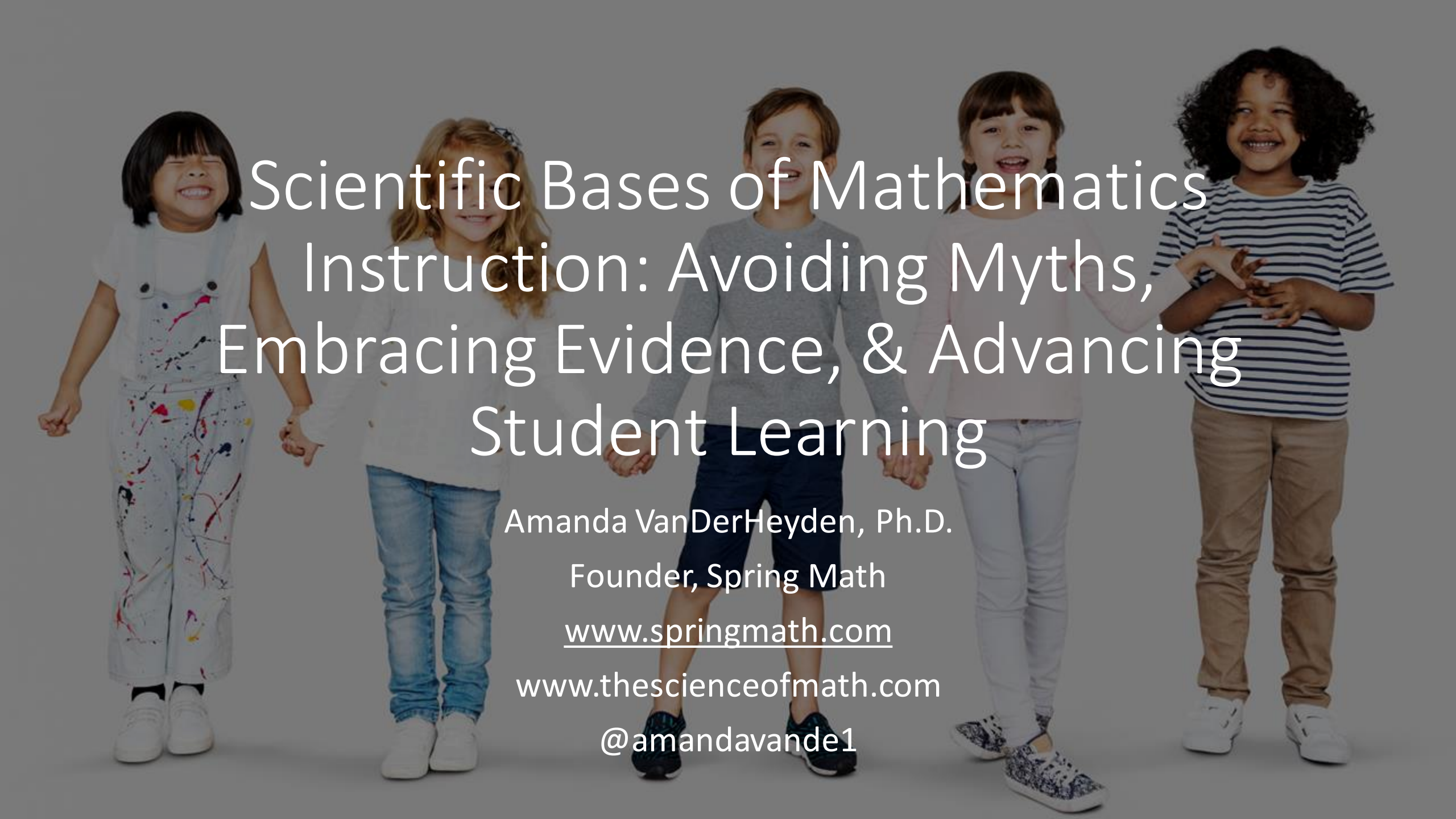


Scientific Bases of Mathematics Instruction: Avoiding Myths, Embracing Evidence, & Advancing Student Learning

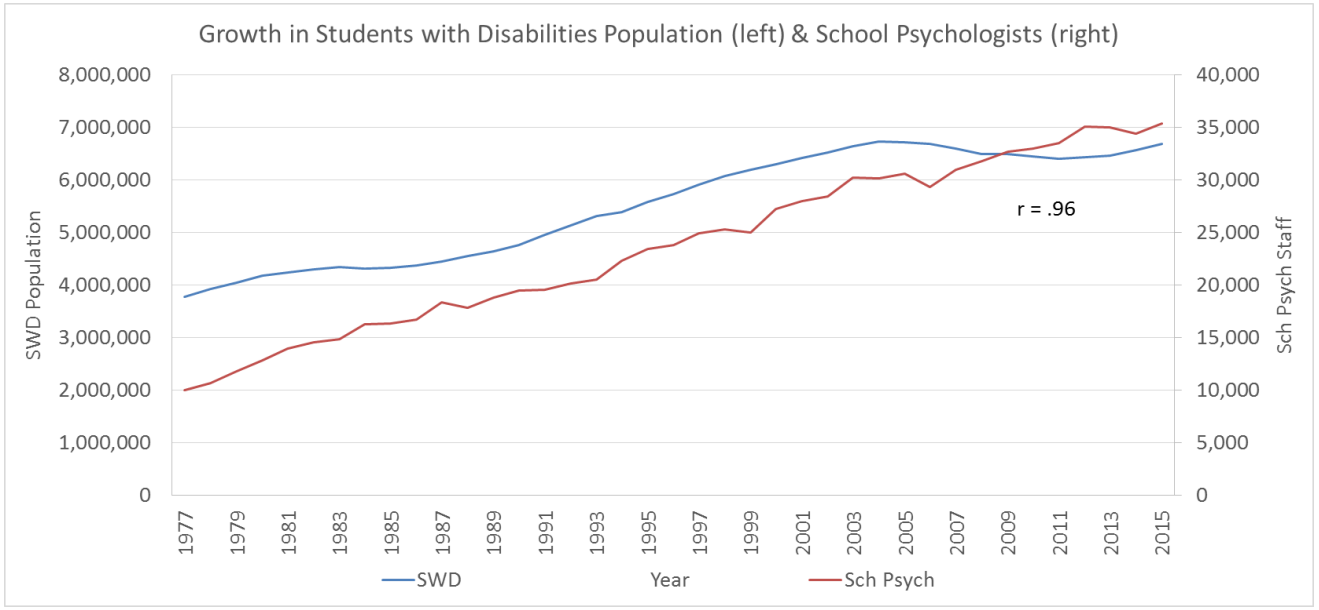
Amanda VanDerHeyden, Ph.D.

