

Establishing a Multi-Tiered System of Support for Mathematics

Robin S. Coddling, Ph.D., BCBA
rcoddling@umn.edu

Ohio School Psychologists Association

Friday, November 11, 2016
Columbus, Ohio

UNIVERSITY OF MINNESOTA

Overview

Content

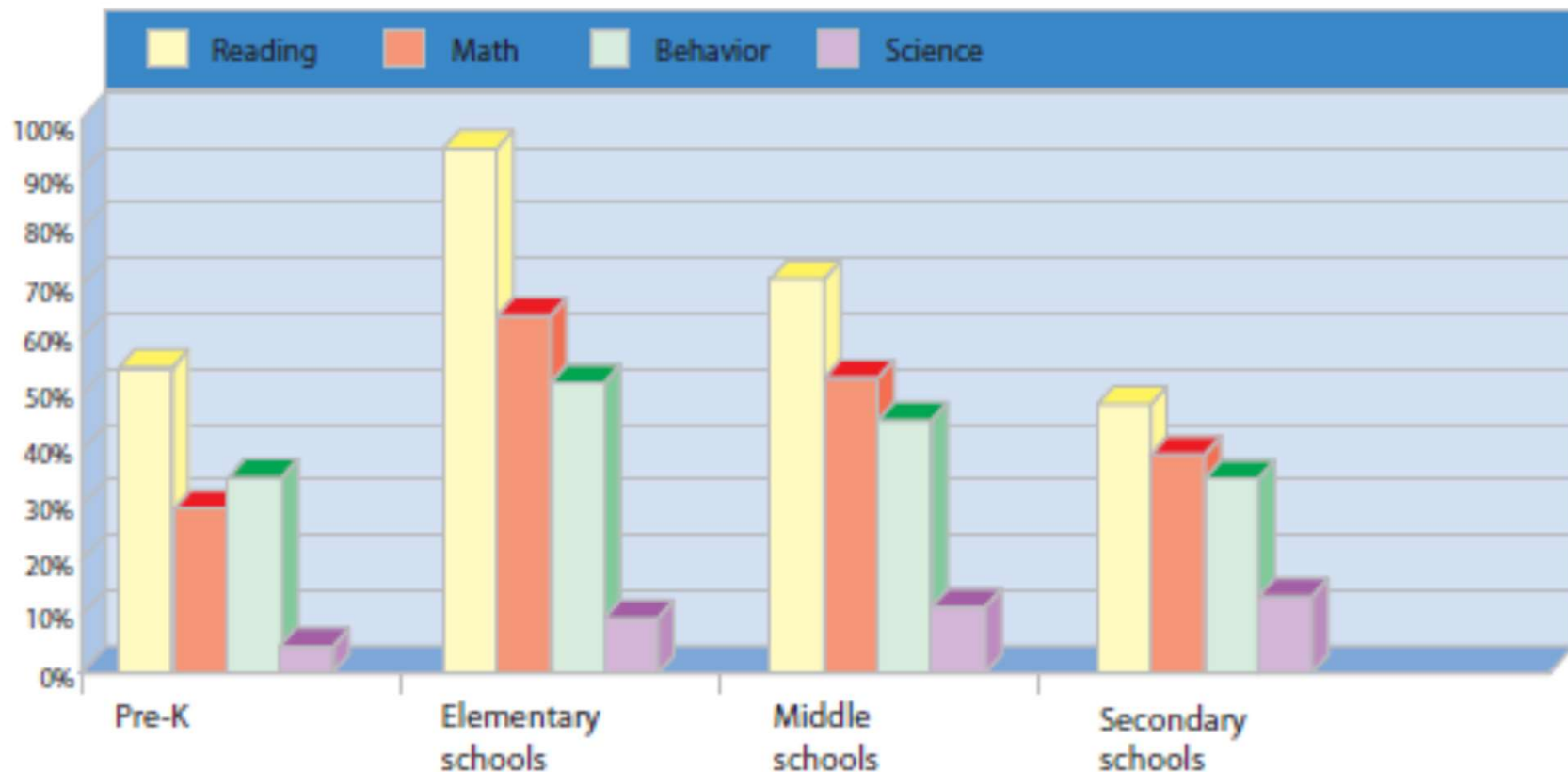
- Mathematics Learning & Learning Challenges
- Tier 1: Screening & Evidence-based Instruction
- Tier 2 & 3: Refining the Problem, Selecting Treatments, & Monitoring Progress

Learning Objectives

1. Participants will evaluate their **school readiness** for MTSS in mathematics
2. Participants will locate & select appropriate **screening & progress monitoring** tools
3. Participants will know how to use **data to match** at-risk students with appropriate **treatments**
4. Participants will be familiar with effective **intervention options according to research and evidence-based standards**

2010 RTI Adoption Survey

For which grades and areas have you implemented RTI? (Check all that apply)

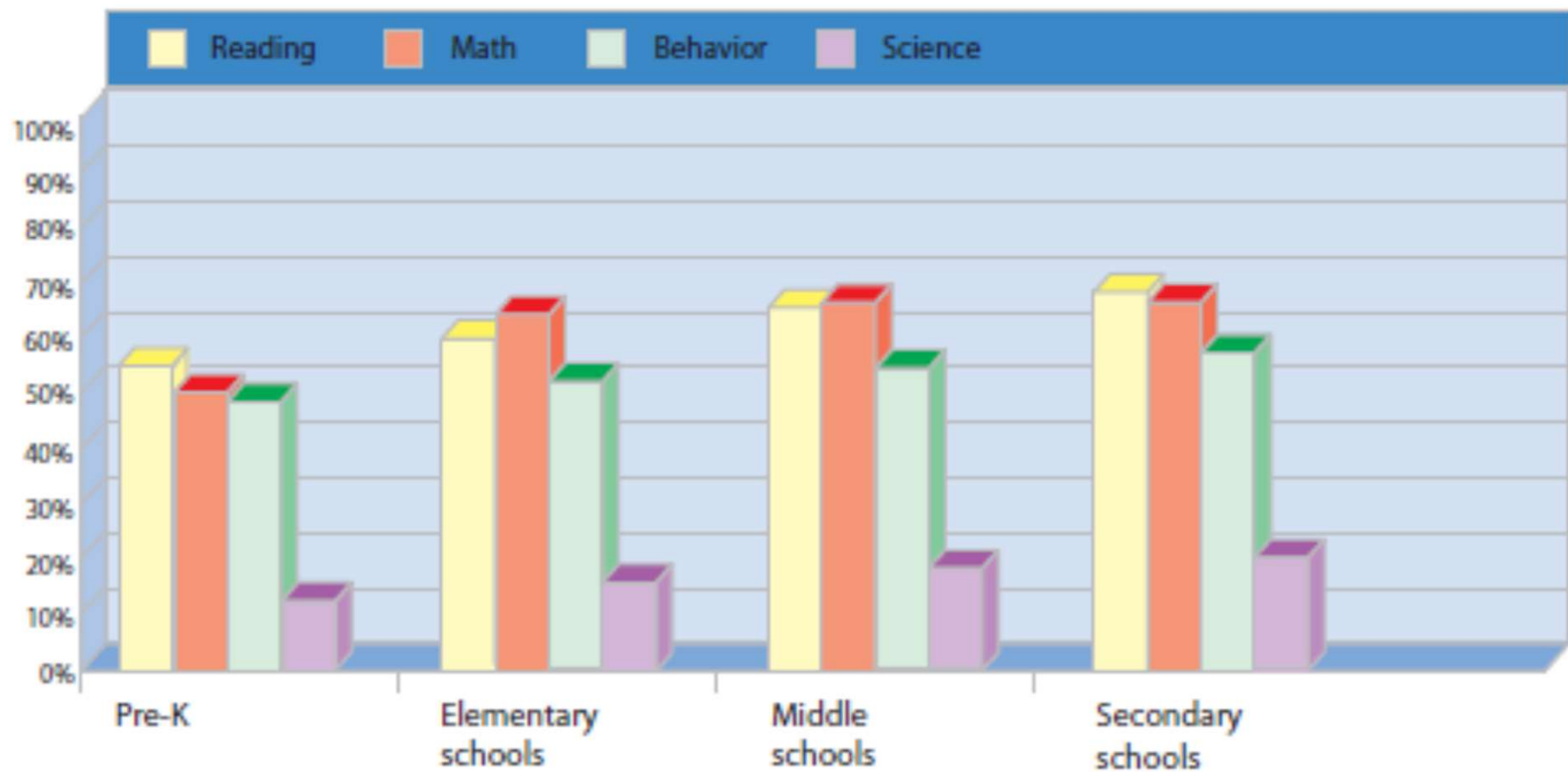


(Council of Administrators of Special Education; American Association of School Administrators; National Association of Stated Directors of Special Education, Inc; www.spectrumK12.com)

UNIVERSITY OF MINNESOTA

2010 RTI Adoption Survey

For which grades and areas do you plan to implement RTI? (Check all that apply)



(Council of Administrators of Special Education; American Association of School Administrators; National Association of State Directors of Special Education, Inc; www.spectrumK12.com)

UNIVERSITY OF MINNESOTA



MATHEMATICS LEARNING

UNIVERSITY OF MINNESOTA

Math Matters

Growth of jobs in mathematics/science & engineering is outpacing general job growth 3:1

Mathematics skills are important for academic, occupational success & for daily living situations

Quantitative literacy = weakest area of adult literacy

Students who do not demonstrate proficiency in basic mathematic skills are at-risk for failure in higher-level material

(Duncan et al., 2007; Gersten & Chard, 1999; Patton, Cronin, Bassett, & Koppel, 1997; National Institute for Literacy, 2003; USDOE, 2008)

UNIVERSITY OF MINNESOTA

U.S. Math Performance

National Performance (NAEP, 2015)

- 40% of 4th, 33% of 8th grade students perform at/above proficiency

International Performance Varies

- Program for International Student Assessment (PISA, 2012): *US mean score significantly below average*
- Trends in International Mathematics & Science Study (TIMSS, 2011): *4th & 8th grade scores were higher than TIMSS average*

Achievement Gaps Persists

- Race, Disability, & SES Status

Persistent Mathematics Difficulties

- 17% → 7% MLD; 5%-10% of School-Age Children Persistent Low Achievement

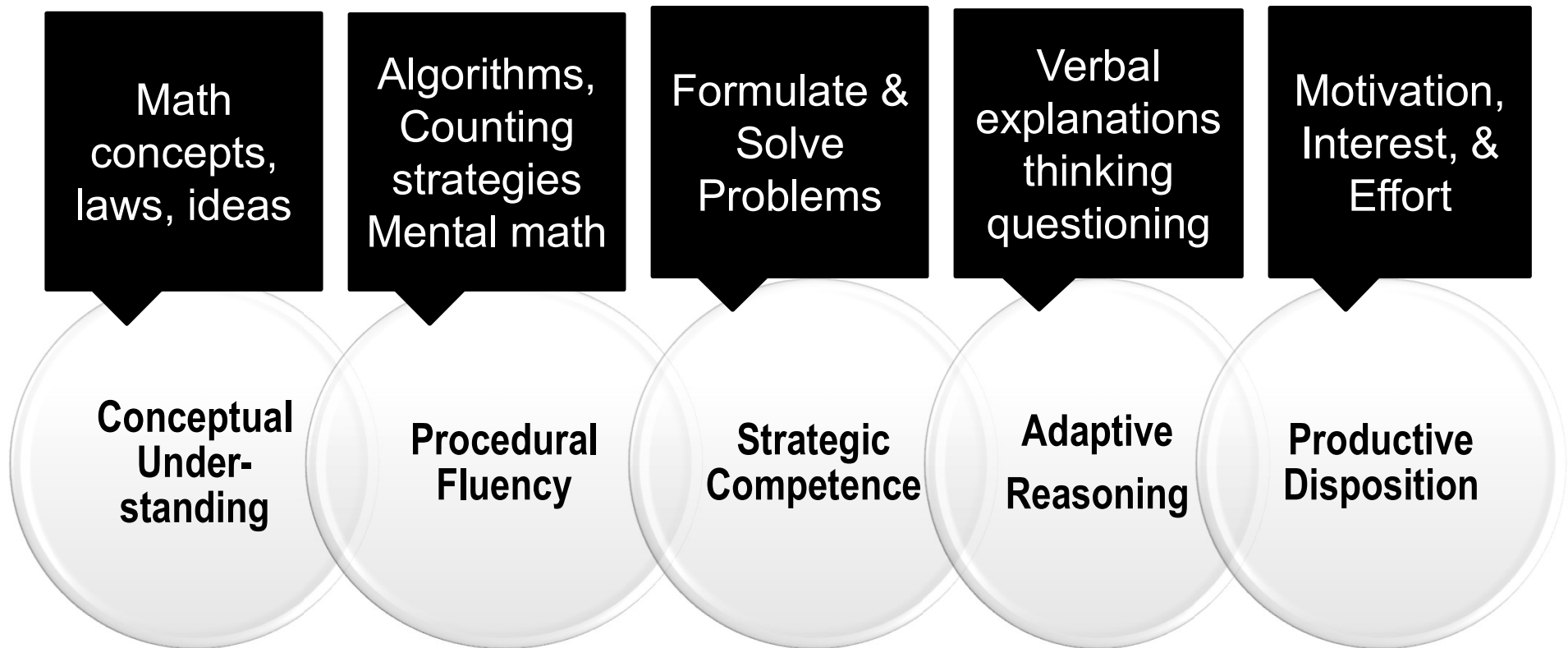
(Berch & Mazzocco, 2007; Bryant et al., 2008; Chard, Ketterlin-Geller, & Jitendra, 2008; Fuchs, Compton et al., 2005; Fuchs, Fuchs, et al., 2008; Geary, 2007; Gersten et al., 2005; National Center for Education Statistics, 2013; 2015)

UNIVERSITY OF MINNESOTA

Improving Mathematics Standards

- Common Core State Standards for Mathematics
 - Coherent Set of Curriculum Standards (2010)
- President & U.S. Department of Education
 - Convened National Mathematics Advisory Panel
 - Final Report (March 2008)
- National Council of Teachers of Mathematics
 - Generated Curriculum Focal Points (2006)
- National Research Council
 - Convened panel of mathematicians, psychologists & educators
 - *Adding it Up* (2001)

Number Proficiency



Standards for Student Mathematical Practice


1 Make sense of problems and persevere in solving them.



Keep on going!

2 Reason abstractly and quantitatively.

Write a story for the mathematical equation

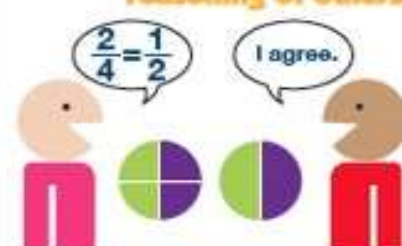


$$\frac{1}{2} \times 4$$

DeJuan exercises $\frac{1}{2}$ hour a day for 4 days. How many total hours does he exercise?

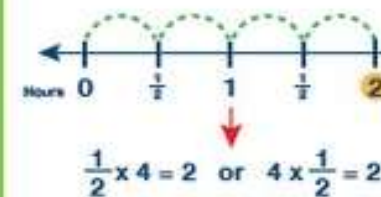
Think what makes sense.

3 Construct viable arguments and critique the reasoning of others.



Talk and explain.

4 Model with mathematics.



Show your thinking.

5 Use appropriate tools strategically.



Use the right tools.

6 Attend to precision.

symbol: equals (the same as)

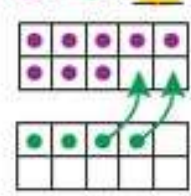
120 minutes = 2 hours

units of measure

Check your work.


7 Look for and make use of structure.

$8 + 4 = 12$



See the pattern or connection.

8 Look for and express regularity in repeated reasoning.



See the pattern or connection.

Math Concepts, Laws, Ideas

Arithmetic
Operation Laws

Commutative
Property

$$2+5 = 5+2$$

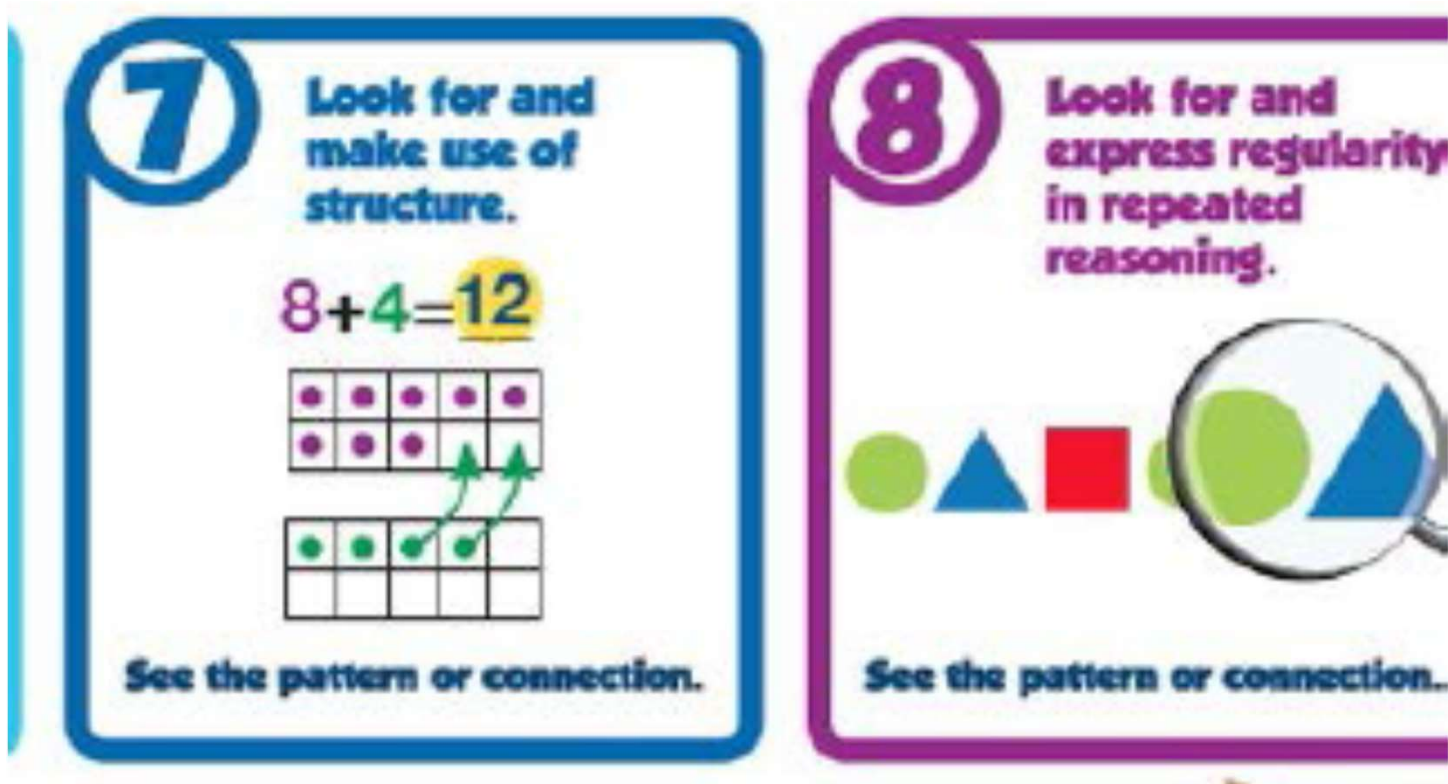
Place Value
(Base-10)

