Mathematics Considerations for Students with Dyslexia

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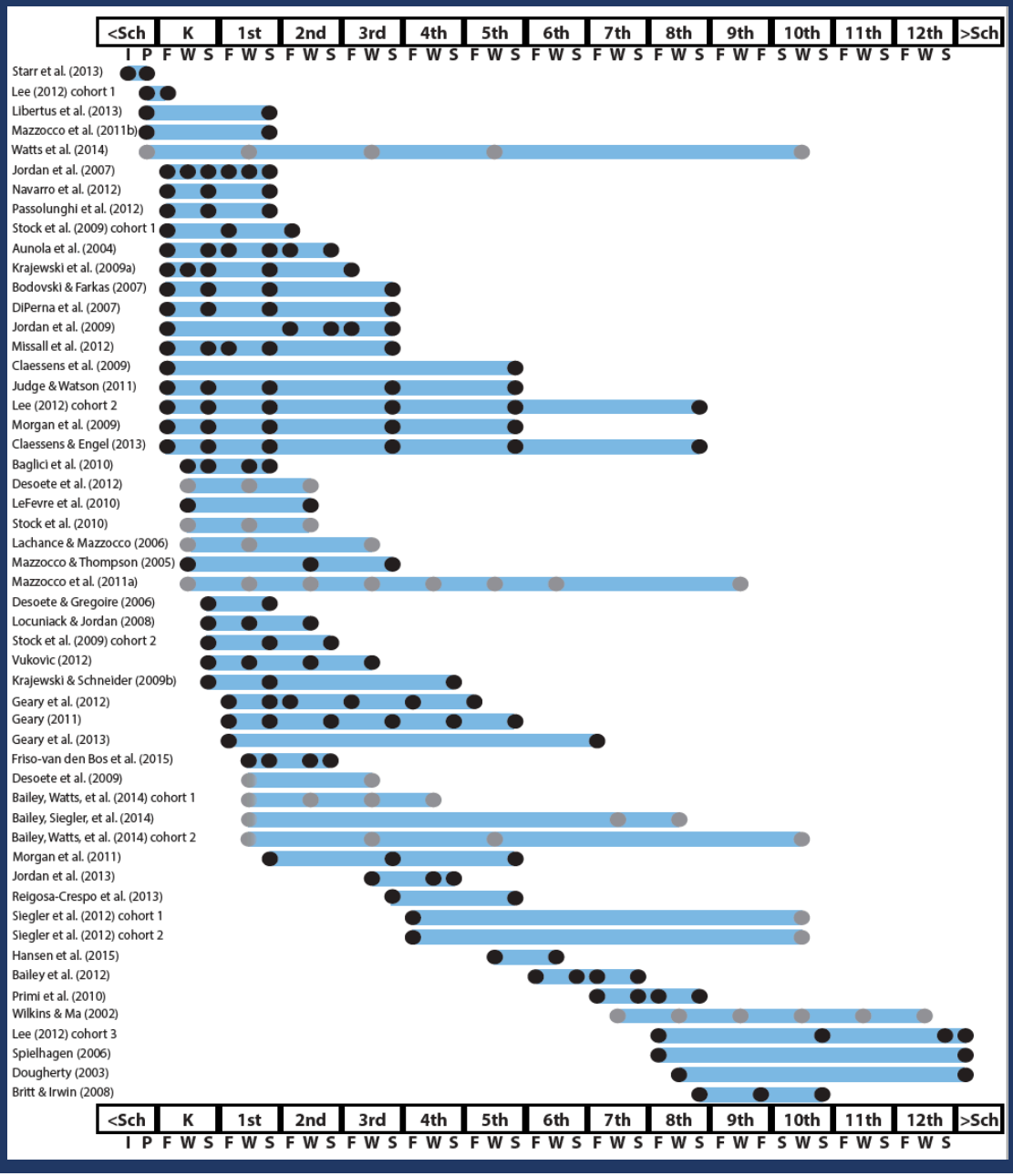
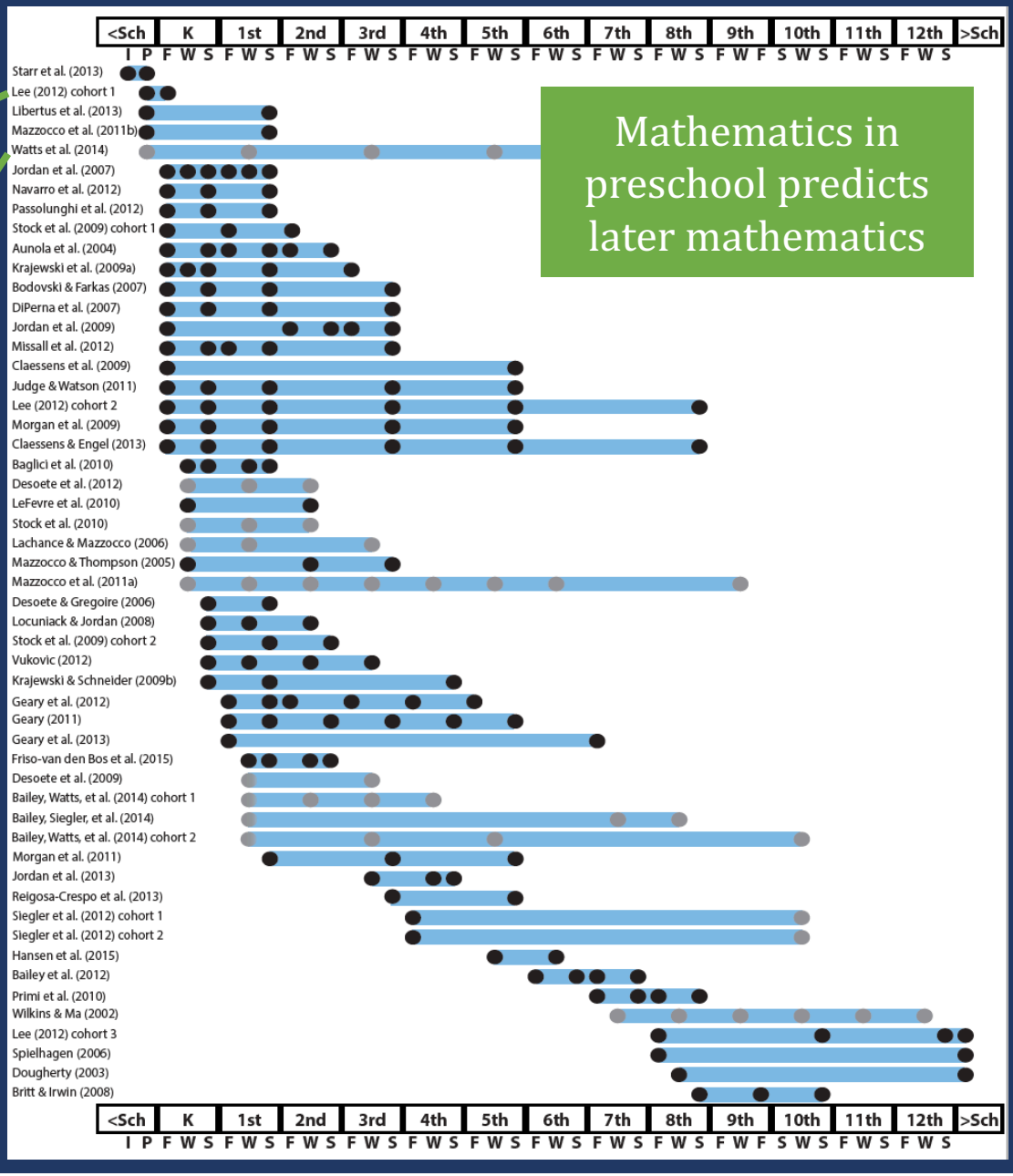


