Classwide Math Intervention

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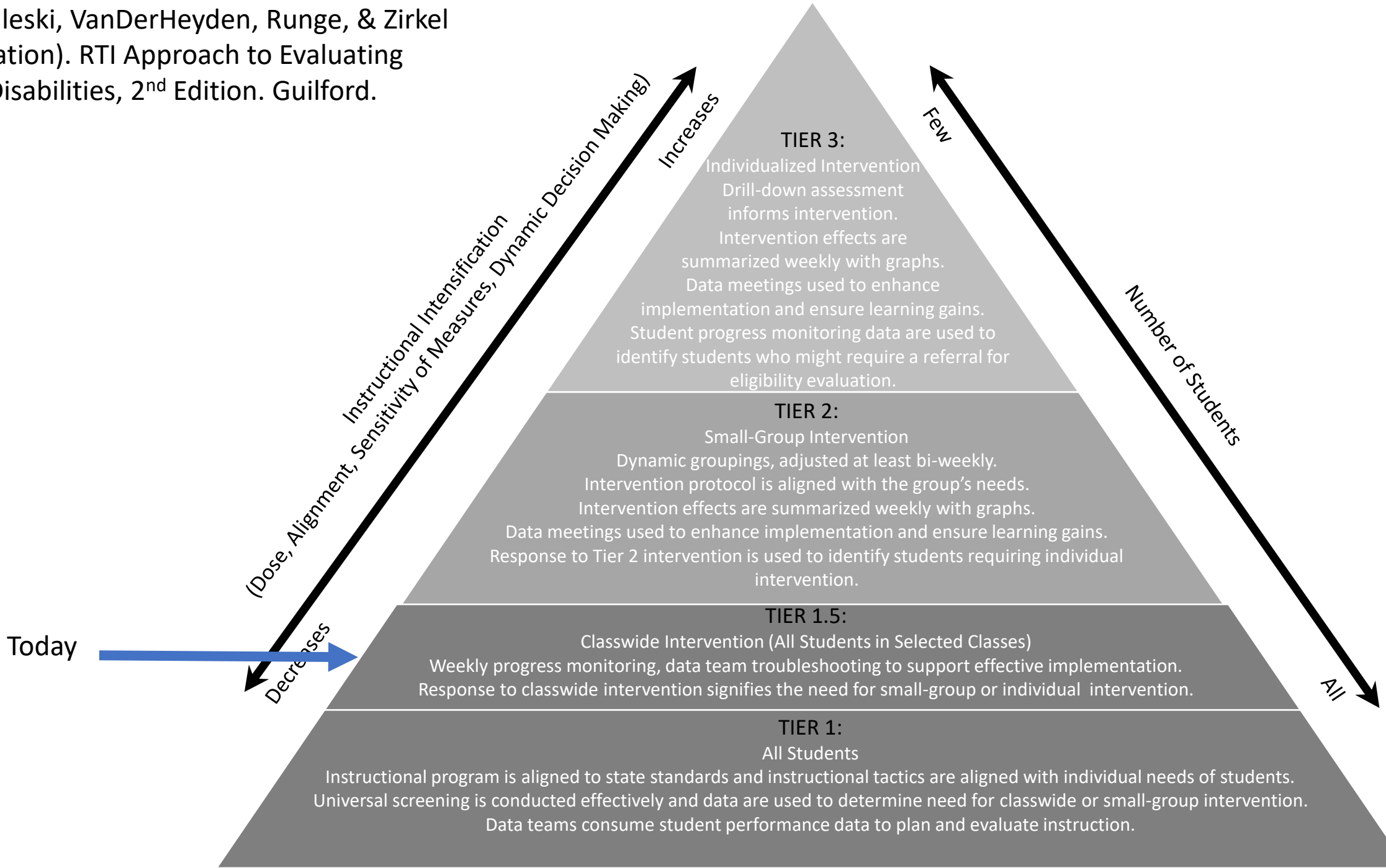
All these kids been learning Common Core math, bout to learn how to "Carry the One" from their new homeschool teachers.

From Kovaleski, VanDerHeyden, Runge, & Zirkel (in preparation). RTI Approach to Evaluating Learning Disabilities, 2nd Edition. Guilford.



Math Success is Highly Predictable (so is risk)

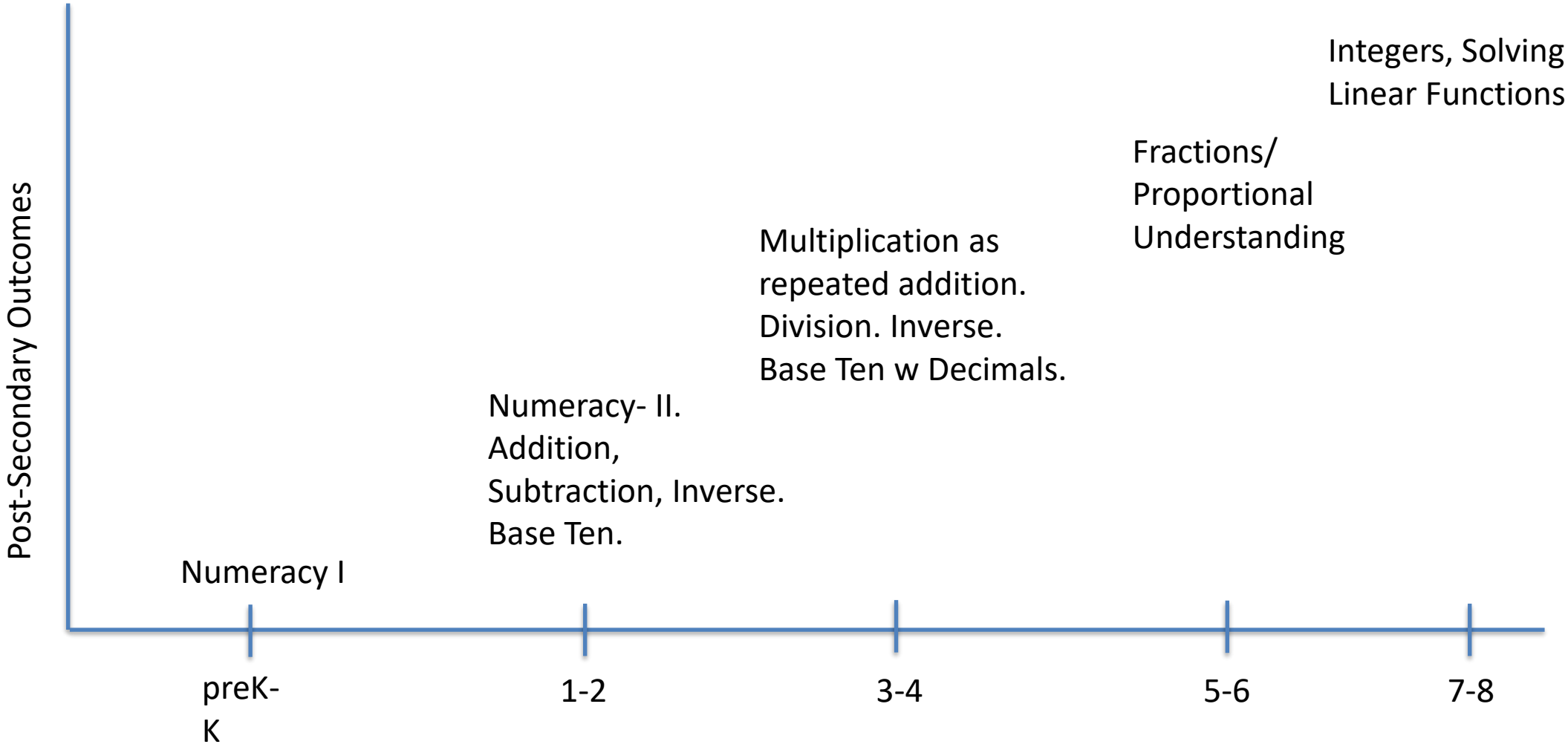
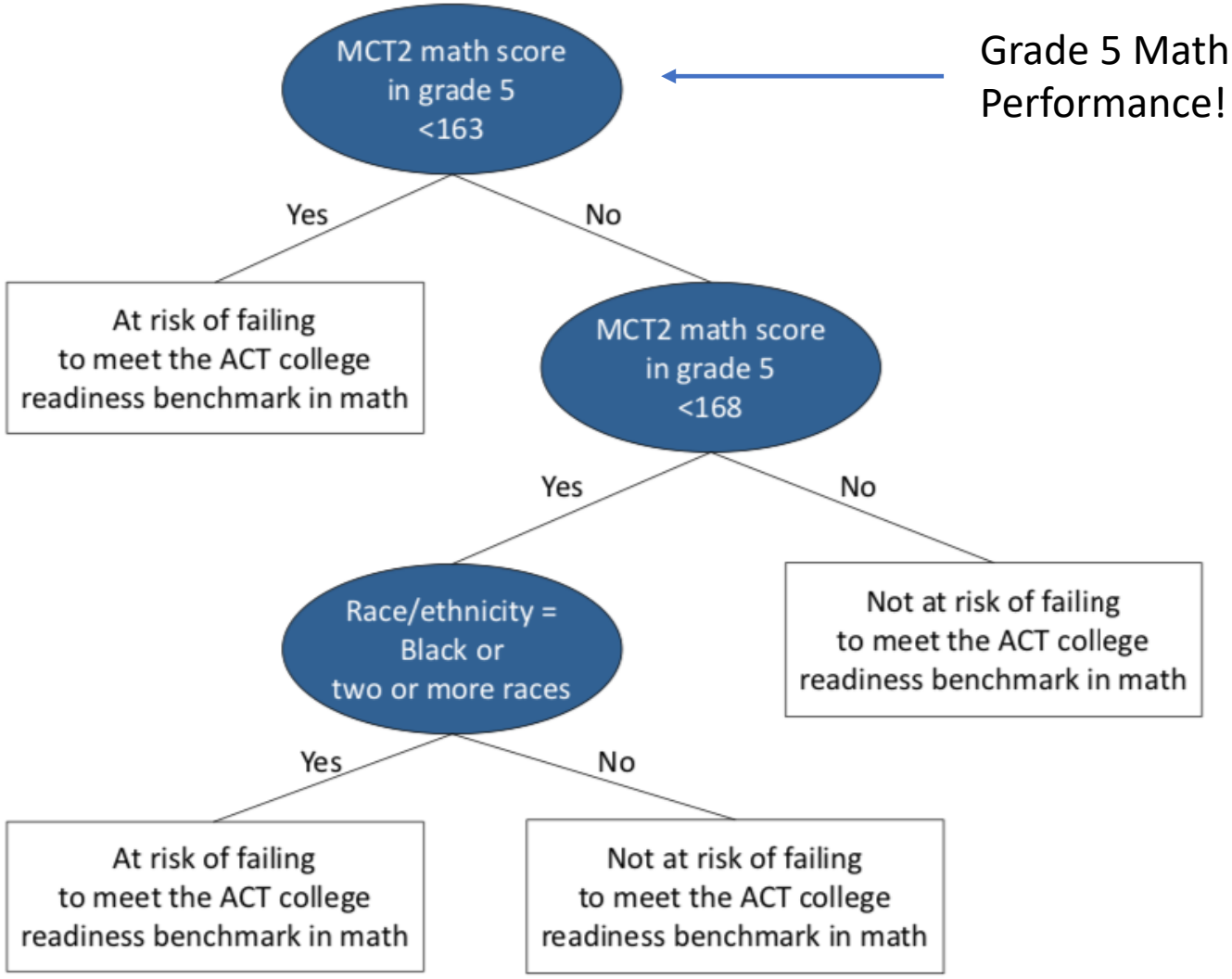


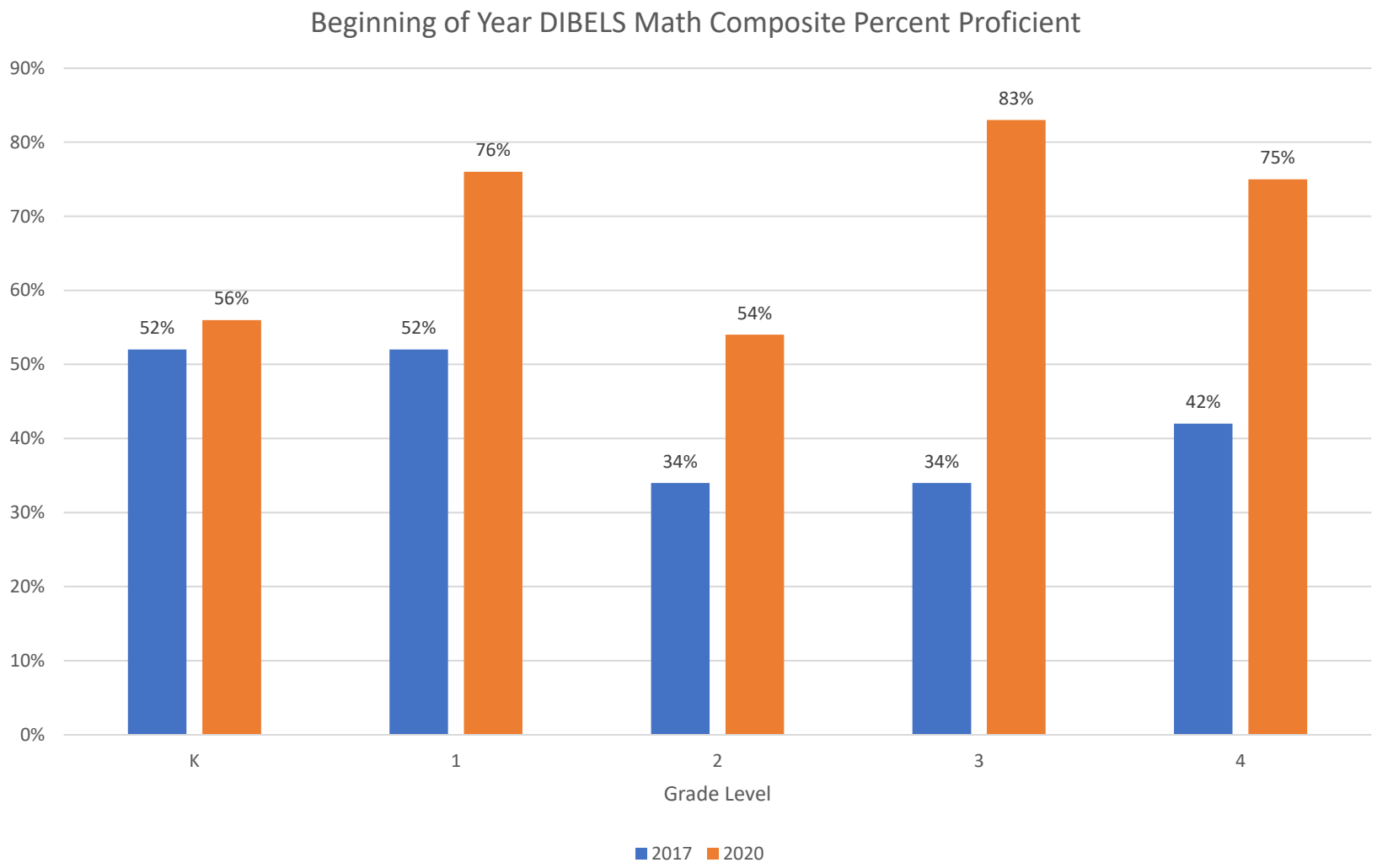
Figure 2. Classification and regression tree model decision rules for identifying Mississippi students as at risk of failing to meet the ACT college readiness benchmark in math, based on grade 5 math achievement and race/ethnicity, 2011/12–2016/17



Grade 5 Math Performance!!

Koon, S., & Davis, M. (2019). Math course sequences in grades 6–11 and math achievement in Mississippi (REL 2019–007). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Southeast. Retrieved from http://ies.ed.gov/ncee/edlabs

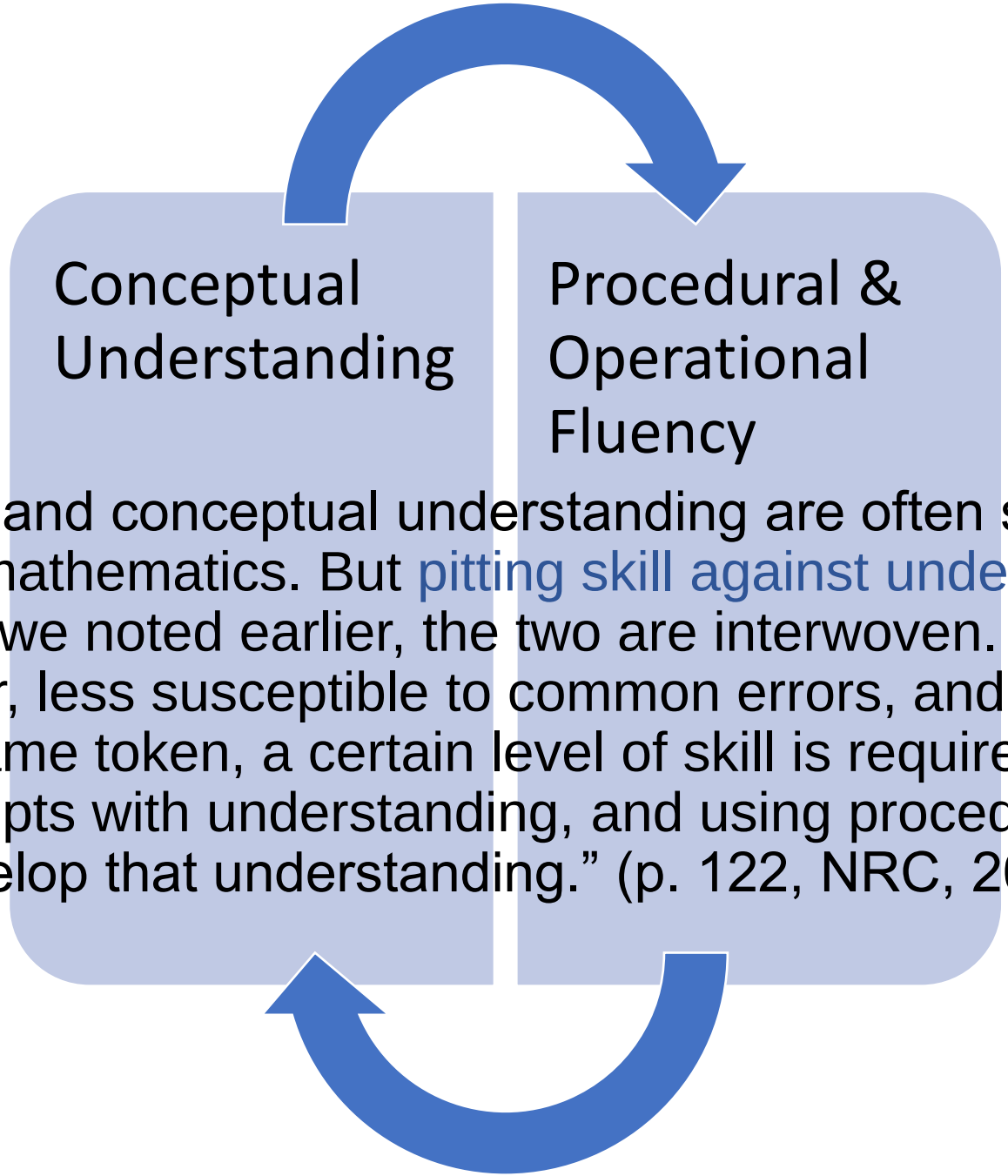
Prevention Effects from Effective Instruction in Math Are Cumulative!