Estimation

Composition
($7+8 = 7 + 7 + 1$)

Decomposition
($200+50+7 = 257$)

CCSSI-M Standards for Mathematical Practice



Procedures

Paper & Pencil

- Algorithms

Mental

- Mnemonics
- Automatic Retrieval
- Skip Counting
- Estimation

CCSSI-M Standards for Mathematical Practice



Linking Aspects of Whole Number Proficiency

Solve this Problem:

What Strategy did
you Use?

$$\begin{array}{r} 54 \\ + 48 \\ \hline 102 \end{array}$$

Linking Aspects of Whole Number Proficiency

1. $48 = 4$ **10** & 8 ones

2. Add 4 **10** to 54

$64 \rightarrow 74 \rightarrow 84 \rightarrow 94$

3. 8 ones is also $6+2$

4. Add 6 to 94 = 100

5. $100 + 2 = 102$

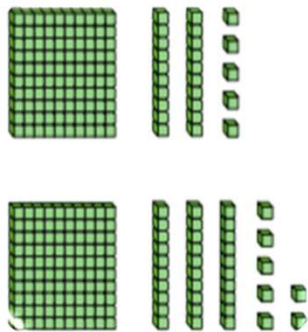
1. $48 = \text{close to } 50 (-2)$

2. $50 + 54 = 104$

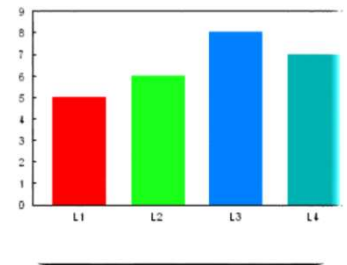
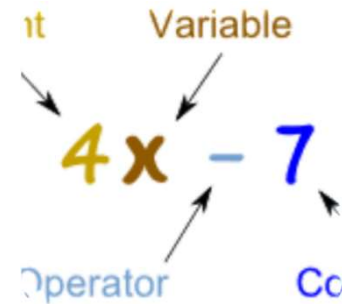
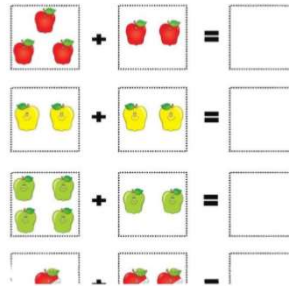
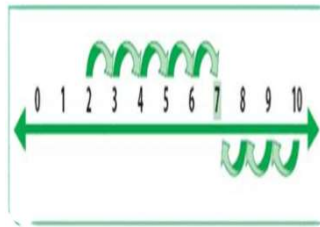
3. $104 - 2 = 102$

$$\begin{array}{r} 1 \\ 48 \\ + 54 \\ \hline 102 \end{array}$$

Strategic Competence



Example 4. Representation of the counting on strategy using a number line



Manipulatives:
Chips
Base-10
Blocks

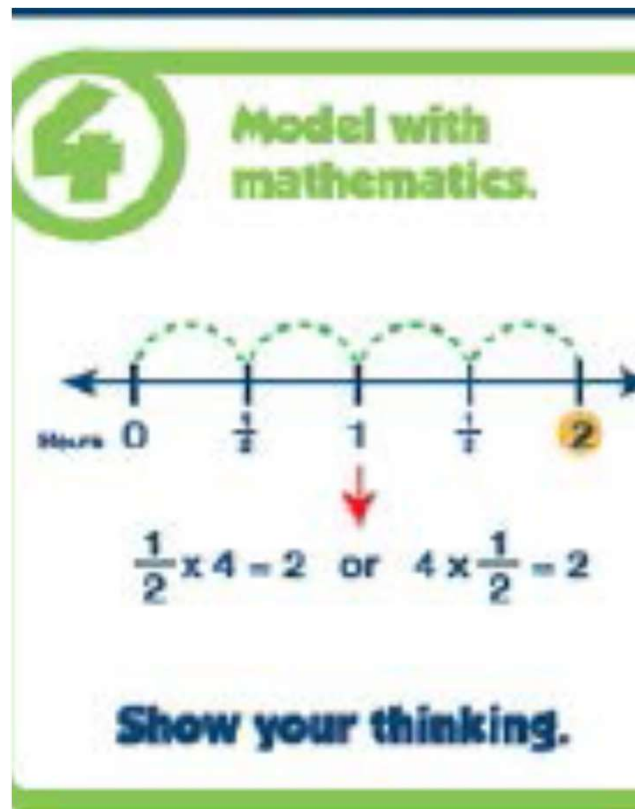
Models:
Number
lines
Strip
Diagrams
Ten
Frames

Drawings

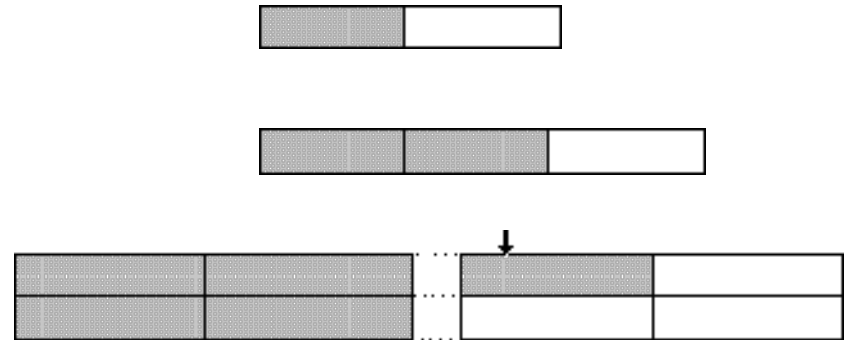
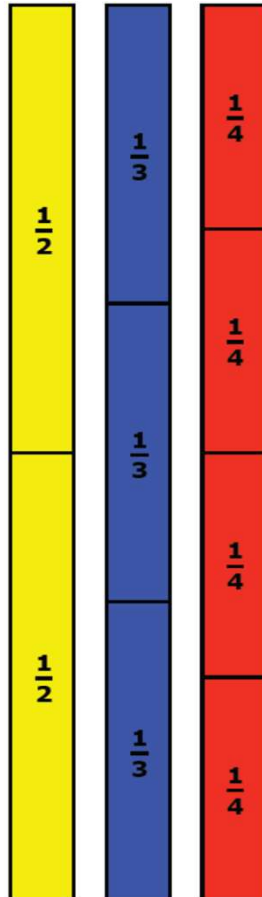
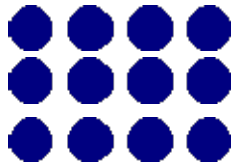
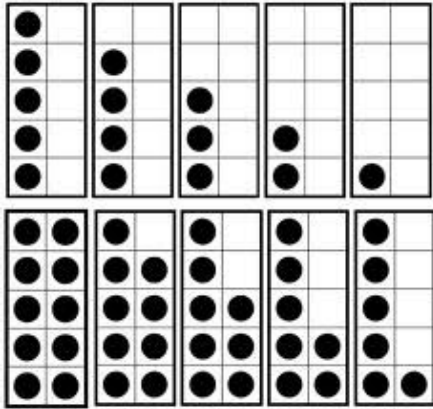
Numbers
&
Symbols

Graphs

CCSSI-M Standards for Mathematical Practice



Visual Representation Examples



Pathway to Automaticity

Counting All

- **Least Efficient & Effective**



Counting Up from First Addend

$$3 + 5$$

Counting on from Larger Addend

$$3 + 5$$

Decomposition

$$7 + 8 = 7 + 7 + 1$$

Mental Retrieval

- **Most Efficient & Effective**

(Butterworth, 2005; Griffin, 2003)

UNIVERSITY OF MINNESOTA

Adaptive Reasoning

Peer Assisted Learning

- Cooperative Learning
- Teams
- Peer Pairs / Tutors

Number Talks

- Students solve problems & share their strategies


Think Aloud

- Introduce Strategy
- Model Thinking
- Practice as Group & in Pairs

CCSSI-M Standards for Mathematical Practice

2 Reason abstractly and quantitatively.

Write a story for the mathematical equation




$\frac{1}{2} \times 4$

DeJuan exercises $\frac{1}{2}$ hour a day for 4 days.
How many total hours does he exercise?

Think what makes sense.

3 Construct viable arguments and critique the reasoning of others.

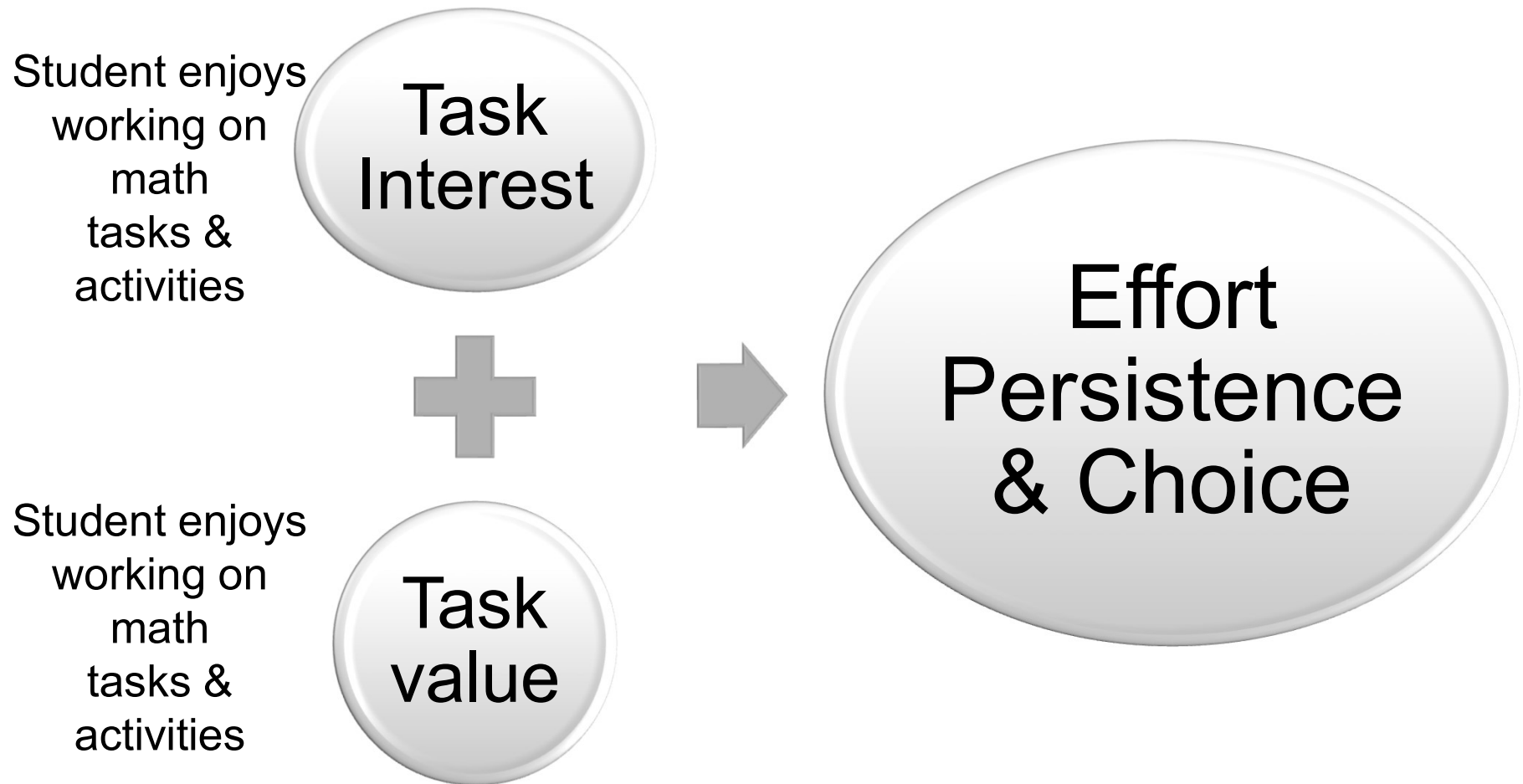


$\frac{2}{4} = \frac{1}{2}$

I agree.

Talk and explain.

Productive Disposition



(Conley, 2012; Cleary & Chen, 2009; Schunk et al., 2008)

UNIVERSITY OF MINNESOTA

Productive Disposition

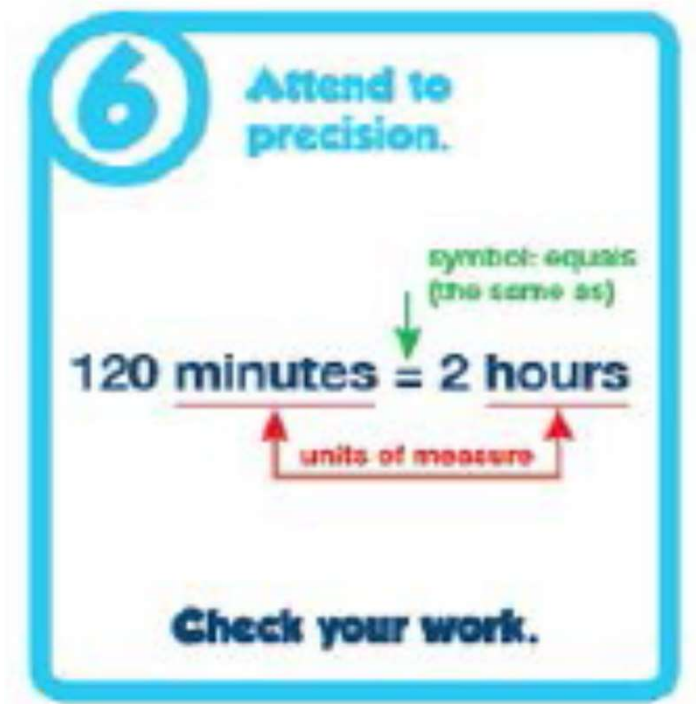
Motivation

- **Goal Orientation?**
 - Mastery: Desire to learn or master skills
 - Performance: Desire to do well/make good impression
 - Avoidance: Desire to avoid failure or looking incompetent

Engagement

- **Attention?**

CCSSI-M Standards of Mathematical Practice



Productive Disposition

Feedback on Effort or Performance

Self-Monitoring

Make Math Learning & Tasks Meaningful

Classroom Orientation

(Conley, 2012; Cleary & Chen, 2009; Schunk et al., 2008)

UNIVERSITY OF MINNESOTA



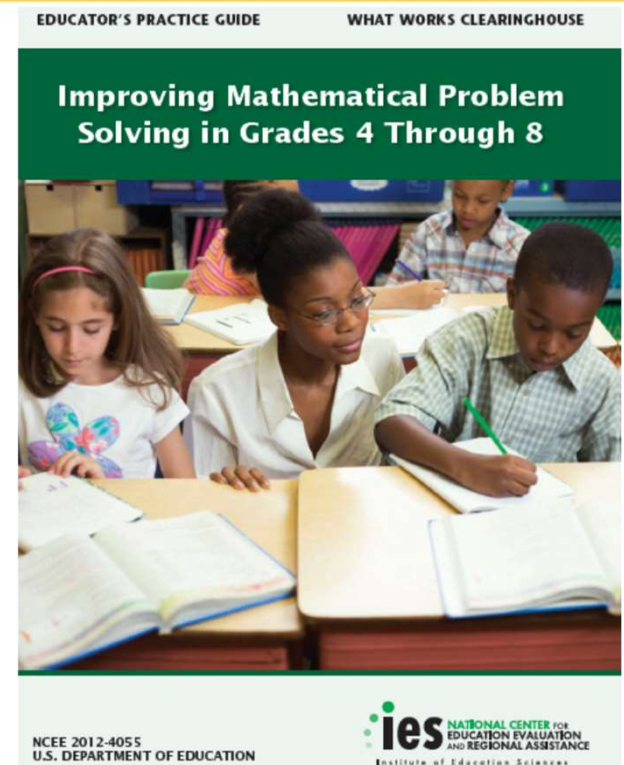
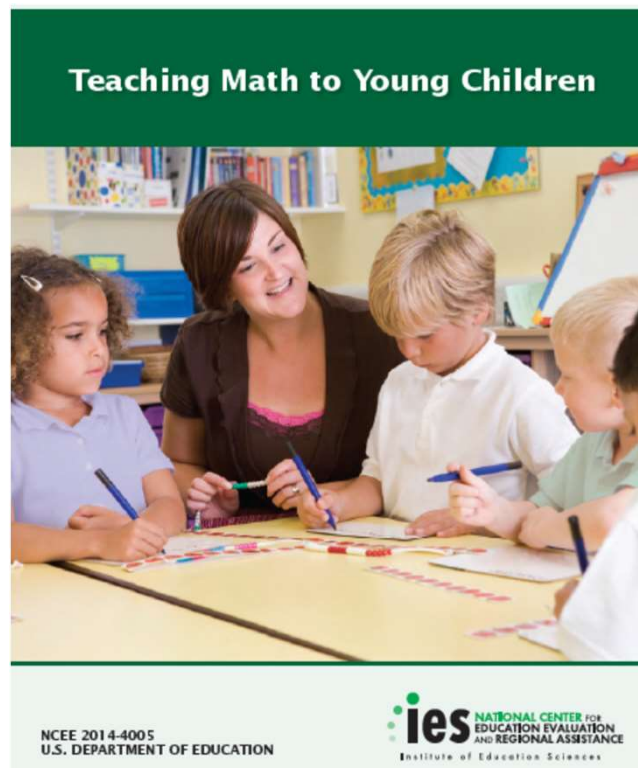
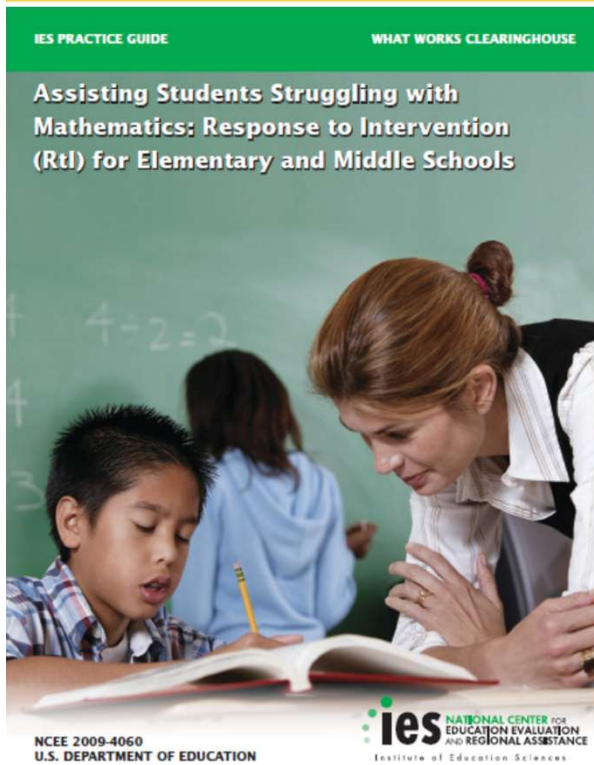
MTSS BASICS