Founder, Spring Math

www.springmath.com

www.thescienceofmath.com

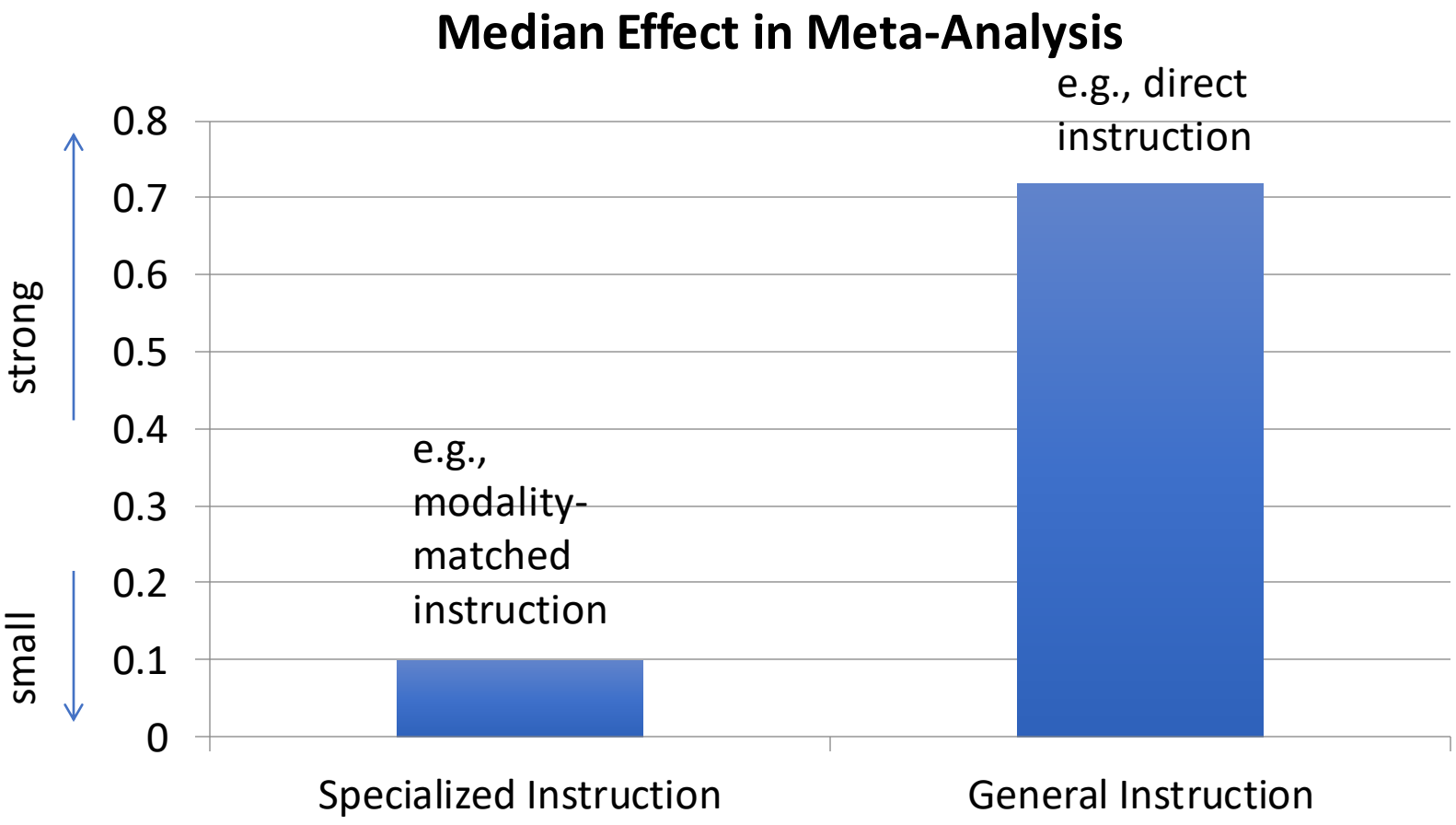
@amandavande1



Where we started...

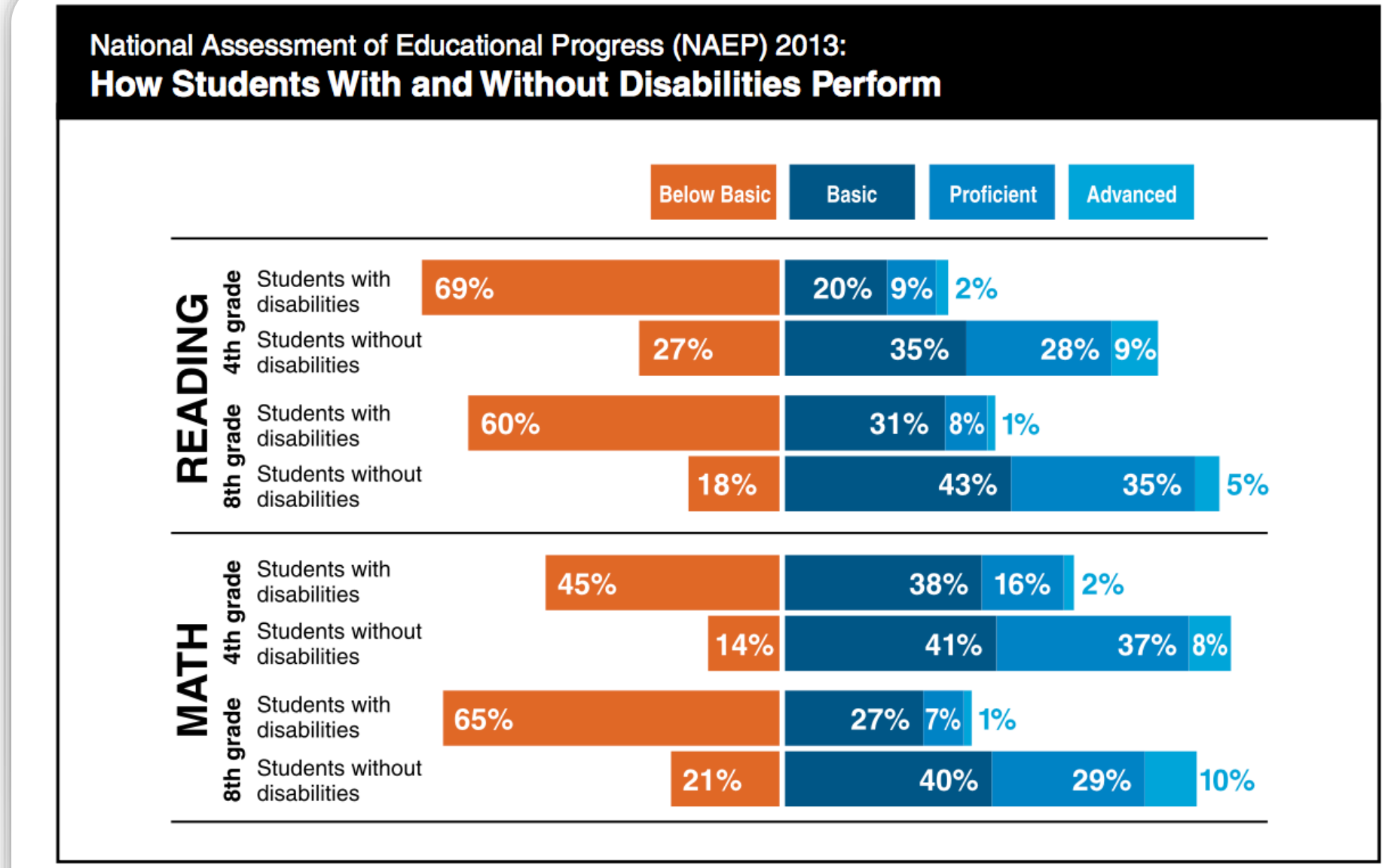
- IDEA and NCLB were companion laws.
- They were mutually referential.
- Together, they envisioned a seamless system of supports, based on the use of scientifically based instruction, in both general and regular education.