Modern Math Myths

- Conceptual Understanding must precede Procedural Knowledge
- Timed assessment causes anxiety
- Directly teaching the algorithm is harmful
- Explicit Instruction only works for struggling learners
- Executive function interventions can improve math achievement

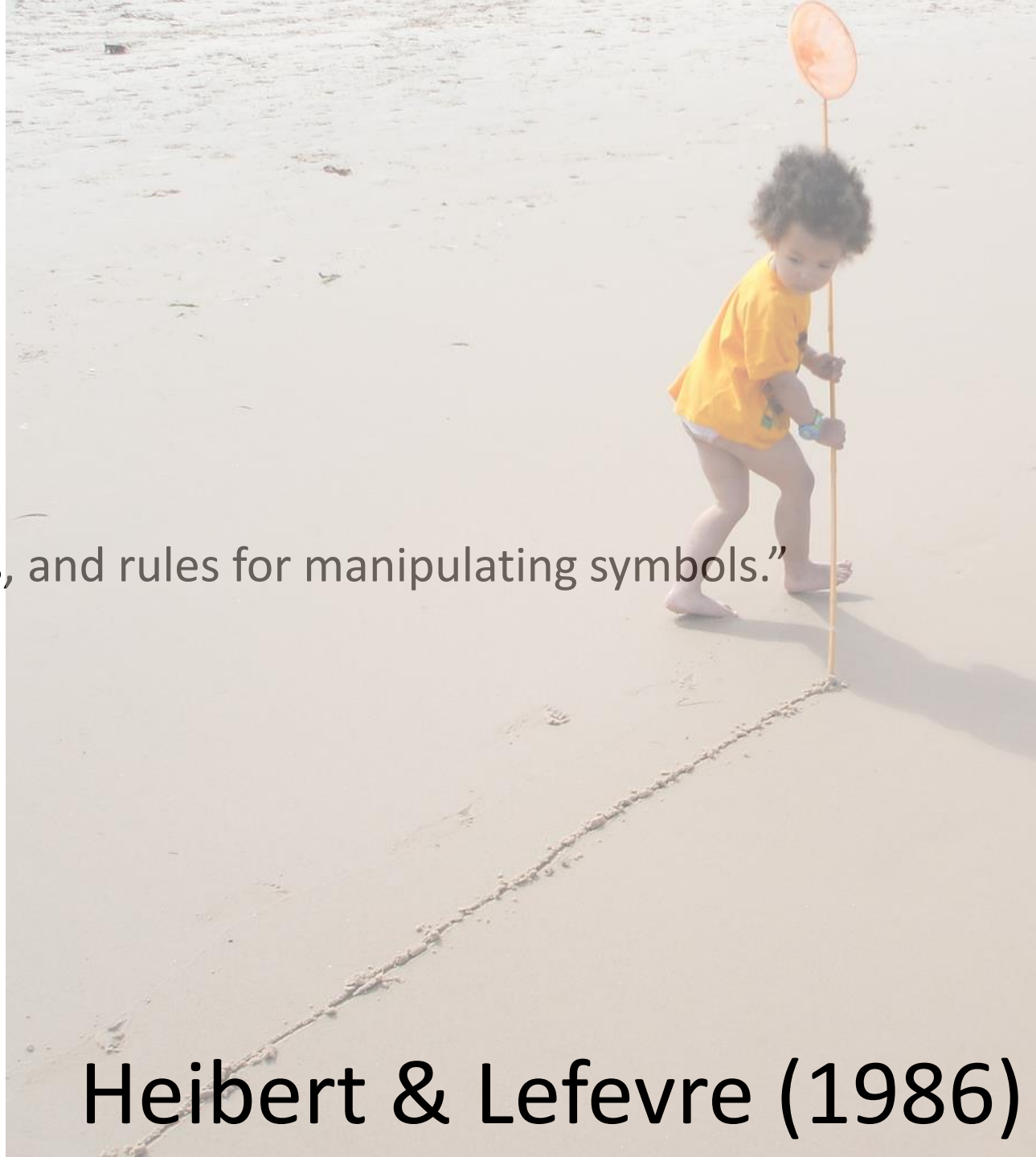
https://www.researchgate.net/publication/338585344_Belief-Based_Versus_Evidence-Based_Math_Assessment_and_Instruction_What_School_Psychologists_Need_to_Know_to_Improve_Student_Outcomes



“Procedural fluency and conceptual understanding are often seen as competing for attention in school mathematics. But pitting skill against understanding creates a false dichotomy. As we noted earlier, the two are interwoven. Understanding makes learning skills easier, less susceptible to common errors, and less prone to forgetting. By the same token, a certain level of skill is required to learn many mathematical concepts with understanding, and using procedures can help strengthen and develop that understanding.” (p. 122, NRC, 2001).

Conceptual v. Procedural Knowledge

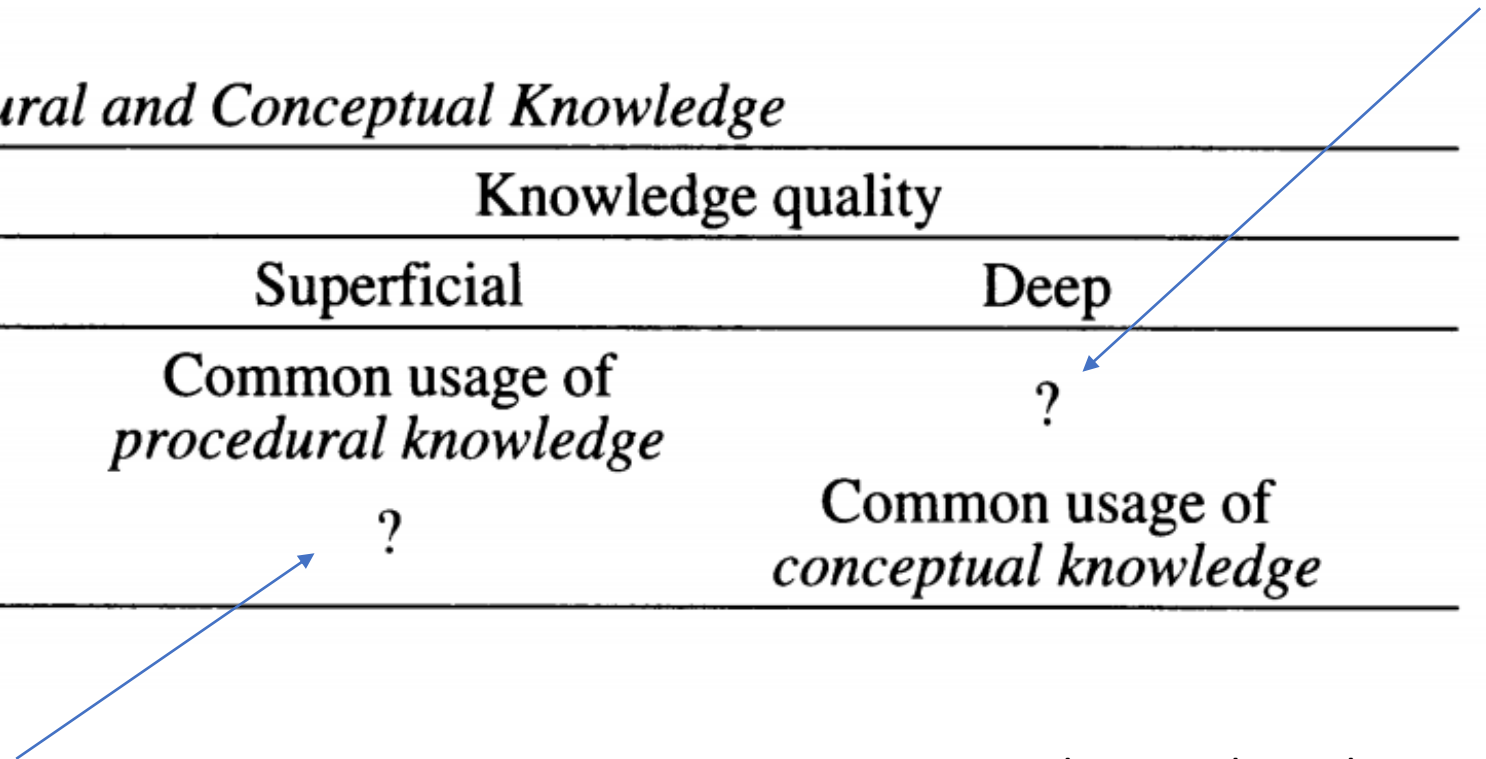
- Procedural knowledge
  - Superficial
  - “knowledge of syntax, steps, conventions, and rules for manipulating symbols.”
  - Only sequential relationships.
  - Basically algorithms



Heibert & Lefevre (1986)

Table 1
Types and Qualities of Procedural and Conceptual Knowledge

Knowledge type	Knowledge quality	
	Superficial	Deep
Procedural	Common usage of *procedural knowledge*	?
Conceptual	?	Common usage of *conceptual knowledge*

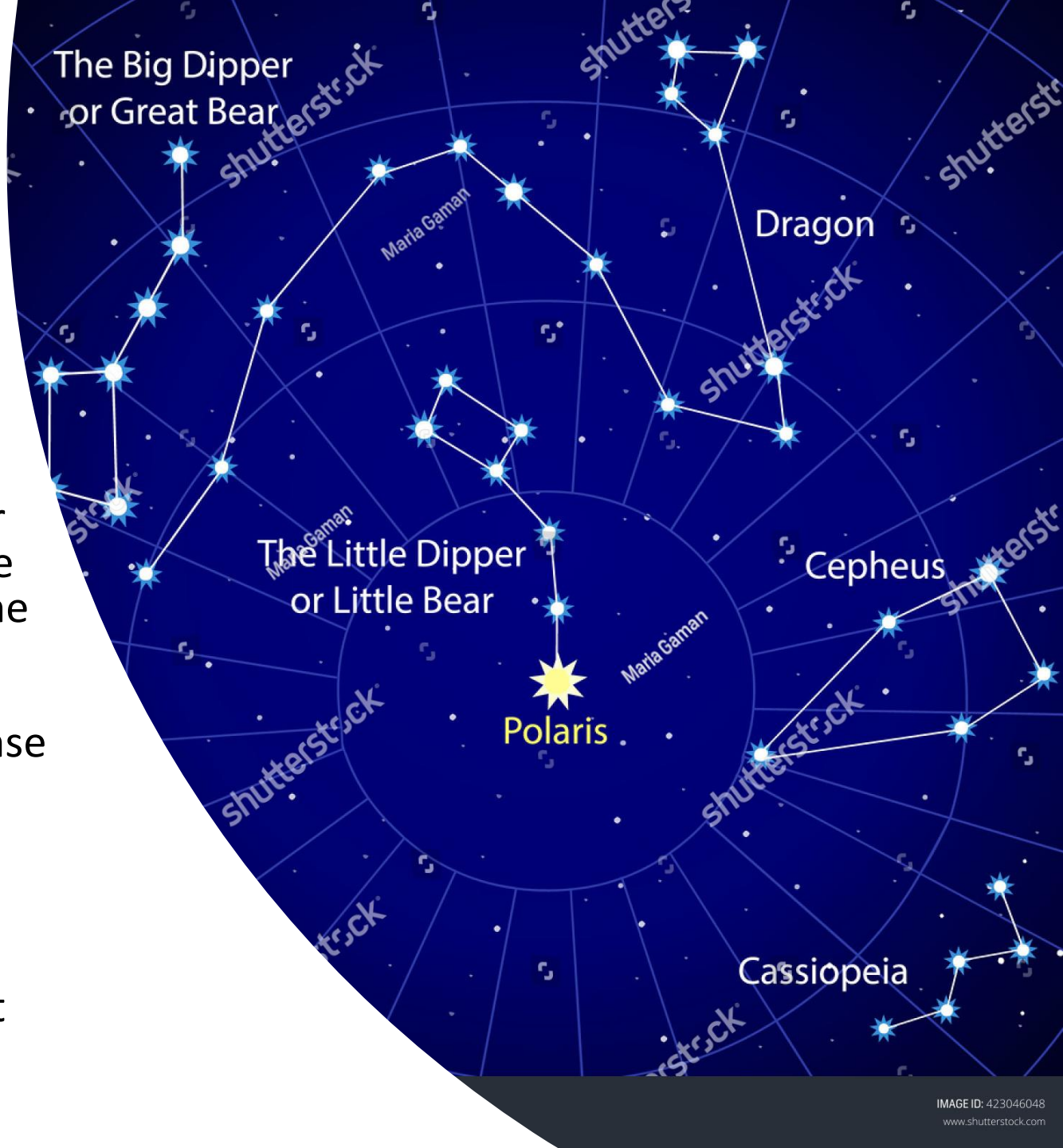


Bi-Directional, Iterative

- https://www.researchgate.net/publication/314230137_Developing_Mathematics_Knowledge (Rittle-Johnson, 2017)
- Iterative knowledge development.
- Predictive, bi-directional relationships between conceptual & procedural knowledge
  - PK 4th graders w fractions predicted 5th grade fraction CK and vice versa after controlling for prior knowledge (Hecht & Vagi, 2010).
  - Targeting CK produces gains in PK and vice versa (Schneider, Rittle-Johnson, & Star, 2011).
- Suggesting that one type of knowledge must precede the other is simply not consistent with research data.

What is Conceptual Understanding? Deep Procedural Knowledge (Star, 2005)

- Not sequential, but RICH in relationships
  - “knowledge of procedures… includes…order of steps, the goals and subgoals of steps, the environment or type of situation in which the procedure is used, the constraints imposed upon the procedure by the environment or situation, and any heuristics or common sense knowledge that are inherent in the environment or situation” (p. 409)
- Flexibility
  - someone w only superficial knowledge will use the standard technique which might not be the most efficient



What do We Mean by Flexibility

- Choosing the format of a proportion
  - 33/57 versus .58; 3/5 versus 60%
- Choosing a method of simplification
  - 22/44 = 11/22 = ½ versus 22/44 = ½
- Choosing to use a fraction to reflect the division operation in parentheses
  - 6 x (14 ÷ 6) + 10
- Choosing a method for solving a linear equation
  - 2 (x + 1) + 3 (x + 1) = 10
    - 5 (x + 1) = 10 (collect then distribute)
    - 2 x + 2 + 3x + 3 = 10 (distribute then collect)
  - 2 (x + 1) + 3 (x + 2) = 10
    - 2x + 2 + 3x + 6 (you must distribute then collect to solve– only one option).

Activity:
Solve: 6 x (14 ÷ 6) + 10

- Math coach says: answer cannot be 24 because 14 ÷ 6 = 2.33 and so 6 x 2.33 + 10 = 23.98
- Does this make sense to you?
- What is the mistake?

We intend for students to use a fraction to represent the division. So the example of 6 x (14 divided by 6) + 10, we want children to solve as 6 x 14/6 + 10. When the problem is represented in this way, it is easy to solve and the correct answer is a whole number. Solving in this way is not only easier, but reflects a child's understanding of the inverse relationship between multiplication and division. Logically, if you divide a number by a factor and then multiply the result by the same factor, you will always get the number you started with. So the solution to this problem is actually pretty simple when the student can solve that way. We believe that part of the work of math (and success with math) is not just going through the motion of problem solving, but thinking about the easiest way to solve a problem given important math skills like creating equivalent quantities and solving for unknowns. This is why we provide rigorous problems like this one that requires a child to think. Also, we do note in the directions for this measure that children should be encouraged to represent division with fractions if that allows for easier problem solving (and here's a hint that is fine to share with students— if the division operation does not result in a whole number answer, then generally using a fraction will be the easier way to solve). Here are the directions for this measure with the relevant part in bold face font.

Timed Assessment Causes Anxiety

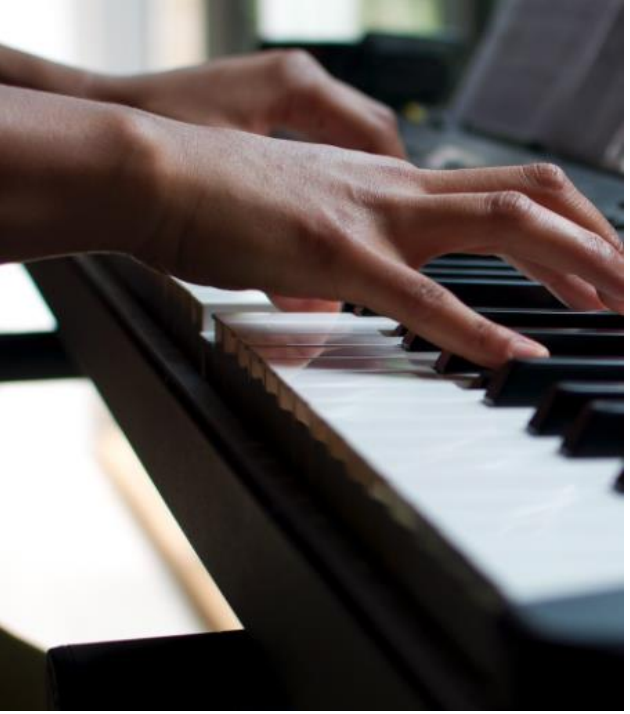
- https://www.researchgate.net/publication/335329914_The_Nature_of_Math_Anxiety_in_Adults_Prevalence_and_Correlates
- Self-reported adult math anxiety was negatively correlated with fluent addition, subtraction, multiplication, and division performance (*r* = - .25 to - .27) and probability knowledge (*r* = - .31 to - .34). Self-reported test taking anxiety was negatively correlated with math skill fluency and probability knowledge, too (*r* = -.22 to -.26).
- very little empirical evidence examining whether timed tests have a causal impact on anxiety and the existing few studies that include school-age participants do not support the idea (Grays, Rhymer, & Swartzmiller, 2017; Tsui & Mazzocco, 2006)

What about Anxiety?