Core Features of MTSS

- ✓ • School System Capacity & Support
- ✓ • Data-Based Decision Making
 - Screening, Progress Monitoring, Intervention Planning
- ✓ • Multi-tiered
 - Tier 1 → Core Instruction for ALL Students
 - Tier 2 → Small Group Instruction/Intervention
 - Tier 3 → Intensive, Individualized
- ✓ • Evidence-Based Instruction & Intervention
- ✓ • Identification of Sub-Group Representing LD

Increasing Intensity of Treatment, Resources, & Monitoring

Resources



U.S. Department of Education; Institute for Education Sciences:
National Center for Educational Evaluation & Regional Assistance

UNIVERSITY OF MINNESOTA

MTSS Math Evaluation Scale



- School System Capacity & Support
- Data-Based Decisions
- Quality Instruction
- Tiered Interventions
- Professional Development

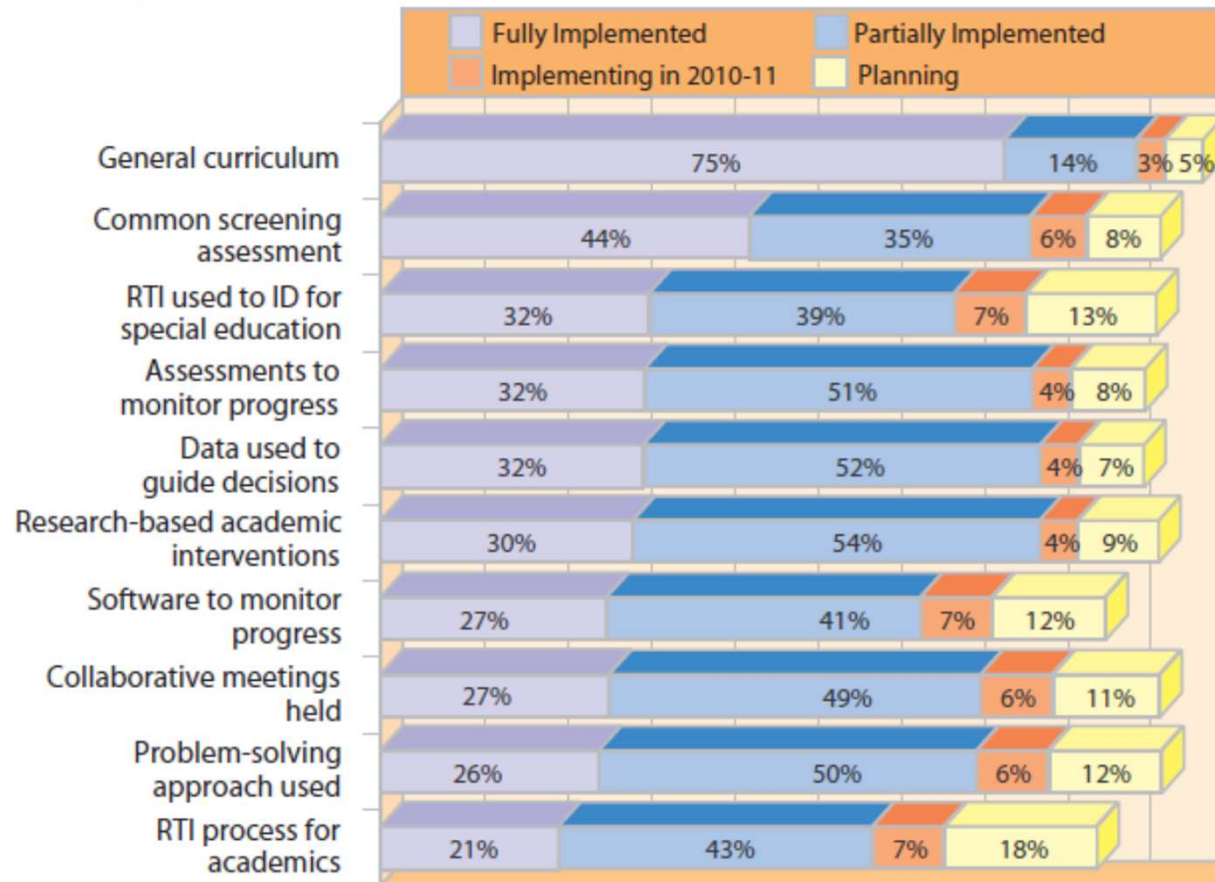
MTSS Math Evaluation Scale

SHARE
Findings

- School System Capacity & Support
- Data-Based Decisions
- Quality Instruction
- Tiered Interventions
- Professional Development

2010 RTI Adoption Survey

Please indicate the academic implementation level(s) for the following RTI components in your district.



(Council of Administrators of Special Education; American Association of School Administrators; National Association of State Directors of Special Education, Inc; www.spectrumK12.com)

UNIVERSITY OF MINNESOTA



TIER 1

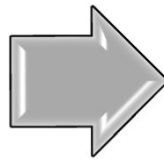
SCREENING & EVIDENCE-BASED INSTRUCTION

Universal Screening + Instructional Practices

How are students and classes of students performing in CORE instructional environment?

Screening (2 to 3 Times Per Year)

- Early Numeracy
- Computation
- Concepts & Applications
- Computer-Adaptive Tests



Core Instruction

- Curriculum
- Supplemental Instruction
 - Computer Assisted
 - Peer-Assisted

Core Mathematics Curricula

Problems

- Breadth at the expense of depth
- Weak conceptual emphasis
- Discovery-based curricula may be insufficient for students with or at-risk for mathematics disabilities

Solutions

- Adopt curricula that follow a coherent progression
- Focus on key foundational areas:
 - Proficiency w/whole numbers
 - Proficiency w/fractions
 - Some aspects of geometry
- Include instructional process elements with proven effectiveness

Successful Curricula

FIGURE 1

A+ Composite: Mathematics topics intended at each grade by at least two-thirds of A+ countries.

Note that topics are introduced and sustained in a coherent fashion, producing a clear upper-triangular structure.

TOPIC	GRADE:	1	2	3	4	5	6	7	8
Whole Number Meaning		■	■	■	■	■			
Whole Number Operations		■	■	■	■	■			
Measurement Units		□	■	■	■	■	■	■	
Common Fractions				□	■	■	■		
Equations & Formulas				□	■	■	■	■	■
Data Representation & Analysis				□	□	■	■		□
2-D Geometry: Basics				□	■	■	■	■	■
Polygons & Circles					■	■	■	■	■
Perimeter, Area & Volume					■	■	■	■	□
Rounding & Significant Figures					■	■			
Estimating Computations					■	■	■		
Properties of Whole Number Operations					□	■			
Estimating Quantity & Size					□	□			
Decimal Fractions					■	■	■		
Relationship of Common & Decimal Fractions					■	■	■		
Properties of Common & Decimal Fractions						■	■		
Percentages						■	■		
Proportionality Concepts						■	■	■	□
Proportionality Problems						■	■	■	■
2-D Coordinate Geometry						□	□	■	■
Geometry: Transformations							■	■	■
Negative Numbers, Integers & Their Properties							□	■	
Number Theory								■	□
Exponents, Roots & Radicals								■	■
Exponents & Orders of Magnitude								□	□
Measurement Estimation & Errors								□	
Constructions w/ Straightedge & Compass								■	□
3-D Geometry								■	■
Congruence & Similarity									■
Rational Numbers & Their Properties									□
Patterns, Relations & Functions									□
Slope & Trigonometry									□
Number of topics covered by at least 67% of the A+ countries		3	3	7	15	20	17	16	18
Number of additional topics intended by A+ countries to complete a typical curriculum at each grade level		2	6	5	1	1	3	6	3

(Schmidt, Houang, & Cogan
2002, p. 3)

Common U.S. Curricula

FIGURE 2

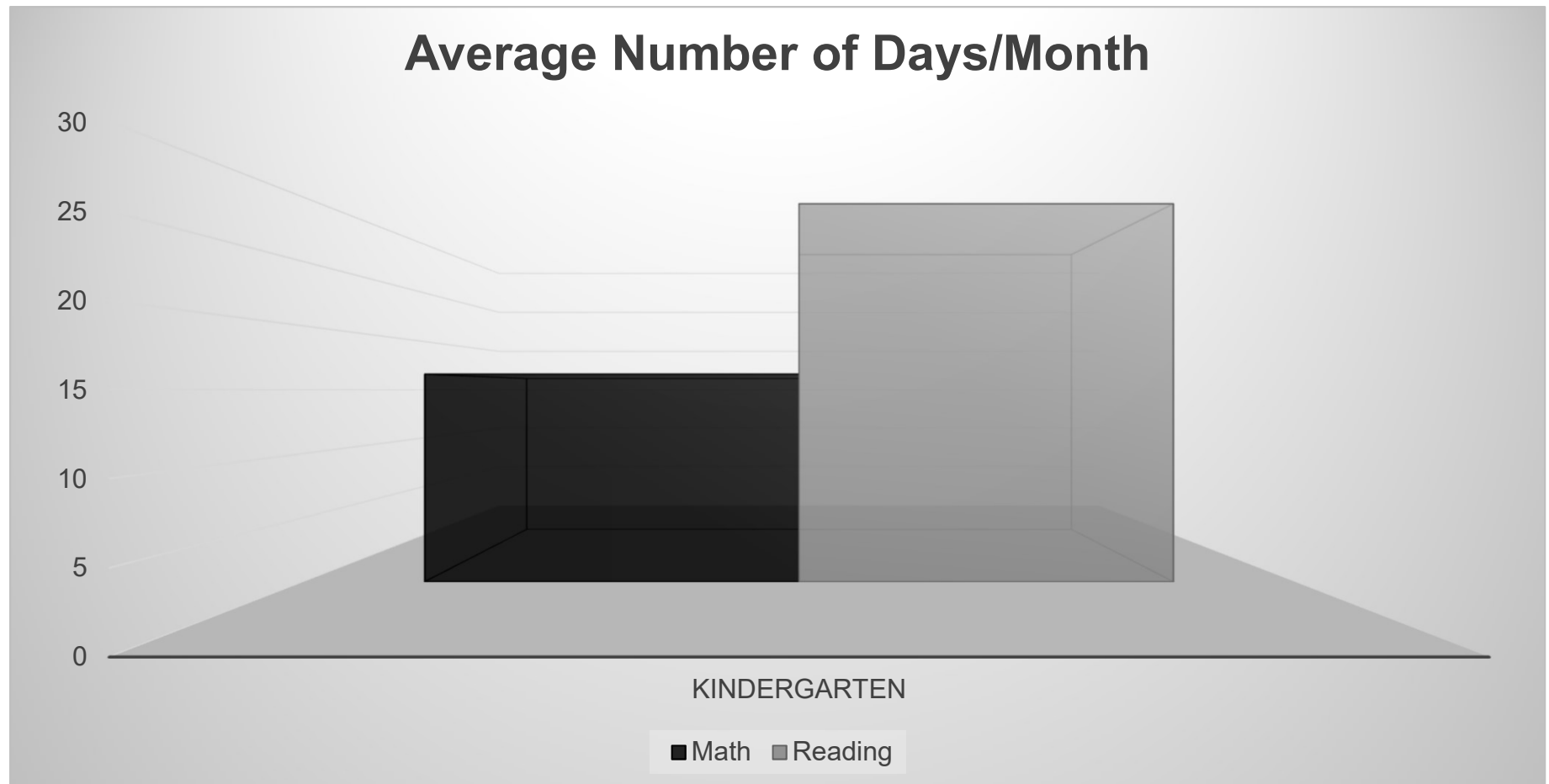
State Composite: Mathematics topics intended at each grade by at least two-thirds of 21 U.S. states.

Note that topics are introduced and sustained in a way that produces no visible structure.

TOPIC	GRADE:	1	2	3	4	5	6	7	8
Whole Number Meaning		■	■	■	■	■	□		
Whole Number Operations		■	■	■	■	■	□		
Measurement Units		■	■	■	■	■	■	■	■
Common Fractions		□	■	■	■	■	■	□	□
Equations & Formulas		□	□	■	■	■	■	■	■
Data Representation & Analysis		■	■	■	■	■	■	■	■
2-D Geometry: Basics		■	■	■	■	■	■	■	■
Polygons & Circles		■	■	■	■	■	■	■	■
Perimeter, Area & Volume			□	□	□	■	■	■	■
Rounding & Significant Figures									
Estimating Computations		□	□	■	■	■	■	■	■
Properties of Whole Number Operations		□	□	□	□				
Estimating Quantity & Size				□					
Decimal Fractions				□	■	■	■	□	□
Relationship of Common & Decimal Fractions					□	□	□		
Properties of Common & Decimal Fractions									
Percentages						□	■	■	□
Proportionality Concepts							■	□	
Proportionality Problems							■	■	■
2-D Coordinate Geometry				□	■	□	□	□	■
Geometry: Transformations		■	■	■	■	■	■	■	■
Negative Numbers, Integers & Their Properties							□	■	□
Number Theory						■	□	□	□
Exponents, Roots & Radicals							□	□	■
Exponents & Orders of Magnitude								□	□
Measurement Estimation & Errors		□	□	■	□	■	■	■	□
Constructions w/ Straightedge & Compass									
3-D Geometry		■	■	■	■	■	■	■	■
Congruence & Similarity						□	■	■	□
Rational Numbers & Their Properties							■	■	□
Patterns, Relations & Functions		■	■	■	■	■	■	■	■
Slope & Trigonometry									
Number of topics covered by at least 67% of the states		14	15	18	18	20	25	23	22
Number of additional topics intended by states to complete a typical curriculum at each grade level		8	8	7	8	8	5	6	6
□ – intended by 67% of the states ■ – intended by 83% of the states ■ – intended by 100% of the states									

(Schmidt, Houang, & Cogan, 2002, p. 5)

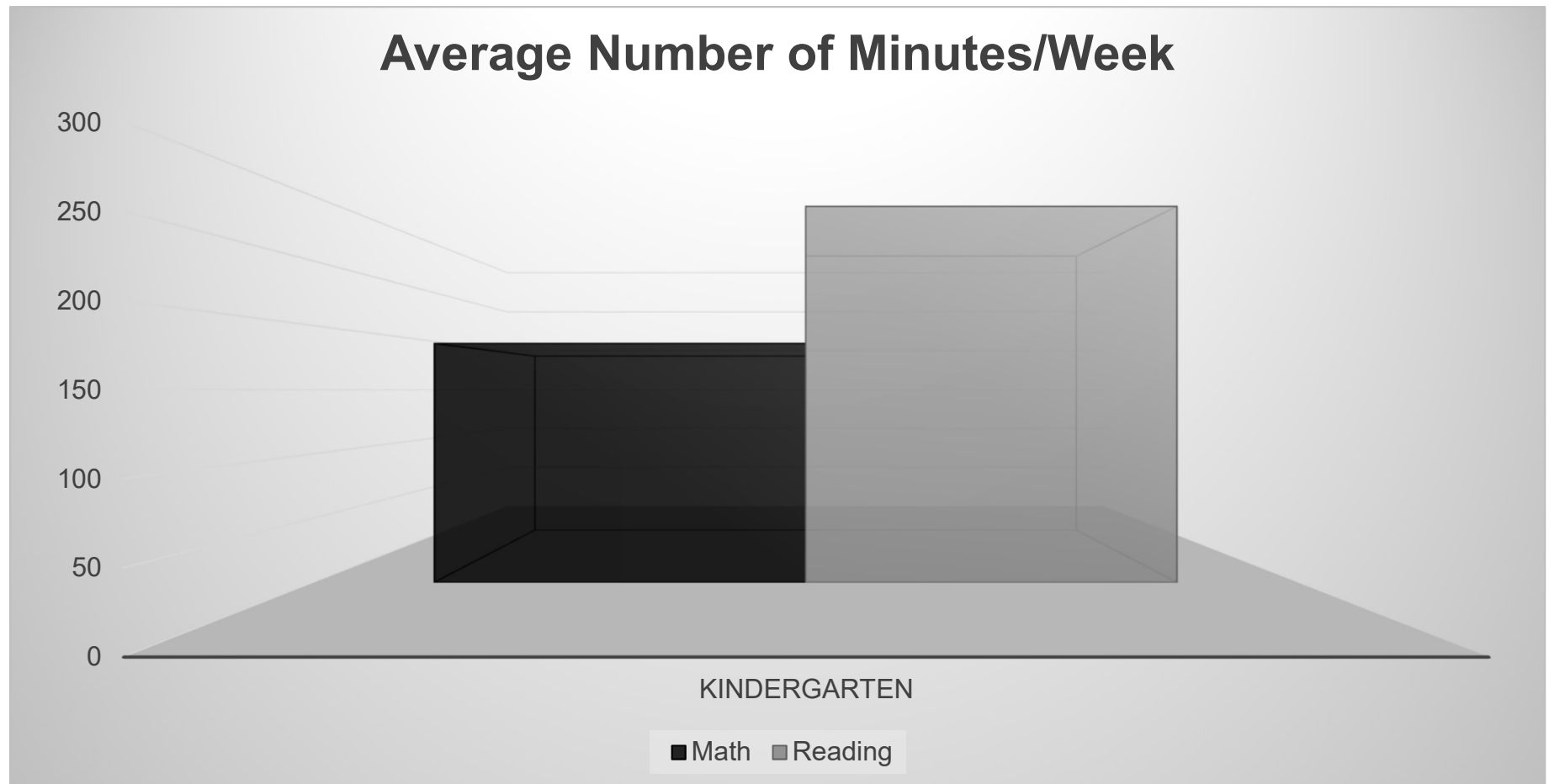
Time Allocated to Mathematics Instruction



(Claessens, Engel, & Curran, 2014, p. 416)