No Effect for “Special” Instruction



Reading comprehension	1.13
Direct instruction	0.84
Psycholinguistic training	0.39
Modality instruction	0.15
Diet	0.12
Perceptual training	0.08

Source: Kavale & Forness, 1999

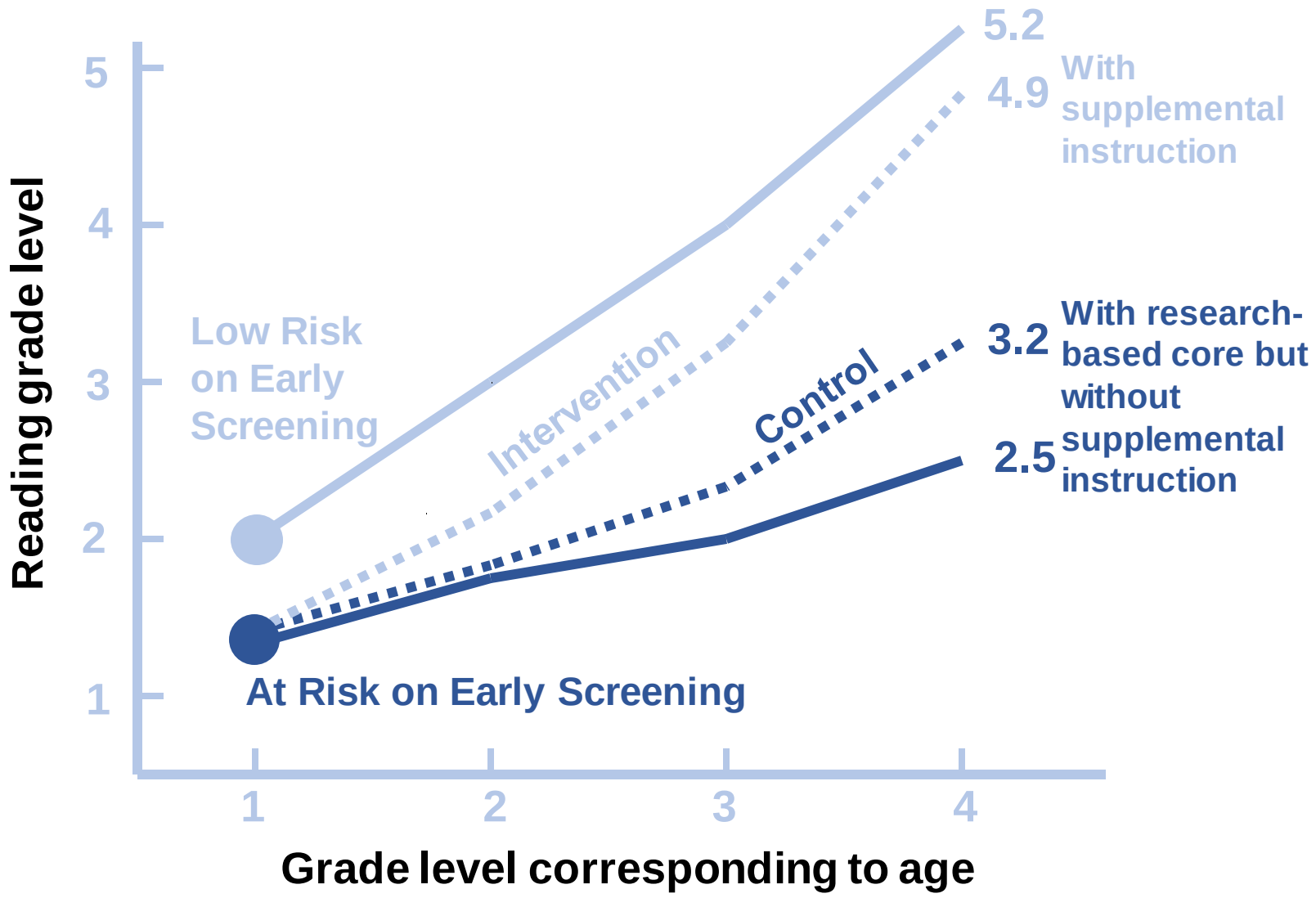


Source: National Assessment of Educational Progress, Reading and Mathematics Grade 4 and 8 National Results, 2013.
Students with disabilities includes students with both IEPs and 504 plans.

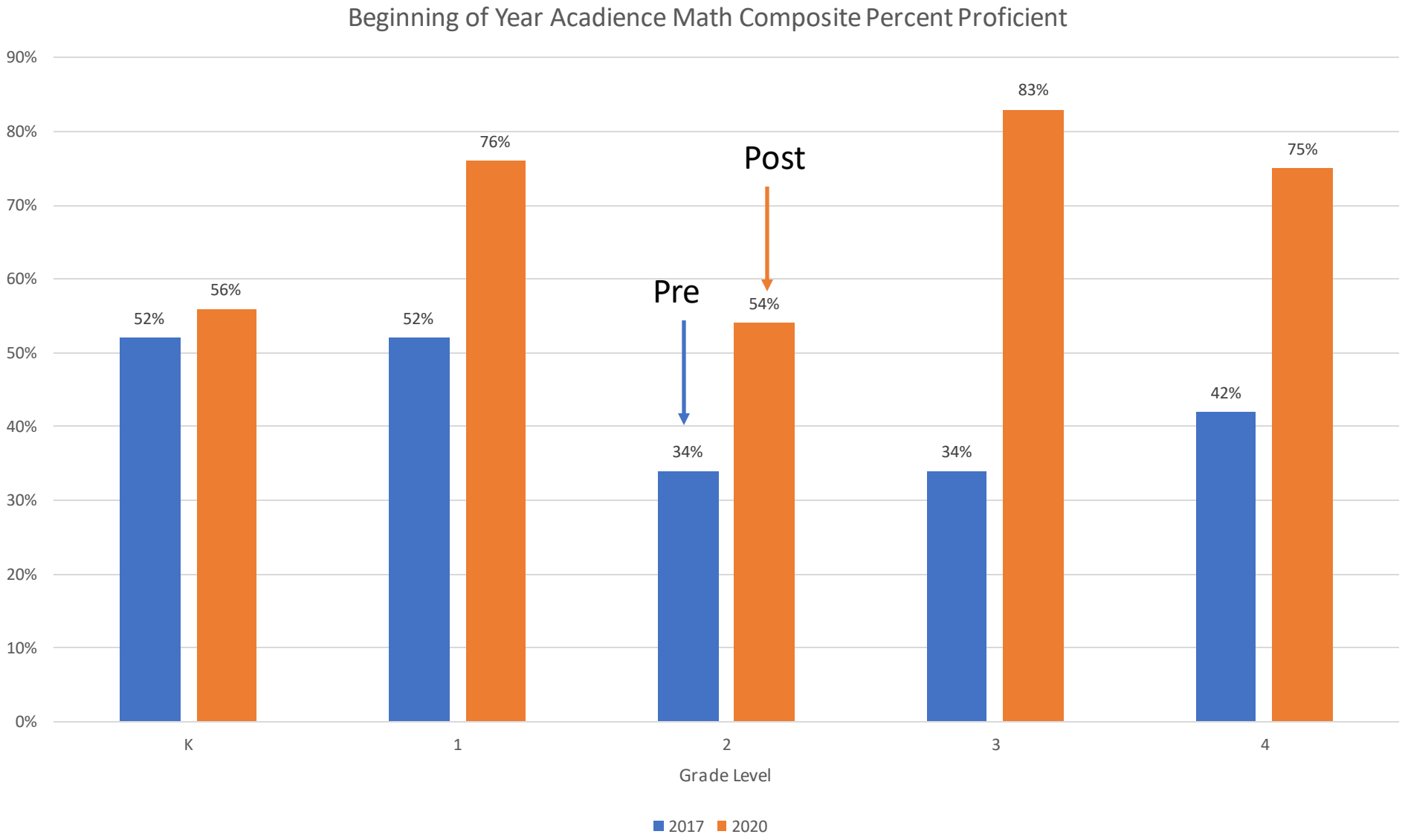
Cortiella, Candace and Horowitz, Sheldon H. *The State of Learning Disabilities: Facts, Trends and Emerging Issues.* New York: National Center for Learning Disabilities, 2014.