http://www.greatertexasfoundation.org/trajectories-of-mathematics-performance/

Broad math in preK predicted K broad math

Broad math in preK predicted grade 10 broad math



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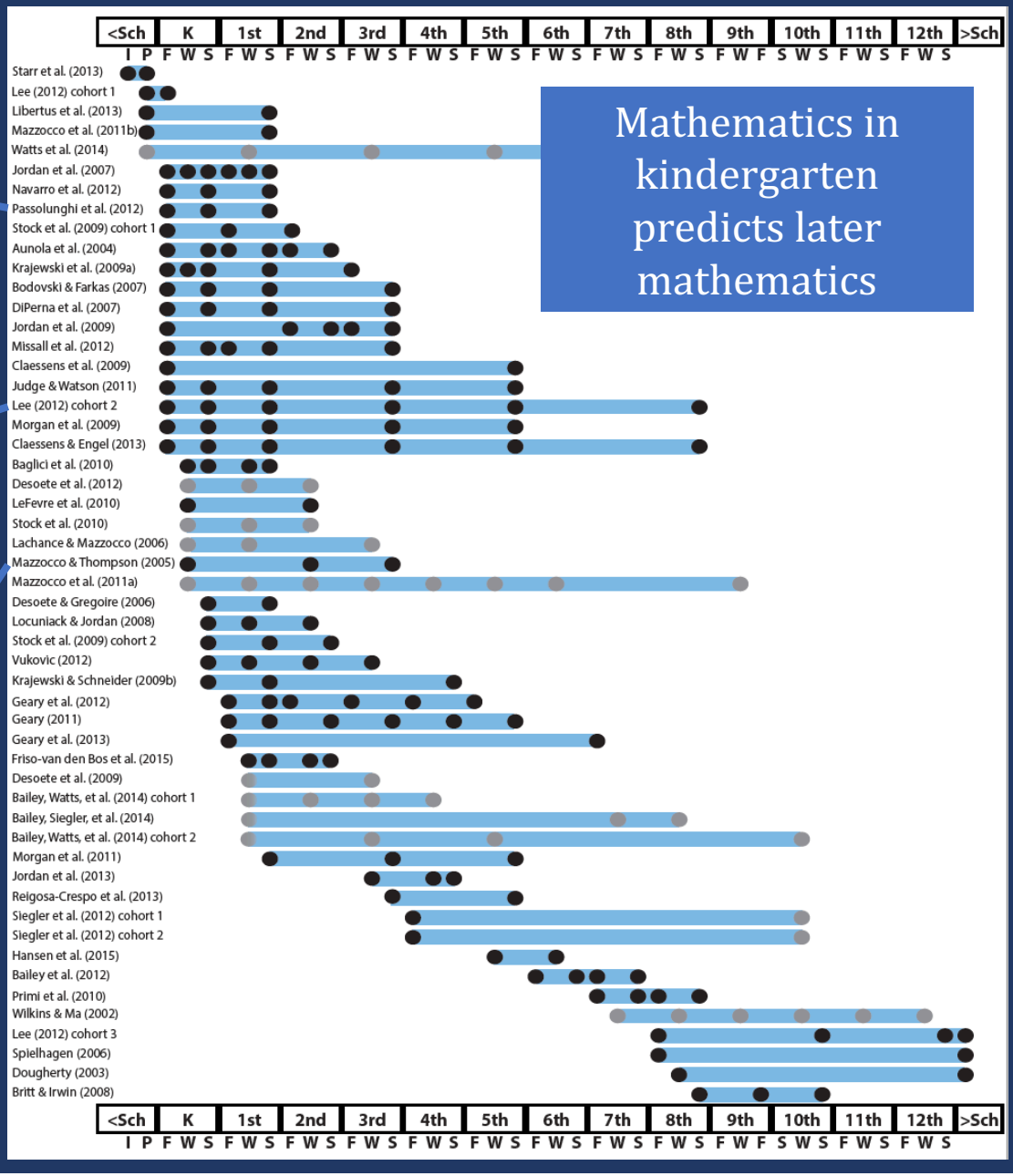
Counting in K predicted grade 1 broad math

Broad math in K predicted grade 8 broad math

K math accurately predicted math performance below 10th percentile in grades 2 and 3 with 84% correct classification



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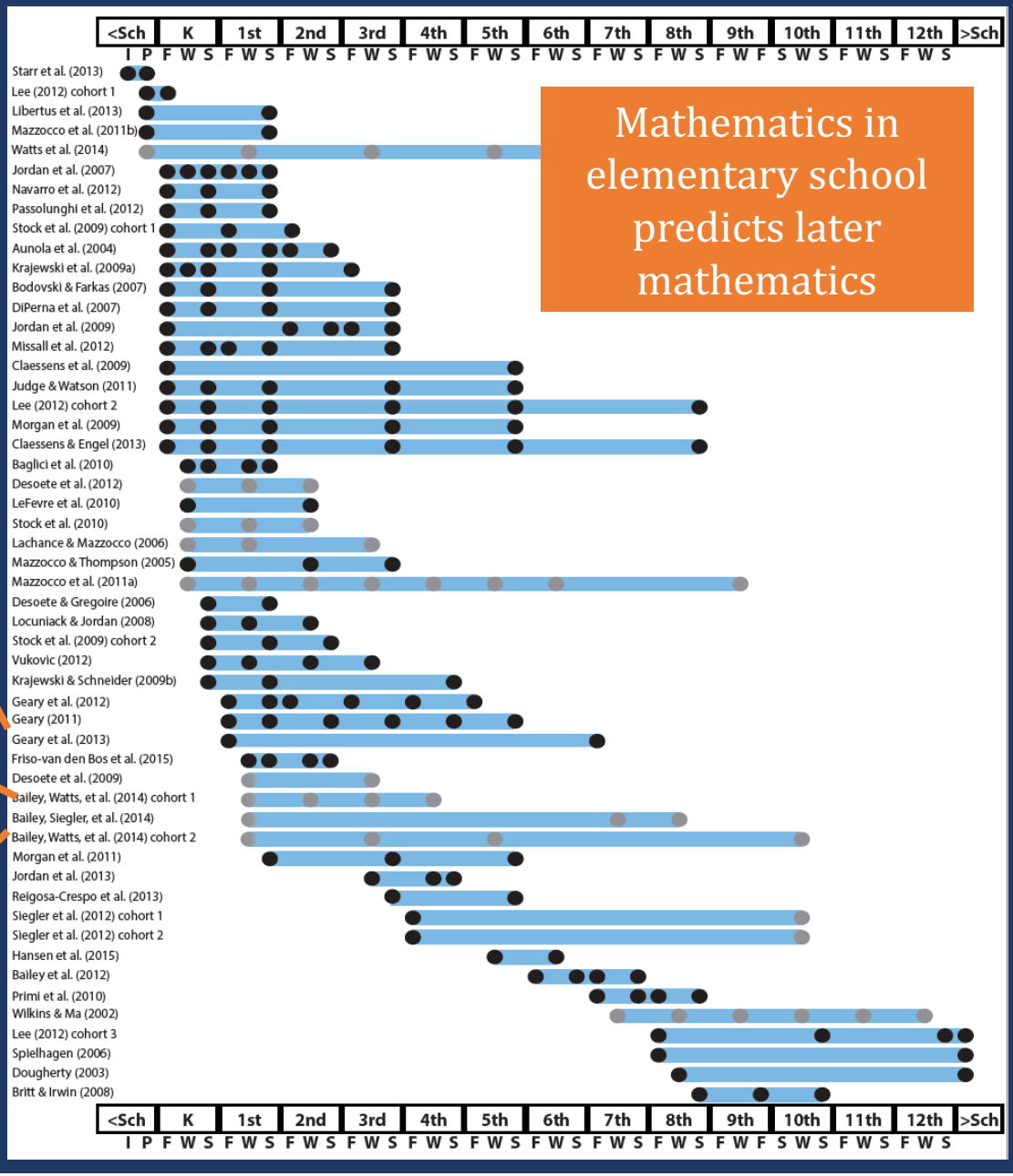
Addition influenced arithmetic with increasing importance from grades 1 to 5