- Gunderson, E. A., Park, D., Maloney, E. A., Beilock, S. L. & Levine, S. C. (2018) Reciprocal relations among motivational frameworks, math anxiety, and math achievement in early elementary school. *Journal of Cognition and Development, 19*, 21-46. doi: 10.1080/15248372.2017.1421538
- High math achievement especially strong predictor of lower math anxiety in first 2 years of school == Reciprocal effect of less entity oriented motivation (ability is fixed), anxiety, achievement.

More on Anxiety in Math

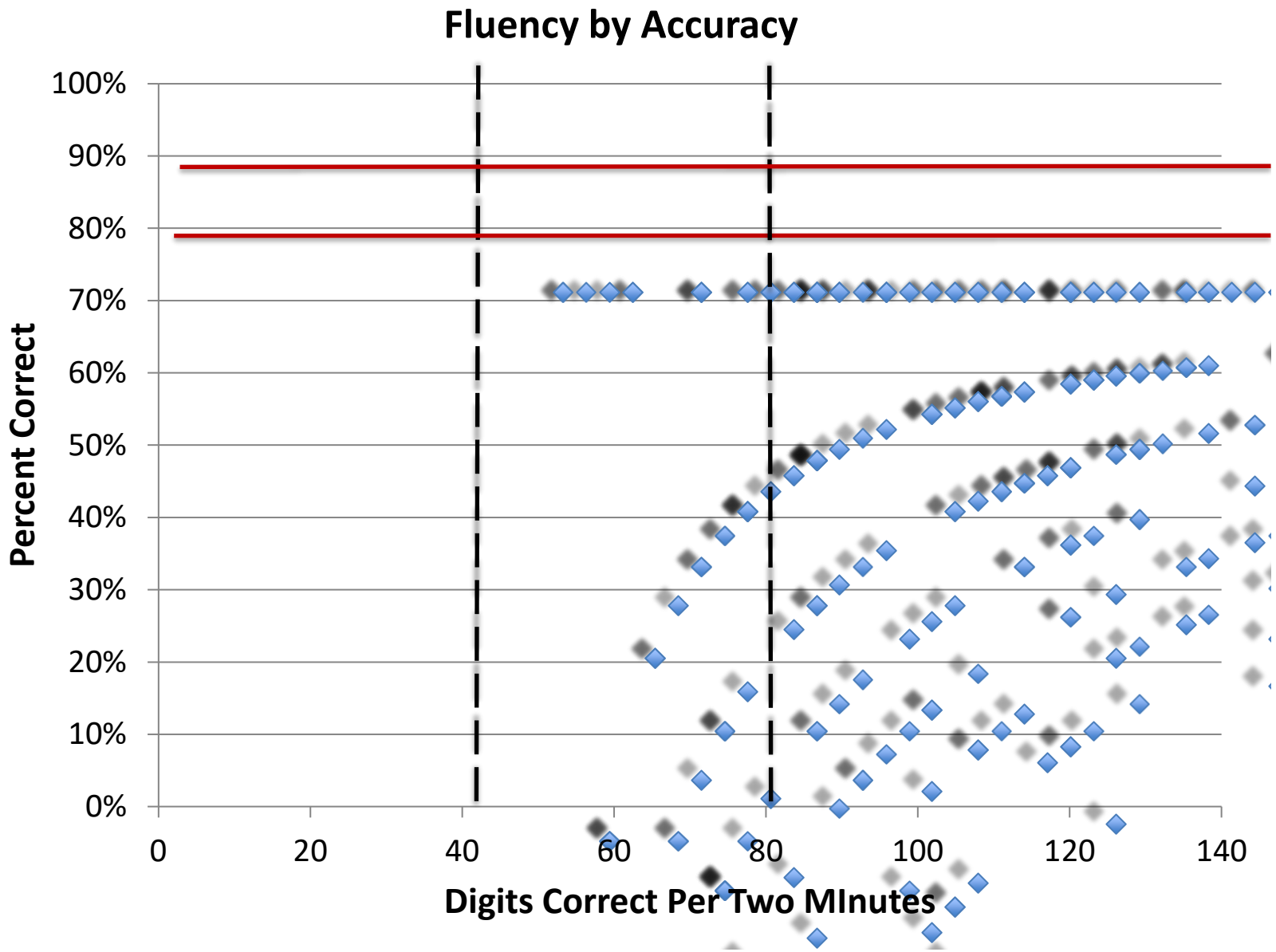
- https://gregashman.wordpress.com/2020/03/12/defeating-maths-anxiety/
- http://www.danielwillingham.com/daniel-willingham-science-and-education-blog/march-13th-2019



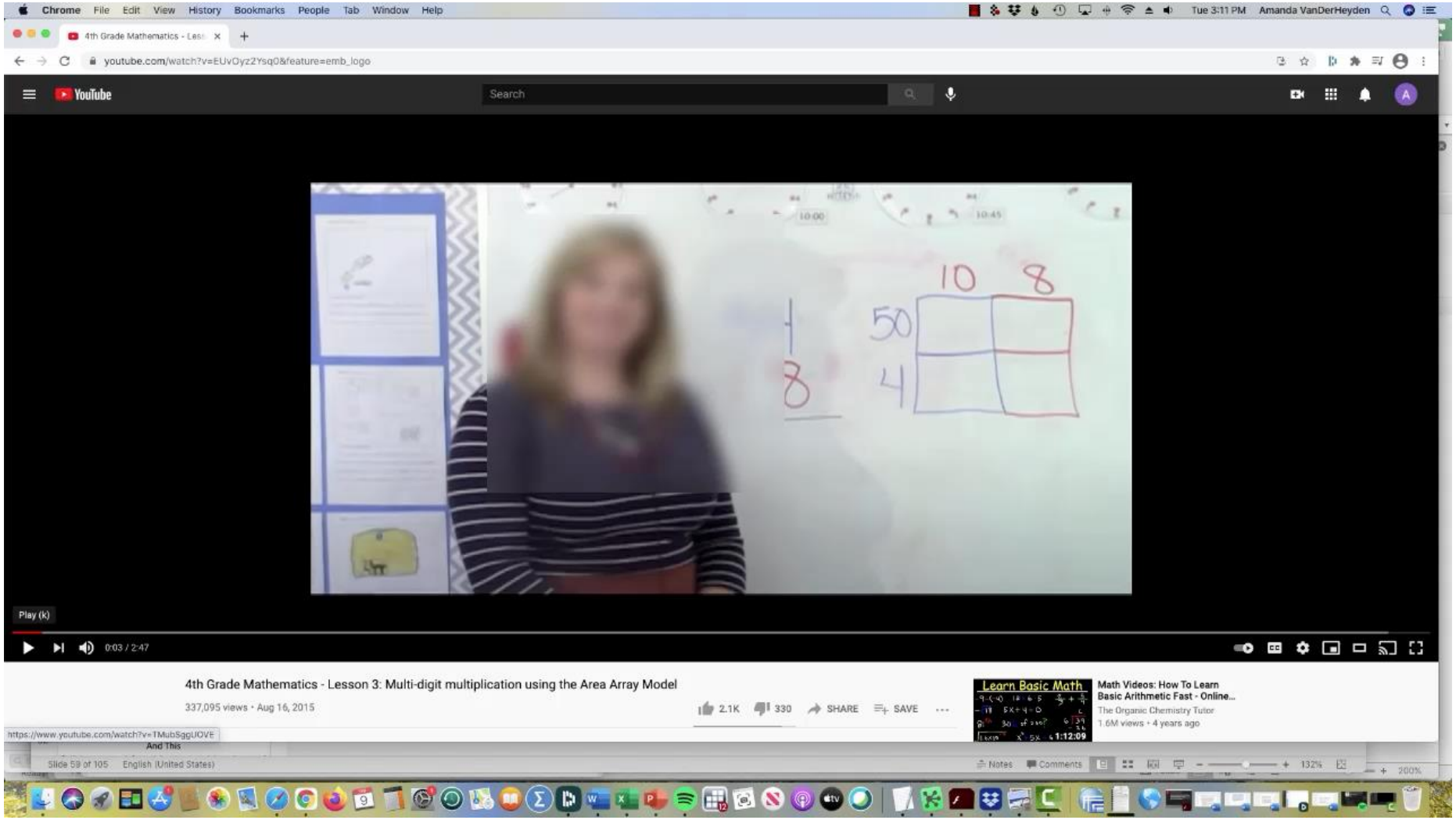
On Fluency

Roediger & McDaniel: “Pitting the learning of basic knowledge against the development of creative thinking is a false choice. Both need to be cultivated. The stronger one’s knowledge about the subject at hand, the more nuanced one’s creativity can be in addressing a new problem. Just as knowledge amounts to little without the exercise of ingenuity and imagination, creativity absent a sturdy foundation of knowledge builds a shaky house.”

Carl Binder: http://binde1.verio.com/wb_fluency.org/Publications/Binder2003.pdf


Fluency by Accuracy
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent Correct
0
20
40
60
80
100
120
140
Digits Correct Per Two MInutes

Don’t Do This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Tue 3:11 PM Amanda VanDerHeyden
youtube.com/watch?v=EUvOyz2Ysq0&feature=emb_logo
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And This
Slide 59 of 105 English (United States)
Notes Comments

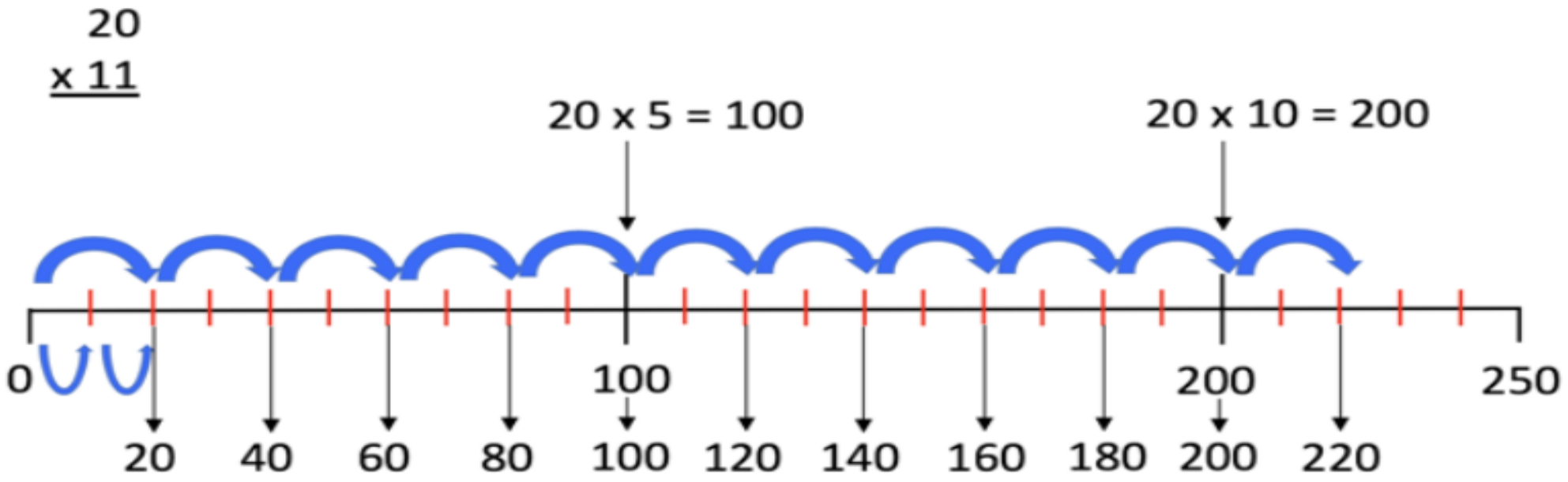
Instead, Do This

Build Conceptual Understanding

Complete several of these each day with the child, encouraging the child to solve each problem aloud:

We know we can use addition to solve multiplication problems. For example, 3 x 5 can be solved as 3 sets of 5 (5 + 5 + 5) or 5 sets of 3 (3 + 3 + 3 + 3).

Let's look at 20 x 11 on a number line. We know that 20 x 11 can be found on the number line by counting up 11 sets of 20 on the numbe to get to 220.



And This

Because we understand multiplication, it is easy for us to answer the questions below without even solving the problems.

Fill in the blank with > (greater than) or < (lesser than) or = (equal) to make the statement true.

31 x 12 _____ 31 x 11

31 x 30 _____ 31 x 31

15 x 14 _____ 14 x 15

13 x 100 _____ 13 x 99

Now try to solve these.

31 x 13 = 31 x 12 + _____

11 x 15 = 10 x 15 + _____

21 x 13 = 20 x 13 + _____

21 x 13 = 22 x 13 - _____

And This

This skill is all about place value understanding. The standard algorithm works because it maintains the place value of the partial products. To demystify how this works, ask the student to solve the problem by multiplying the tens first and then the ones using the example below. Is the answer the same?

Now you try a few.

And This

Problem	Break Factor into Tens & Ones	Multiply the Tens	Multiply the Ones	Add the Tens and the Ones	Add the Ones and the Tens	Is the Answer the Same?
67 x 44 98 x 16 64 x 54 99 x 52	44 = (40 + 4)	67 x 40	67 x 4	2680 + 268	268 + 2680	

And This

When we are working with numbers that are greater in quantity, multplication works the same way, but it gets very cumbersome to add that many numbers.

Problem	Break Factor into Tens & Ones	Can Be Further Broken Into	Multiply all Tens and Ones	Add the Partial Products for the Final Answer
67 x 44	44 = (40 + 4)	44 = (10 + 10 + 10 + 10 + 4)	67 x 10 = 670 67 x 10 = 670 67 x 10 = 670 67 x 10 = 670 67 x 4 = 268	670 670 670 670 + 268 2948 4 x 670 = 2680

Can you imagine adding 13 sets of 99? That would take forever. So we can use what we know about place value to make these problems easy to solve. Let's practice breaking a factor into tens and ones and solving each problem.

And This

Problem	Break Each Factor into Tens & Ones	Tens +	Ones +	Combine to Solve
92 x 86 →		92 x 80 7360 +	92 x 6 552 =	7360 + 552 = 7912
76 x 61				
69 x 30				
34 x 31				
92 x 88				
98 x 14				
31 x 31				

Use Classwide Intervention

- It takes 15-20 min per day.

- It’s curriculum neutral and supplements.

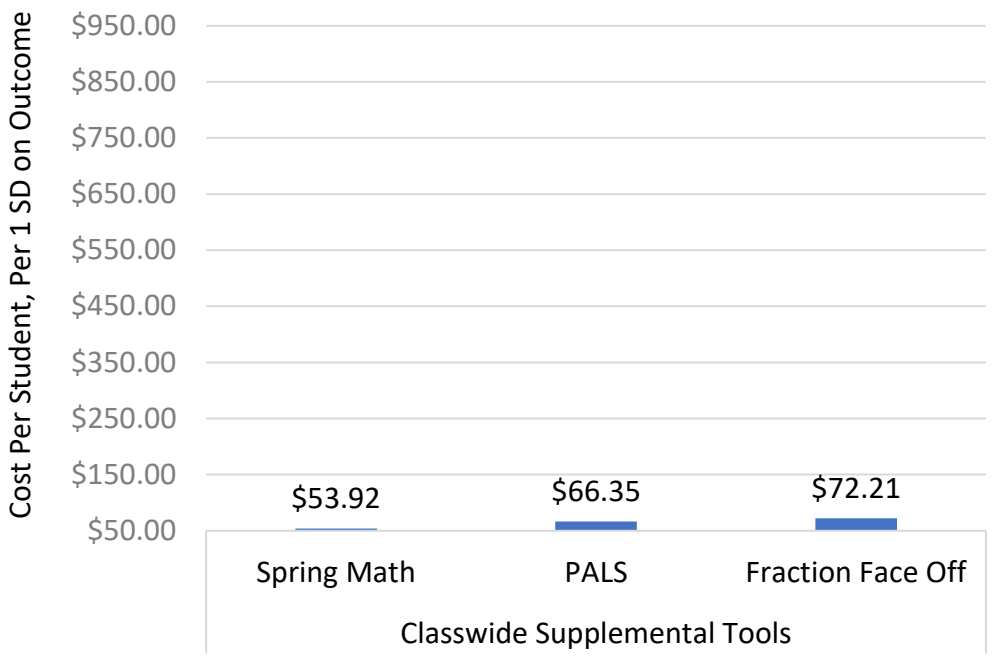
- All students show benefits.