Where We Are Now

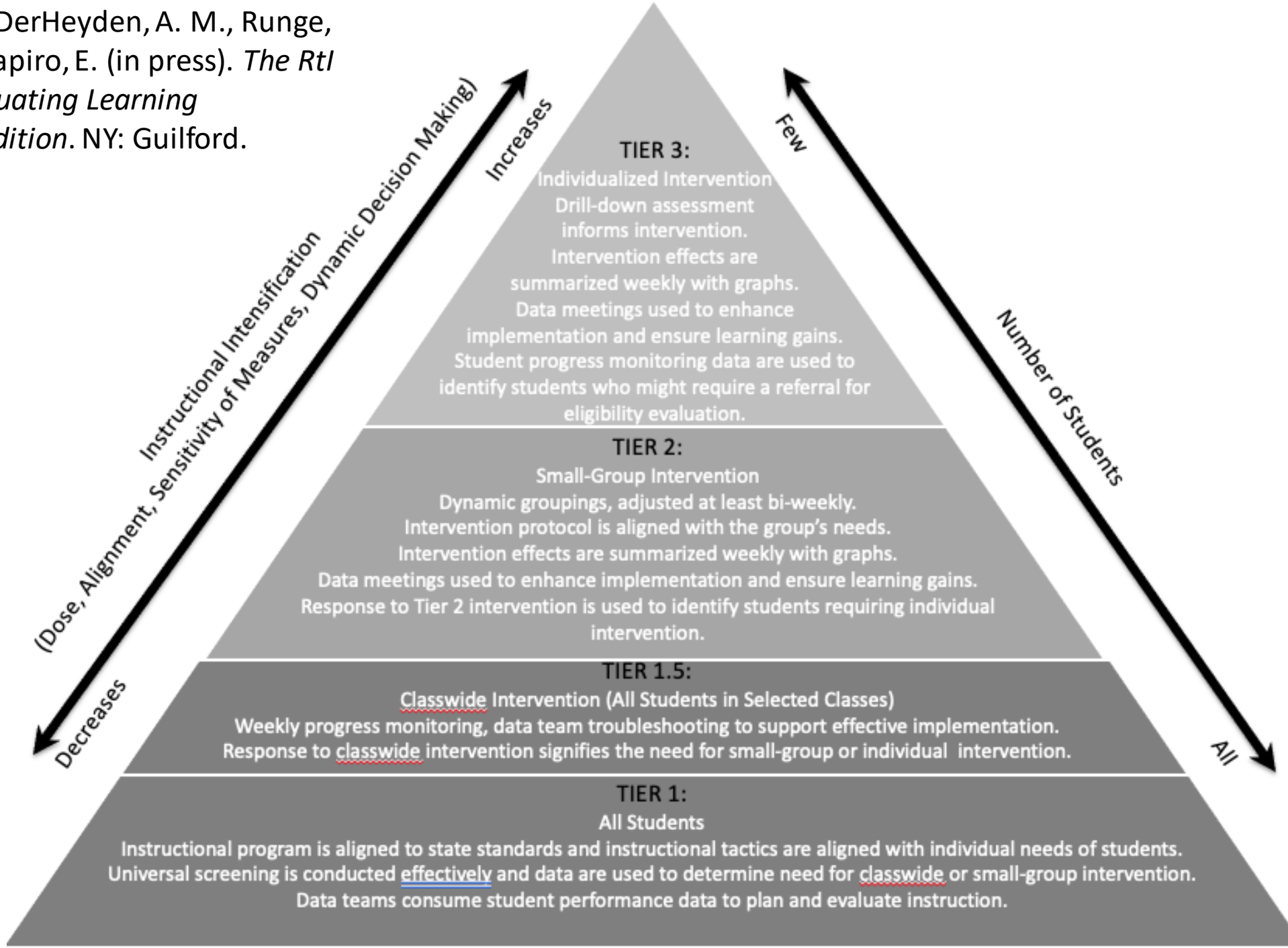
Torgesen et al. (2001)



Prevention Effects from Effective Instruction Are Cumulative! (2018-2020)

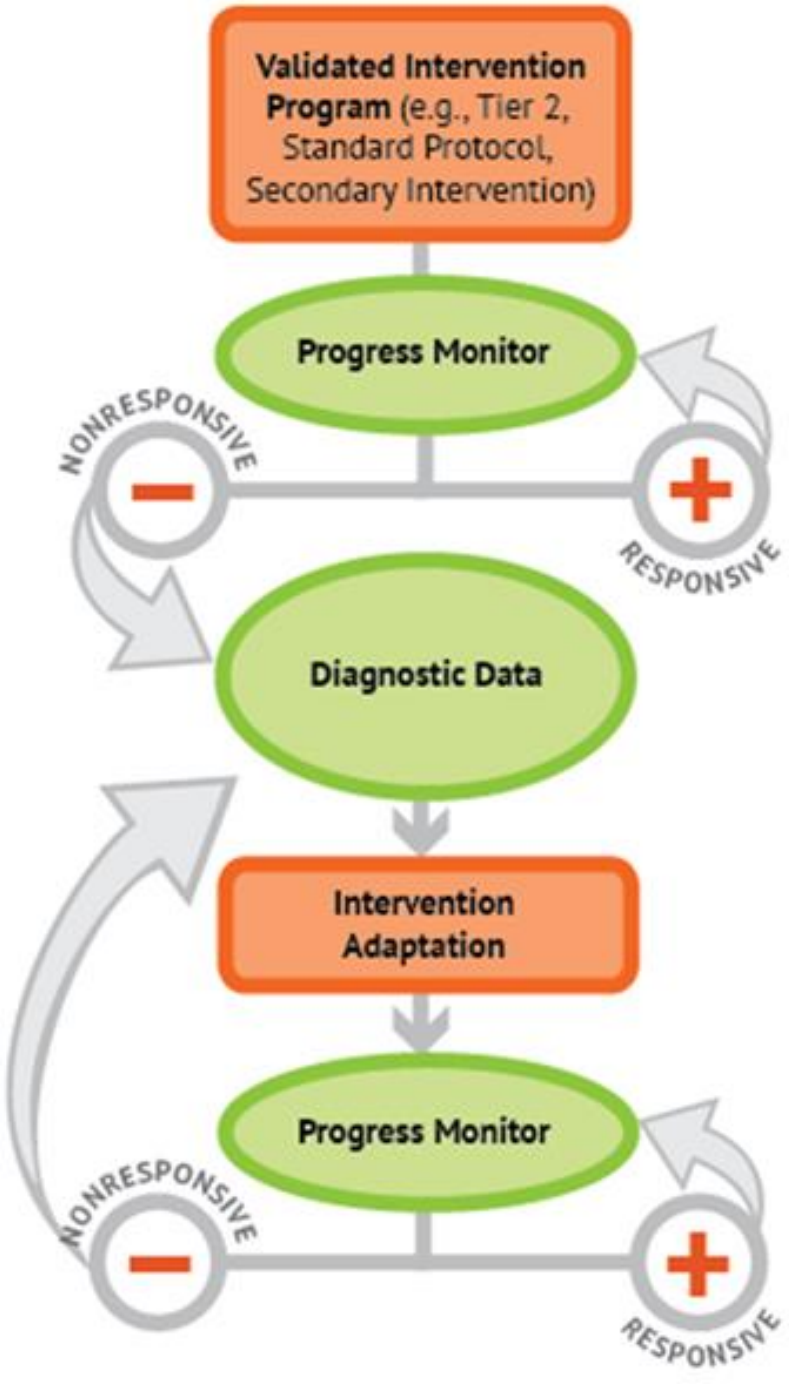


Kovaleski, J., VanDerHeyden, A. M., Runge, T., Zirkel, P., & Shapiro, E. (in press). *The RtI Approach to Evaluating Learning Disabilities, 2nd Edition*. NY: Guilford.

