

Recall

**DOK Level 2:**

Skills/Concept

**DOK Level 3:**

Strategic Thinking

**DOK Level 4:**

Extended Thinking

# Depth of Knowledge

**Level 1: Recall** – Recall of a fact, information or procedure.

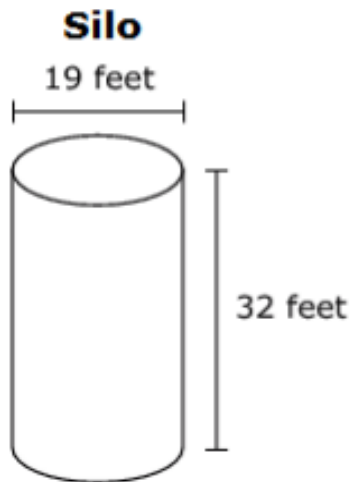
**Level 2: Skills/Concept** – Use information or conceptual knowledge, two or more steps, etc.

**Level 3: Strategic Thinking** – Requires reasoning, developing a plan or sequence of steps, some complexity, or non-routine, more than one possible answer.

**Level 4: Extended Thinking** – Requires an investigation, time to think and process multiple conditions of the problem.

Webb, 2015

An empty corn silo in the shape of a cylinder is being filled with corn.



The silo is filled at a constant rate for a total of 10 hours. The table shows the amount of corn, in cubic feet, in the silo at the given number of hours after filling started.

Number of Hours	Amount of Corn (cu ft)
0	0
3	2475
5	4125
8	6600

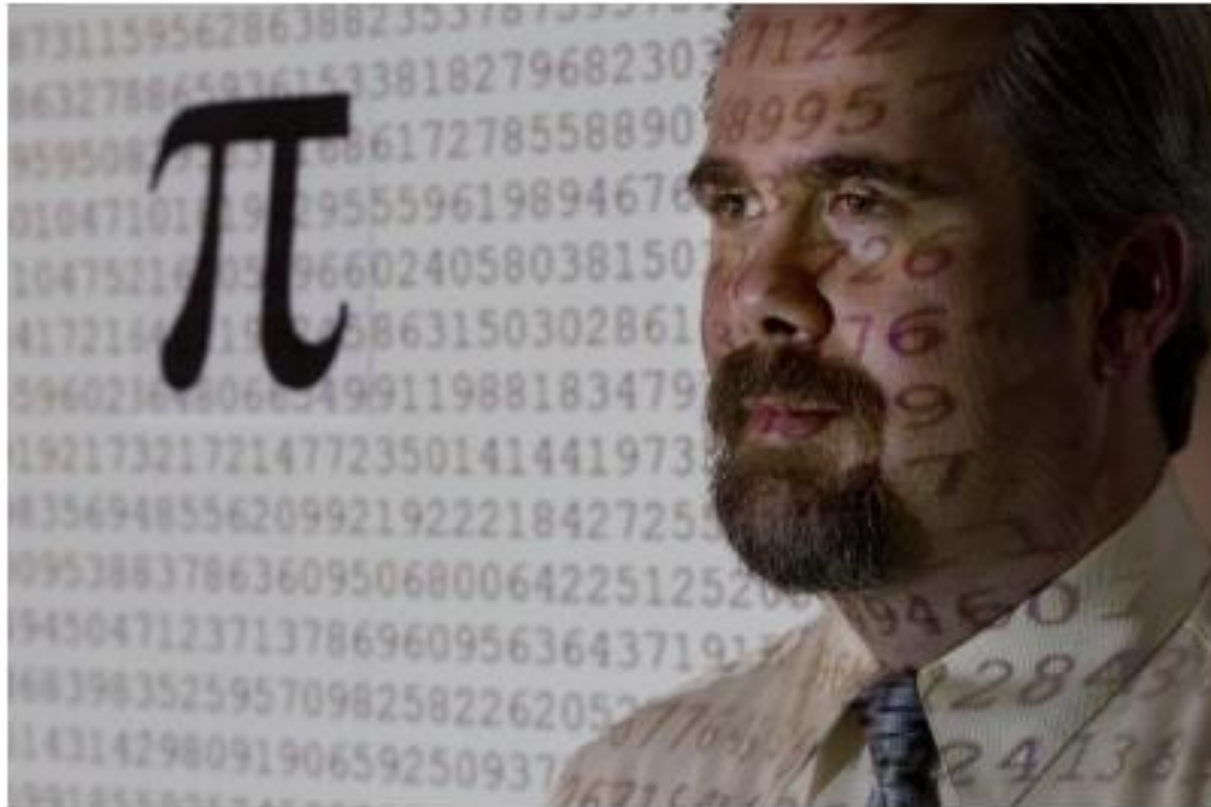
Enter the **percent** of the silo that is filled with corn at 10 hours.



Decide if each equation is true or false. Click True or False for each equation.