UNIVERSITY OF MINNESOTA

Time Allocated to Mathematics Instruction

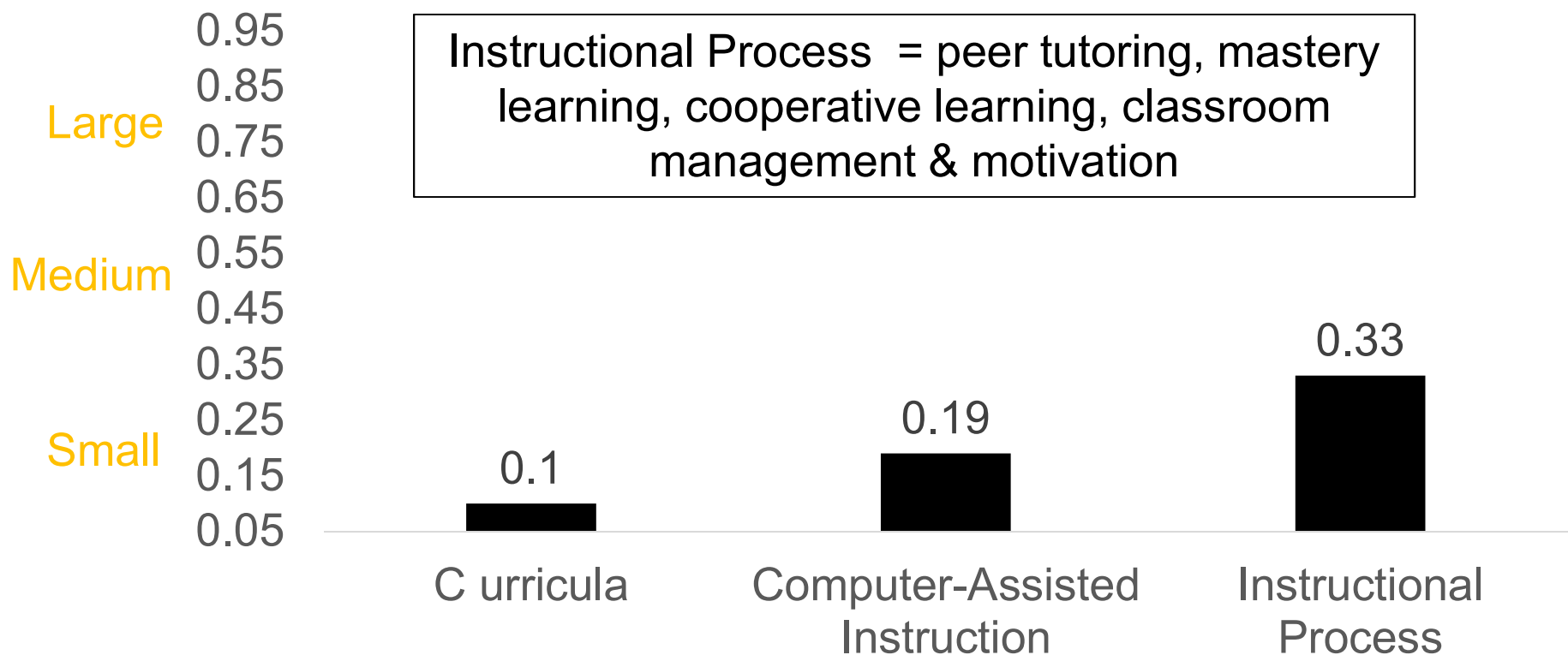


(Claessens, Engel, & Curran, 2014, p. 416)

UNIVERSITY OF MINNESOTA

Evidence for Core Instructional Practices

Effect Sizes



(Kroesbergen & Van Luit, 2003; Slavin & Lake, 2008; 2009; Swanson & Sasche-Lee, 2000)

UNIVERSITY OF MINNESOTA

Pre-K to Kindergarten Level

Curricula/ Program	What Works Clearinghouse	Best Evidence Encyclopedia
CURRICULA		
Building Blocks for Math (SRA Real Math)	Positive	NA
Pre-K Mathematics	Positive	Moderate
SUPPLEMENTAL PROGRAMS		
Peer Assisted Learning Strategies (PALS)	No Discernible Effect	Moderate
Classwide Peer Tutoring (CWPT)	NA	Strong

Elementary Level

Curricula/ Program	What Works Clearinghouse	Best Evidence Encyclopedia
CURRICULA		
Odyssey Math	Potentially Positive	NA
Everyday Mathematics	Potentially Positive	Limited Evidence
Saxon Math	Potentially Positive	NA
Singapore Math → Commonly Recommended b/c Match with Effective International Curricula (Primary Mathematics; New Elementary Mathematics; Math in Focus; My Pals are Here Math)		
SUPPLEMENTAL PROGRAMS		
Peer Assisted Learning Strategies (PALS)	NA	Strong
Class-wide Peer Tutoring (CWPT)	NA	Strong
Team Assisted Instruction (TAI)	NA	Strong
PowerTeaching: Mathematics	NA	Strong
Accelerated Mathematics	Potentially Positive	Limited Evidence

Practice....

One of the best predictors of adult mathematics competency

Should consume a majority of instructional time (according to some experts)

Promotes automaticity

Is limited or not meaningful in many common textbook & curricular activities

Promoting Productive Practice

Definition

- Materials match individual student's instructional level & are sequenced systematically
- Brief & frequent sessions
- Material is delivered in small sets

Activities

- Teacher Guided Practice
- Peer Practice
- Independent Practice
- Isolated Drill
- Practice in Context

(Baroody, Eiland, et al., 2009; Burns et al., 2006; Coddling et al., 2011; Daly et al., 2007; Fuchs, Fuchs, Powell, et al., 2008; Martens & Eckert, 2007)

UNIVERSITY OF MINNESOTA

Building Fluency Practice into Core Instruction

Identify Grade Skill Needs Via Screening & Standards

- Target Instructional Grade Level &/or Pre-Requisite Skills

Identify Time (10 minutes) & Practice Strategy

- Examples: peer tutoring, explicit timing, flash cards, computer assisted, cover-copy-compare
- Teach efficient counting strategies (K-2)
- Teach distributive, commutative, & associative properties (2-8)

Students Set Goals & Receive Performance Feedback

Move up Skill Hierarchy with Mastery

(Coddling, Chan-Iannetta, George, & Ferreira, 2009; Gersten, Bechmann, Clarke, Foegen, Marsh, Star, & Wintzal, 2009; VanDerHeyden & Burns, 2005)

UNIVERSITY OF MINNESOTA

Building Fluent Retrieval of Basic Facts

10 Min
Per
Session

Flashcards
Technology
Explicit
Timing

Counting
Up
Strategies

Apply
Commutative
& Distributive
Properties

If $5 + 3 = 8$
then $3 + 5 = 8$
 $5 + 3 = 8 = 3 + 5$

$13 \times 7 = ?$
 $13 = 10 + 3$
 $13 \times 7 = (10 + 3) \times 7$
 $10 \times 7 + 3 \times 7$

Summary: Recommendations for Instructional Practices

1. Match Curriculum w/ Common Core Standards

2. Incorporate Differentiated & Explicit Instruction

3. Designate 45-60 Minutes for DAILY Instruction

- Assume additional 20-40 minutes for tiered activities

4. Supplement w/Instructional Process Strategies

- Peer-Assisted Learning, Small Groups, Cooperative Learning
- Classroom Management & Motivation
- Computer Assisted

5. Provide Targeted Practice to Promote Fluency

6. Conduct Universal Screening



Tier 1

UNIVERSAL SCREENING

Screening in Mathematics

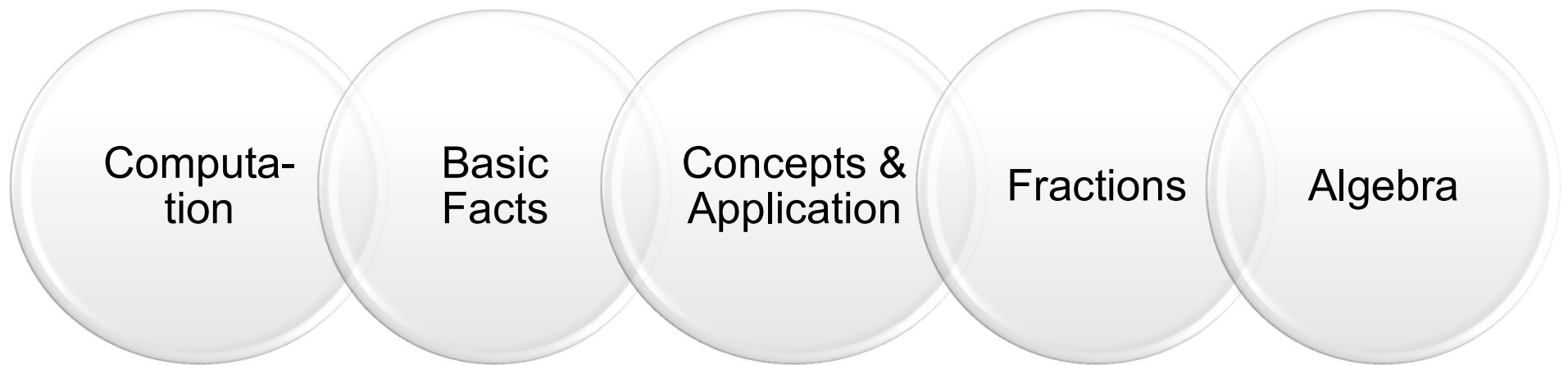
Purpose & Psychometrics

- Identify ***all*** students' current levels of performance
- Tools are:
 - **Efficient**,
 - **Reliable**,
 - **Valid** (predictive),
 - **Sensitive** (low rates of false negatives)

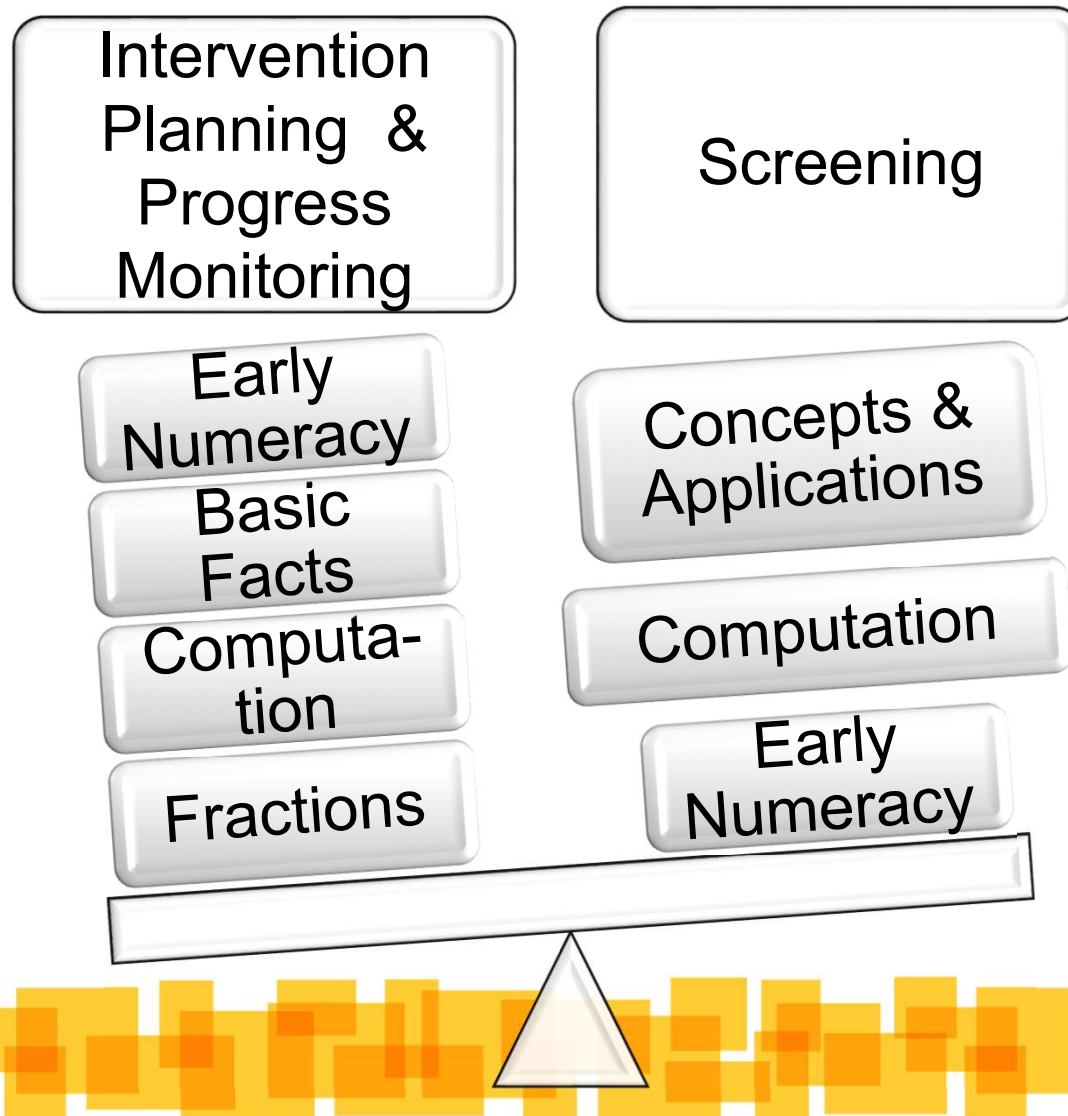
Resources & Types

- National Center on Intensive Intervention
www.intensiveintervention.org/chart/progress-monitoring
- **CBM:** AIMSweb, EasyCBM, DIBELS Math, Monitoring Basic Skills Progress, STEEP
- **Computer Adapted:** FASTBridge, STAR
- **Norm- &/or Criterion-Referenced:** State Assessments

Challenges Measuring Mathematics



Challenges Measuring Mathematics



Measurement in math is a challenge due to its multi-topic nature & lack of capstone task

Current Screening Recommendations

Grade	Early Numeracy	Computation	Concepts Application	State Testing
K	X			
1	X	X		
2		X	X	
3		X	X	
4		X?	X?	X
5		X?	X?	X

- Screening Measures require ≤ 20 min to administer
- Screening should occur at least 2 times per year (fall, winter)
- Content should reflect grade specific instructional objectives
- Monitor Progress of students scoring near the cut point

(Gersten et al., 2009; VanDerHeyden, Coddling, & Martin, 2016)

UNIVERSITY OF MINNESOTA

Screening Tools

National Center on Intensive
Intervention Academic Progress
Monitoring

www.intensiveintervention.org/chart/progress-monitoring



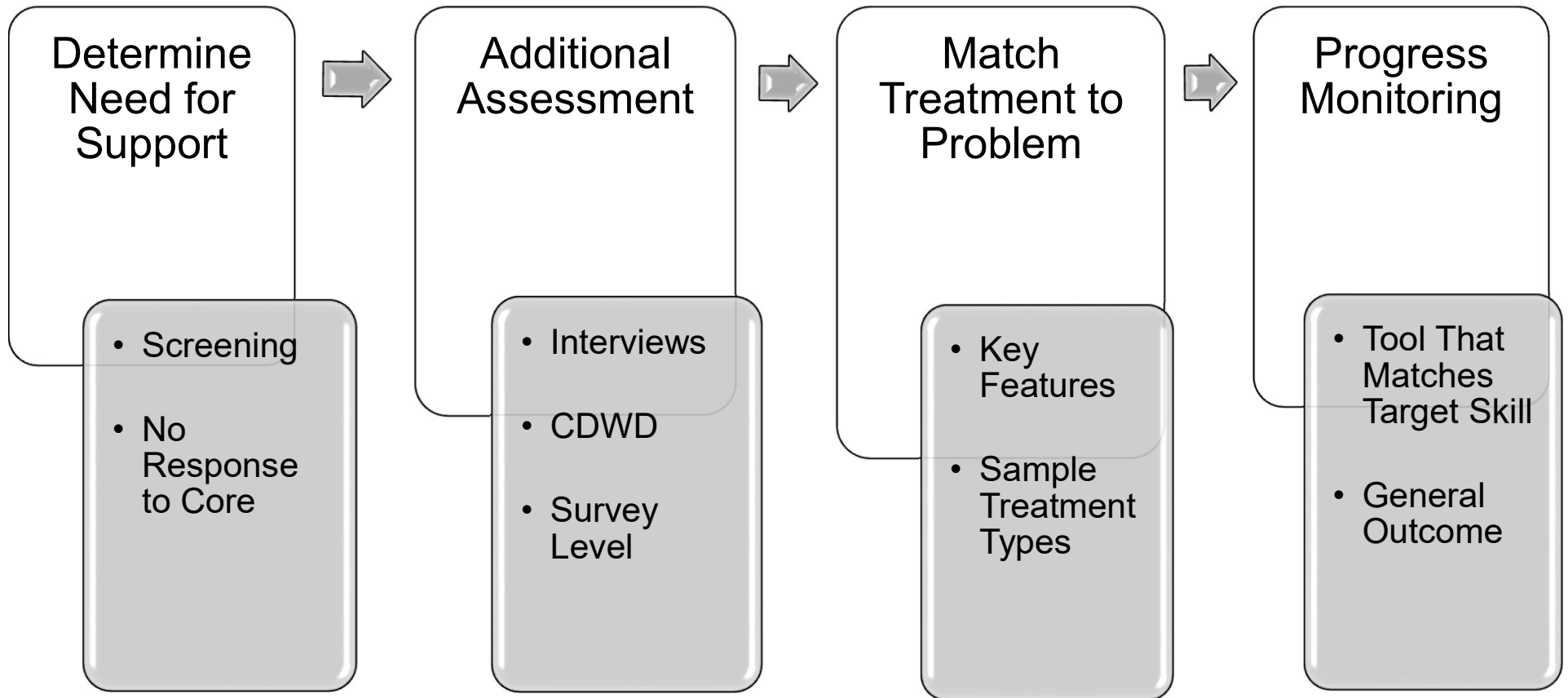
Work with your
neighbor(s) to identify
tools