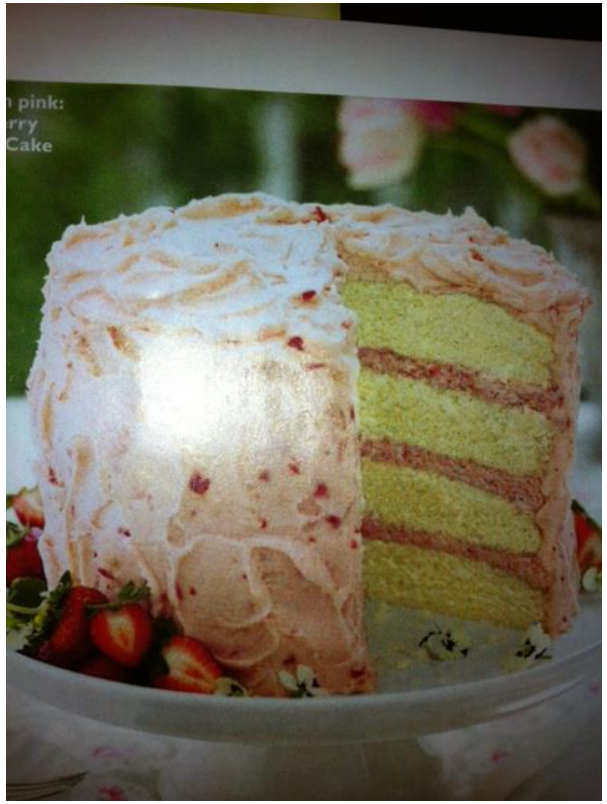


Where we are now…

- The mission is (still) the development of proficiency in useful skills (particularly reading and math) for all students.
- MTSS is the structure needed to implement the mission.
  - Standards-aligned curricula
  - Core instruction based on science
  - Efficient and effective universal screening
  - Data-analysis teaming
  - Robust interventions
  - Progress monitoring
  - Decision-making based on students' RTI



What I wanted



What I got

Opportunity Gaps

	Instruction-Sensitive	**Instruction-Proof**
Precise Instruction	Low Risk	
Imprecise Instruction		

Opportunity Gaps

	Instruction-Sensitive	**Instruction-Proof**
Precise Instruction	Low Risk	Low Risk
Imprecise Instruction		

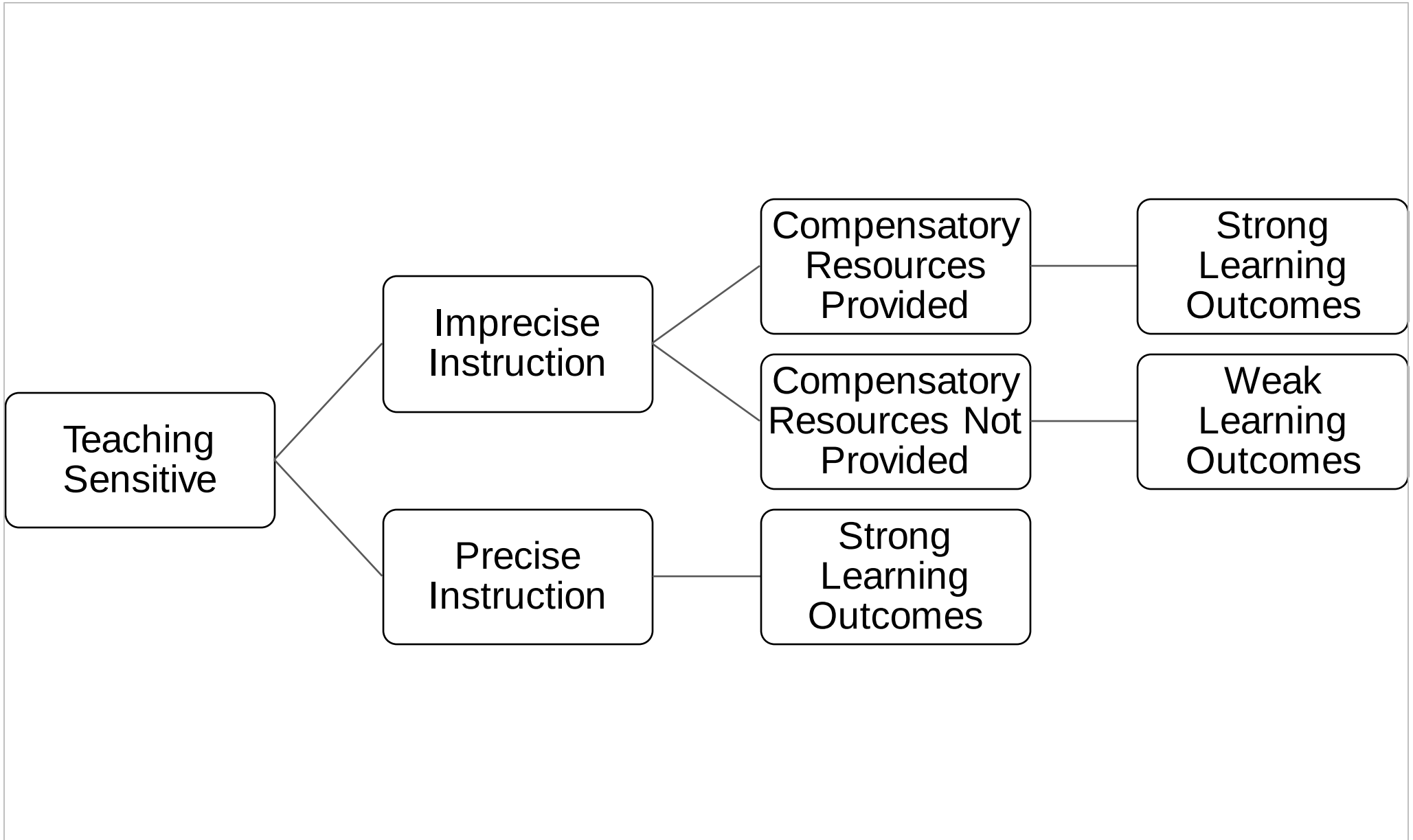
Opportunity Gaps

	Instruction-Sensitive	**Instruction-Proof**
Precise Instruction	Low Risk	Low Risk
Imprecise Instruction		Low Risk

Opportunity Gaps

	Instruction-Sensitive	**Instruction-Proof**
Precise Instruction	Low Risk	Low Risk
Imprecise Instruction	High Risk	Low Risk