Grade 1 arithmetic predicted arithmetic at grades 2, 3, and 4

Grade 1 broad math predicted broad math at grades 3, 5, and 10



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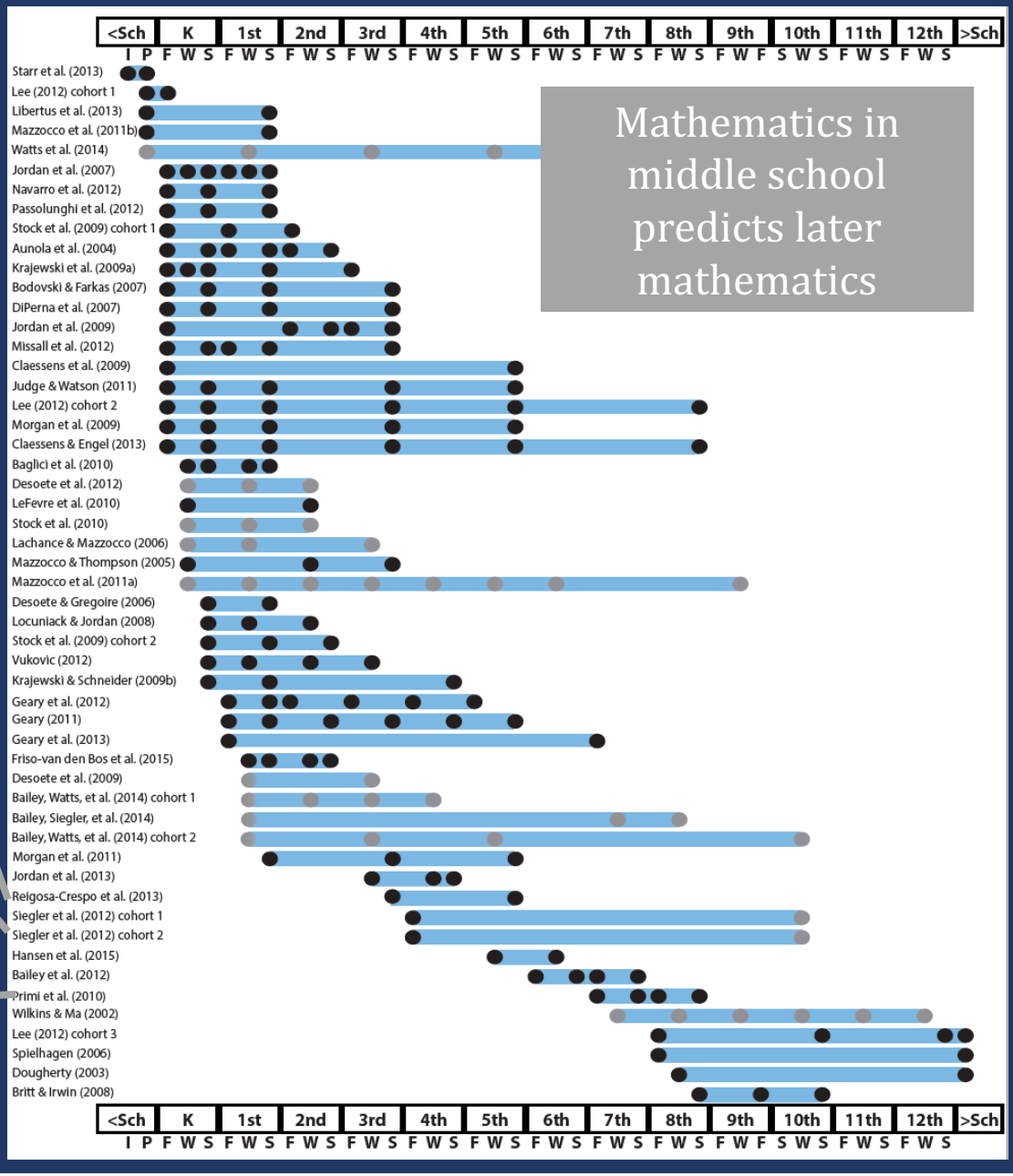
Counting and comparison in grades 2 or 4 predicted broad math 1 year later

Fractions at 10-12 years old predicted broad math 5 years later

Broad math in grade 7 predicted broad math in grade 8



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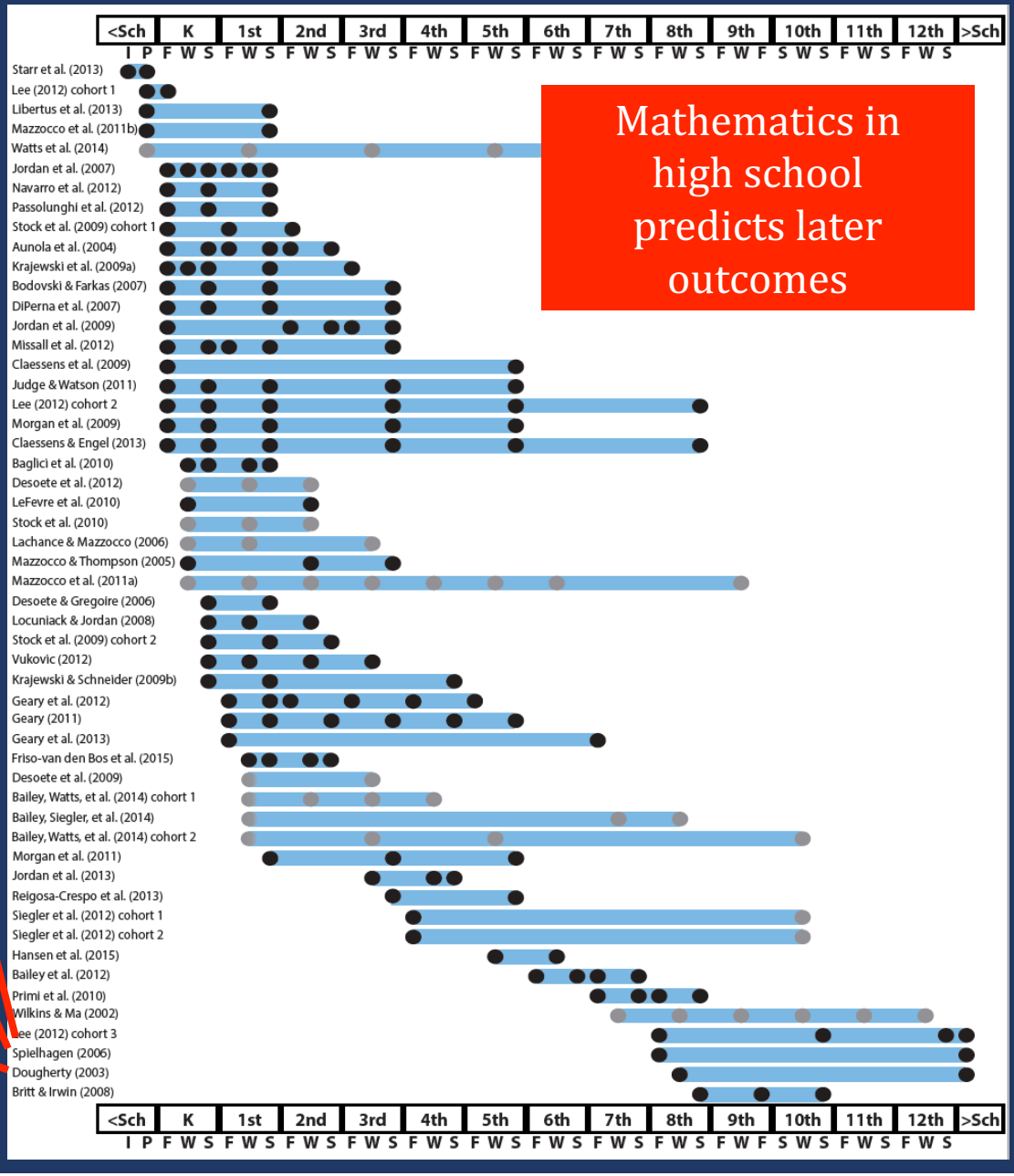
Broad math in grade 8 predicted completion of 4-year college degree

Students who took algebra in grades 8 took more advanced math courses and enrolled in 4-year colleges more often than students who took algebra in grade 9

Numeracy measured in adolescence impacted hourly earnings 7 to 15 years later



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Mathematics in preschool predicts later mathematics