- With good psychometric properties
- Feasible for implementation

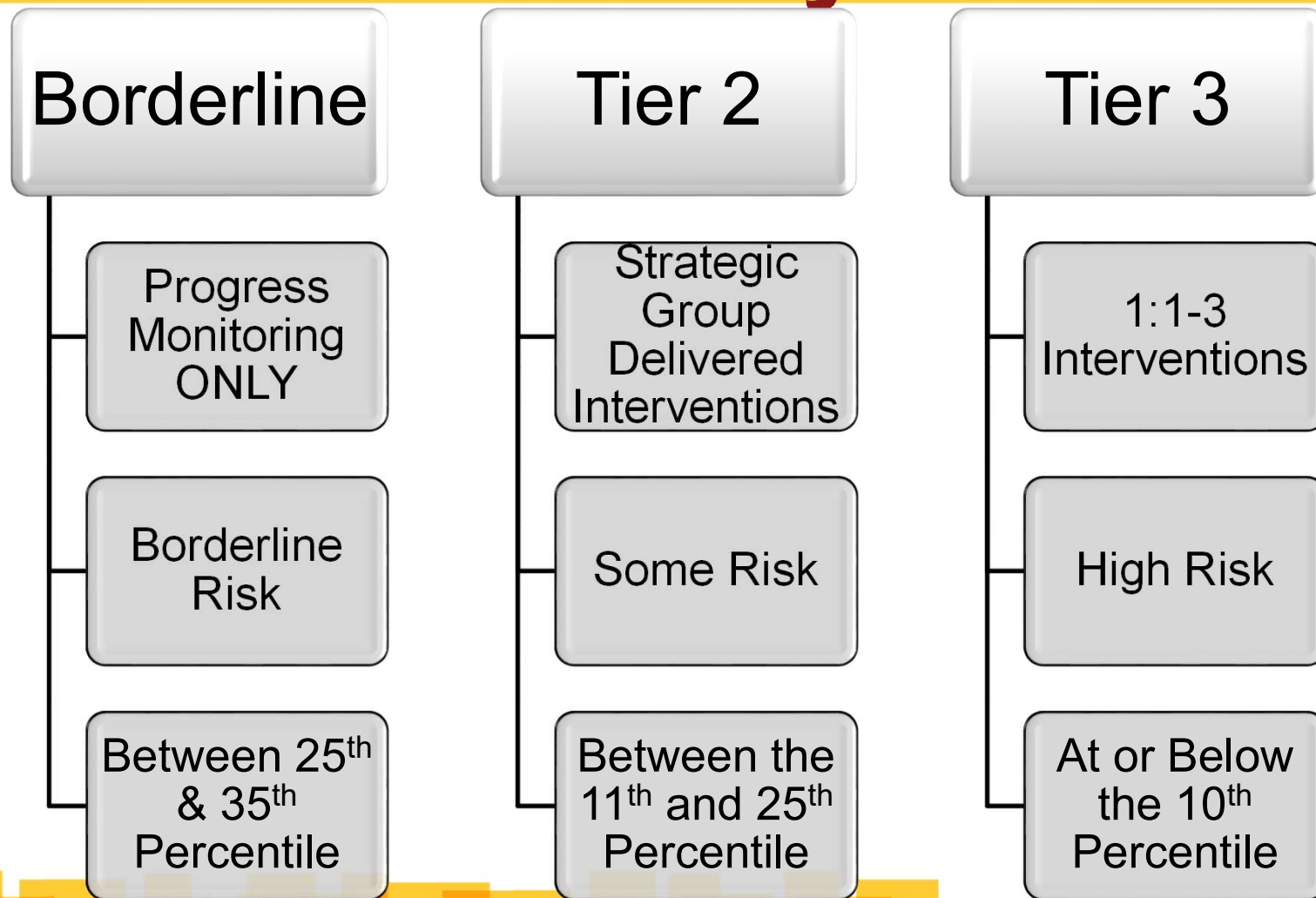


MTSS: TIERS 2 & 3

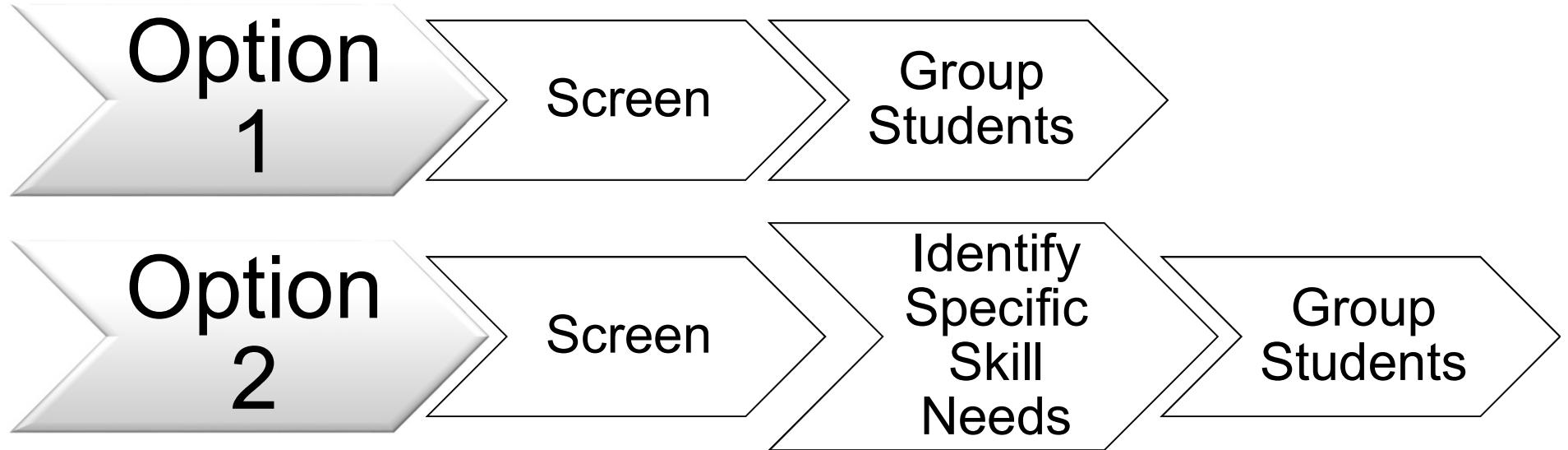
Tier 2 Process & Procedures



Guidelines for Service Delivery



How to Use Screening Data



Refine Assessment

Attendance

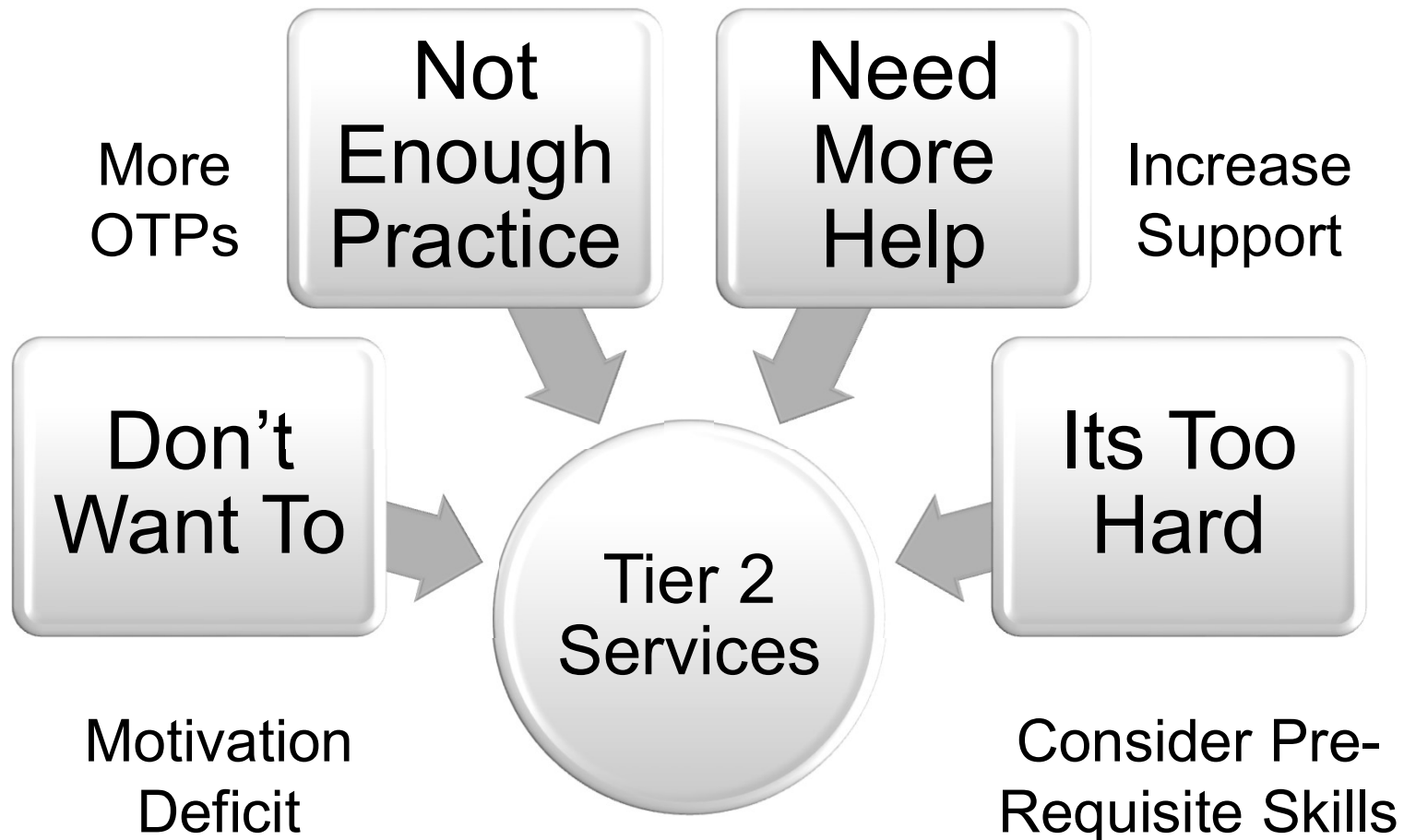
Rating Scales or Office Discipline Referrals

Interview Teacher/Student/Parent

Curriculum-based Measurement

Record Review/Report Cards

Reasons For Students' Math Difficulties



(Daly et al., 1997)

UNIVERSITY OF MINNESOTA

Skill X Treatment Interaction

Skill or Motivation Deficit?

- Can't Do, Won't Do, or Both

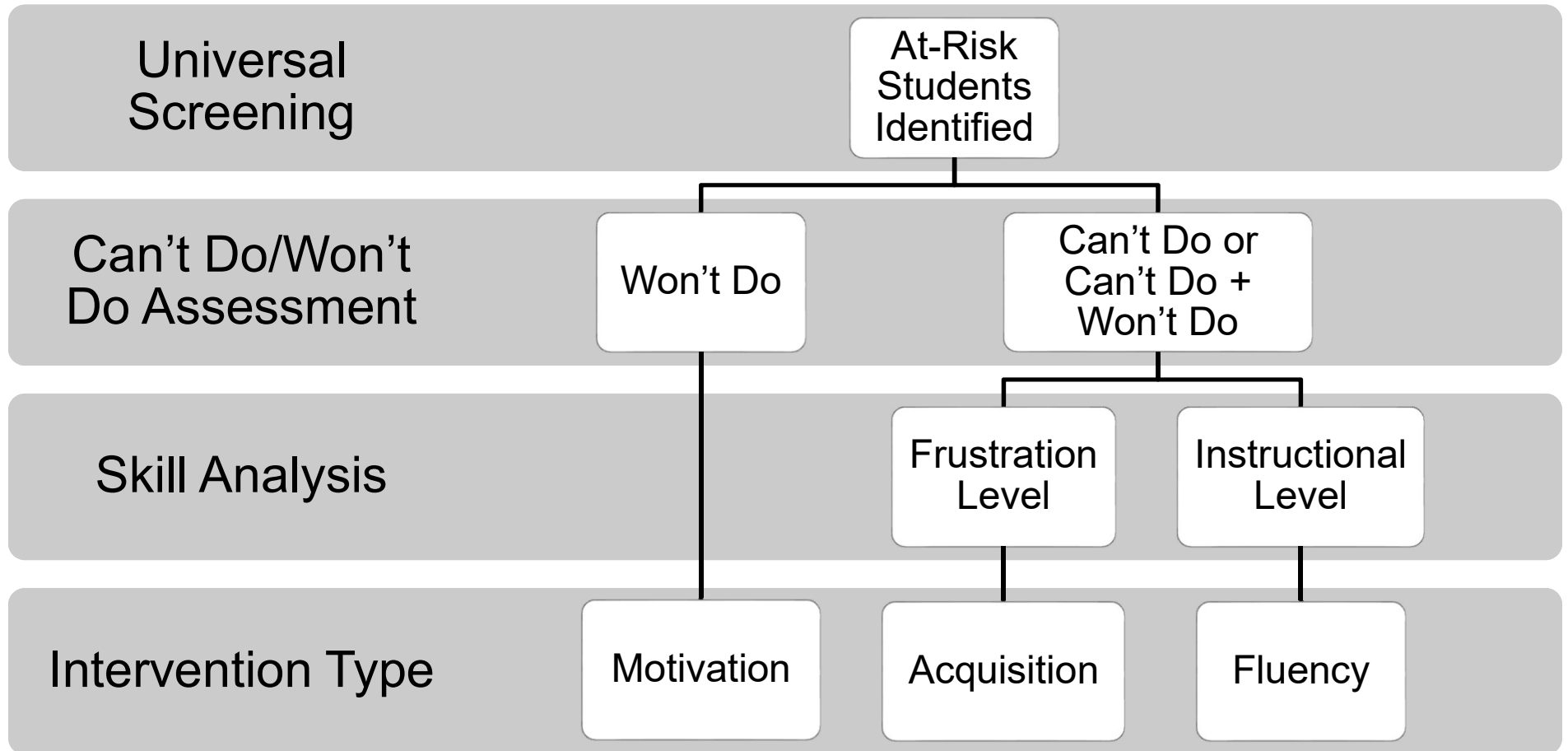
What Type of Skill Deficit?

- Acquisition (inaccurate), Fluency (accurate but slow)

Poor Instructional Match?

- Missing Pre-Requisite Skills

Assessment Framework



Can't Do/Won't Do Assessment



Materials

- Baseline CBM performance + CBM probe
- OR 2 CBM probes (alternate forms)
- “Treasure Chest” of Rewards (age appropriate)

Procedures

- Administer CBM probe using standard Instruction
- Administer another CBM probe modifying standard instructions
- A score 20% higher than the original score is rewarded

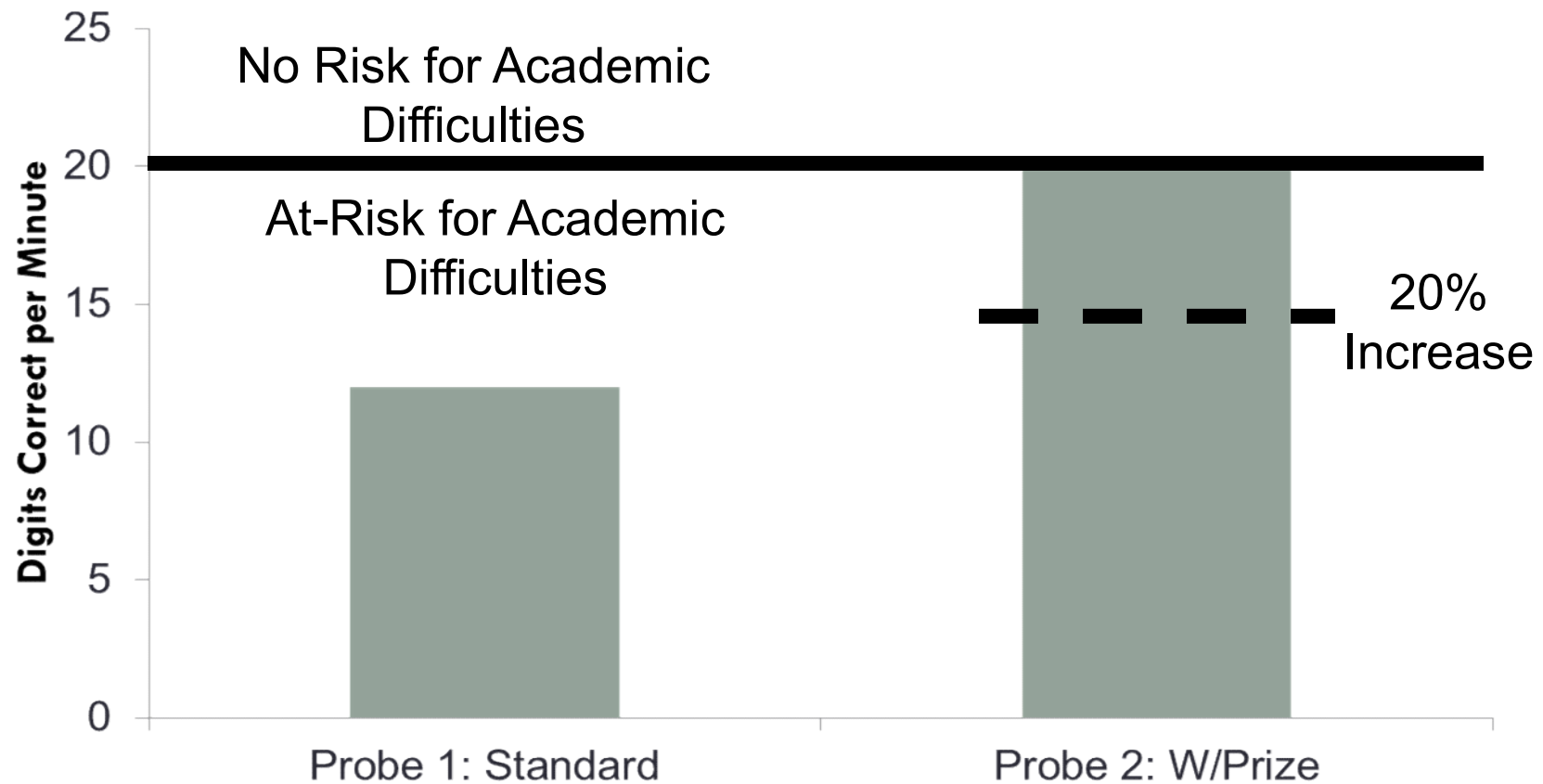
Interpretation

- Skill Deficit = similar performance
- Motivation Deficit = better with reward
- Combined = better with reward; below benchmark

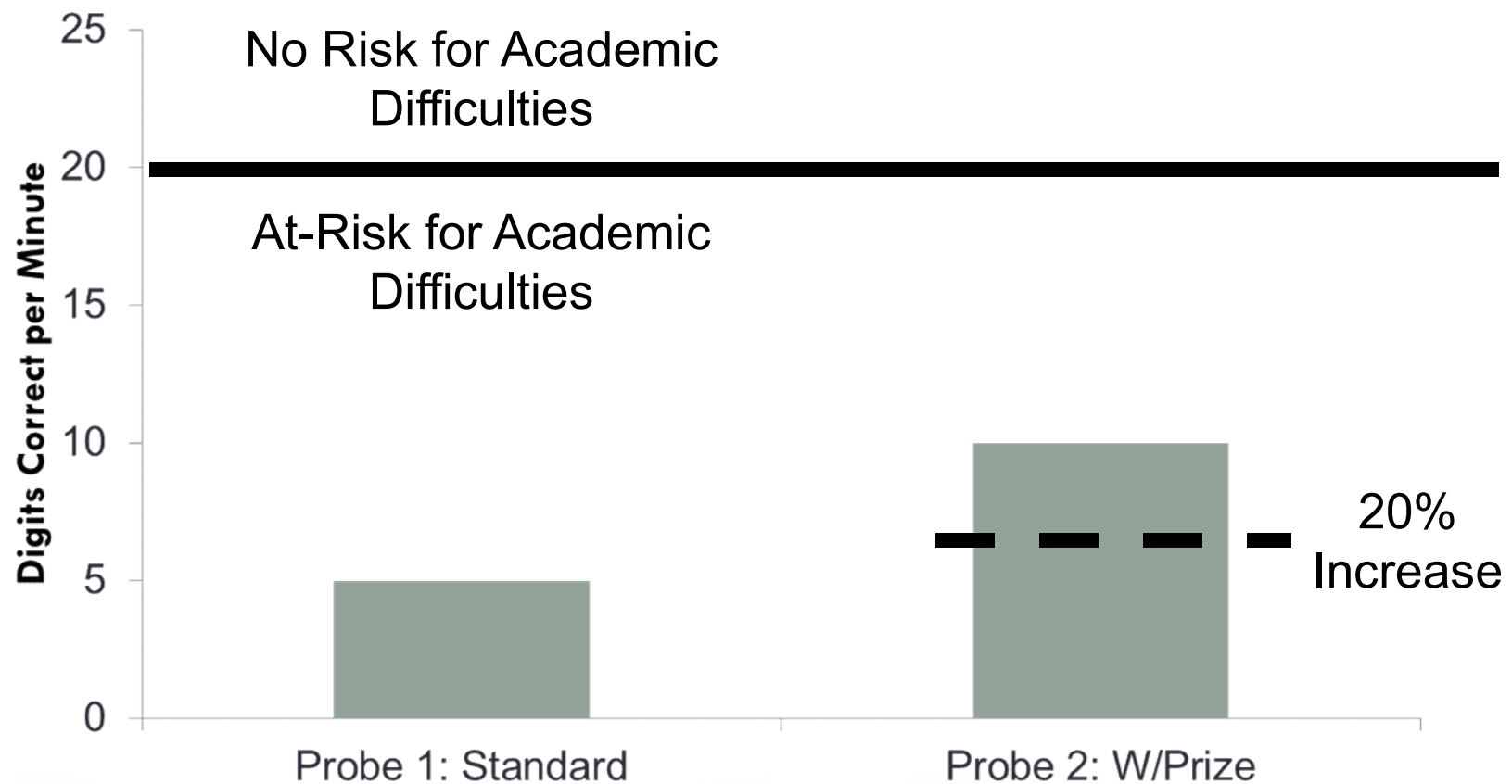
(VanDerHeyden & Witt, 2008)