Opportunity Gaps

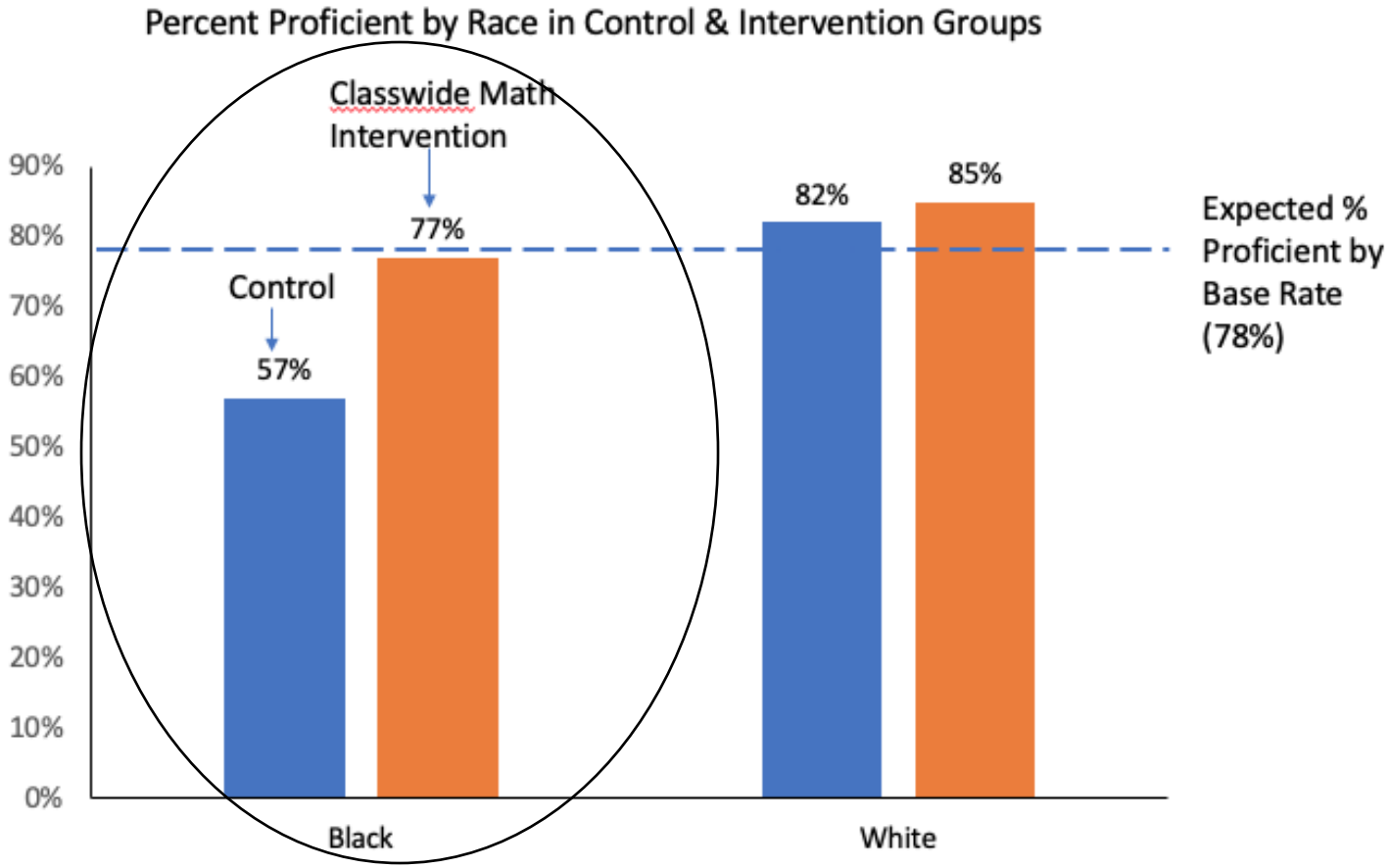


Opportunity Gaps

- Barrett, C. A., Guttman-Lapin, D. (2020). LIEM and actionable opportunities for school psychologists: The year in review. *Communique*, *48*, 18-20.
- “Race is not a risk factor. Racism is a risk factor.” Collins, T. A., Newman, D. S., Endres, B. E., McIntire, H., Newman, C. L., Scott, M. N., Villarreal, J. N., & Gerrard, M. K. (under review). The future of social justice research in school psychology: From special issue to priority.

MTSS Can Close Opportunity Gaps By Delivering More Effective Instruction

Where It's Needed



VanDerHeyden, A. M. & Codding, R. (2015). Practical effects of classwide mathematics intervention. *School Psychology Review, 44*, 169-190. doi: http://dx.doi.org/10.17105/spr-13-0087.1

Excellent Science-Based Core Instruction

Advantages ALL students

Avoids inefficiencies in instruction

Avoids/prevents unstable instructional effects

MTSS is the best way to improve instruction at scale

Learning is a Very Predictable Outcome of High-Quality Instruction

College Completion

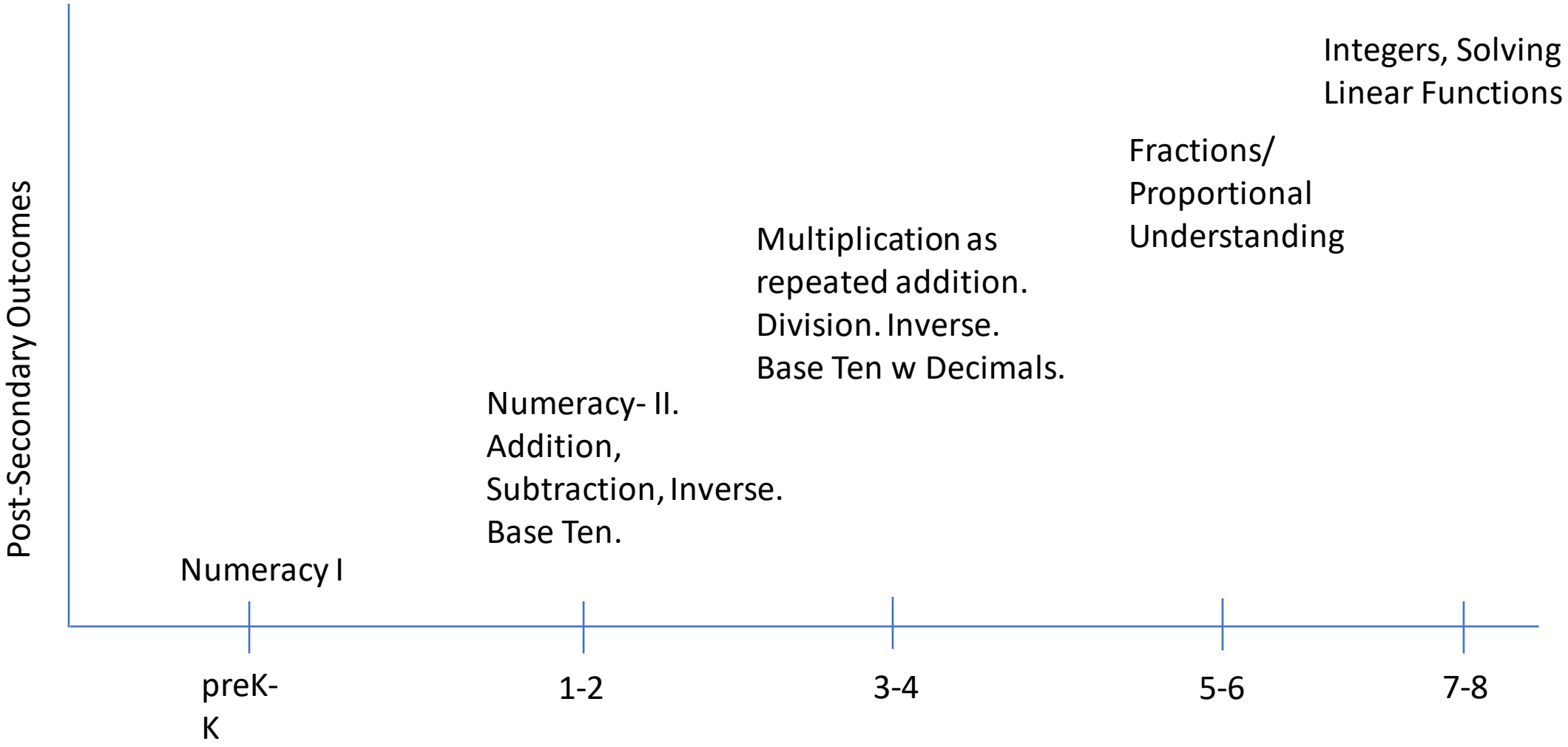
Linear Functions

Proportions

Whole Number Operations

Numeracy

Math Success is Highly Predictable (so is risk)