	True	False
$3 \times 6 = 18 \div 2$	<input type="checkbox"/>	<input type="checkbox"/>
$4 \times 9 = 36 \div 4$	<input type="checkbox"/>	<input type="checkbox"/>
$2 \times 5 = 20 \div 2$	<input type="checkbox"/>	<input type="checkbox"/>

# Difficult but not complex! Still a Level 1



MATT ROURKE/AS SOCIATED PRESS

**Marc Umile has recited pi to 12,887 digits.**

<http://www.nydailynews.com/news/national/geek-best-ways-celebrate-pi-day-article-1.1287969here>

# 3<sup>rd</sup> Grade Standards

## Operations and Algebraic Thinking (3.OA)

**Represent and solve problems involving multiplication and division.**

4. Determine the unknown whole number in a multiplication or division equation relating three whole numbers. *For example, determine the unknown number that makes the equation true in each of the equations  $8 \times ? = 48$ ,  $5 = ? \div 3$ ,  $6 \times 6 = ?$ .*

# 3<sup>rd</sup> Grade Standards

## Operations and Algebraic Thinking (3.OA)

**Understand properties of multiplication and the relationship between multiplication and division.**

5. Apply properties of operations as strategies to multiply and divide.<sup>2</sup> *Examples: If  $6 \times 4 = 24$  is known, then  $4 \times 6 = 24$  is also known. (Commutative property of multiplication.)  $3 \times 5 \times 2$  can be found by  $3 \times 5 = 15$ , then  $15 \times 2 = 30$ , or by  $5 \times 2 = 10$ , then  $3 \times 10 = 30$ . (Associative property of multiplication.) Knowing that  $8 \times 5 = 40$  and  $8 \times 2 = 16$ , one can find  $8 \times 7$  as  $(8 \times 5) + (8 \times 2) = 40 + 16 = 56$ . (Distributive property.)*

<sup>2</sup>Students need not use formal terms for these properties.

# Mathematics DOK Definitions

## **Individually:**

- Read DOK definitions

## **With a partner:**

- Compare Level 1 & Level 2
- Compare Level 2 & Level 3
- Use evidence from the definitions in your discussion

# Examining Standards & Objectives for DOK

Before we look at math tasks,  
we must consider the  
standards we are teaching  
and later assessing.



# Digging into Standards

## With a partner:

- Read the sample mathematics objectives.
- Determine DOK of each objective.
- Use **evidence** from the definitions.
- Compare your Levels to Webb and Associates

# Examining Sample Mathematics Assessment Items for DOK

If our instruction is designed around standards at different DOK Levels, then we should assess student learning at different DOK Levels.



# Digging into Assessment Items

## With a partner:

- Read sample assessment items 5, 6, 9.
- Determine DOK of each item.
- Use evidence from the definitions.
- If you have time discuss additional assessment items.

# Digging into Assessment Items

## **With a partner:**

- Compare your levels to Webb and Associates.
- Discuss any differences.
- Revisit definitions.

What does this mean for  
my practice?

# Tips from Webb

1. Clarify important learning outcomes and priorities.
2. Plan and deliver effective instruction.
3. Select and design appropriate assessments.
4. Align standards, instruction, and assessments.

Webb, 2015

# Assigning DOK Levels

## Key Considerations

- Collaboration is key
- Student experience matters
- DOK is not about verbs
- Difficult is not the same as complex
- Context does not guarantee rigor
- Align standards, instruction, assessment

# Big Ideas of DOK

- Levels are continuous **NOT** discrete
- DOK is **NOT** a progression
- Level numbers are **NOT** a value judgment
- **ALL** levels are important for **ALL** students
- Implementation is critical
- Definitions are specific to each discipline

# Reflections

As you think about going back to your district, in what ways will you support teachers to assure that student assessments reflect the depth of knowledge of the standards?



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define and quantify mathematical rigor using Webb's Depth of Knowledge.



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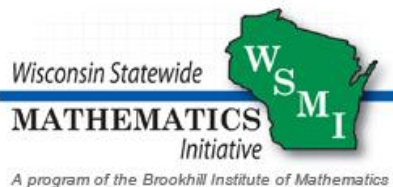
## MISSION STATEMENT

*Our mission is to provide K-12 teachers and higher education the opportunity to participate, collaborate, develop, and improve the teaching of mathematics.*

## UPCOMING EVENTS

Jan 11, 2016  
DPI H.S. Work Group

# www.wsmi.net



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DEVELOPMENT

APPLICATIONS AND  
REGISTRATION

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SPECIALIST (EMS)

RESOURCES

CAREERS



Establish a sustainable, statewide effort for high quality mathematics education and learning!

## Sign Up for WSMI Updates

First name \*

Last name \*

Email address \*

Organization/School/District \*

Sign Up

# Module Content

- K-2: Operations and Algebraic Thinking
- K-2: Number and Operations in Base Ten
- 3-5: Operations and Algebraic Thinking
- 3-5: Number and Operations Fractions
- 6-8: Ratios and Proportional Relationships
- 6-8: Expressions and Equations
- 6-8: Statistics
- 9-12: Statistics and Probability for ALL High School Mathematics Teachers
- 8-12: Algebra and Functions with Modeling

# WSMI Institutes

K-2 Operations and Algebraic Thinking  
and  
3-5 Operations and Algebraic Thinking  
are CLOSED at Greendale and  
Sauk Prairie!

3-5 Operations and Algebraic Thinking  
And  
6-8 Expressions and Equations  
are CLOSED at New London!

## Summer 2016

CESA 3

June 20-24

West Salem  
New London

July 11-15

Sauk Prairie

July 18-22

DC Everest  
Greendale

August 1-5

Thank you!

# Mathematics Program Specialists

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