Mathematics in kindergarten predicts later mathematics

Mathematics in elementary school predicts later mathematics

Mathematics in middle school predicts later mathematics

Mathematics in high school predicts later outcomes

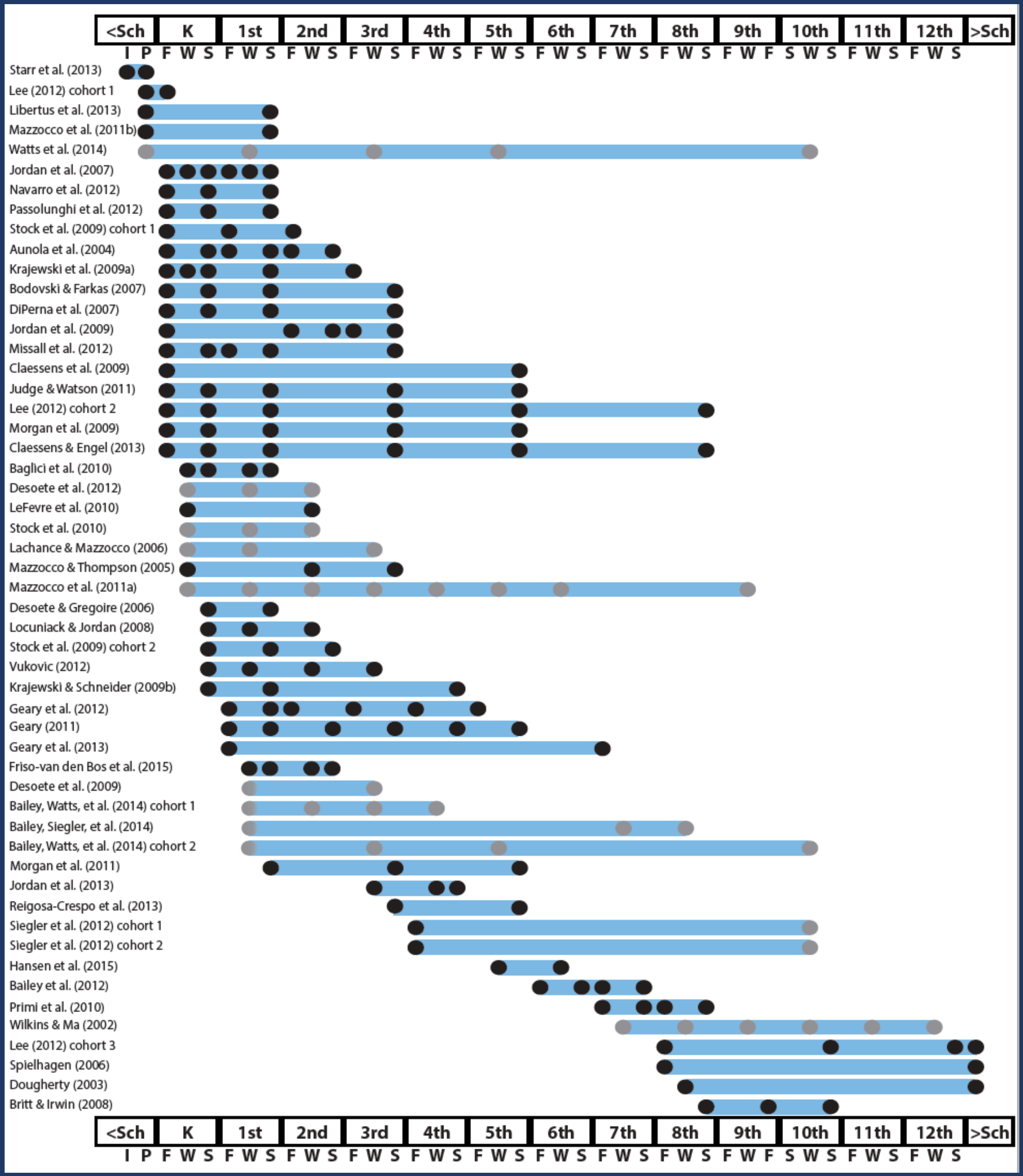

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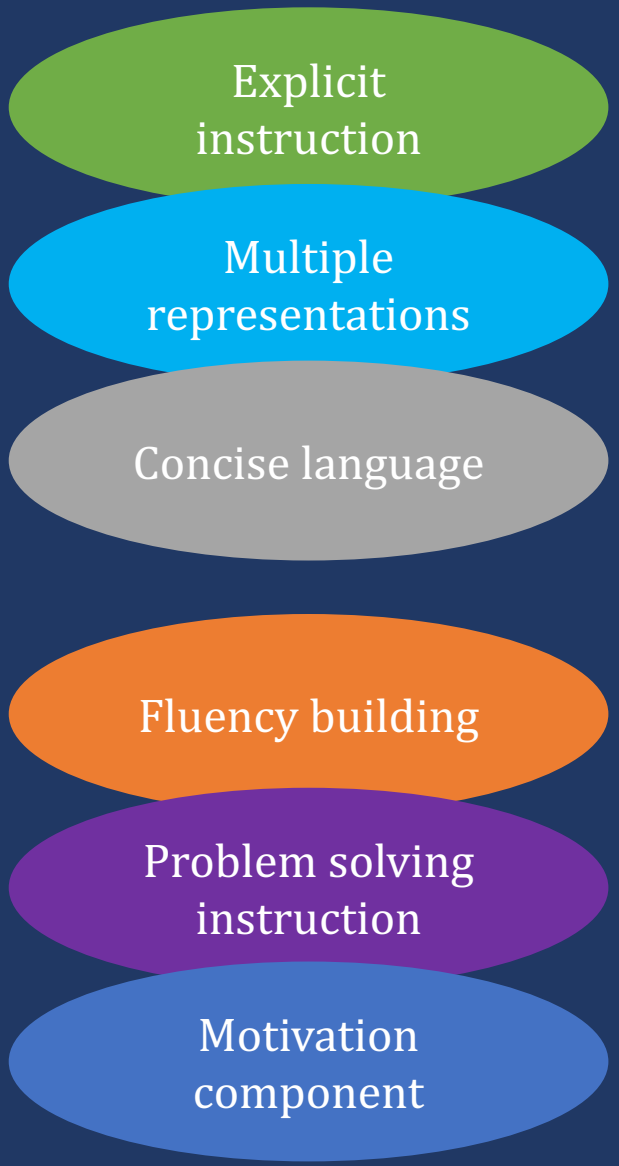
Table 2. Recommendations and corresponding levels of evidence

Recommendation	Level of evidence
Tier 1	
1. Screen all students to identify those at risk for potential mathematics difficulties and provide interventions to students identified as at risk.	**Moderate**
Tiers 2 and 3	
2. Instructional materials for students receiving interventions should focus intensely on in-depth treatment of whole numbers in kindergarten through grade 5 and on rational numbers in grades 4 through 8. These materials should be selected by committee.	**Low**
3. Instruction during the intervention should be explicit and systematic. This includes providing models of proficient problem solving, verbalization of thought processes, guided practice, corrective feedback, and frequent cumulative review.	**Strong**
4. Interventions should include instruction on solving word problems that is based on common underlying structures.	**Strong**
5. Intervention materials should include opportunities for students to work with visual representations of mathematical ideas and interventionists should be proficient in the use of visual representations of mathematical ideas.	**Moderate**
6. Interventions at all grade levels should devote about 10 minutes in each session to building fluent retrieval of basic arithmetic facts.	**Moderate**
7. Monitor the progress of students receiving supplemental instruction and other students who are at risk.	**Low**
8. Include motivational strategies in tier 2 and tier 3 interventions.	**Low**

Source: Authors' compilation based on analysis described in text.

Gersten et al. (2009)



Explicit instruction

Explicit Instruction

I Do

Modeling	Practice	
Clear Explanation	Guided Practice	We Do
Planned Examples	Independent Practice	You Do

Supporting Practices

- Asking the right questions
- Eliciting frequent responses
- Providing immediate specific feedback
- Maintaining a brisk pace

Goal and importance

I Do

Modeling

Clear Explanation

Planned Examples

"Today, we are learning about division. This is important because sometimes you have to share objects or things with your friends."