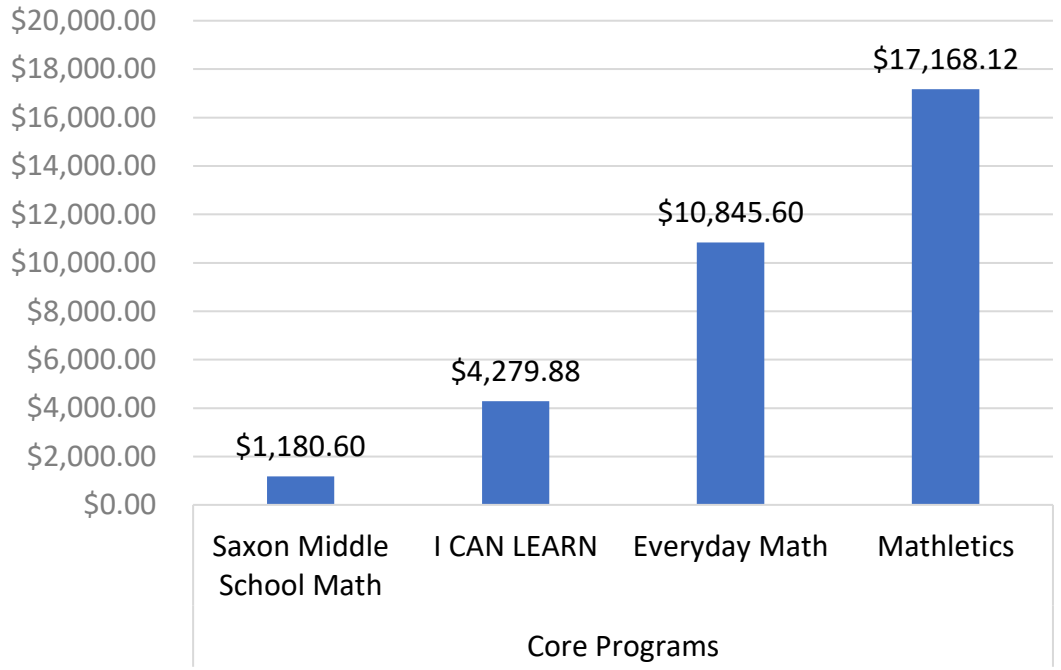
- It makes future risk decisions more accurate.

Strong Return on Investment

Cost Per Student, Per 1 SD gain in outcome

Lower is Better





"Changing math curricula as an approach for whole-school intervention when large numbers of students do not achieve proficiency is more costly than targeted, preventative math intervention" (Barrett & VanDerHeyden, 2020)

Barrett, C. A., & VanDerHeyden, A. M. (2020). A cost-effectiveness analysis of classwide math intervention. *Journal of School Psychology, 80,* 54-65. https://doi.org/10.1016/j.jsp.2020.04.002

Use Class-wide Intervention

Classwide Intervention | Screening | Students

Classroom Performance

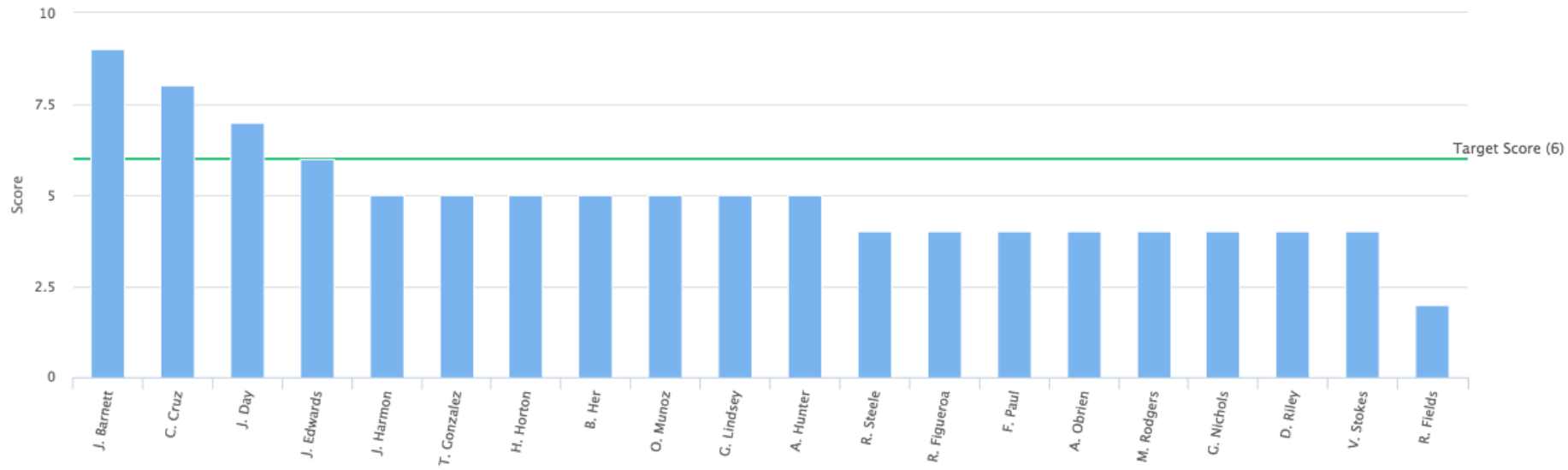
80% of your class appears to be at risk and in need of intervention to benefit from grade-level instruction.

We call this a classwide problem and *recommend a classwide intervention*.

20% !	20% !	25% !	30% !
Measure 1	*Measure 2*	*Measure 3*	*Measure 4*

Measure 1: Multiply 1 Digit by 2-3 Digit w/ & w/o Regrouping

Your students' screening scores compared to the target score.



Next Steps: Performing Class Wide Interventions

Skill packets will be provided to help practice foundational math skills.

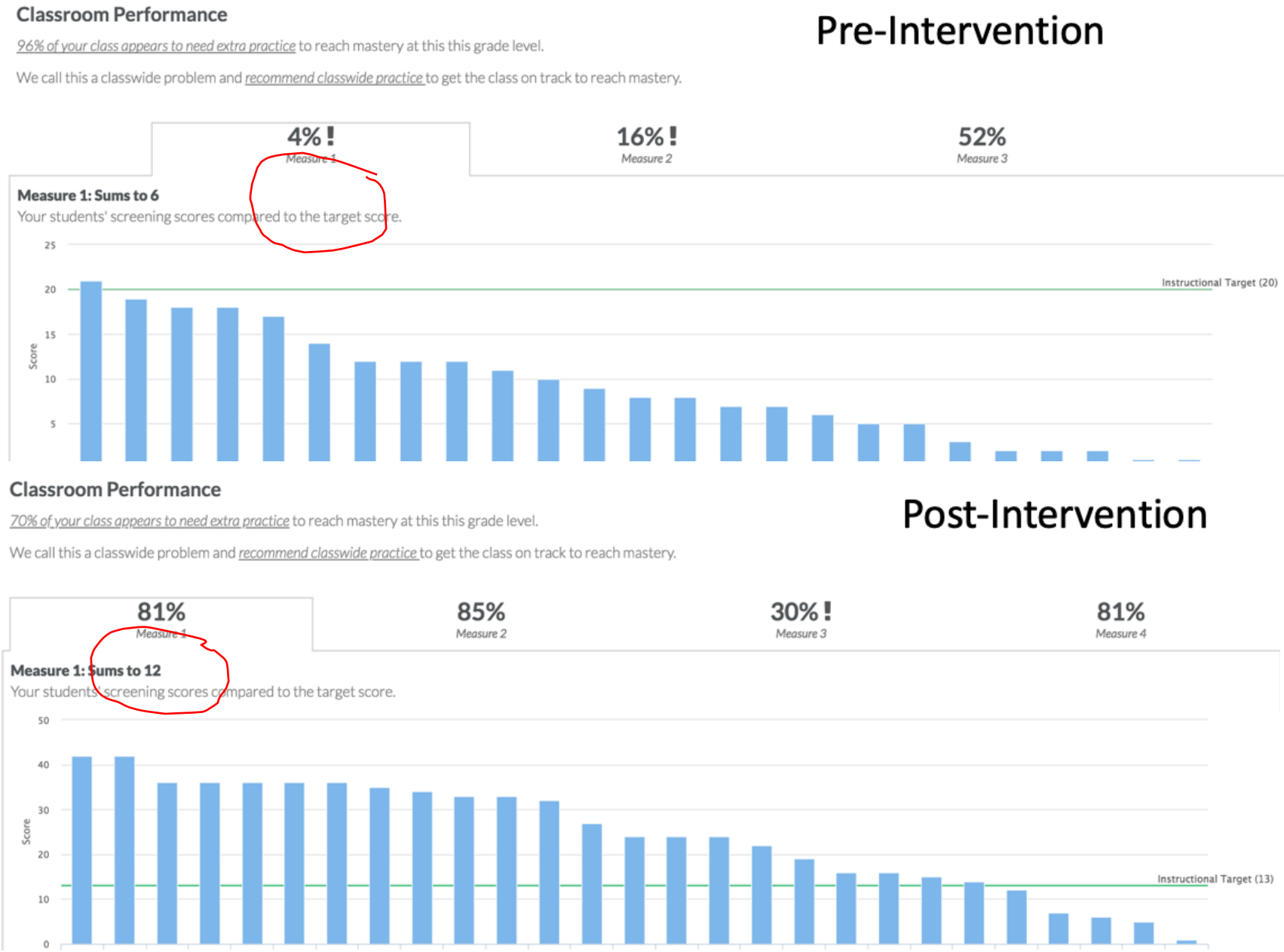
As you complete skills you will receive new packets and be able to view your class' skill progress.

Use Classwide Intervention

High-Yield Action: Use Class-wide Intervention

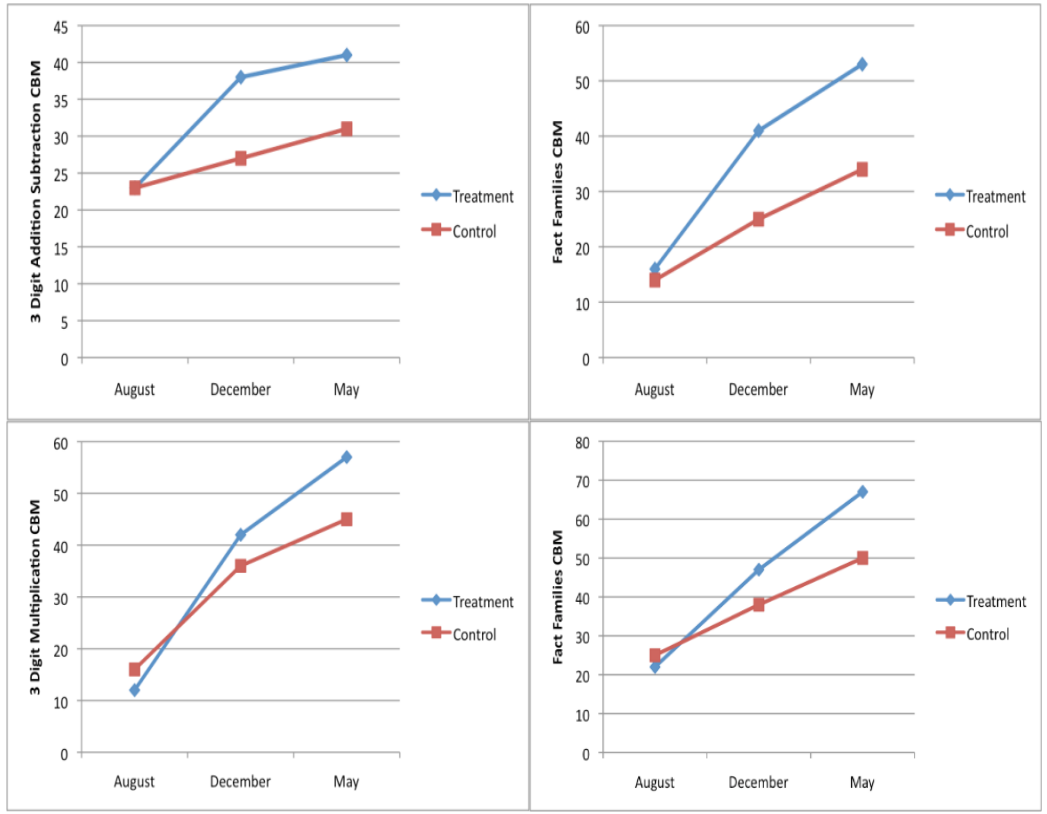
Pre

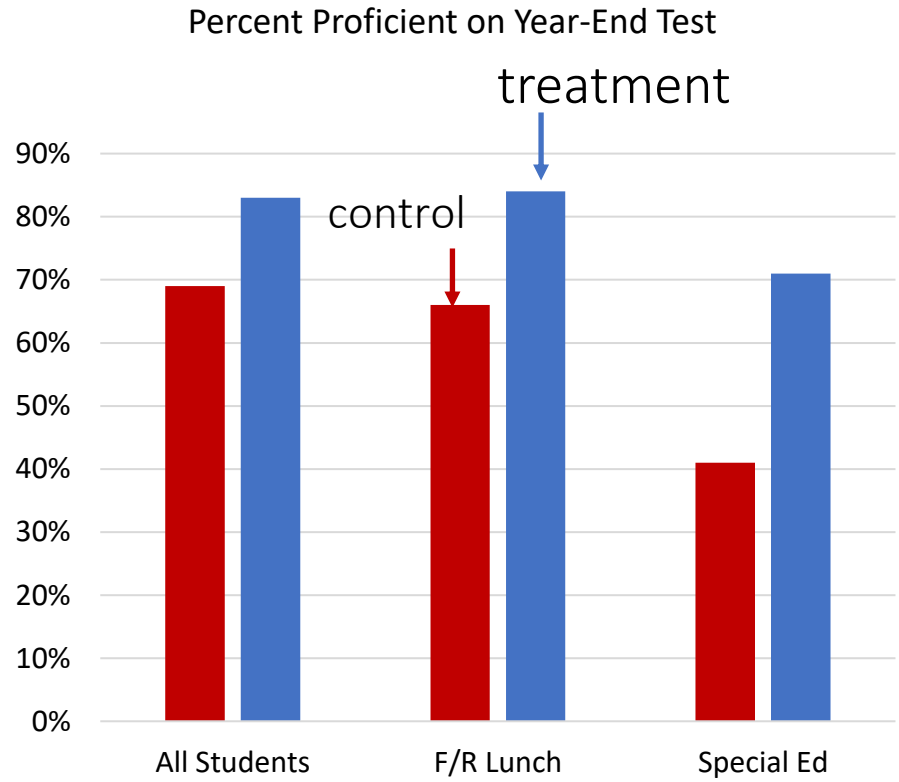
Post



Use Classwide Intervention

Classwide Intervention Works (when used well)





All	Title	Study	Study Type	Participants	Design	Fidelity of Impl.	Measures (Targeted)	Measures (Broader)
☐	Spring Math	Codding, VanDerHeyden, Martin, & Perrault (2016)	Group Design	●	◒	●	●	●
☐	Spring Math	VanDerHeyden, McLaughlin, Algina, & Snyder (2012)	Group Design	●	●	●	●	●

ES = .68 CBMs
ES = .18 Gr 4
ES = .79 for at-risk

http://www.intensiveintervention.org/chart/instructional-intervention-tools (NCII)

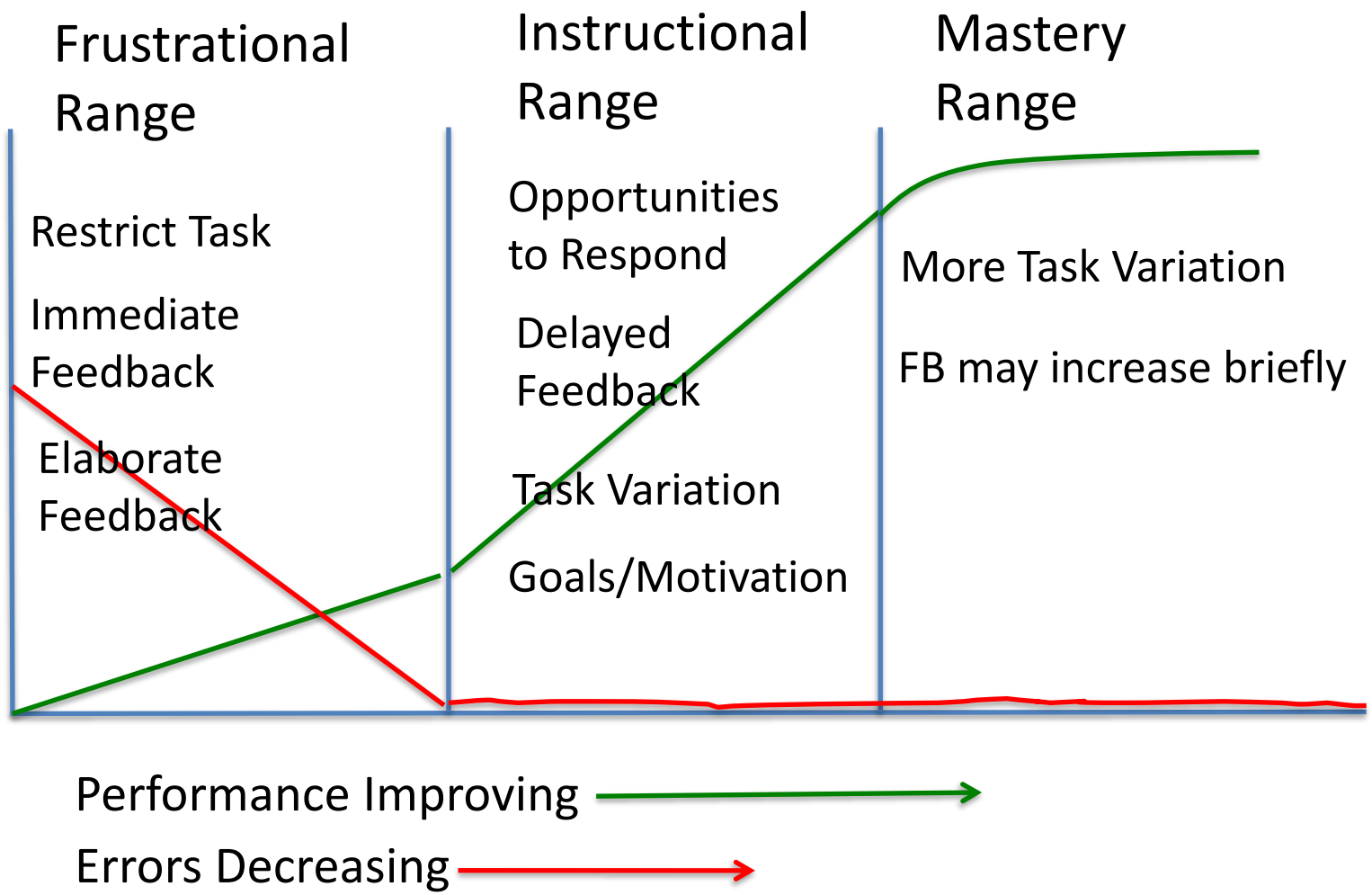
Use Classwide Intervention

When Managed, Classwide Intervention Works!