Modern Math Myths
www.thescienceofmath.com

Timed assessment causes anxiety

- https://youtu.be/XCe0JXKeQIg

Directly teaching the algorithm is harmful

- https://www.youtube.com/watch?v=rDi7z3IZOyk

Conceptual Understanding must precede Procedural Knowledge

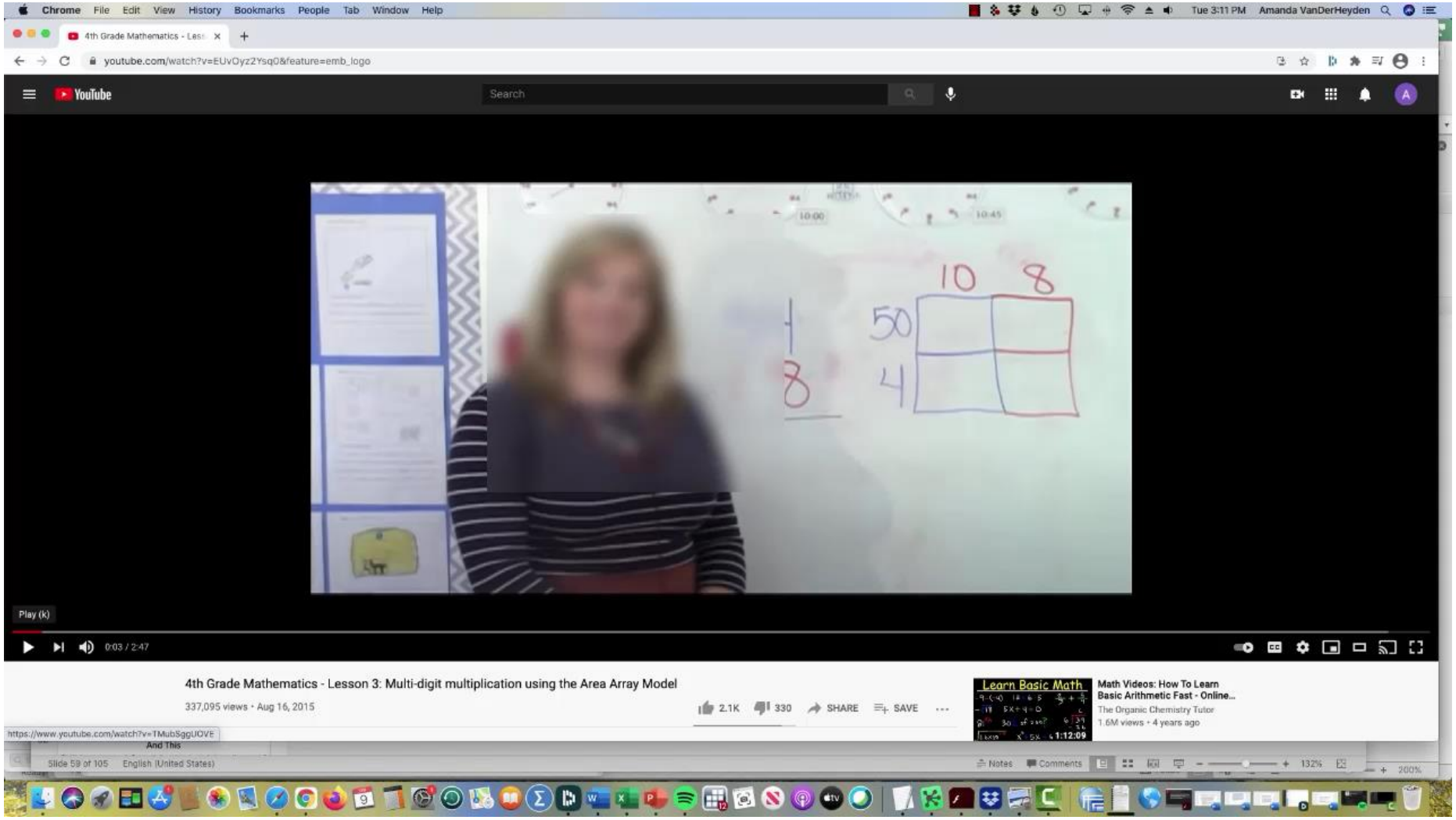
- https://youtu.be/Ch4aEm9CkAc

Explicit Instruction only works for struggling learners

- https://youtu.be/43dUNg3jCxQ
- Executive function interventions can improve math achievement
- https://www.youtube.com/watch?v=NuHBZ2i68_E

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

Don’t Do This


Chrome File Edit View History Bookmarks People Tab Window Help
Tue 3:11 PM Amanda VanDerHeyden
youtube.com/watch?v=EUvOyz2Ysq0&feature=emb_logo
YouTube
Search
10 8
50
4
Play (k)
0:03 / 2:47
4th Grade Mathematics - Lesson 3: Multi-digit multiplication using the Area Array Model
337,095 views • Aug 16, 2015
2.1K 330 SHARE SAVE
Learn Basic Math
1:12:09
Math Videos: How To Learn Basic Arithmetic Fast - Online...
The Organic Chemistry Tutor
1.6M views • 4 years ago
https://www.youtube.com/watch?v=TMubSggUOVE
And This
Slide 59 of 105 English (United States)
Notes Comments 132%

Let’s Unpack Screening

Screening Measures: www.springmath.org/sites/default/files/2021-08/SM_ScreeningByGrades_TimeOfYear_0821_Final_0.pdf

	FALL	WINTER	SPRING
5th Grade	• Fact Families Mult/Div 0-12 • Add & Sub Decimals to 100ths • Multiply 2 x 2 with and without Regrouping • Find Least Common Denominator	• Convert Improper Fractions to Mixed Numbers • Add & Subtract Fractions with Unlike Denominators • Quantity Comparison fractions, decimals, whole numbers	• Simplify Fractions • Multiply & Divide Decimals • Multiply & Divide Proper & Improper Fractions • Quantity Comparison with whole numbers, fractions, decimals, percents
6th Grade	• Add & Subtract Fractions with Unlike Denominators • Order of Operations • Multiply 2 x 2 with decimals • Multiply & Divide Mixed Numbers	• Distributive Property of Expression • Collect Like Terms • Find Percent of a Whole Number • Mixed Fraction Operations	• Substitute Whole Number to Solve Equations • Mixed Decimal Operations • Graph Points in a Coordinate Plane • Quantity Comparison w Negative Numbers
7th Grade	• Solve Algebraic Proportions • Solve Missing Value in a Percentage Problem • Mixed Operations Integers	• Order of Operations • Mixed Inverse Operations • Complex Fractions	• Solve 2-step Equations • Translate Verbal Expressions into Math Equations • Solve 2-step Equations with Fractions
8th Grade	• Distributive Property to Simplify Expressions • Collect Like Terms to Simplify Expressions • Solve for Slope & Intercept using Linear Function	• Mixed Operations with Exponents • Order of Operations II • Point on a Line	• Linear Combinations to Solve Equations • Substitute Equation to Solve Linear Equations • Comparison Method to Solve Linear Equations

Teacher: _____
Grade: _____
Student: _____

Translate verbal expressions into math equations

Date: 10/29/2021 (version: 42h6)

"The words in each of these problems can be changed into mathematical equations. Let's do the first one together." Work the first problems with the student(s) to make sure the student(s) understand the task. "When I say begin, start with the second problem on the first row and work across. Don't skip any problems. Work as many problems as you can before the time is up. Do you have any questions?" Set timer for 4 minutes, start timer, and say, "Begin." Stop student after 4 minutes and count up problems correct.

The product of 10 and a number is 2.	2 times the sum of x and 4 is 32.	( )/1
73 decreased by 10 times x is 44.	93 decreased by 3 times a number is 76.	( )/3
6 times x is 57.	4 times a number is 39.	( )/5
One fifth of a number is 8	8 times the sum of x and 8 is 16.	( )/7
81 increased by 6 times x is 67.	2 times the sum of a number and 9 is 66.	( )/9
8 times a number is 63.	91 decreased by 10 times a number is 19.	( )/11

Spring 2017-18 Screening Results

The results are in. Let's take a look...