"Let's continue working with our three-dimensional shapes and volume. Understanding volume and calculating volume helps with measuring capacity."

I Do

Modeling

Clear Explanation

Planned Examples

Goal and importance

Model steps

"To solve 26 plus 79, I first decide about the operation. Do I add, subtract, multiply or divide?"

"The plus sign tells me to add. So, I'll add 26 plus 79. I'll use the partial sums strategy. First, I add 20 plus 70. What's 20 plus 70?"

"20 plus 70 is 90. I write 90 right here."

"Then I add 6 plus 7. What's 6 plus 7?"

"6 plus 7 is 13. So, I write 13 here."

"Finally, we add the partial sums: 90 and 13. 90 plus 13 is 103. So, 26 plus 79 equals 103."

I Do

Modeling

Clear Explanation

Planned Examples

Goal and importance

Model steps

Concise language

"To solve 26 plus 79, I first decide about the operation. Do I add, subtract, multiply or divide?"

"The plus sign tells me to add. So, I'll add 26 plus 79. I'll use the partial sums strategy. First, I add 20 plus 70. What's 20 plus 70?"

"20 plus 70 is 90. I write 90 right here."

"Then I add 6 plus 7. What's 6 plus 7?"

"6 plus 7 is 13. So, I write 13 here."

"Finally, we add the partial sums: 90 and 13. 90 plus 13 is 103. So, 26 plus 79 equals 103."

Examples

I Do

Modeling

Clear Explanation

Planned Examples

"Today, we are learning about division. This is important because sometimes you have to share objects or things with your friends."

$24 / 6$ $28 \div 7$ $35 \overline{)\,5}$

I Do

Modeling

Clear Explanation

Planned Examples

Examples

"Today, we are learning about division. This is important because sometimes you have to share objects or things with your friends."

$24 / 6$ $28 \div 7$ $35 \overline{)\,5}$

Non-examples

$32 \div 8$ $42 \div 7$ $25 - 5$

Explicit Instruction

I Do

Modeling	Practice	
Clear Explanation	Guided Practice	We Do
Planned Examples	Independent Practice	You Do

Supporting Practices

- Asking the right questions
- Eliciting frequent responses
- Providing immediate specific feedback
- Maintaining a brisk pace

Practice

Guided Practice — We Do

Independent Practice — You Do

Teacher and student practice together

Practice

Guided Practice

We Do

Independent Practice

You Do

Practice

Guided Practice

We Do

Teacher and student practice together

Independent Practice

You Do

Student practices with teacher support

Explicit Instruction

I Do

Modeling	Practice	
Clear Explanation	Guided Practice	We Do
Planned Examples	Independent Practice	You Do

Supporting Practices

- Asking the right questions
- Eliciting frequent responses
- Providing immediate specific feedback
- Maintaining a brisk pace

Supporting Practices

- Asking the right questions
- Eliciting frequent responses
- Providing immediate specific feedback
- Maintaining a brisk pace

Supporting Practices

- Asking the right questions
- Eliciting frequent responses
- Providing immediate specific feedback
- Maintaining a brisk pace

Low-level and high-level

"What is 7 times 9?"

"Which shape has 6 sides?"

"What do you do when you see a word problem?"

"Why do you have to regroup?"

"How would you solve this problem?"

"Why do you have to use zero pairs?"

Supporting Practices

- Asking the right questions
- Eliciting frequent responses
- Providing immediate specific feedback
- Maintaining a brisk pace

Low-level and high-level

Classwide, individual, partner, write on paper, write on whiteboard, thumbs up, etc.

"Turn and discuss the formula for perimeter with your partner."

"Write the multiplication problem on your whiteboard."

"In your math journal, draw a picture to help you remember to term *parallelogram*."

Supporting Practices

- Asking the right questions
- Eliciting frequent responses
- Providing immediate specific feedback
- Maintaining a brisk pace

Low-level and high-level

Classwide, individual, partner, write on paper, write on whiteboard, thumbs up, etc.

Affirmative and corrective

"Good work using your word-problem attack strategy."

"Let's look at that again. Tell me how you added in the hundreds column."

Supporting Practices

- Asking the right questions
- Eliciting frequent responses
- Providing immediate specific feedback
- Maintaining a brisk pace

Low-level and high-level

Classwide, individual, partner, write on paper, write on whiteboard, thumbs up, etc.