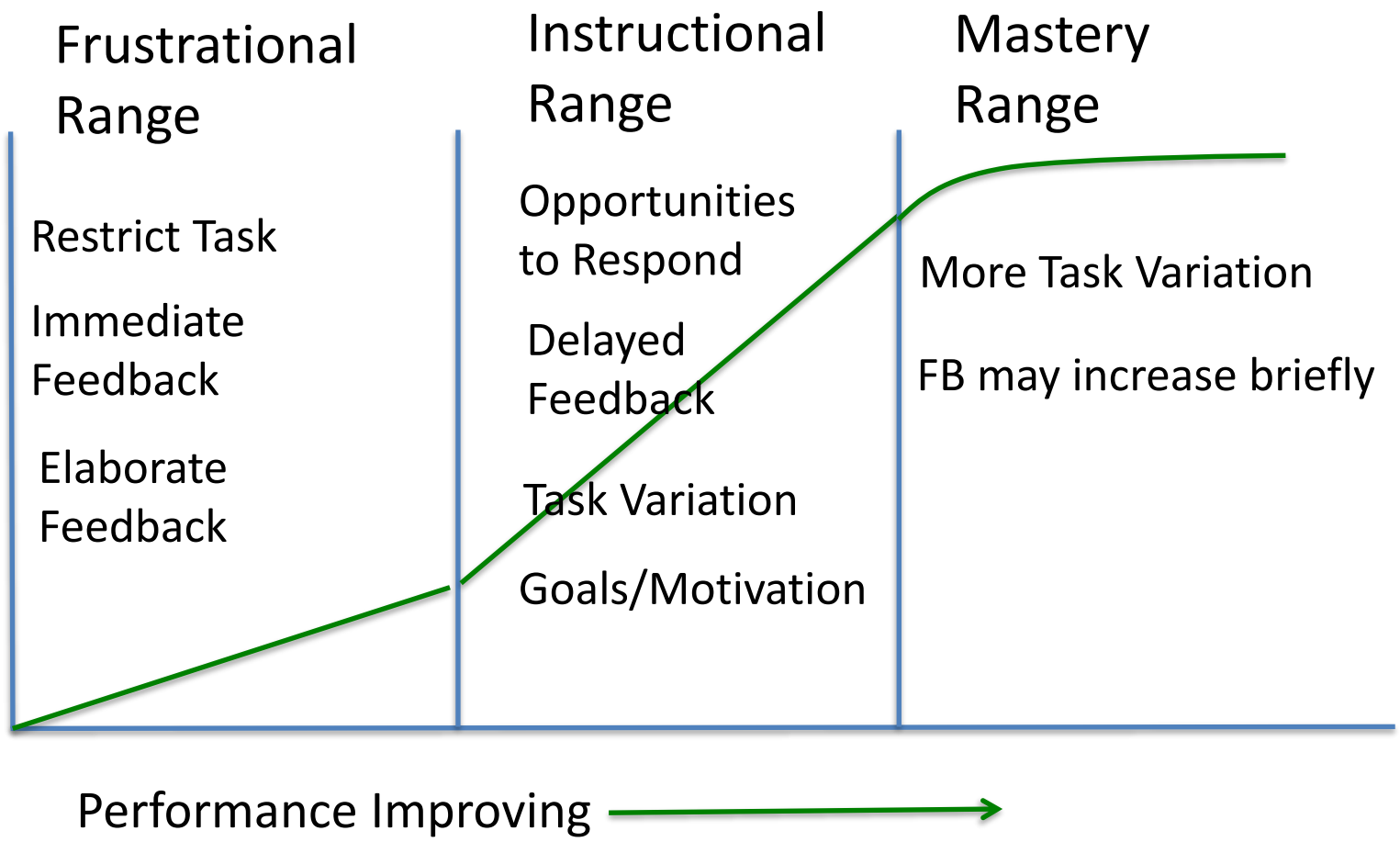
	Absolute Risk Reduction	Number Needed to Treat
All Students	15%	7
Students receiving F/R Lunch	18%	6
Students receiving Special Education Services	39%	3
Low-Performing Students	44%	2

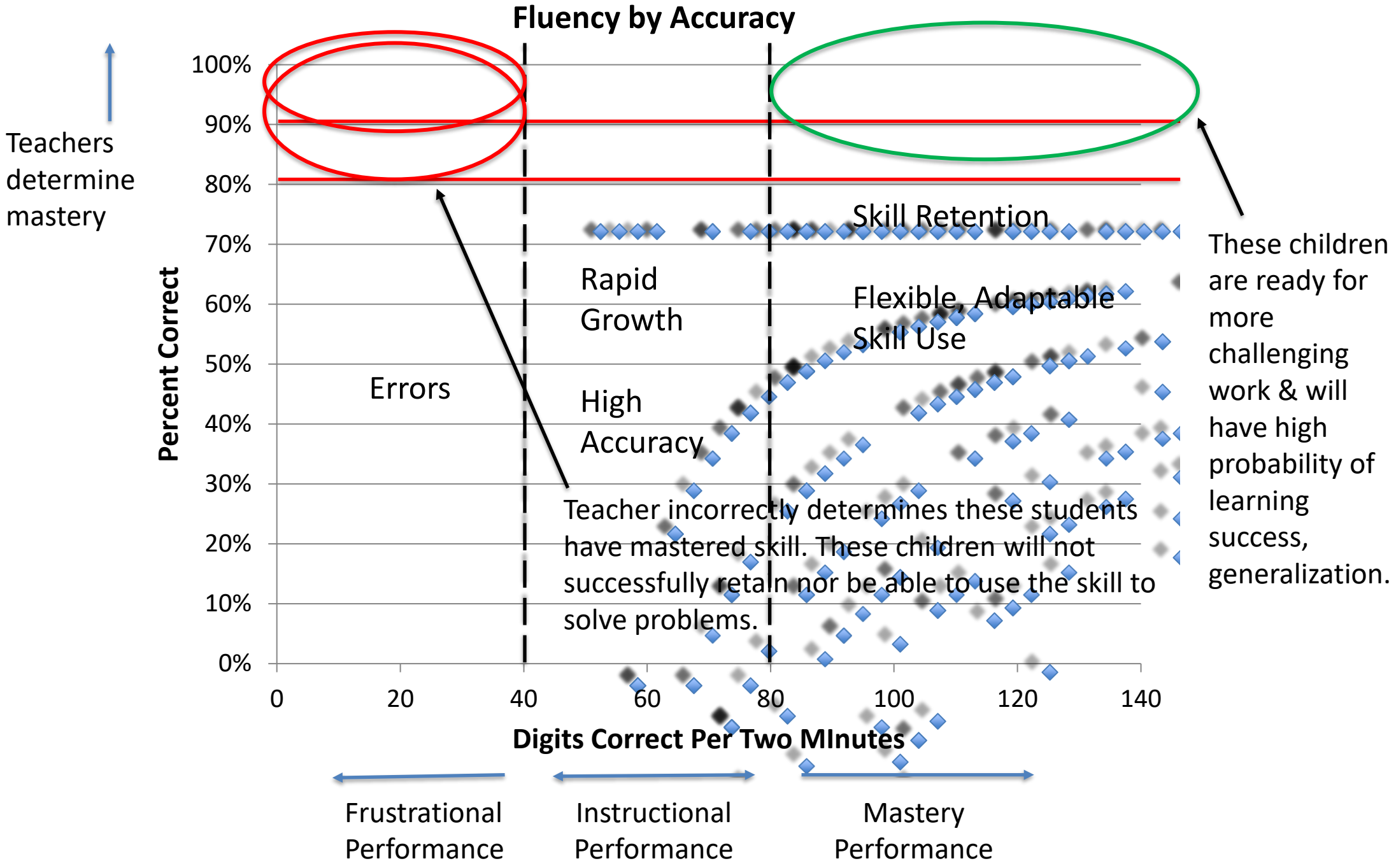
Source: VanDerHeyden, McLaughlin, Algina, & Snyder, 2012; VanDerHeyden & Codding, 2015

The Instructional Hierarchy: How it Works



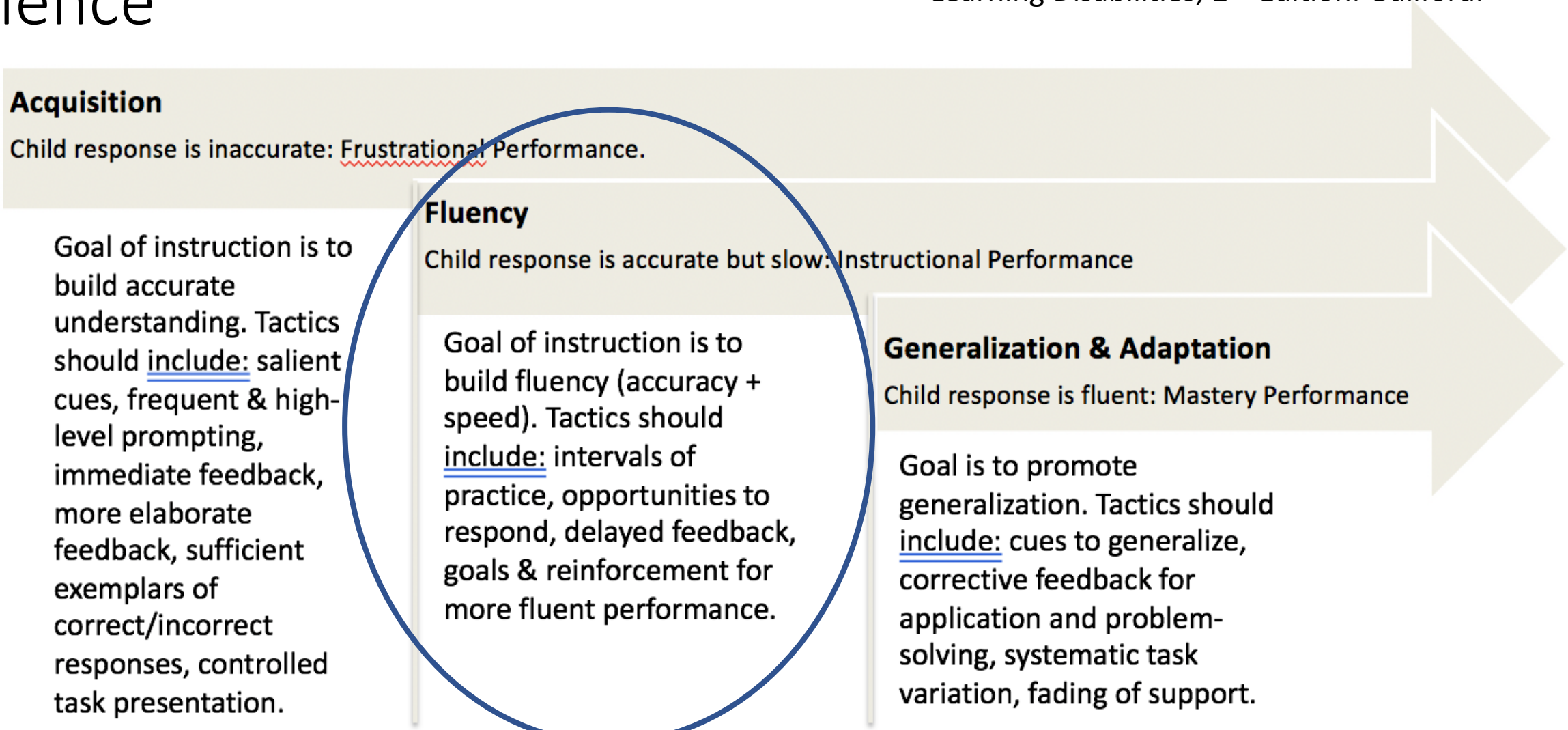
Amanda- show skill by treatment animation




Fluency by Accuracy
Teachers determine mastery
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent Correct
0
20
40
60
80
100
120
140
Digits Correct Per Two MInutes
Skill Retention
Rapid Growth
Flexible, Adaptable Skill Use
Errors
High Accuracy
Teacher incorrectly determines these students have mastered skill. These children will not successfully retain nor be able to use the skill to solve problems.
These children are ready for more challenging work & will have high probability of learning success, generalization.
Frustrational Performance
Instructional Performance
Mastery Performance

How to Plan Instruction Using Science

From Kovaleski, VanDerHeyden, Runge, & Zirkel (in preparation). RTI Approach to Evaluating Learning Disabilities, 2nd Edition. Guilford.



Haring, N. G., & Eaton, M. D. (1978). Systematic instructional procedures: An instructional hierarchy. In N. G. Haring, T. C. Lovitt, M. D. Eaton, & C. L. Hansen (Eds.), *The fourth R: Research in the classroom* (pp. 23–40). Columbus, OH: Merrill.

How-To For Classwide Intervention in Math

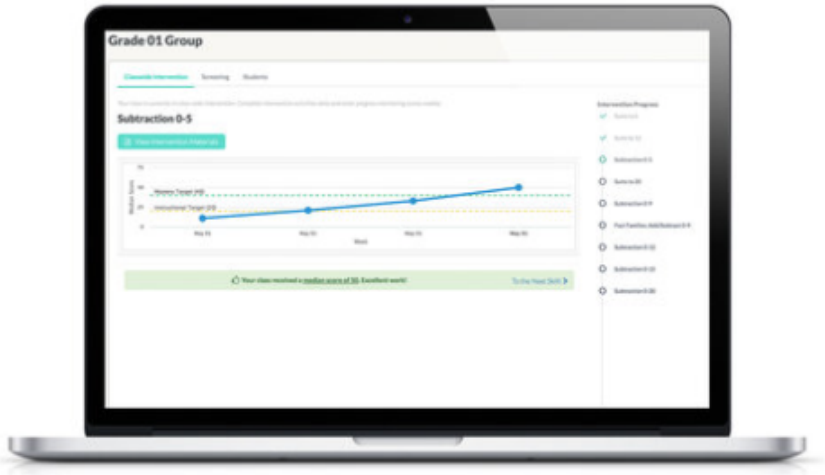
How To Get Started:

- Intervention protocol.
  - Here is one to try: https://static1.squarespace.com/static/57ab866cf7e0ab5cbba29721/t/5d67ed2a390a160001c5b4ac/1567092010232/Spring+Math+Classwide+IP.pdf
  - www.springmath.com > How it Works > View a sample classwide intervention

Classwide Interventions

- Intervention packets targeting foundational math skills
- Students work in pairs for 15-20 minutes per day
- Each week students are assessed on the skill being taught.
- Class progress is graphed and when the class has achieved the target score, they move on to the next skill
- Updates on group progress for coaches and administrators

View a sample classwide intervention



How To Get Started:

- Intervention protocol.
- Sequence of skills.
- Daily practice materials.
- Weekly assessment materials.
- Criteria for decision making, a way to graph progress, and implementation support structures.

Suggested Student Pairings

Adams, Maximus	Goyette, Dangelo
Homenick, Darrin	Rolfson, Keegan
Lehner, Salvador	Blick, Jerald
Collins, Lamont	Waelchi, Jacinthe
Reichert, Marlen	Skiles, Daphnee
Greenholt, Clovis	Kozey, Monserrat
Kreiger, Selena	Turcotte, Kayleigh
Larson, Kobe	Champlin, Gertrude

Close

Workers

We use our **brains** to **think**.

We use our **mouths** to **explain**.

We use our **hands** to **write**.

Helpers

We use our **ears** to **listen**.

We use our **eyes** to **watch**.

We use our **mouths** to **help**.

Intervention Protocol

Classwide Fact Families: Add/Subtract 0-9

Student:

Grade: 01

Teacher: Paul Muyskens

Class name: 1 Mathematics (-Hayden-)

Date: 1/22/2019

Classwide Math Intervention

Preparation:

- This is your master set of materials for the week.
- Make 1.5 copies of the practice sheets Day 1-5 for each student in your class (ex. if you have 20 students make 30 copies). Each student will have one copy for independent practice, while each pair of students will have one copy for paired practice.
- If you are using flashcards to practice, you can make only 1 copy per student.
- To set up your student pairs click on "Students" in your dashboard, then "Suggested Student Pairs."
- Identify the first "Worker," which should be the higher-performing student. This student will always work first.

☐ Say, **It's time for Spring Math. Please get together with your math partner. Please take out your practice materials, have your colored pen and pencil out, and show me you are ready.**

☐ Say, **Workers, your job is to work as many problems correctly as you can. As you work, be sure to talk through the problem so your partner can HEAR and SEE you solve the problem. Use a quiet voice while you work.**

☐ Say, **Helpers, your job is to follow along, listen and watch as the worker is working problems. If you see an error, speak up! Say, "Stop, Let's check this one."**

You should give the worker a hint, point to the exact error, but don't give them the answer. See if the worker can fix the error.

If the worker is stuck, give the answer but solve it aloud so the worker knows how you got that answer. If you get really stuck, circle the problem and ask me for help.

☐ Set the timer for 3 minutes.

☐ Say, **Remember, your goal is to work as many problems as possible with 100% accuracy. Ready? Begin!**Start the timer when you say Begin.