UNIVERSITY OF MINNESOTA

Example 1: Can't Do/Won't Do



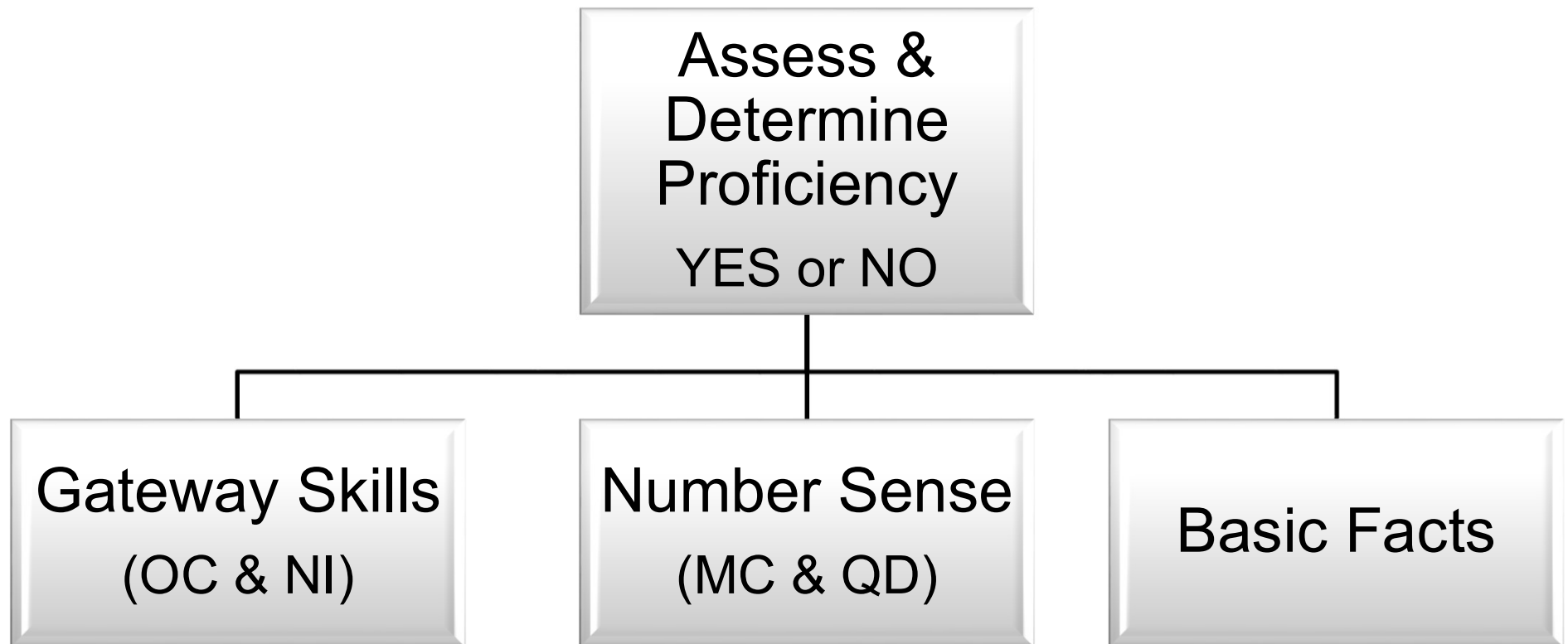
Example 2: Can't Do/Won't Do



Survey Level Assessment

Purpose	Grade Level	Target Skills	Interpretation
<ul style="list-style-type: none">Identify Specific Skill Strengths & Weaknesses	<ul style="list-style-type: none">Administer CBM-GOM in lower grade levels to find instructional level	<ul style="list-style-type: none">Determine pre-requisite skill hierarchyUse single-skill CBM or CAT & determine instructional level	<ul style="list-style-type: none">Frustration <14 DCPM <24 DCPMInstruction 14-31 DCPM 24-49 DCPMMastery >31 DCPM >49 DCPM

Early Numeracy



Computation

Add

Subtract

Multiply

Divide

Multi
Digit

Assess & Determine Proficiency
YES or NO

(Coddling, Volpe, Poncy, 2017)

UNIVERSITY OF MINNESOTA

Computation Skill Hierarchy

Operation	Skill
Addition	<ul style="list-style-type: none">• One-digit facts to 10• One-digit facts to 20• Two-digit, no regrouping• Two-digit, regrouping
Subtraction	<ul style="list-style-type: none">• One-digit facts to 10• One-digit facts to 20• Two-digit, no regrouping• Two-digit, regrouping
Multiplication	<ul style="list-style-type: none">• One-digit facts 0-2, 5• One-digit facts 3-4, 6-12• 1 x 2 digit• Multiple digits (w/ & w/o regrouping)
Division	<ul style="list-style-type: none">• One-digit facts 0-2, 5• One-digit facts 3-4, 6-12• Long division, no remainder• Long division, remainder

Application

**Measure-
ment**

**Charts &
Graphs**

Money

Fractions

**Word
Problems**

Assess & Determine Proficiency
YES or NO

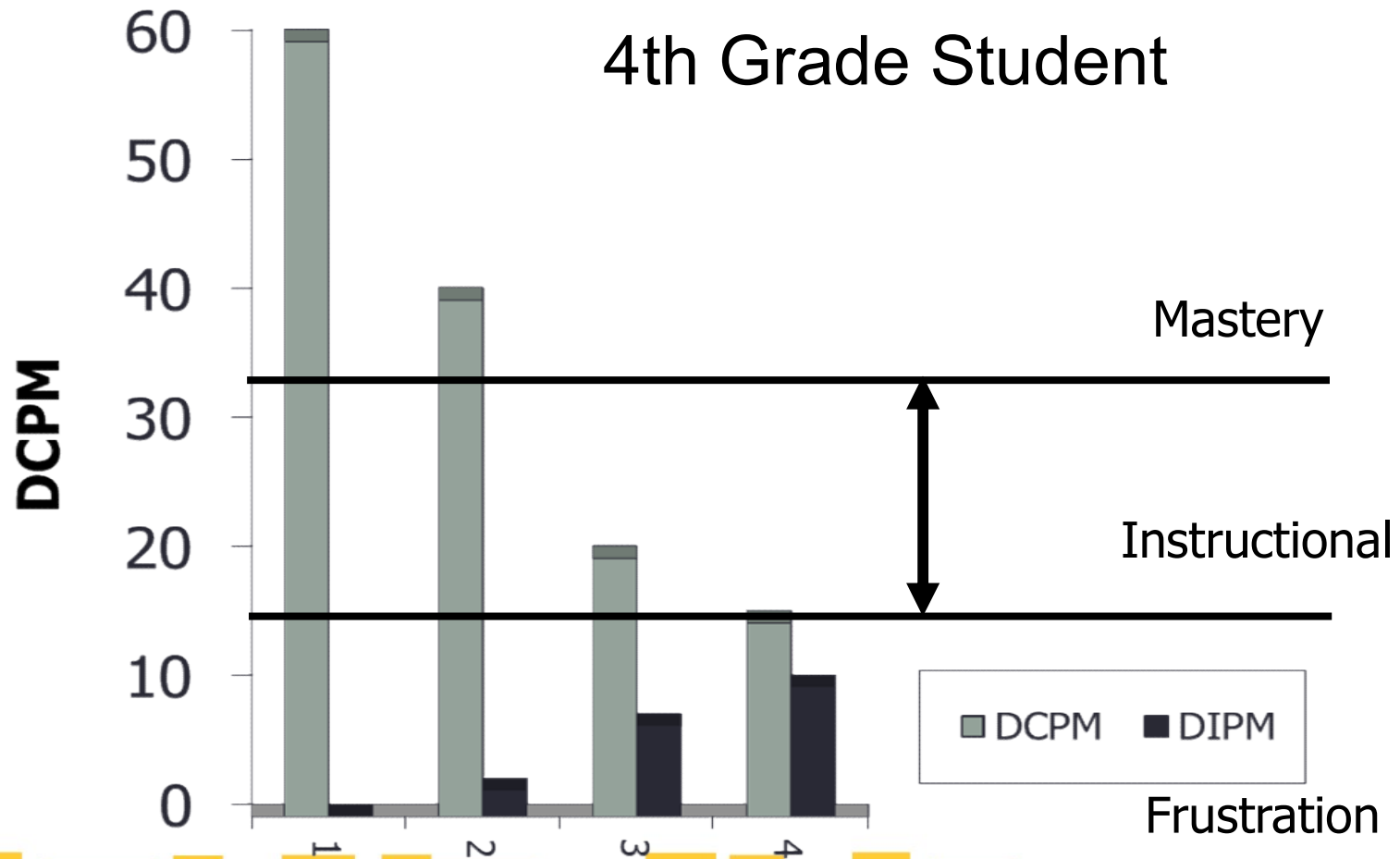
(Coddling, Volpe, Poncy, 2017)

UNIVERSITY OF MINNESOTA

Skill Benchmarks By Grade

Grade	Fractions	Geometry & Measurement
4	<ul style="list-style-type: none">Identify & Represent Fractions & DecimalsCompare Fractions & Decimals on Number Line	<ul style="list-style-type: none">Understand Concepts of Angle & Measurement Angles
5	<ul style="list-style-type: none">Compare Fractions, Decimals, & Common PercentAdd/Subtract Fractions & Decimals	<ul style="list-style-type: none">Solve Perimeter & Area Problems for Triangles and Quadrilaterals
6	<ul style="list-style-type: none">Multiplication & Division of Fractions & DecimalsAll Operations w/Positive & Negative Integers <p>(Common Core, 2010; Shapiro, 2011)</p>	<ul style="list-style-type: none">Analyze Properties of 2D ShapesSolve Perimeter & Area Problems for 2D ShapesAnalyze Properties of 3D ShapesSolve Surface Area & Volume Problems for 3D Shapes

Curriculum-based Survey Level Assessment





DELIVERING TIER 2 & 3 INTERVENTIONS

Structuring Tier 2 & 3 Services

Determine At-Risk Group of Students

Establish List of Interventions for Different Areas

- Whole Numbers, Rational Numbers, Word Problem Solving

Schedule Time for Interventions

- End of Math Block (walk for math); Study/Free Class; Content Class

Identify Interventionists

- Teaching Assistant, Para Professional, Volunteers, Librarian, Practicum Students/Interns, Special Education Teachers, Math Specialists

Identify Progress Monitoring Tools & Schedule

Evaluate Progress & Make Adjustments Accordingly

Behaviors of Students With Mathematics Problems

Poor Recall of Number Combinations (Facts)

Not Understanding Commutative Property

Ineffective Counting Strategies

Regrouping Errors

Misaligns Numbers

Trouble with Meaning of Signs (+, -, <, %)

Difficulty Solving Word Problems

Problems Implementing a Plan to Solve Word Problems

Trouble Identifying Tangential Information

Not Understanding the ? Asked

Math Language

Failing to Check Work

(Bryant, Bryant, & Hammill, 2000)

UNIVERSITY OF MINNESOTA

Frequently Cited Math Difficulties

Solving
word
problems

Multi-step
procedural
calculations

Mathematics
language

Checking
work and
answers

Automatic
recall of
basic facts

Fractions

Key Content Areas for Intervention

Kindergarten to Grade 5

- Strategic Counting
- Number Composition
- Number Decomposition
- Place Value
- Operations
(add, subtract, multiply, divide)
- Explicit Teaching of Word Problems

In Depth
Knowledge
of Whole
Numbers

Grades 4 to 8

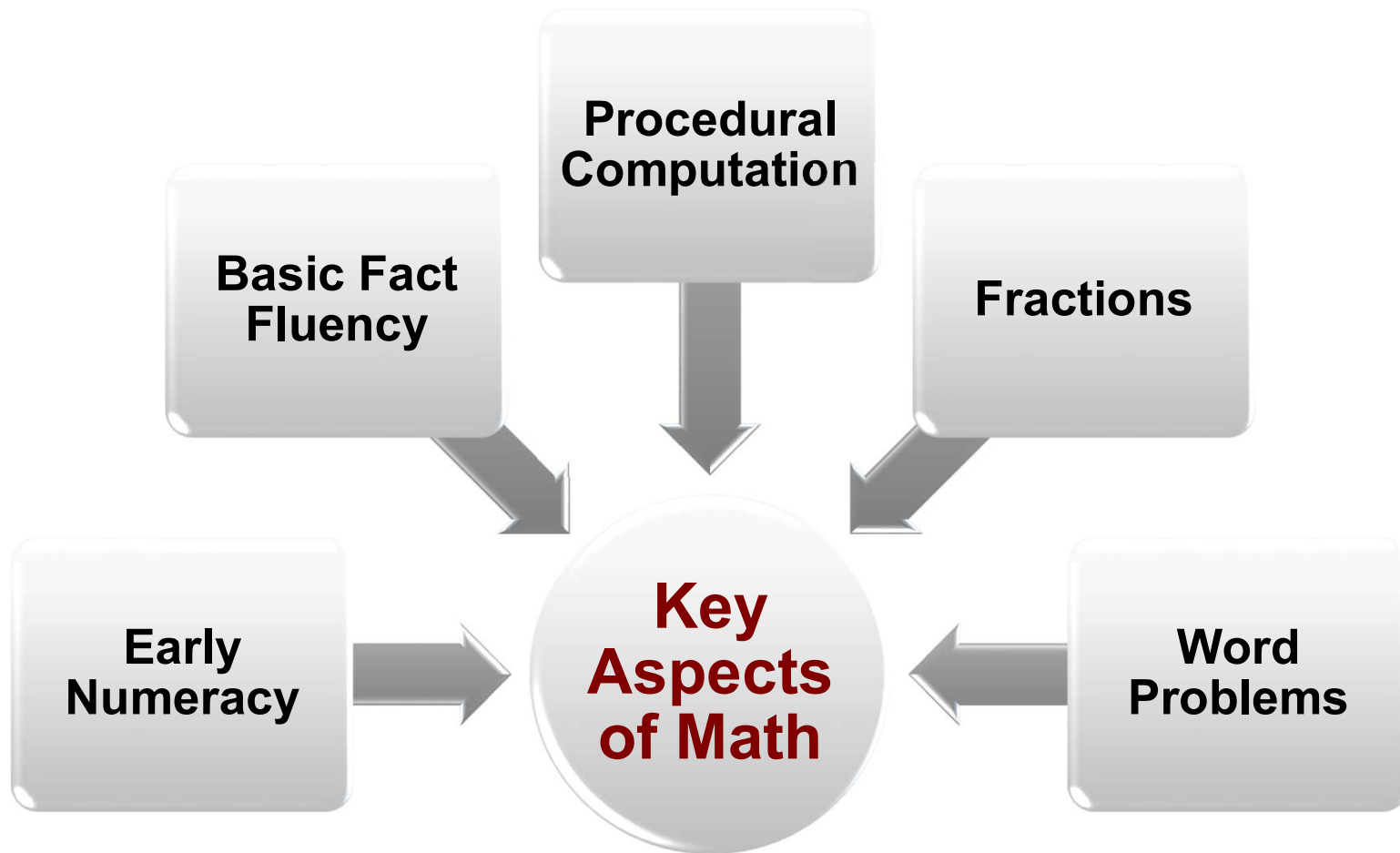
- Operations
(fractions, decimals, ratios, percentages)
- Complex Operations
(e.g., long division)
- Explicit Teaching of Word Problems

In Depth
Knowledge of
Rational
Numbers

(Gersten et al., 2009; USDOE, 2008)

UNIVERSITY OF MINNESOTA

Target Areas for Intervention



Locating Intervention Programs: Resources

Best Evidence Encyclopedia: Center For Data Driven Reform

- John Hopkins University; <http://www.bestevidence.org>

Center on Response to Intervention

- <http://www.rti4success.org/>

National Center on Intensive Interventions

- <http://www.intensiveintervention.org>

RTI Action Network

- www.rtinetwork.org

What Works Clearinghouse

- <http://ies.ed.gov/ncee/wwc/findwhatworks.aspx>

Key Active Ingredients

1. Use of Explicit & Strategy Instruction
2. Sequence Instruction: *Foundational pre-requisite skills 1st*
3. Provide Opportunities for Student Verbalization
4. Visually Represent Concepts
5. Build Fluent Retrieval of Basic Facts
6. Incorporate Motivation Strategies
7. Monitor Progress & Provide Feedback

(Burns, Coddling, Boice, & Lukito, 2010; Coddling, Burns & Lukito, 2011; Fuchs, Fuchs, Powell et al., 2008.; Baker et al., 2002; Gersten et al., 2009; Swanson, 2009)

UNIVERSITY OF MINNESOTA

Finding Treatment Matches By Examining Skill Needs

Acquisition

- **< 10 DCPM**
- **60% Accuracy**
- Explicit & Strategy Instruction
- Modeling & Concrete Examples
- Guided Practice
- Frequent Feedback on Accuracy

Acquisition/ Fluency

- **0-20 DCPM**
- **60-90% Accuracy**
- Guided Practice & Modeling
- Isolated Practice
- Concrete + Visual Representation
- Frequent Feedback

Fluency

- **20+ DCPM**
- **90% Accuracy**
- Novel & Frequent Practice
- Feedback on Fluency
- Goal Attainment & Reinforcement
- Self-Monitoring