Affirmative and corrective

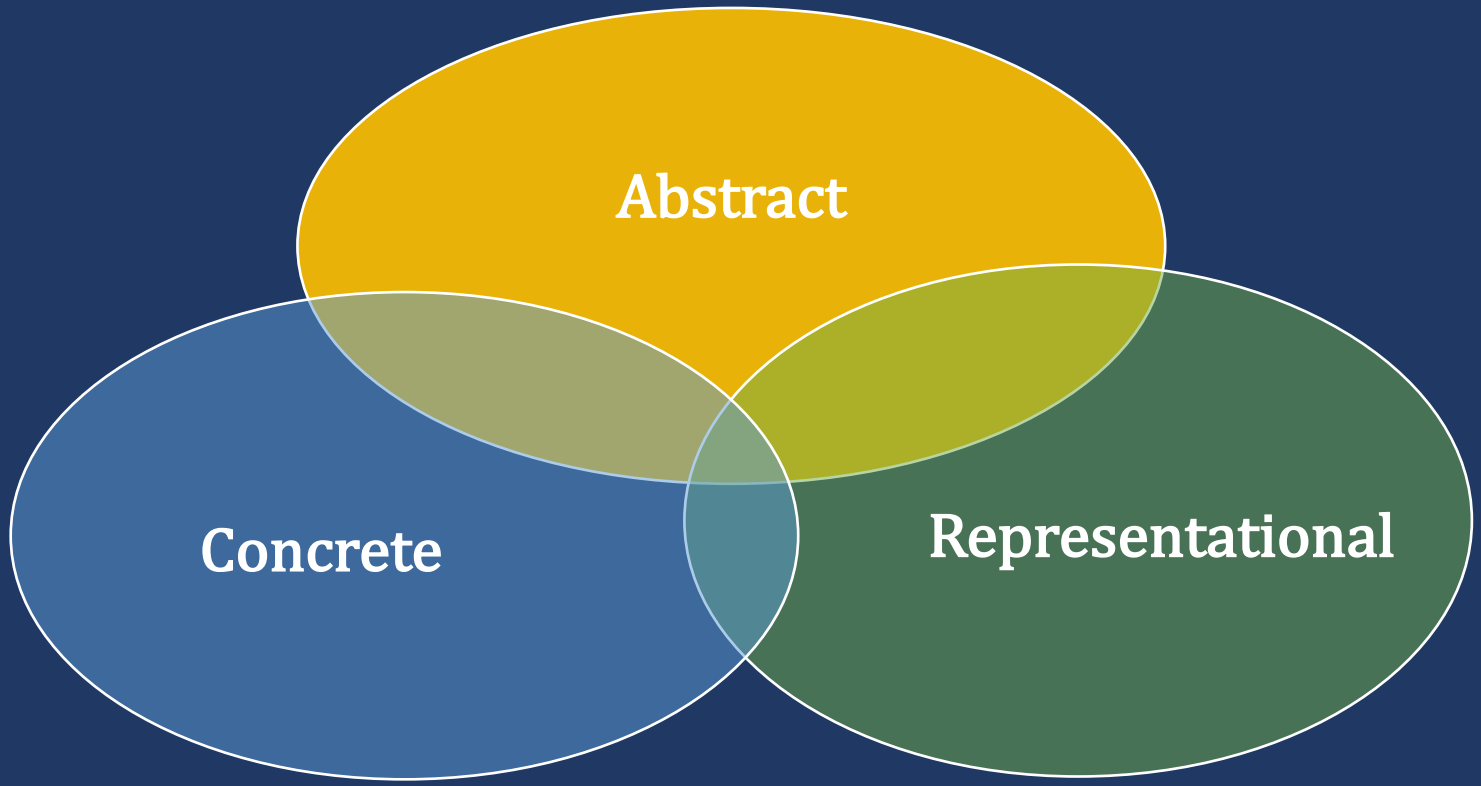
Planned and organized

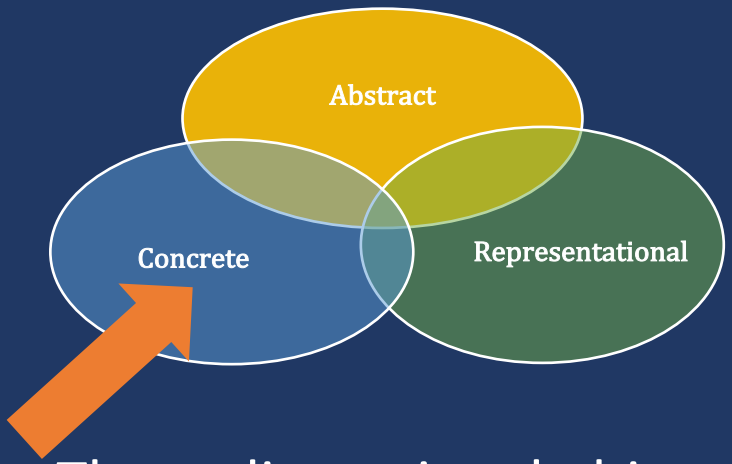
Introduction of material

Review of material

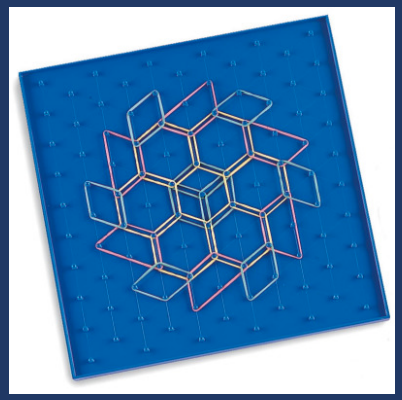
Multiple representations

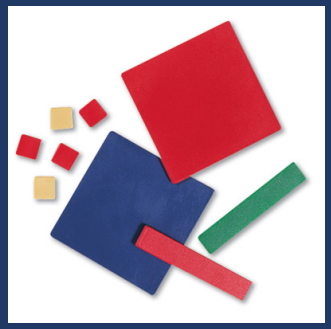
Multiple Representations

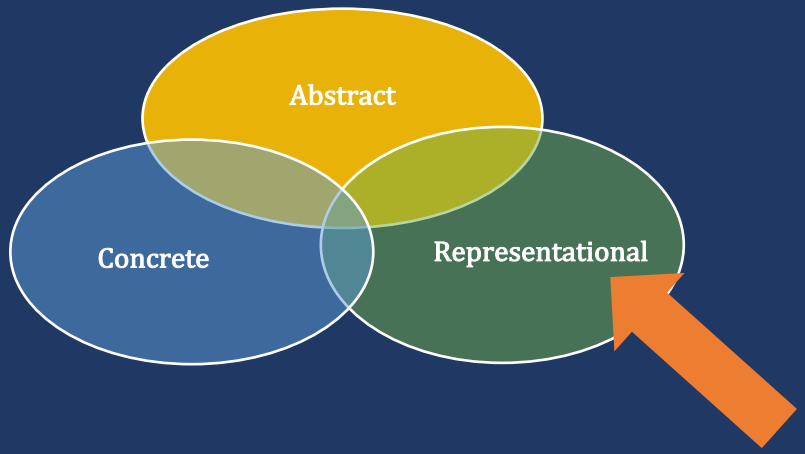


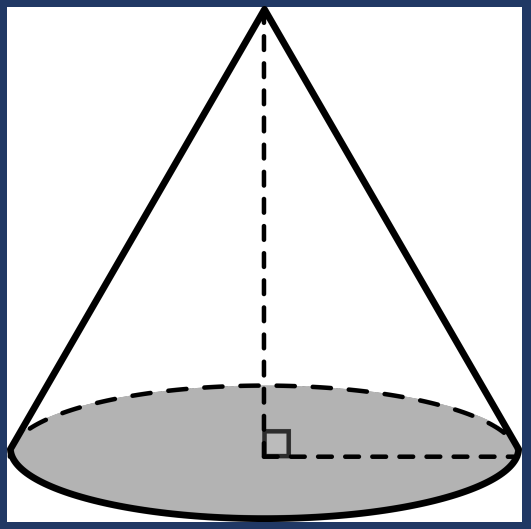


Three-dimensional objects

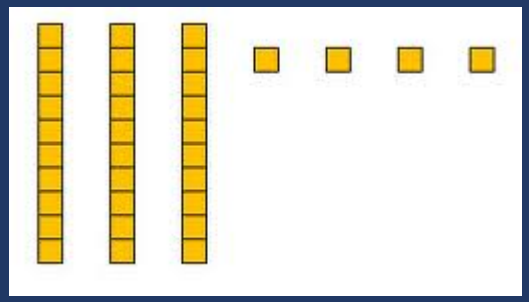


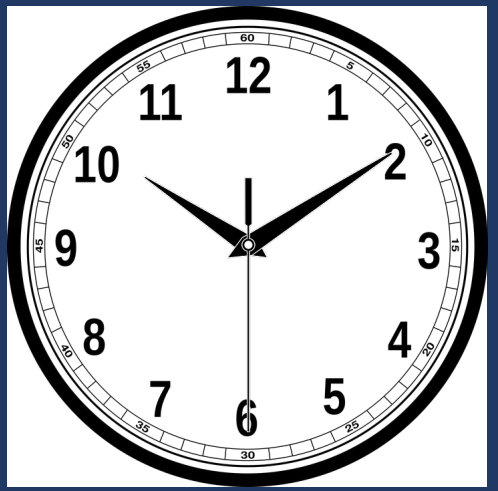


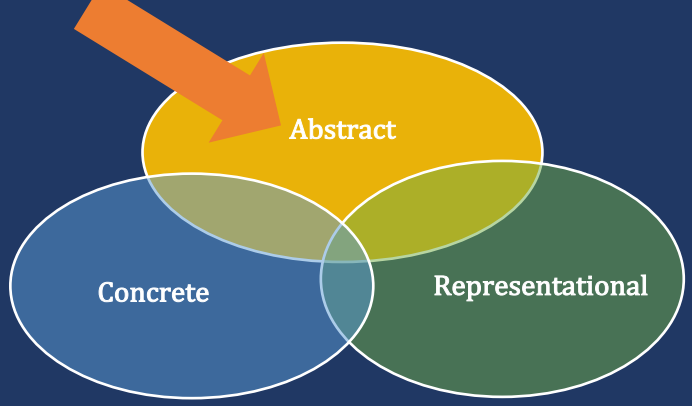




Two-dimensional images







Numerals and symbols

$2 + 8 = 10$

$34 = 3$ tens and 4 ones

$x - 6 = 8$

$$\begin{array}{r} 4{,}179 \\ +\ \ 569 \\ \hline \end{array}$$

Concise language

Confusion with Mathematical Language

- Homonyms

left

base

square

round

mean

- Homophones

pie
pi

some
sum

rows
rose

ate
eight

Language of Mathematics

- Technical terms

trapezoid	rhombus	numerator	addend	subtract

- Subtechnical terms

base	degrees	cube	plane	arc

- Symbolic terms

plus	zero	twelve	dollars	and

- General terms

above	measure	answer	longest	outside

Instead of…	Say…
"And the last one is 10."	"8, 9, 10. We'll stop counting there but we could count more."
"What number is in the tens place?"	"What digit is in the tens place?"
"Six hundred and forty-eight"	"Six hundred forty-eight"
"Bigger number and smaller number"	"Number that is greater and the number that is less"

Hughes et al. (2016)

Instead of…	Say…
“Numbers in the fraction”	“This fraction is one number.”
“Top number and bottom number”	“Numerator and denominator”
“Reduce”	“Find an equivalent fraction”
“One point two nine”	“One and twenty-nine hundredths”

Hughes et al. (2016)

Instead of…	Say…
“Corner”	“Angle”
“Flips, slides, and turns”	“Reflections, translations, and rotations”
“Box or ball	“Cube or sphere”
“Long hand and short hand”	“Minute hand and hour hand”

Hughes et al. (2016)

precise

"The denominator is the number of equal parts that make the whole."