Use Classwide Intervention

Active Ingredients

- Modeling
- Practice for the right level of difficulty (opps to respond, complete learning trials)
- Corrective feedback & repetition loop
- Goal setting
- Delayed error correction w verbal rehearsal component
- Reward
- Advances difficulty based on proficiency

Use Classwide Intervention

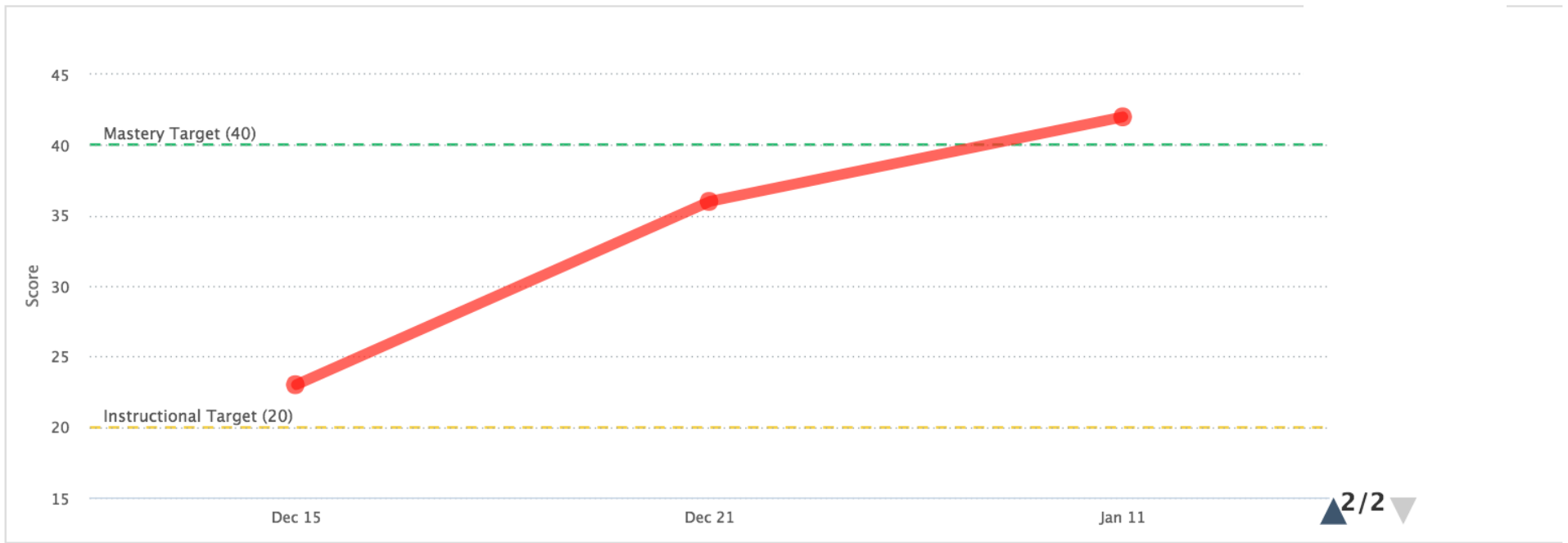
Use Classwide Intervention

It's time to start Winter screening! Start Screenir

Classwide Intervention Progress

Subtraction 0-9

Classwide Rate of Improvement: 4.1

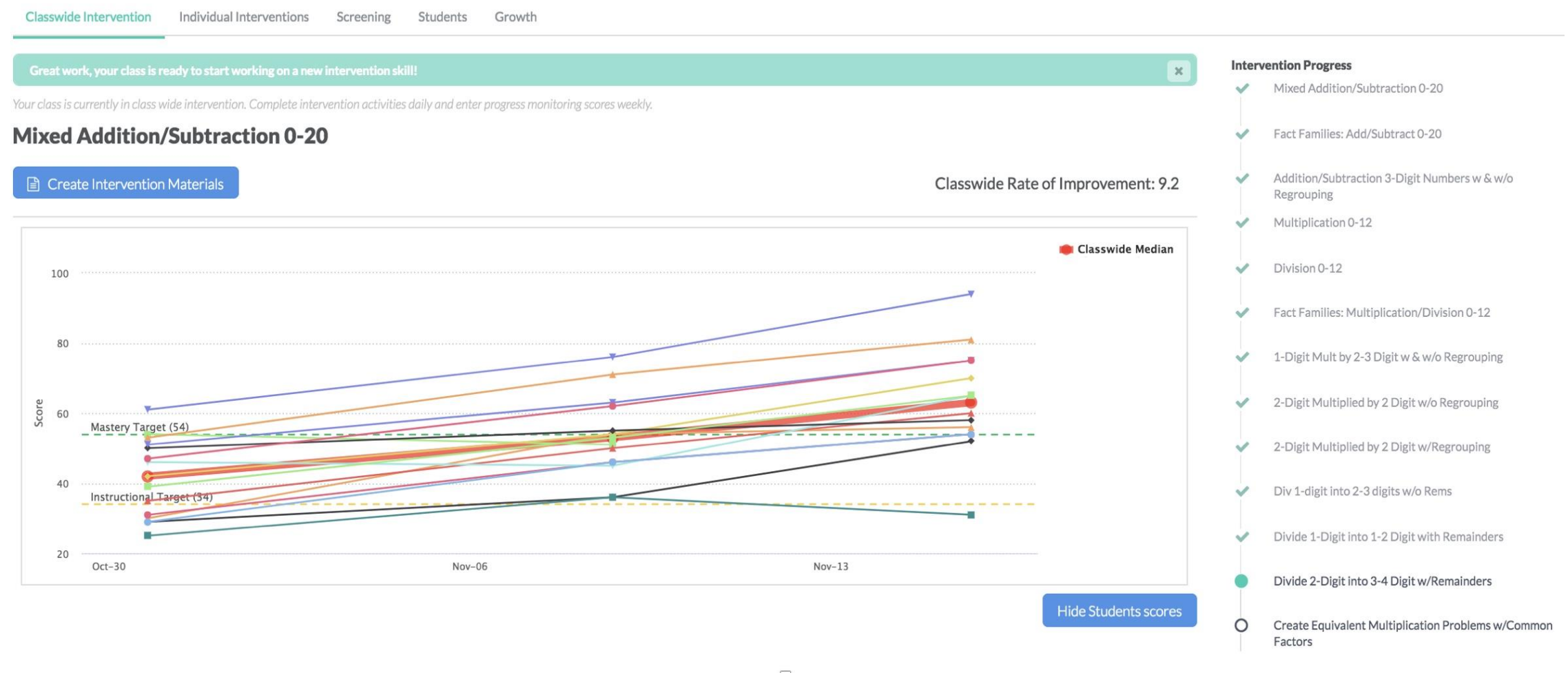


Skill Tree Progress

- Sums to 6
- Sums to 12
- Subtraction 0-5
- Sums to 20
- Subtraction 0-9
- Fact Families: Add/Subtract 0-9
- Subtraction 0-12
- Subtraction 0-15
- Subtraction 0-20

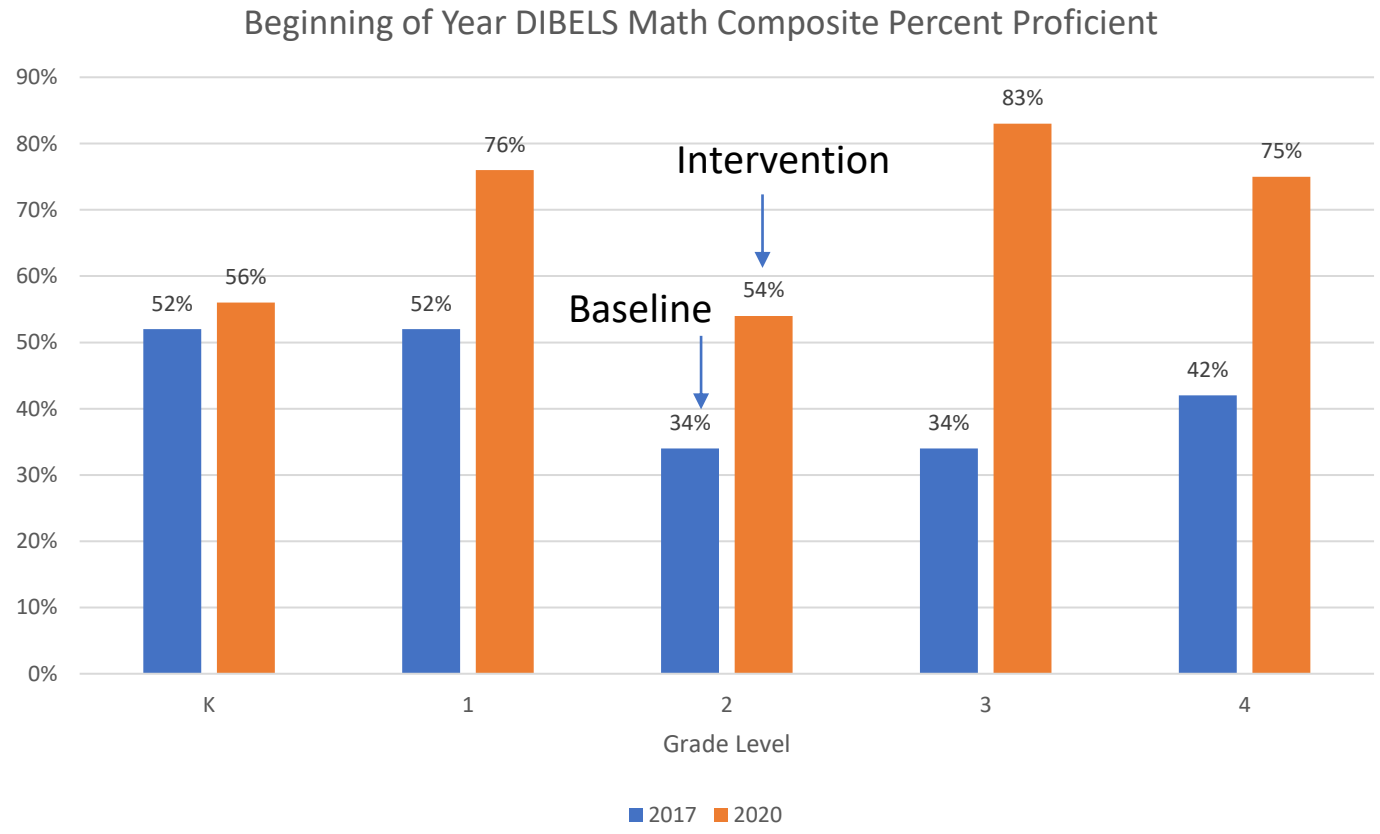
Use Classwide Intervention

Improves Learning, but Makes it Clear Who Needs More

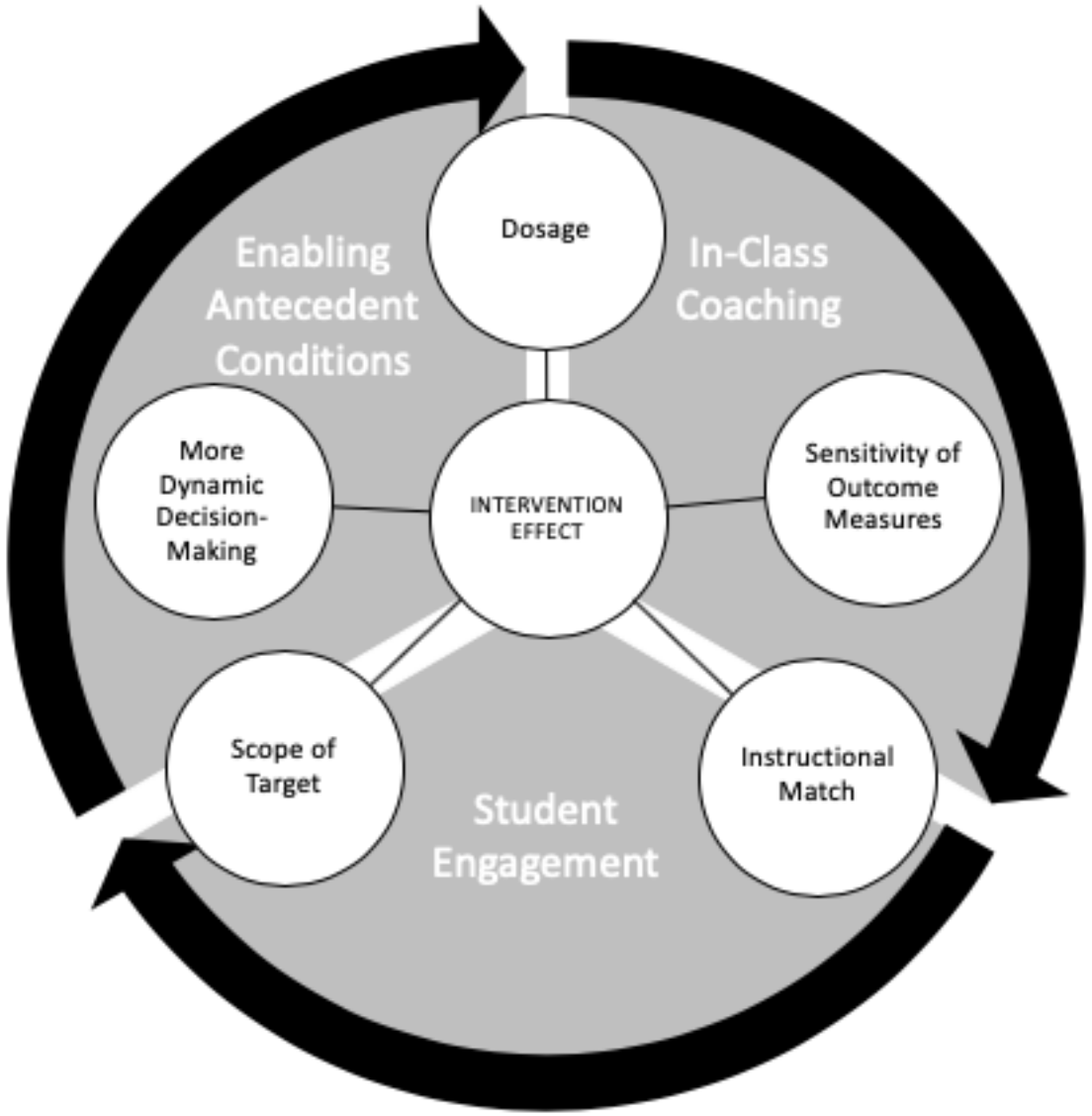


Use Classwide Intervention

Prevention Effects From Effective Instruction In Math Are Cumulative!



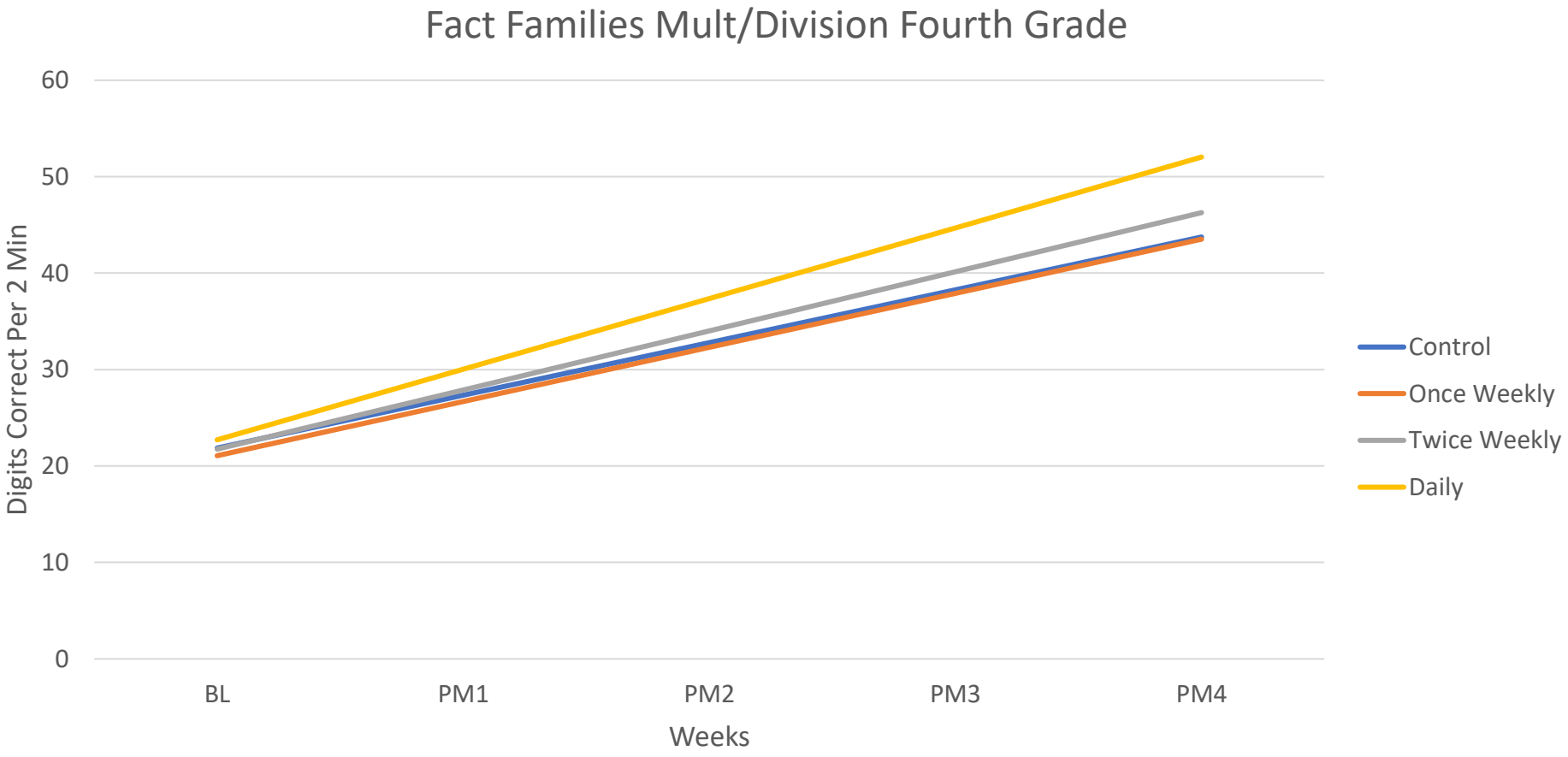
Program evaluation data from Spring Math Classwide Math Intervention. Beginning of Year Percent Not at Risk on DIBELS math composite before (baseline) and after the introduction of intervention. Child performance gains transferred to subsequent years.