EARLY NUMERACY INTERVENTIONS

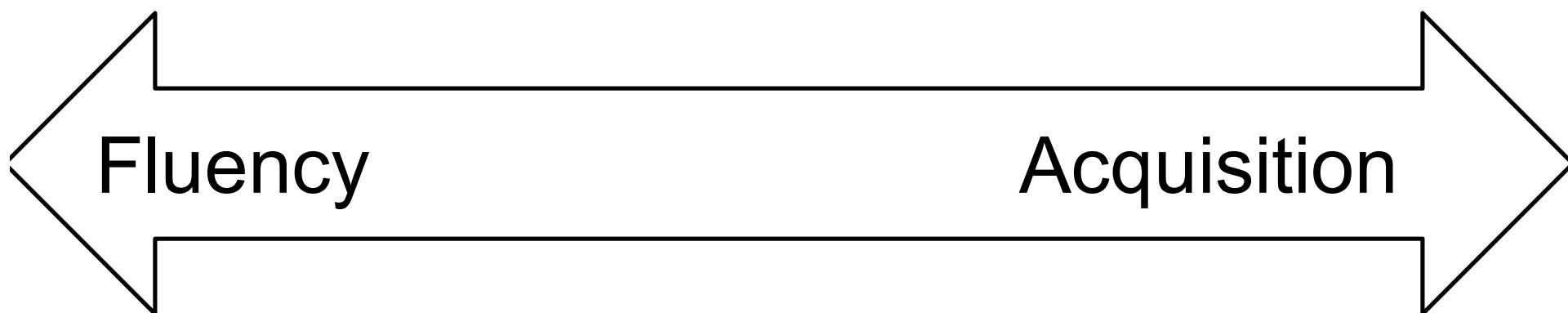


UNIVERSITY OF MINNESOTA

Early Numeracy Interventions

	Grade	Details	Topics	Length
DreamBox Learning® http://www.dreambox.com/	K-2	Online; Tailors Activities to Instructional Level	Subitizing, Counting, Magnitude Comparison, # Line, # Identification, # Writing, Part-Whole Relations, Place Value, Basic Facts, Problem Solving	90 Min Weekly
Early Numeracy Interventions Psychoeducational Services	1	Small Group Intervention Program 3-4 Times Weekly		25-30 Min
focusMath Intensive Intervention® http://www.pearsonschool.com/focusmath	K-6	Small Group or Individual Administration		45-60 Min
Fusion https://dibels.uoregon.edu/market/movingup/firstfoundation	1	Small Groups of 3-5 Students; 4-5 Days Weekly		30 Min
Number Rockets http://vkc.mc.vanderbilt.edu/numberrockets/	1	Small Group Tutoring; 3 times Weekly		40 Min
Number Sense Interventions Brookes Publishing	K	Small Group; 3 Times Weekly		30 Min
Roots https://dibels.uoregon.edu/market/movingup/kfoundation	K	Small Group, 2-3 Times Weekly		20 Min
SRA Number Worlds® (http://www.sranumberworlds.com/)	PK-8	Curricula w/Intervention Element		15-60 Min

Early Numeracy Interventions



Great Race	Number Race Adaptive Software	Dream Box Learning	ROOTS	Fusion	Number Rockets	SRA Number Worlds	Early Numeracy Interventions	Numeracy Recovery
------------	-------------------------------	--------------------	-------	--------	----------------	-------------------	------------------------------	-------------------

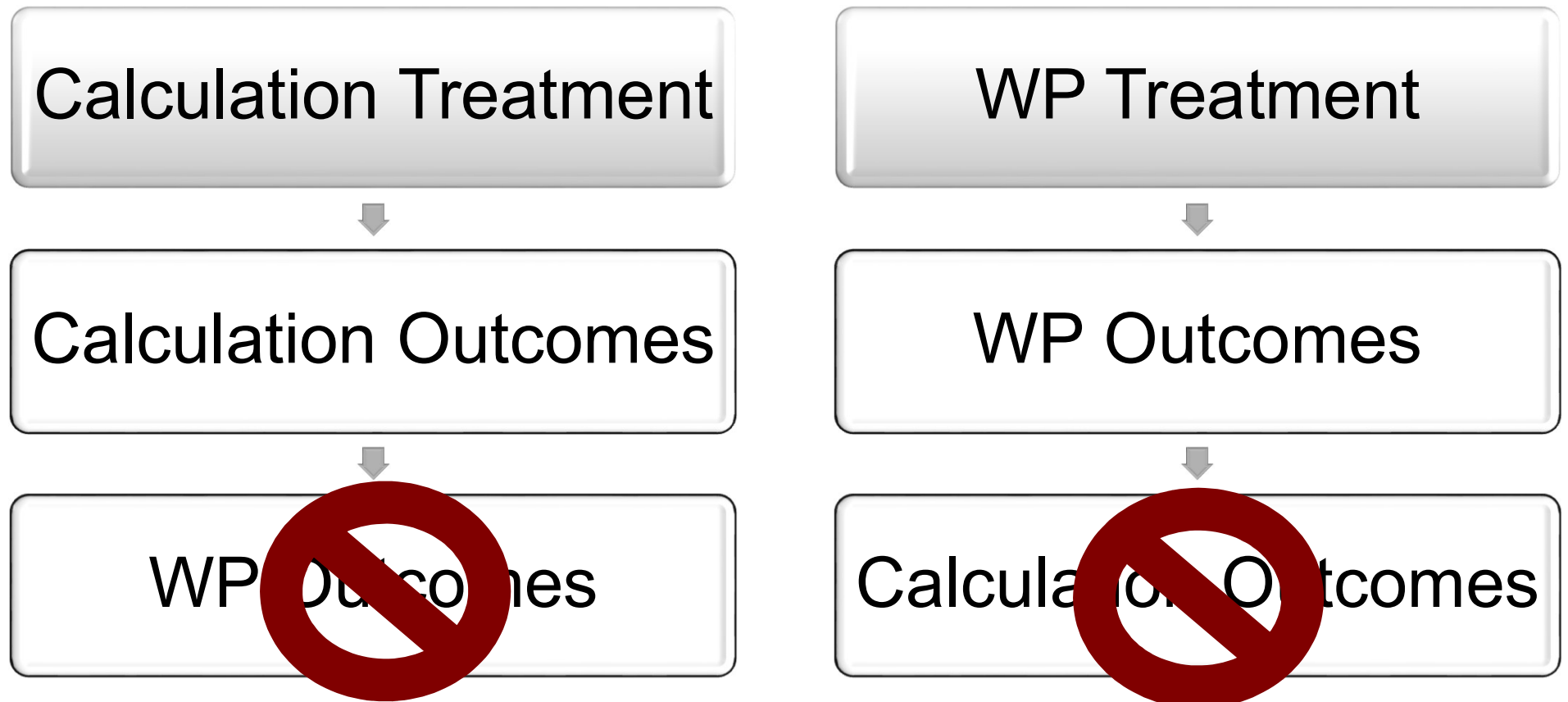


COMPUTATION INTERVENTIONS



UNIVERSITY OF MINNESOTA

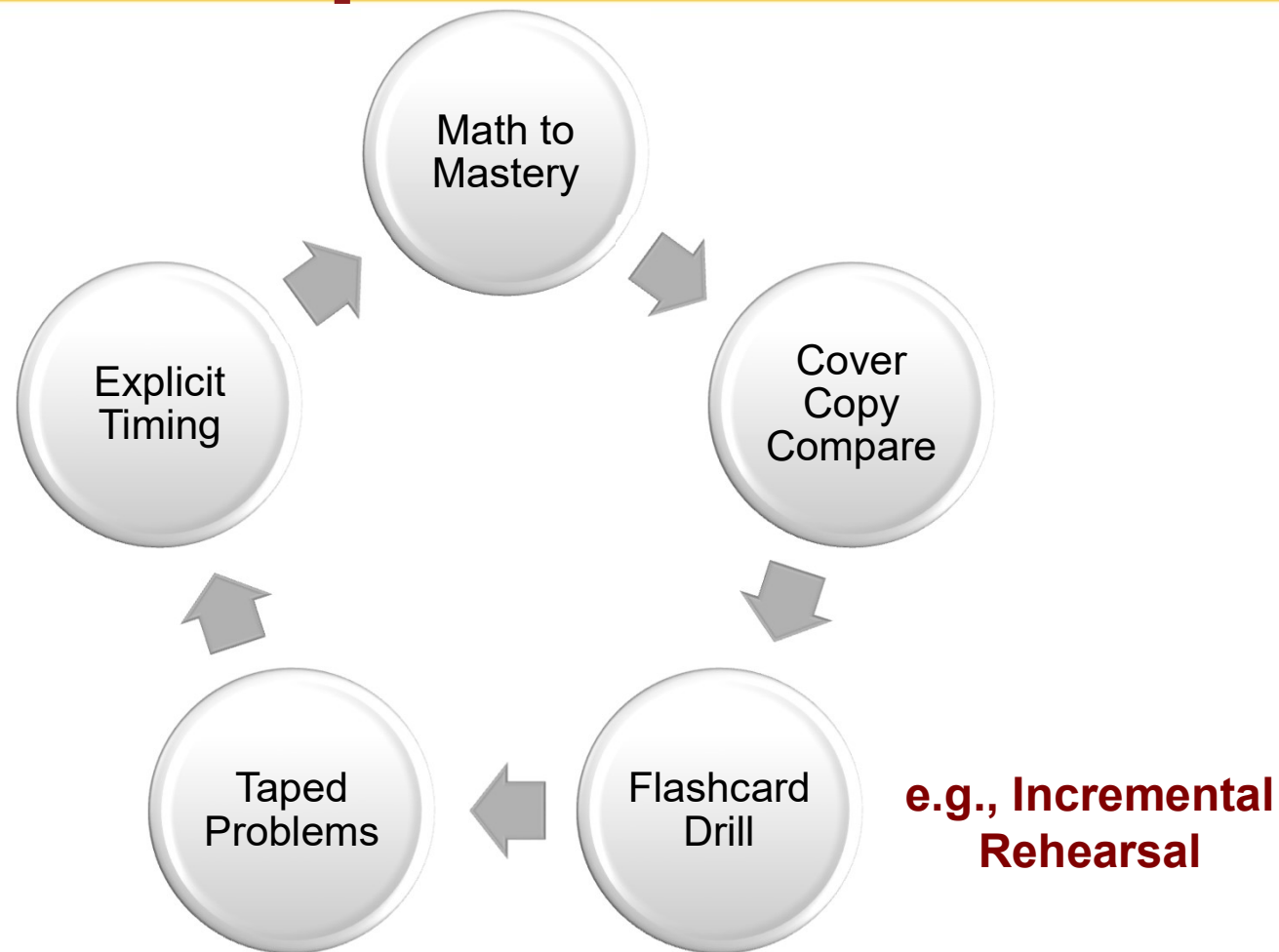
Relationship Between Computation & Word Problem Solving



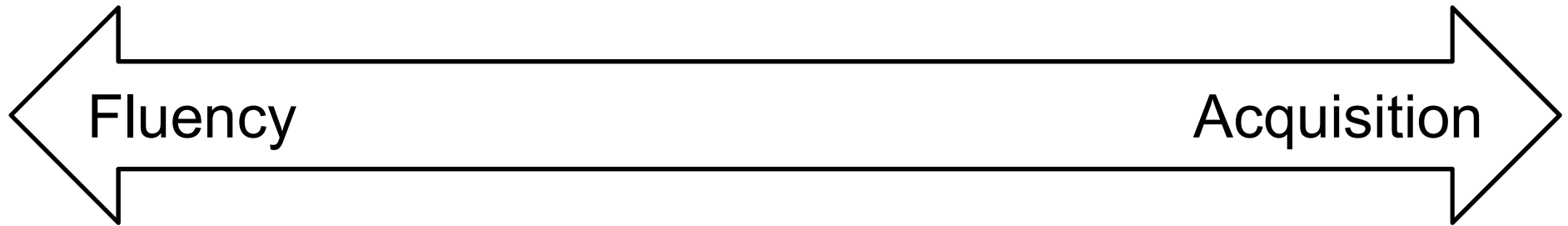
(Fuchs, L.S., Powell, S.R., Seethaler, P.M., Cirino, P.T., Fletcher, J.M., ... Zumeta, R.O., 2009; Fuchs, L. S., Powell, S. R., Cirino, P. T., Schumacher, R. F., Marrin, S., Hamlett, C. L., & ...Changas, P. C.,2014)

UNIVERSITY OF MINNESOTA

Computation Interventions with Empirical Evidence



Computation Interventions with Empirical Evidence



High Preference/ Interspersed Problems	Explicit Timing	Taped Problems	Cover-Copy- Compare	Math to Mastery	Incremental Rehearsal	Concrete Representation Abstract
---	--------------------	-------------------	------------------------	--------------------	--------------------------	--

Commercially Available Computation Interventions

	Grade	Details	Length
Academy of MATH® EPS/School Specialty Literacy and Intervention	2-12	Online tool; Small Groups; 3 Times Weekly	30 Min
Accelerated Math Renaissance Learning	1-12	Supplement; Computer Program; Comprehensive Topics	Varies
Odyssey Math CompassLearning®	K-8	Supplement; Web-Based; Comprehensive Topics	Varies
FASTT Math (Scholastic)	2-12	Independent Computer Practice	Daily
Mastery Math Facts (Crawford, 2003)	1-8	Curriculum Supplement	Daily

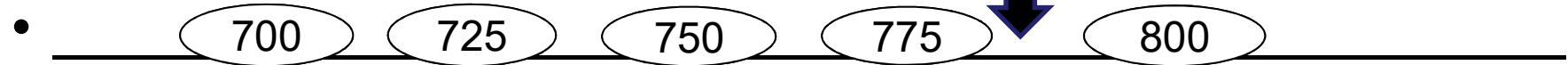
Procedural Computation (Multi-Digit)

Students need to compose and decompose large numbers by place value

- $358 \rightarrow 300 + 50 + 8$

Students should be able to use number line knowledge to estimate an answer

- $358 + 421$

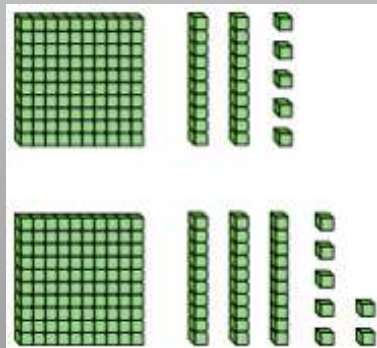


Conceptual Understanding & Visual Representation

$$\begin{array}{r} 54 \\ + 48 \\ \hline \end{array}$$

Concrete

Base-10
Blocks

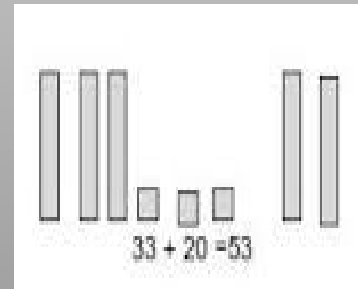


Representation

Pictures of Objects

Tallies

Number lines



Abstract

Symbolic

RENAME

R = Read the Problem

E = Examine the Ones Column

N = Note the Ones in the Ones Column

A = Address the Tens Column

M = Mark the Tens in the Tens Column

E = Examine & Note the Hundreds; Exit with a Quick Check



WORD PROBLEM SOLVING INTERVENTIONS

Visual Representation & Schema-Based Instruction

Organize Problems on Structural Features

Change (join/separate), Group (part-part-whole), & Compare

Explicit Modeling of Strategy Steps, Explanations, & Elaborations Using “Think-Alouds”

Strategy Checklists

4-Step Strategy (FOPS)

Find the Problem Type

Organize Using Diagram

Plan to Solve the Problem

Solve the Problem

3-Step Strategy (RUN)

Read the Problem

Underline Question

Name Problem Type

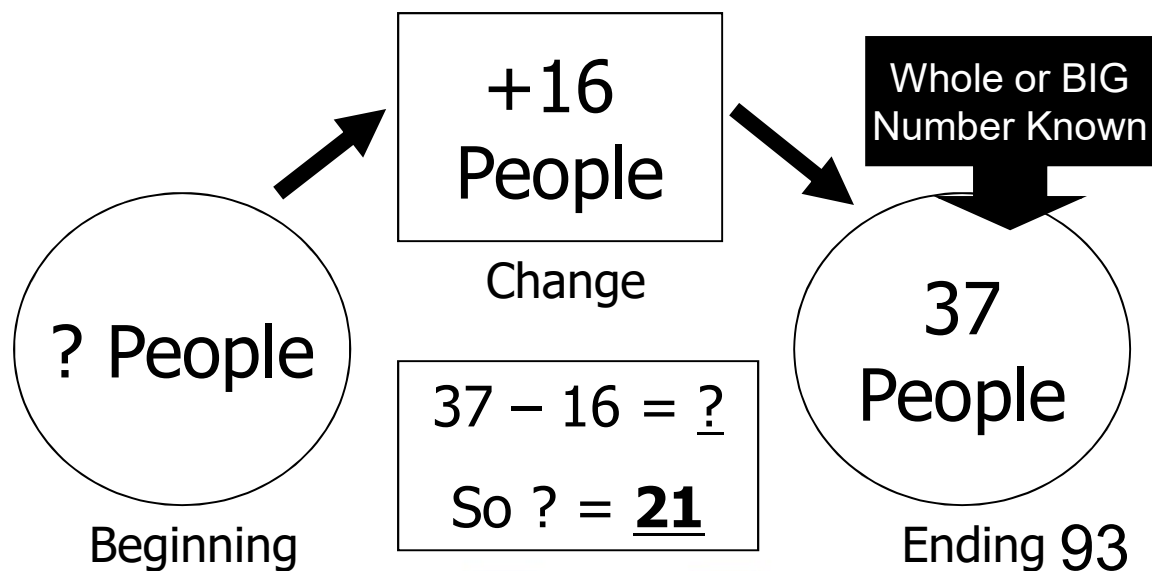
(Chard et al., 2008; Fuchs, Fuchs, Powell et al., 2008; Jitendra, 2007)

UNIVERSITY OF MINNESOTA

Sample Change Schema

CHANGE: The MBTA Number 9 bus is pulling into the Boylston Street stop. 16 people get on the bus. Now there are 37 people on the bus. How many people were on the bus before the Boylston Street stop?