"A difference problem is two amounts compared for the difference."

concise

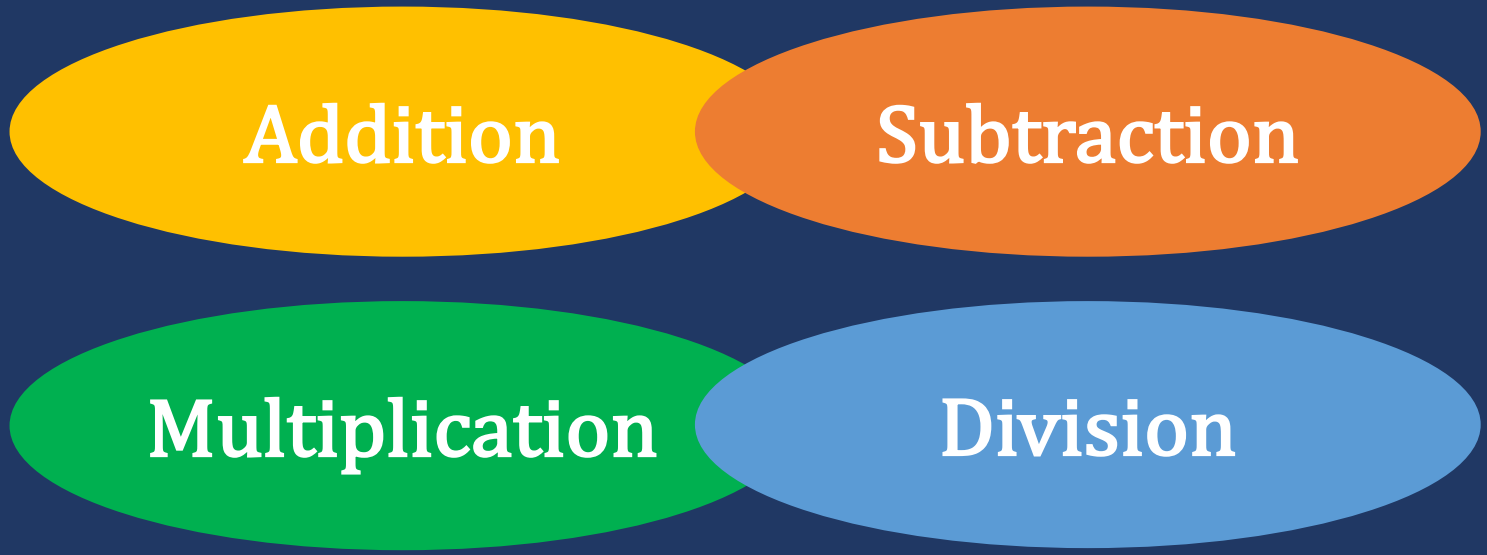
"To show the fraction, look at the denominator. A denominator of 5 means I need to break the whole into 5 equal parts."

"To use partial sums, add the hundreds, then add the tens, then add the ones. Finally, add all the partial sums."

Fluency building

Facts

There are 390 facts.



Why Emphasize the Facts?

Lack of mastery of basic facts influences higher-level mathematics performance and confidence with mathematics

Addition

100 addition basic facts

- Single-digit addends sum to a single- or double-digit number

	5	**(addend)**
+	4	**(addend)**
	9	**(sum)**

Subtraction

100 subtraction basic facts

- Subtrahend and difference are single-digit numbers and minuend is single- or double-digit number

$$\begin{array}{rr} & 16 \\ - & 8 \\ \hline & 8 \end{array}$$

(minuend)

(subtrahend)

(difference)

Multiplication

100 multiplication basic facts

- Multiplication of single-digit factors results in a single- or double-digit product

	2	**(factor)**
×	3	**(factor)**
	6	**(product)**

Division

90 division basic facts

- Divisor and quotient are single-digit numbers and dividend is single- or double-digit number

8	÷	4	=	2
(dividend)		**(divisor)**		**(quotient)**

Instruction on the Facts

1. Students must understand the **concepts** of addition and subtraction
2. Students should learn and use **strategies** to solve the facts
3. Students should develop **fluency** with facts

2. Students should learn and use strategies to solve the facts

$4 + 3 = \_$

$9 + 2 = \_$

$6 + 8 = \_$

COUNTING UP
Addition

1. Put the greater number in your fist and say it.
2. Count up the other number on your fingers.
3. Your answer is the last number you say.

2. Students should learn and use strategies to solve the facts

$5 - 3 = \_\_$

$11 - 7 = \_\_$

$15 - 9 = \_\_$

COUNTING UP
Subtraction

1. Put the minus number in your fist and say it.
2. Count up your fingers to the number you start with.
3. Your answer is the number of fingers you have up.

Problem solving instruction

Mr. Conley delivers packages. The bar graph shows the total number of packages he delivered on five days last week.

6. Part A

What is the total number of packages Mr. Conley delivered on Monday and Tuesday?

Ⓐ 300

Ⓑ 340

Ⓒ 350

Ⓓ 360

Reading the problem

Understanding *vocabulary*

Identifying *relevant* information

Ignoring *irrelevant* information

Interpreting *charts and graphs*

Identifying appropriate *operation*

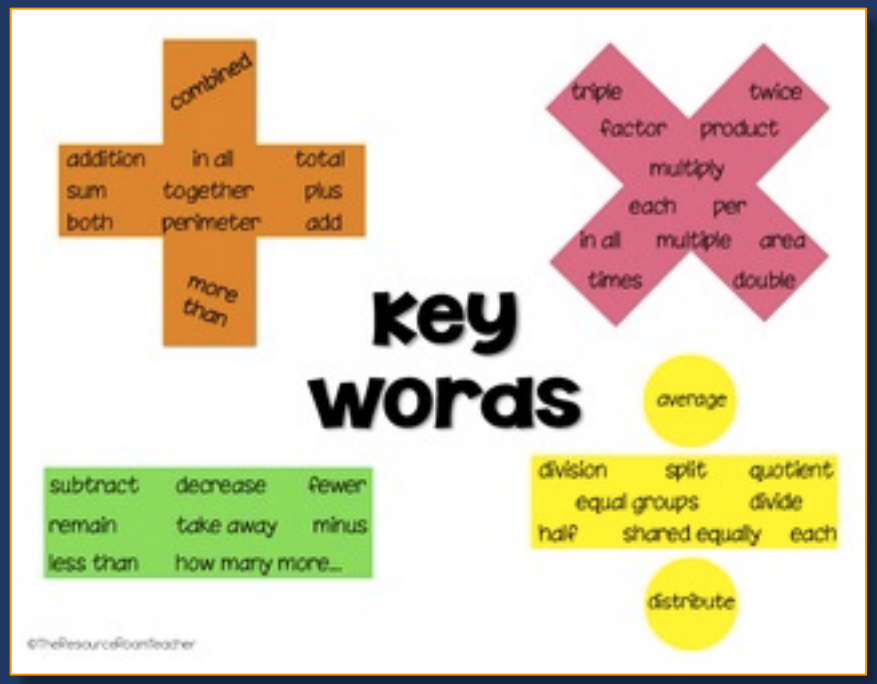
Performing *computations*

PARCC third-grade release item (2015)

How Should We Teach Problem Solving?

1. **Don't** use key words tied to operations
2. **Do** teach students an *attack strategy*
3. **Do** teach students *schemas*

1. Don't use key words tied to operations



1. Don't use key words tied to operations

Addition
Sum
Plus
And
Total
Increase
More
Raise
Combined
In all
Altogether
Extra

Kasey made $42, and Mandy made $37. How much money did they make **altogether**?

Kasey and Mandy made $79 **altogether**. If Kasey made $42, how much money did Mandy make?

1. Don't use key words tied to operations

Becky has $70 **more than** Perla. If Becky has $120, how much money does Perla have?

Becky has $70 **more than** Perla. If Perla has $50, how much money does Becky have?