Manage the Intervention

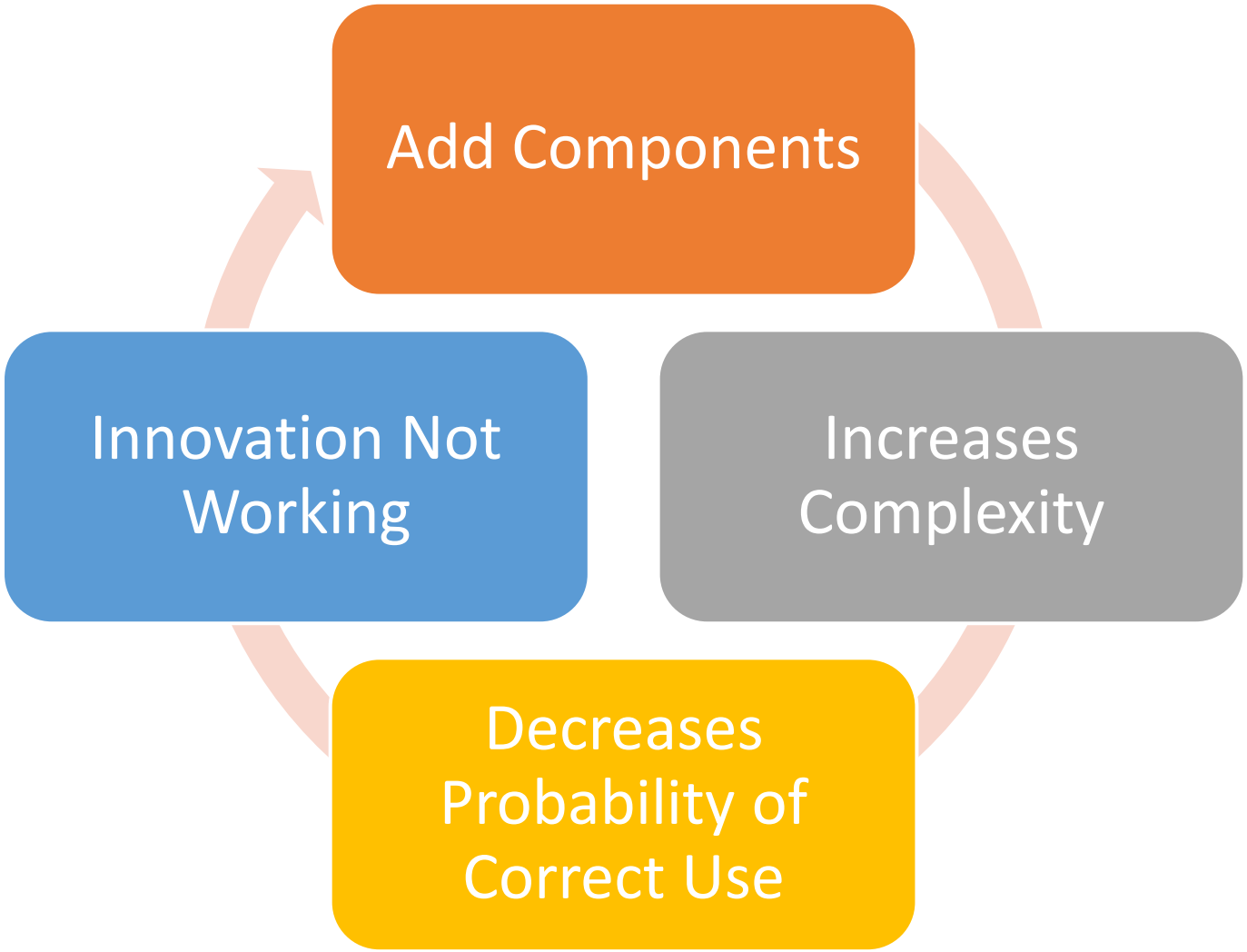
Recent survey findings reported by:
Silva, M.R., Collier-Meek, M.A., Codding, R.S. et al. (2020). Data Collection and Analysis in Response-to-Intervention: a Survey of School Psychologists. Contemporary School Psychology. https://doi.org/10.1007/s40688-020-00280-2

Dose What is Needed, Not What Fits Schedule



Codding, R., VanDerHeyden, Martin, R. J., & Perrault, L. (2016). Manipulating Treatment Dose: Evaluating the Frequency of a Small Group Intervention Targeting Whole Number Operations. *Learning Disabilities Research & Practice, 31*, 208-220.

Don’t Do This


Add Components
Increases Complexity
Decreases Probability of Correct Use
Innovation Not Working

Use Implementation Science

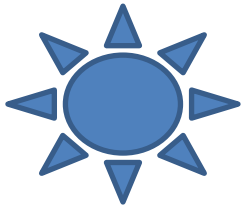
Plan to be present when intervention is started.

Track intervention effects weekly.

When growth is weak, check-in with teacher by watching intervention being implemented.

Help troubleshoot any barriers and say that you will check in again next week.

Wash, Rinse, Repeat.



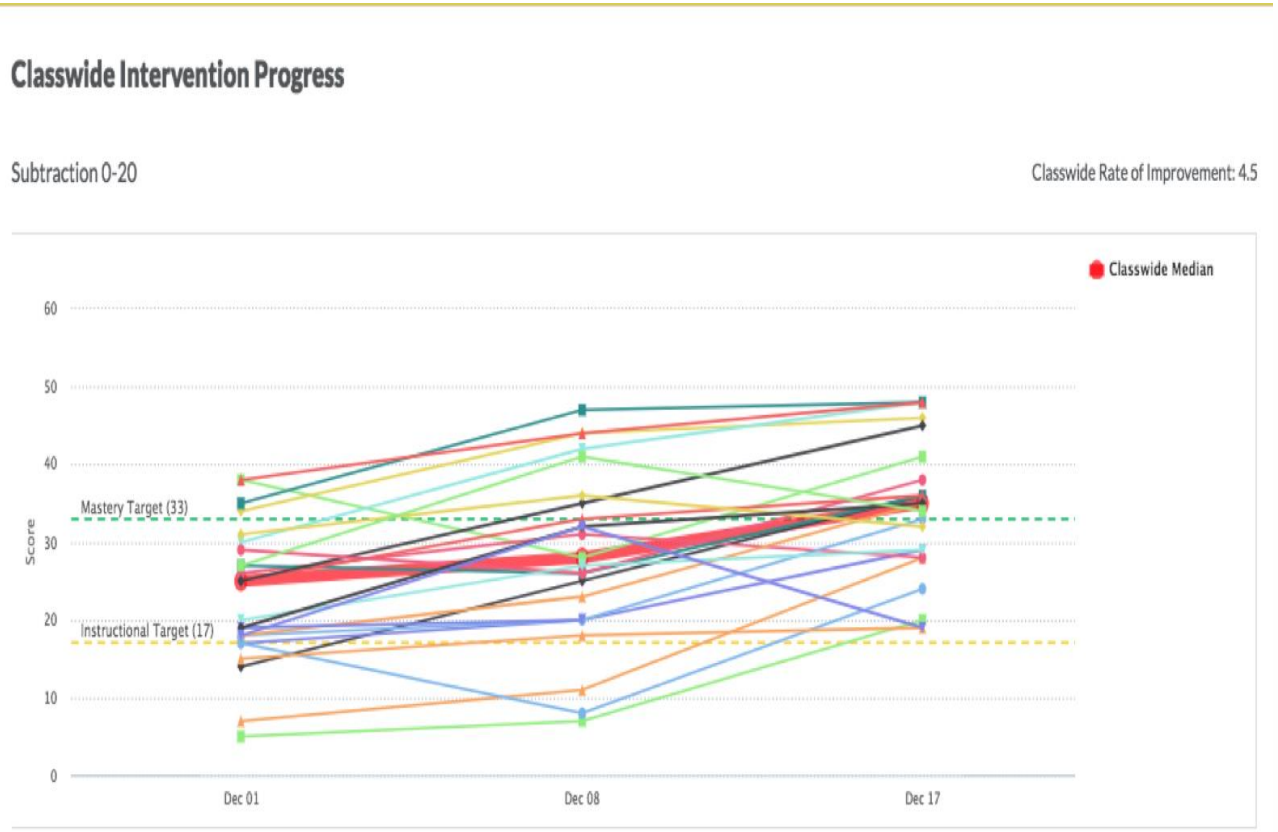
Signs of an Effective Intervention

- Scores available for each week.
- Median increases each week within instructional groupings.
- Most students grow week over week.
- Very few students remain in the frustrational range.
- Few students require more intensive intervention.

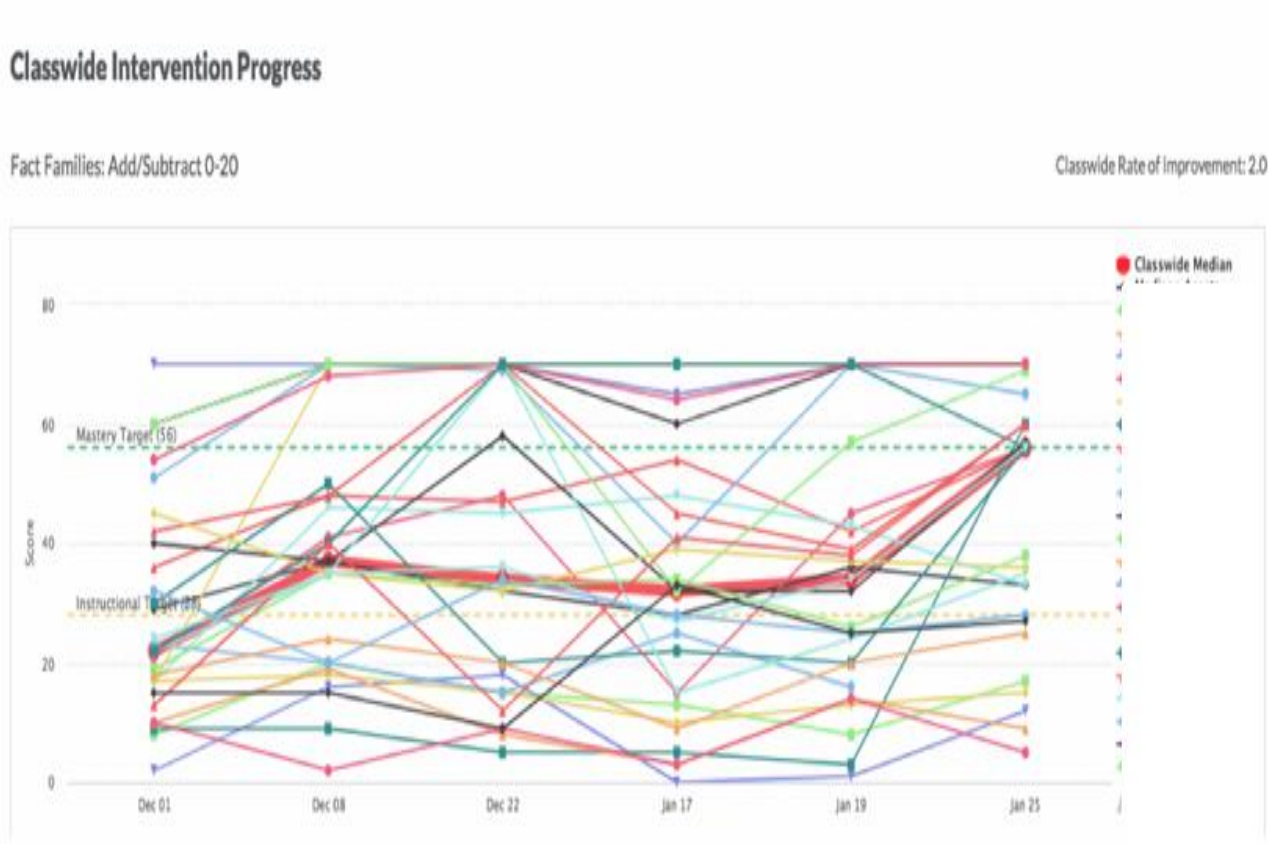
Activity: NCII DBI Implementation Rubric

https://intensiveintervention.org/resource/dbi-implementation-rubric-and-interview

This is a High-Integrity Intervention



This is a Low-Integrity Intervention



Manage Intervention

It's time to start Winter screening!

Classwide Intervention Progress

Sums to 6

Classwide Rate of Improvement: 1.8

Skill Tree Progress

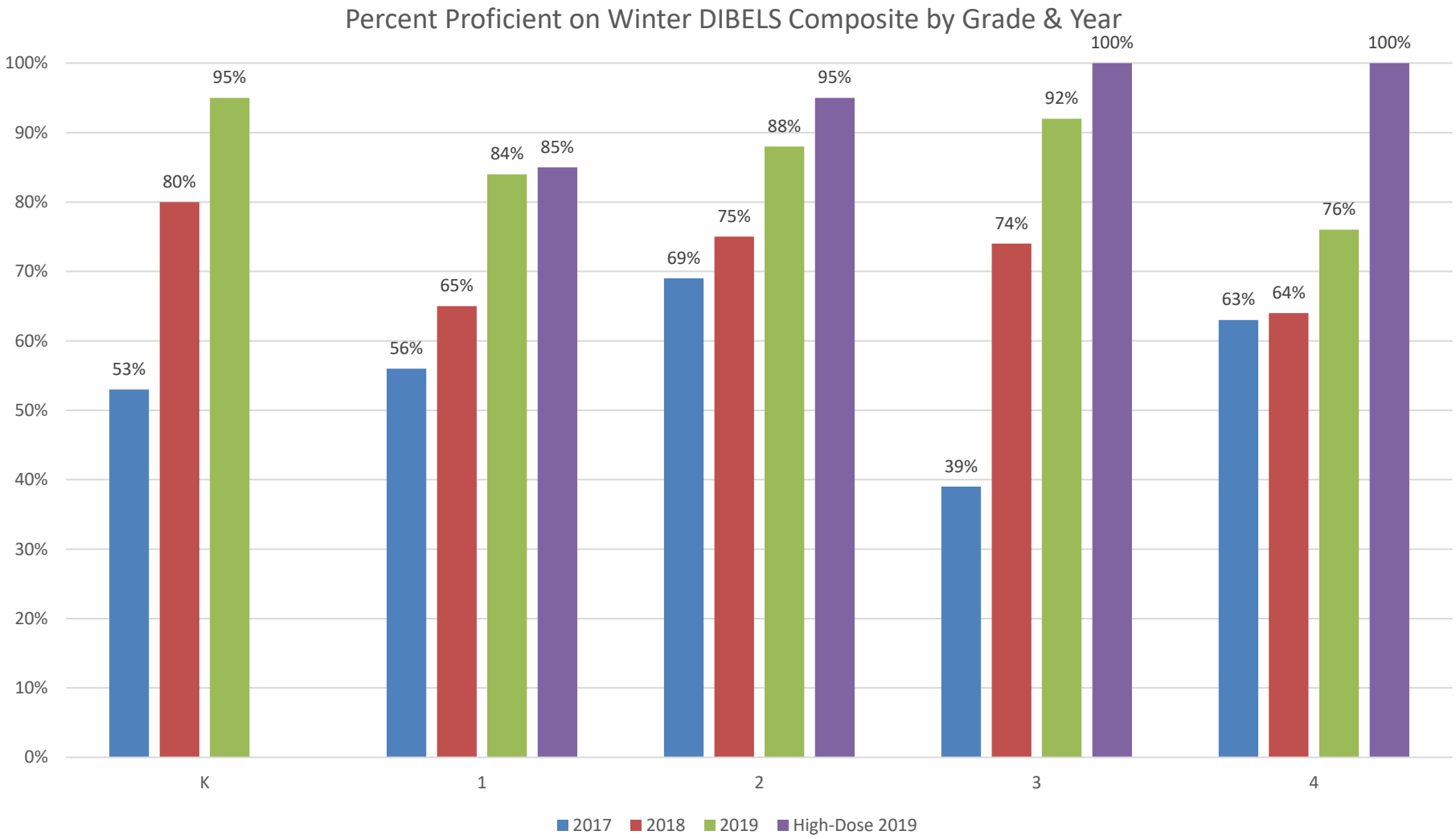
- Sums to 6
- Sums to 12
- Subtraction 0-5
- Sums to 20
- Subtraction 0-9
- Fact Families: Add/Subtract 0-9
- Subtraction 0-12
- Subtraction 0-15
- Subtraction 0-20

Manage Intervention

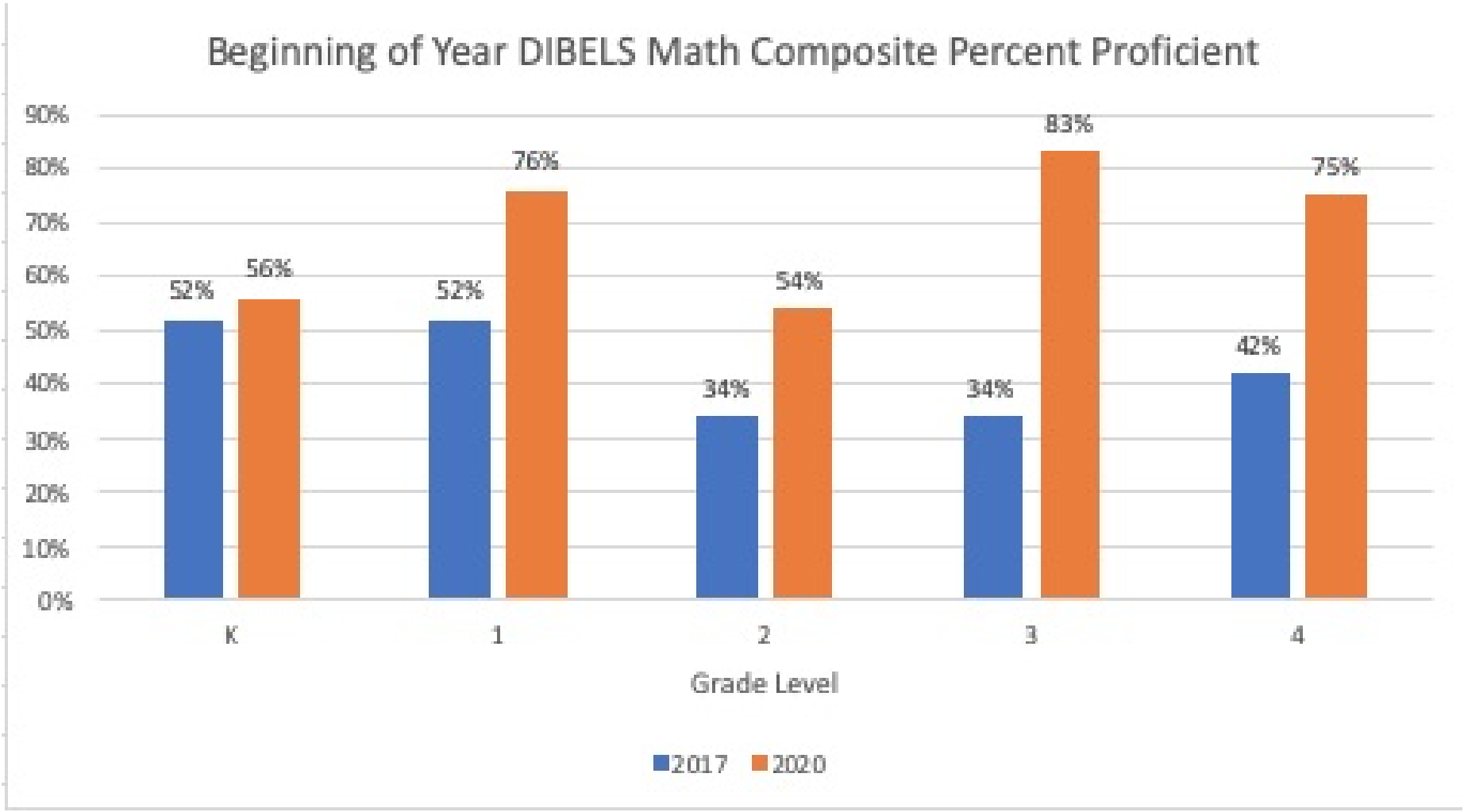
Manage Intervention

Not doing the intervention.	Make intervention use fail-proof: Make sure you have materials. Make sure you know HOW to implement. Make sure there is a scheduled time for intervention.
Students do not know how to follow the classwide intervention routine.	Re-train the students. Show the students how to get into working pairs, how to use the materials, how to provide high-quality feedback, and how to be engaged.
Teacher is not completing all steps of the intervention.	Review missed steps and understand rationale. Papers must be scored during the intervention because that provides feedback to the student, provides the error correction opportunity, and provides goal attainment opportunity. The error correction component is important because it improves student accuracy for the next session.
Children seem bored with the intervention.	Include rewards to motivate students. Display the median graph on dashboard for the class to see their growth. Be sure to set daily goals with the students!