(Note: based on Chard et al., 2008, p. 239)



Word Problem Solving Interventions

	Grade	Details	Topics	Length
Hot Math Tutoring http://www.kc.vanderbilt.edu/pals/	3-6	Supplement to Curricula; Small Group	Addition & Subtraction Word Problems	30 Minutes
Pirate Math http://www.kc.vanderbilt.edu/pals/	2-3	Individual; Small Group Tutoring	Addition & Subtraction Word Problems; Computation	25-30 Minutes
Solving Math Word Problems http://www.proedinc.com/	1-8	Small Group Tutoring & Computer Practice	Complex Word Problems: Add, Subtract, Multiply, Divide	30-60 Minutes
Solve It! Exceptional Innovations: http://www.exinn.net/solve-it.html http://sites.education.miami.edu/solveit/	5-12	Curriculum Supplement	Applying Cognitive Strategy Instruction to Word Problem Solving	3 Times Weekly



FRACTIONS

Recommendations for Fractions

Table 2. Recommendations and corresponding levels of evidence

Recommendation	Levels of Evidence		
	Minimal Evidence	Moderate Evidence	Strong Evidence
1. Build on students' informal understanding of sharing and proportionality to develop initial fraction concepts.	◆		
2. Help students recognize that fractions are numbers and that they expand the number system beyond whole numbers. Use number lines as a central representational tool in teaching this and other fraction concepts from the early grades onward.		◆	
3. Help students understand why procedures for computations with fractions make sense.		◆	
4. Develop students' conceptual understanding of strategies for solving ratio, rate, and proportion problems before exposing them to cross-multiplication as a procedure to use to solve such problems.	◆		
5. Professional development programs should place a high priority on improving teachers' understanding of fractions and of how to teach them.	◆		

(Siegler, Carpenter, Fennell, Geary, Lewis, Okamoto, Thompson, & Wray, 2010, p.11)

UNIVERSITY OF MINNESOTA

1. Equal Sharing Activities

Problems Require Equal Sharing of Objects



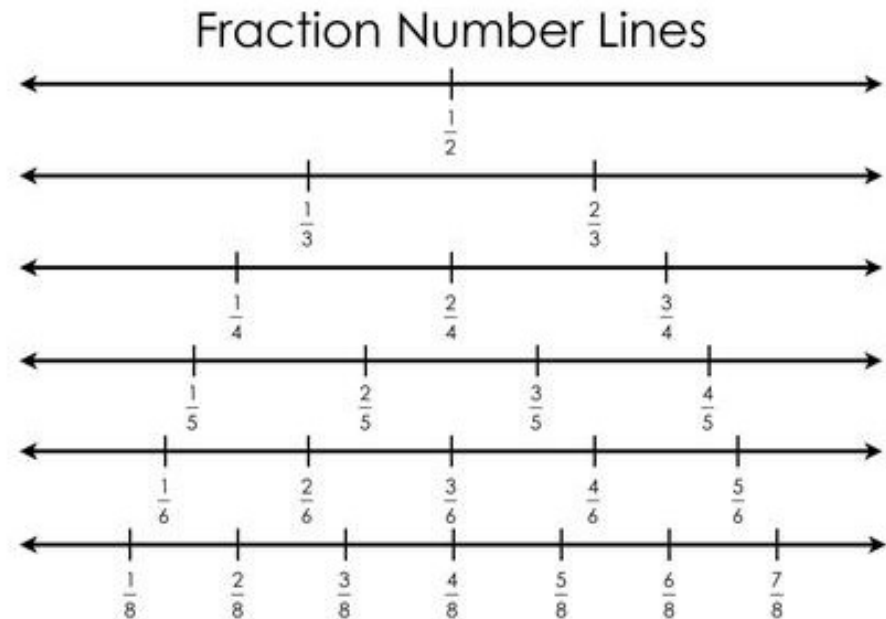
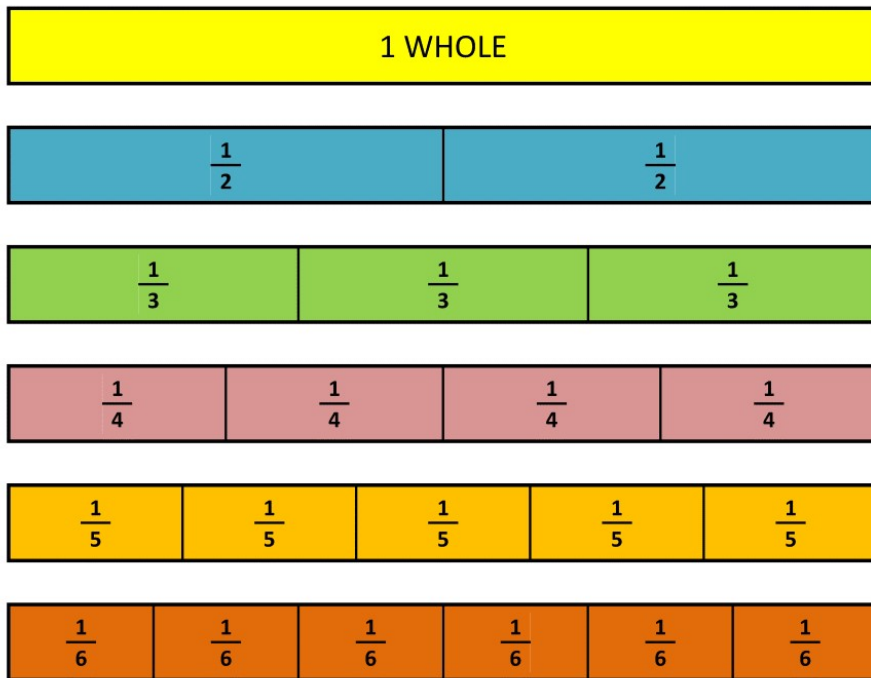
Problems Divide 1 Object into Equal Parts (e.g., $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{9}$, etc.)



Problems Require Sharing a Set of Objects among Multiple People (e.g., $\frac{3}{4}$)



2. Fractions are Numbers with Magnitudes



$$\frac{3}{4} = \frac{6}{8} = \frac{9}{12} = 0.75 = 75\%$$

3. Procedures for Computation with Fractions

Use Visual Representations

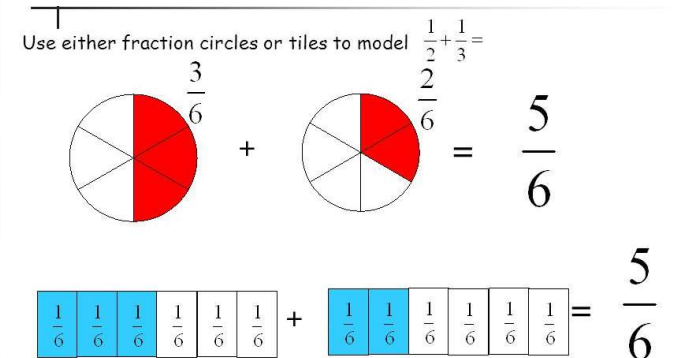
Use Estimation

Address Common Misconceptions

- e.g., failing to find the common denominator

Use Real World Measuring Contexts

- Rulers, Pizza, Carton of Eggs





PROGRESS MONITORING

Progress Monitoring Basics

- Scientifically based practice used to assess academic performance & evaluate effectiveness of instruction
- Tools need to be: **efficient, valid, reliable, sensitive to growth, have multiple forms**
- Progress toward meeting the student's goals is measured by comparing expected and actual rates of learning

	General Outcome Measure	Mastery or Curriculum-Embedded Measures
Borderline Risk	Monthly	----
Tier 2	Bi-Weekly or Monthly	Daily, Weekly
Tier 3	Bi-Weekly or Monthly	Daily, Weekly

(Gersten et al., 2009; Salvia, Ysseldyke, & Bolt, 2007)

UNIVERSITY OF MINNESOTA

Monitor Student Progress TWO Ways

General Outcome Measure

Curriculum-Embedded/Mastery Measure

Are Students Making Progress on Grade Level Skills?

Grade Level Content

Can Be Consistent with Screening Tool

Specific Sub-Skills

Measures Mastery on Smaller Aspects

Are Students Learning Each Skill Along the Way?

Progress Monitoring Tools

- **Curriculum-Based Measurement (CBM)**

- AIMSweb
- DIBELS Math
- EASYcbm
- mCLASS: Math
- Monitoring Basic Skills Progress
- iSTEOP
- Yearly Progress Pro

- **Computer Adaptive Tests (CAT)**

- FAST/FAST BRIDGE
- STAR

intensiveintervention.org/chart/progress-monitoring?grade=all&subject=math

National Center on
INTENSIVE INTERVENTION
at American Institutes for Research

Coaches' Corner

Signup for our newsletter and updates!
Join

Search
Advanced Search

Resources Tools Charts Implementation Support Instructional Support About Us

Home > Tools Charts >

Academic Progress Monitoring GOM

This tools chart presents information about academic progress monitoring tools. The three tabs, *Psychometric Standards*, *Progress Monitoring Standards*, and *Data-based Individualization Standards* include ratings from our TRC members on the technical rigor of the tool. **Additional information** is provided below the chart.

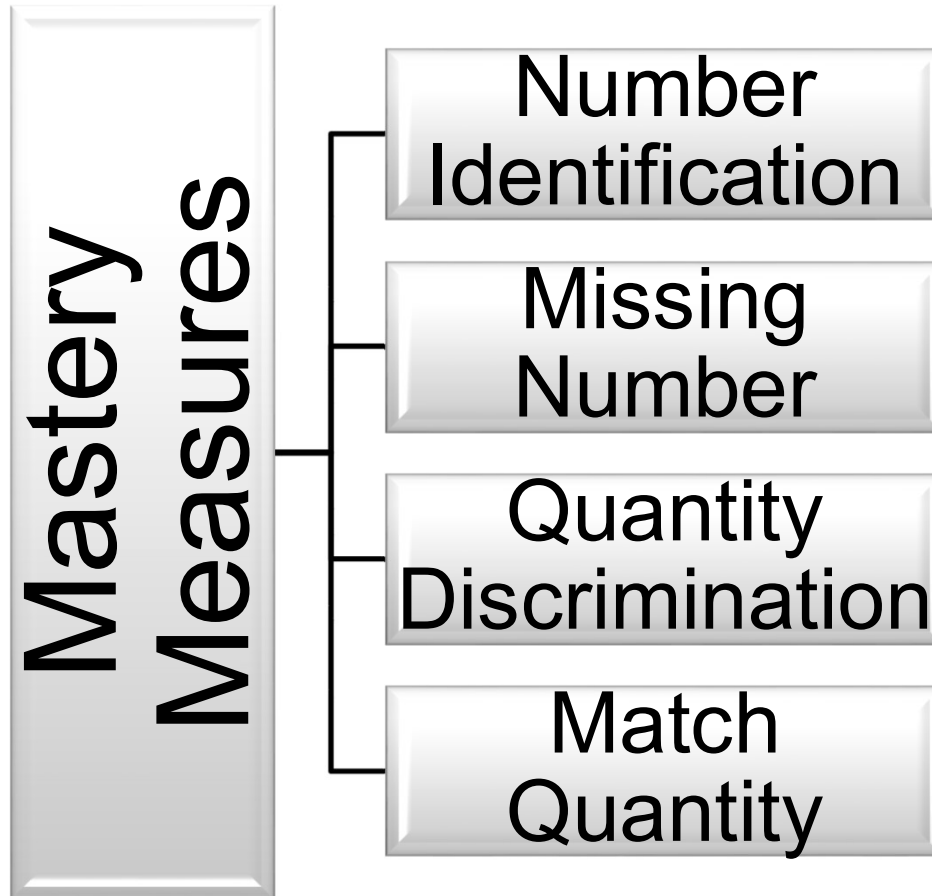
View the **Progress Monitoring Mastery Measures** >

Grade Level: - Any - Subject: Math Apply

Psychometric Standards Progress Monitoring Standards Data-based Individualization Standards

Title	Area	Reliability of the Performance Level Score	Reliability of the Slope	Validity of the Performance Level Score	Predictive Validity of the Slope of Improvement	Disaggregated Reliability and Validity Data
AIMSweb	Test of Early Numeracy - Number ID					
AIMSweb	Test of Early Numeracy - Oral Counting					

Early Numeracy Options



- FASTBridge earlyMath
- AIMSweb TEN
- mCLASS: Math
- DIBELS Math

Computation Options

Mastery Measures

M-CBM for Each Operation

2x1/2 Digit

2x3 Digit

- Accelerated Math
- AIMSweb M-CBM

Online CBM Progress Monitoring Tools

Content Available

- Single Skill Computation
- Multi-digit Computation
- Fractions
- Decimals
- Word Problems

Free Resources

- Intervention Central
 - www.interventioncentral.org
- Math Fact Café
 - <http://www.mathfactcafe.com>
- The Math Worksheet Site
 - <http://themathworksheetsite.com/>
- SuperKids Math Worksheet Creator
 - <http://superkids.com/aweb/tools/math/>
- Facts on Fire
 - www.factsonfire.com

Progress Monitoring & Mastery Tools

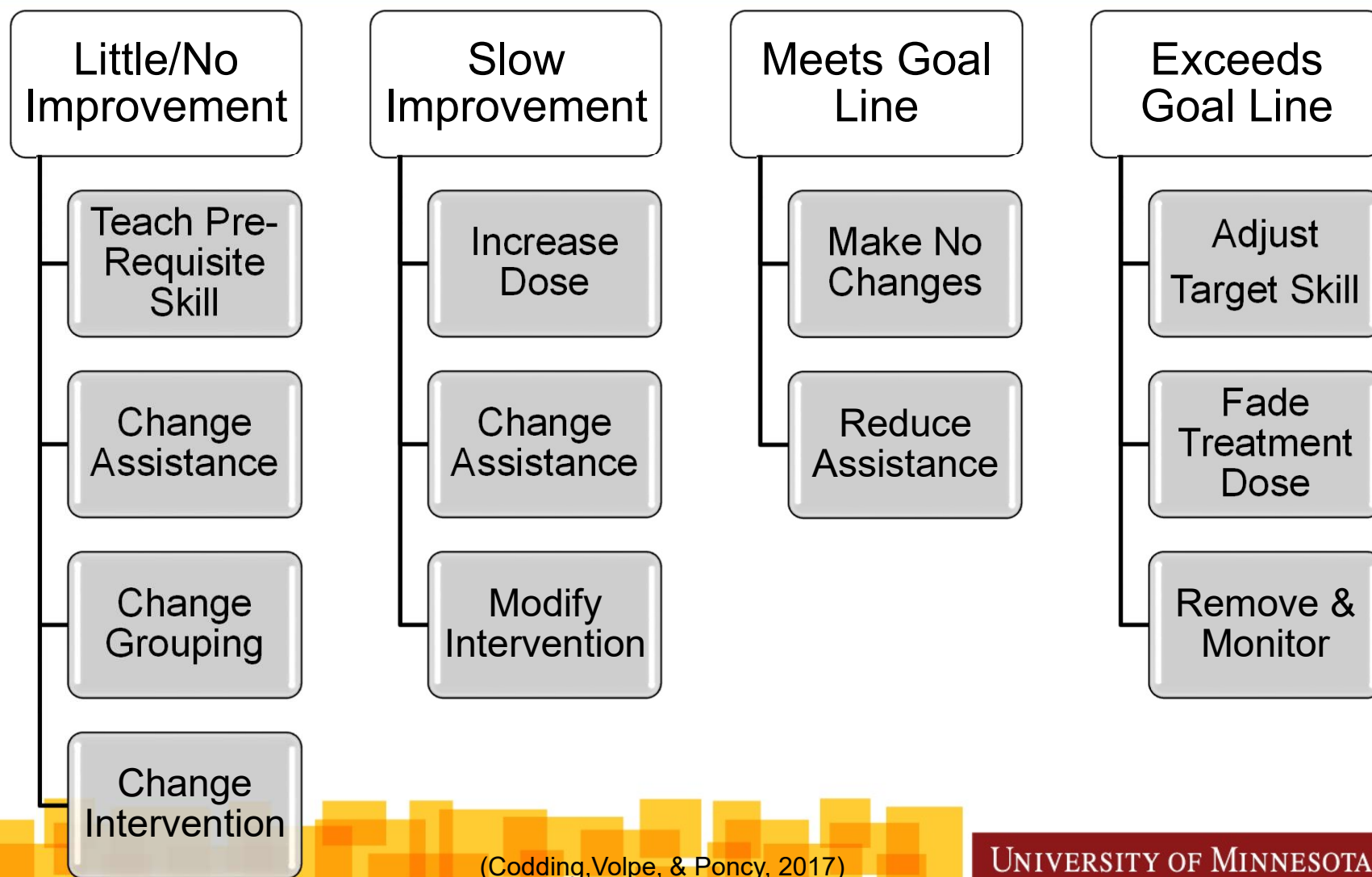


- Work with your neighbor(s) to identify tools
 - With good psychometric properties
 - Feasible for implementation



EVALUATING RESPONSIVENESS

Data-Based Decision Making



(Coddington, Volpe, & Poncy, 2017)

UNIVERSITY OF MINNESOTA

Fine Tuning Intervention Supports with Assessment

Implement a Brief Experimental Analysis

- Tests Different Intervention Strategies

Administer a Fact Assessment

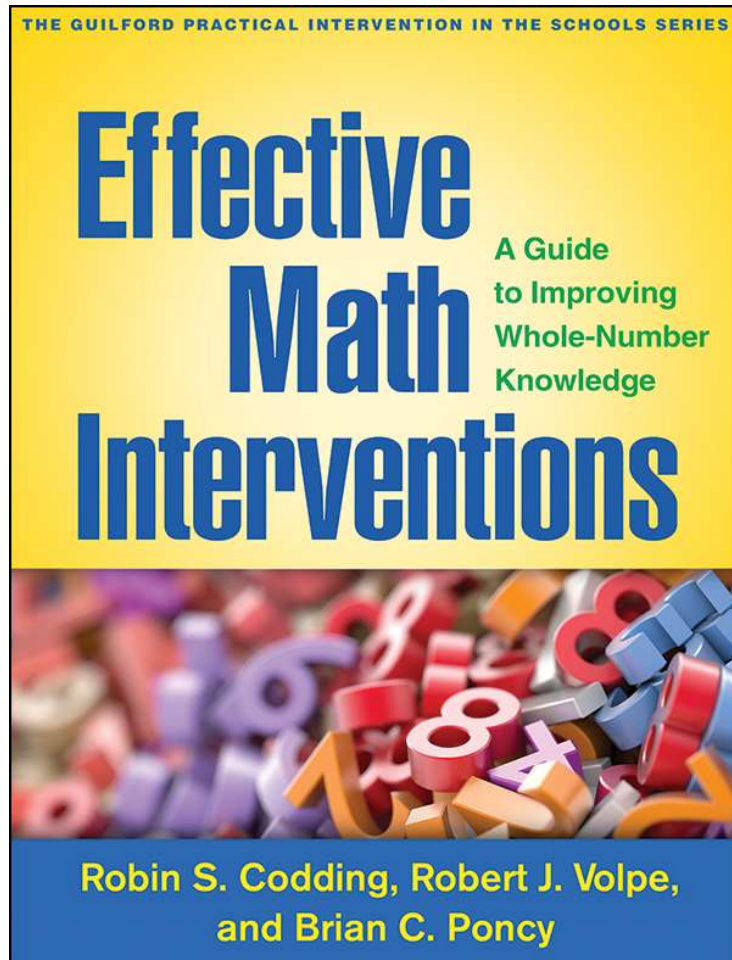
- Determines Knowns and Unknowns of Basic Facts

Conduct an Error Analysis

- Determine Error Patterns

Interview a Student

- Assess the HOW or WHY of Problem Solving
- Student Explains or Demonstrates Understanding



<http://www.guilford.com/books/Effective-Math-Interventions/Coddling-Volpe-Poncy/9781462528288>

Establishing a Multi-Tiered System of Support for Mathematics

Robin S. Coddling, Ph.D., BCBA
rcoddling@umn.edu

Ohio School Psychologists Association

Friday, November 11, 2016
Columbus, Ohio

UNIVERSITY OF MINNESOTA