Subtraction
More than
Less than
Decrease
Difference
Reduce
Change
Left
Remain
Dropped
Lost
Nearer

1. Don't use key words tied to operations

Multiplication
Product
Of
Multiplied
Times
As much
Lost
By
Twice
Multiplication
Product
Of

Matt baked 18 cookies. His brother baked **twice** as many. How many cookies did his brother bake?

Matt's brother baked **twice** as many cookies as Matt. If Matt's brother baked 36 cookies, how many did Matt bake?

1. Don't use key words tied to operations

Rachel wants to **share** 36 brownies with 6 friends. How many cookies will **each** friend receive?

Rachel **shared** brownies with 6 friends. **Each** friend ate 6 brownies. How many brownies did Rachel have to start with?

Division
Divide
Evenly
Cut
Split
Each
Every
Out of
Shared
Average
Ratio
Quotient

Note:

Students need to understand *key words*. But, key words should not be directly tied to *operations*.

2. Do teach students an *attack strategy*

Regardless of the word problem (i.e., routine word problems, instructional word problems), students need an ***attack strategy*** for working through the problem.

Carol plays a ball game. She gets 7 points each time her ball hits a target. If she hits the target at least 5 times in a row, she gets an extra 25 points.

What is the total number of points Carol gets if she hits the target 5 times in a row?

Enter your answer in the box.

Which **two** statements can be represented by the expression 4×8?

Ⓐ A teacher puts 8 chairs at each of 4 tables.

Ⓑ Tom buys 4 red markers and 8 black markers.

Ⓒ Marie shares her 8 marbles equally among 4 friends.

Ⓓ There are 4 rows of flowers. There are 8 flowers in each row.

Ⓔ There are 8 ducks in the pond. Then, 4 more ducks join them.

PARCC third-grade release items (2015)

2. Do teach students an *attack strategy*

UPSCheck

Understand
Plan
Solve
Check

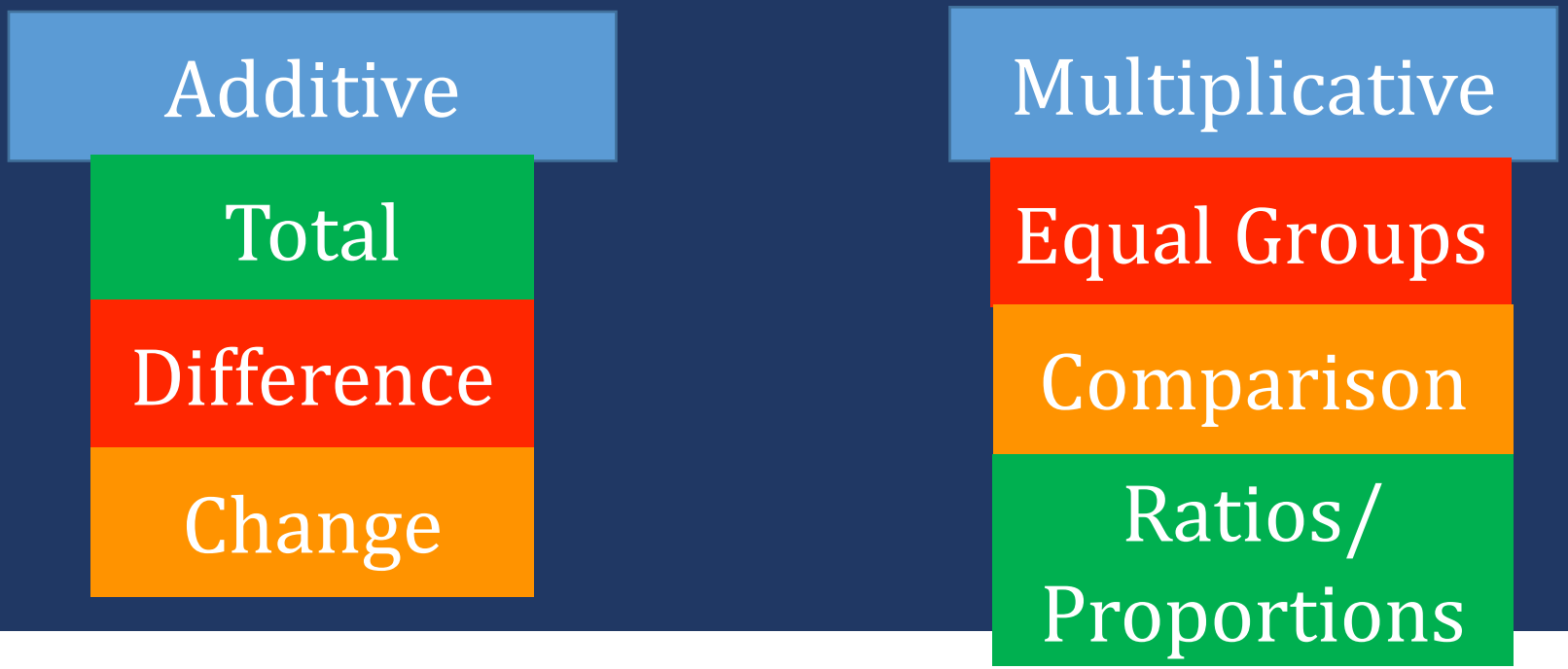
R-CUBES

Read the problem.
Circle key numbers.
Underline the question.
Box action words.
Evaluate steps.
Solve and check.

3. Do teach students *schemas*

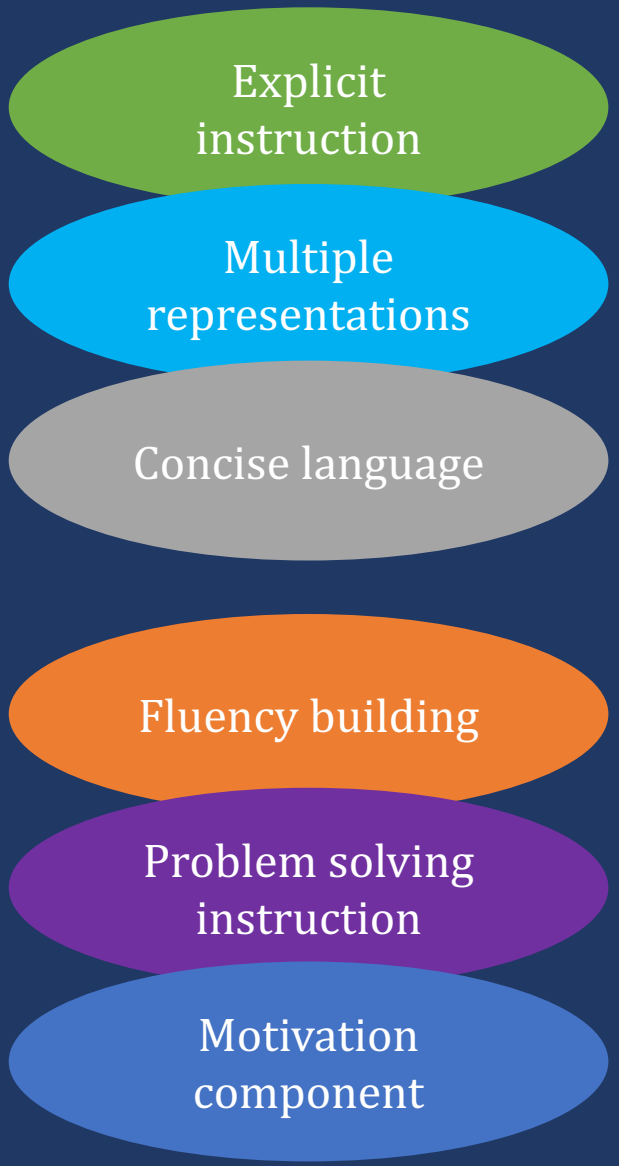
When teaching about word problems, students should learn the *schema* of the word problem.

- Structure
- Problem type



Jitendra & Star (2011); Riley & Greeno (1988); Van de Walle, Karp, & Bay-Williams (2010)

Motivation component


Explicit instruction
Multiple representations
Concise language
Fluency building
Problem solving instruction
Motivation component

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