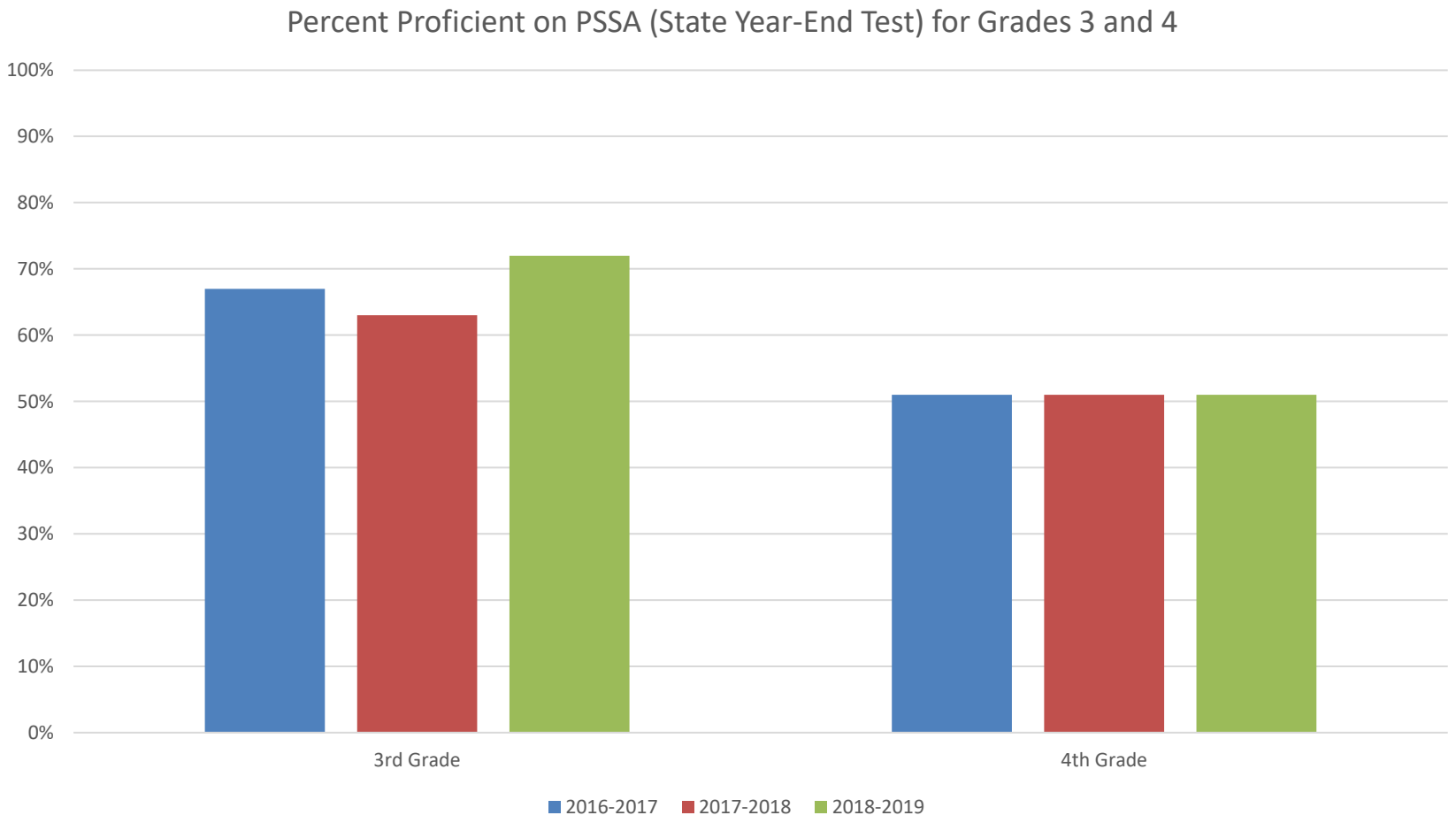
Gains Across Years and By Dosage



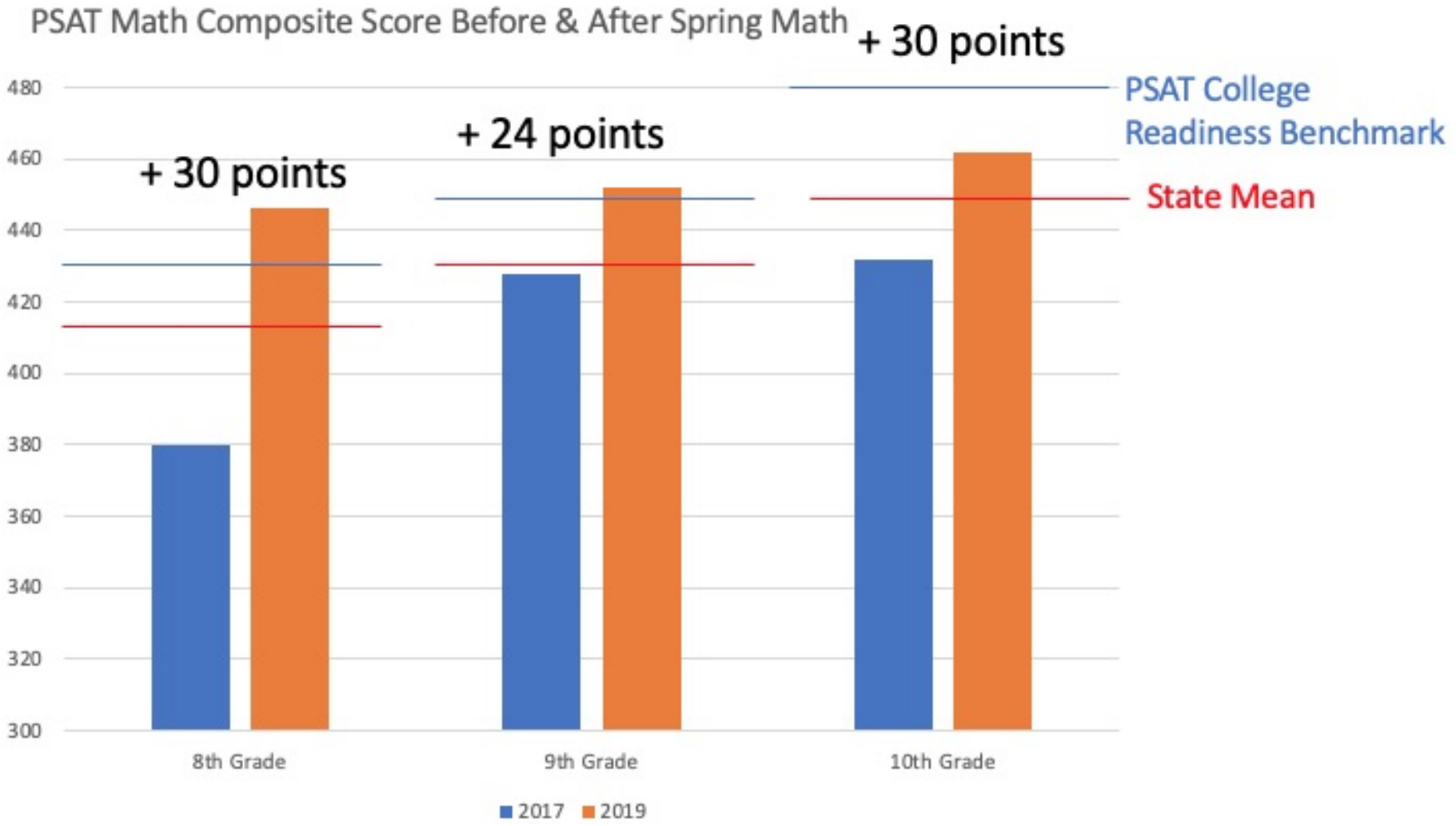
Cumulative Protective Benefit Can Be Seen

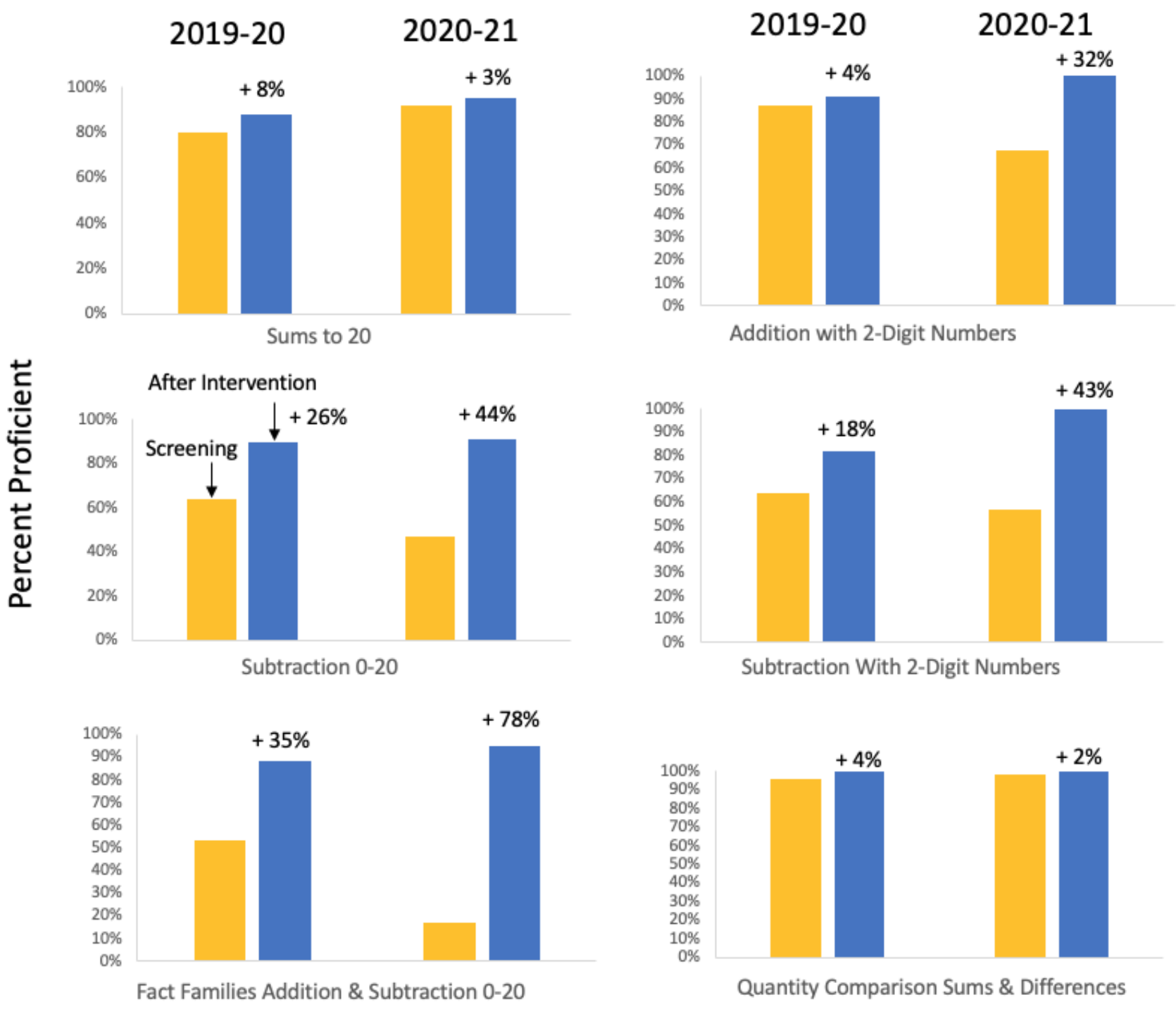


It Takes Time to Move the “Big” Indicators



But After Year 2, they Move




2019-20
2020-21
+ 8%
+ 3%
Sums to 20
2019-20
2020-21
+ 4%
+ 32%
Addition with 2-Digit Numbers
Percent Proficient
After Intervention
Screening
+ 26%
+ 44%
Subtraction 0-20
+ 18%
+ 43%
Subtraction With 2-Digit Numbers
+ 35%
+ 78%
Fact Families Addition & Subtraction 0-20
+ 4%
+ 2%
Quantity Comparison Sums & Differences

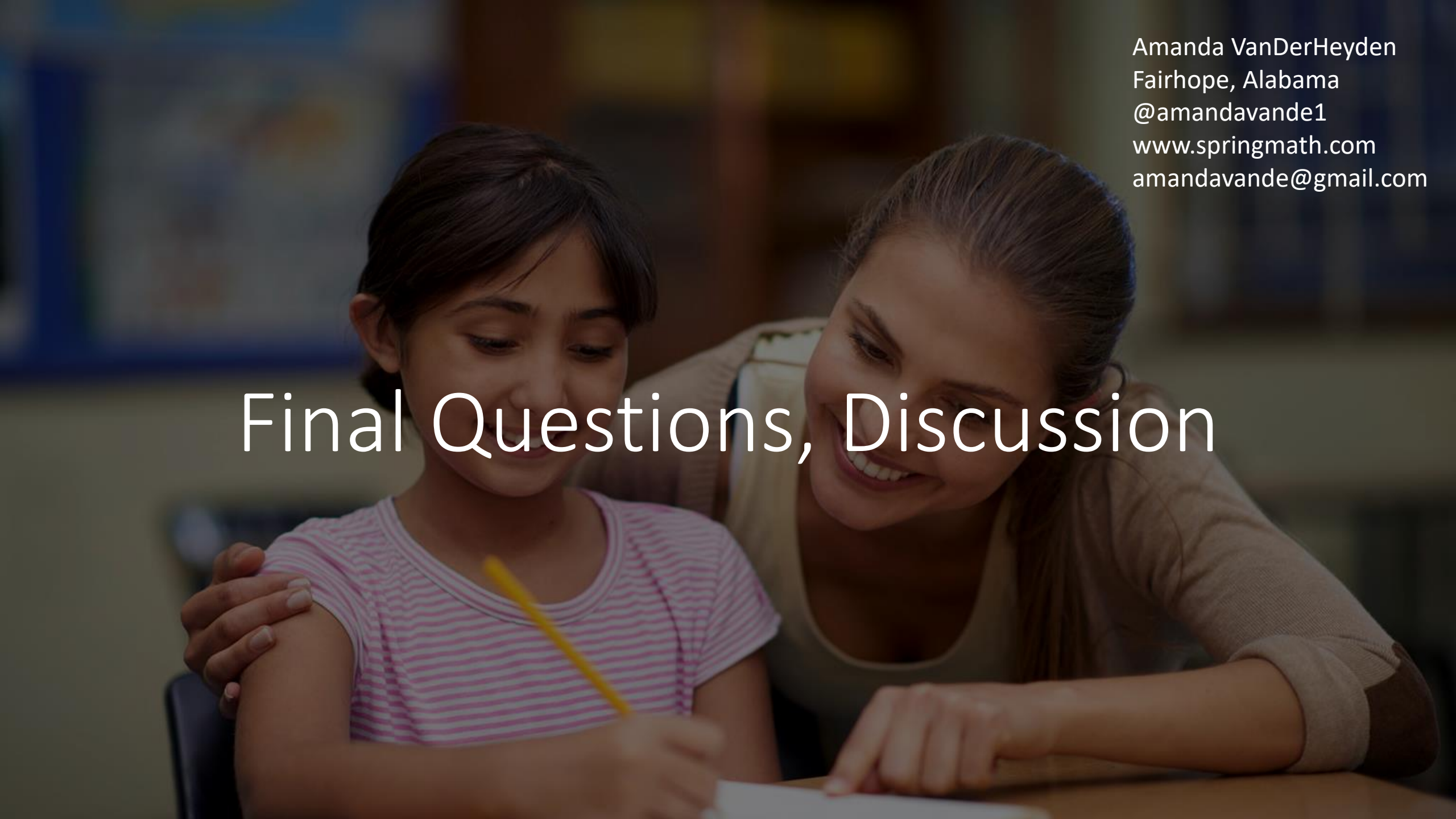
In Summary,

1. Classwide intervention will help you address high base rates of risk: improve learning rapidly in a highly efficient way & allow for more accurate risk determination.

2. Classwide intervention is a fluency-building intervention.

3. Daily use, 10-15 min per day, produces reduced risk, improved learning, more accurate decisions.

4. Implementation management is key to success.



Final Questions, Discussion

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