Classroom Performance

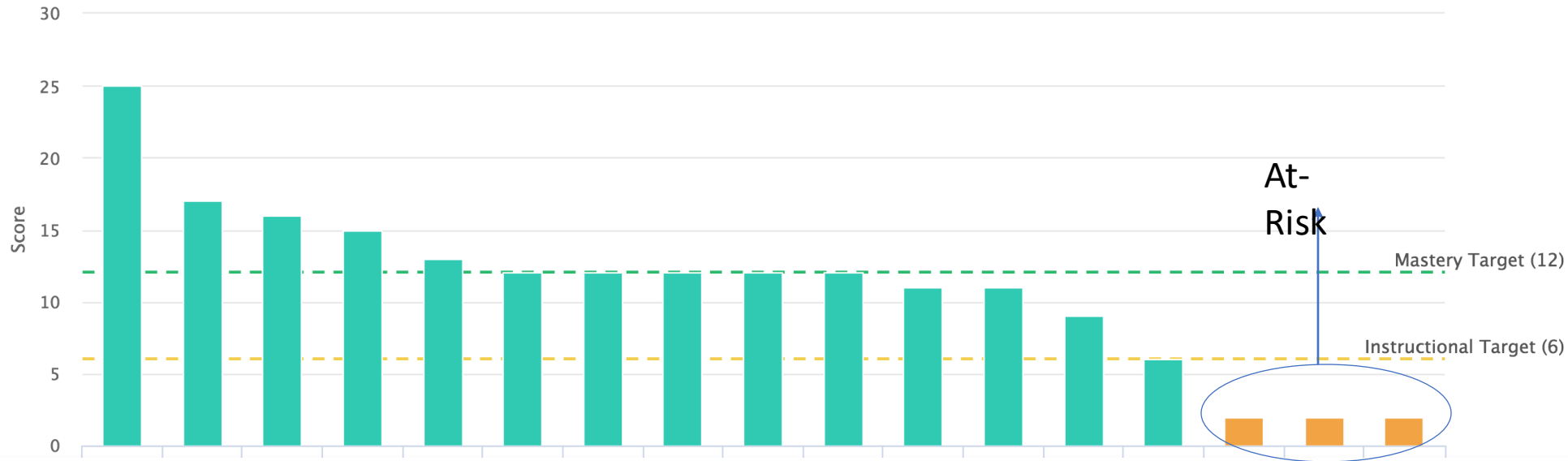
6% of your class reached the target on all of the screening assessments. Extra practice will help you reach mastery at this grade level.

The classwide intervention has already been started.

82%	12%	94%	24%
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.



Smart Use of Data to Determine Educational Need

Classwide Intervention | Screening | Students | Growth

Fall 2019-20 Screening Results

The results are in. Let's take a look...

Classroom Performance

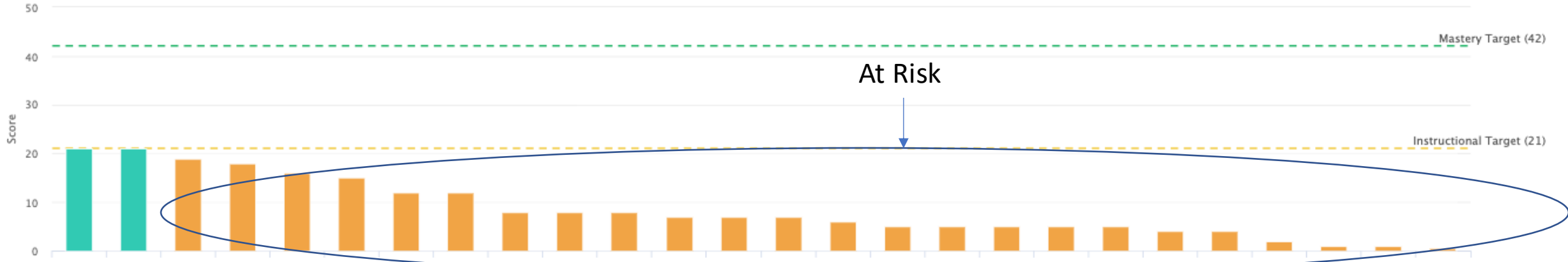
4% of your class reached the target on all of the screening assessments. Extra practice will help you reach mastery at this grade level.

The classwide intervention has already been started.

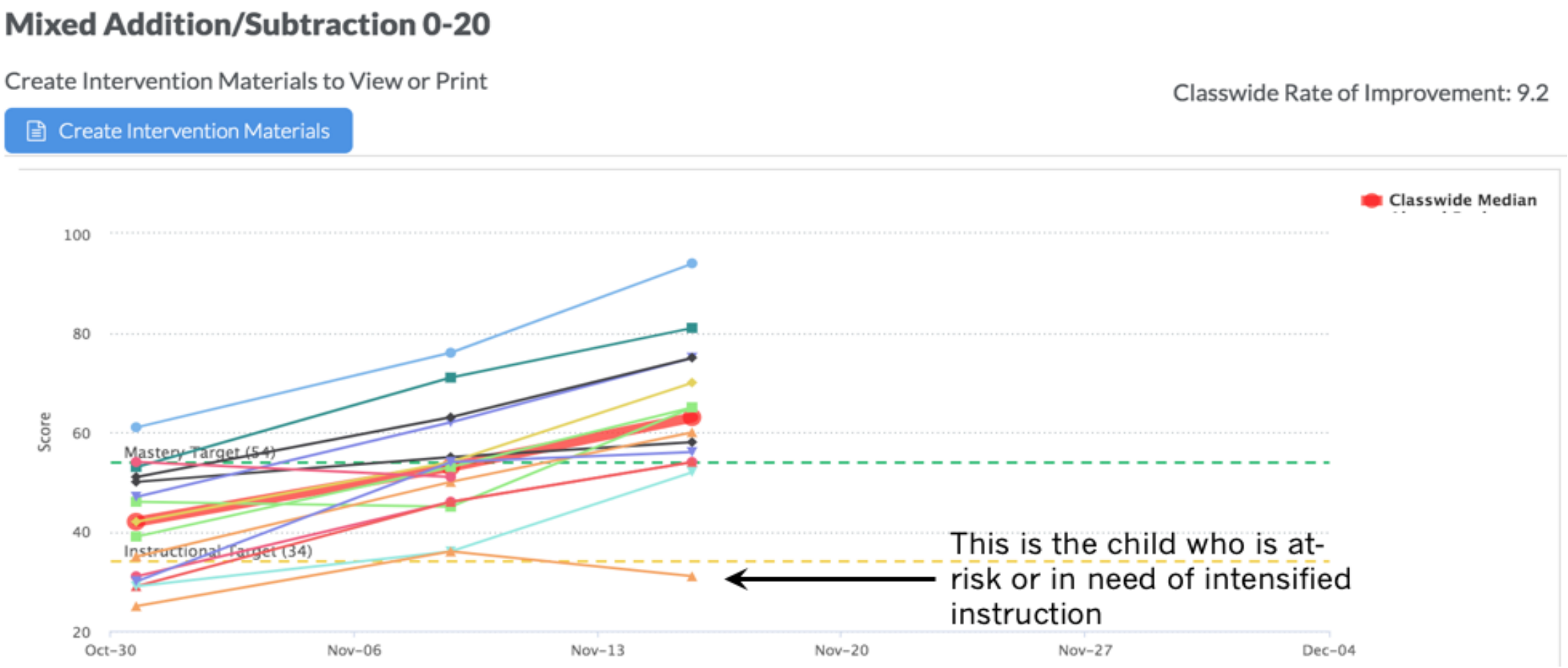
8%	19%	19%
Measure 1	*Measure 2*	*Measure 3*

Measure 1: Fact Families: Addition/Subtraction 0-20

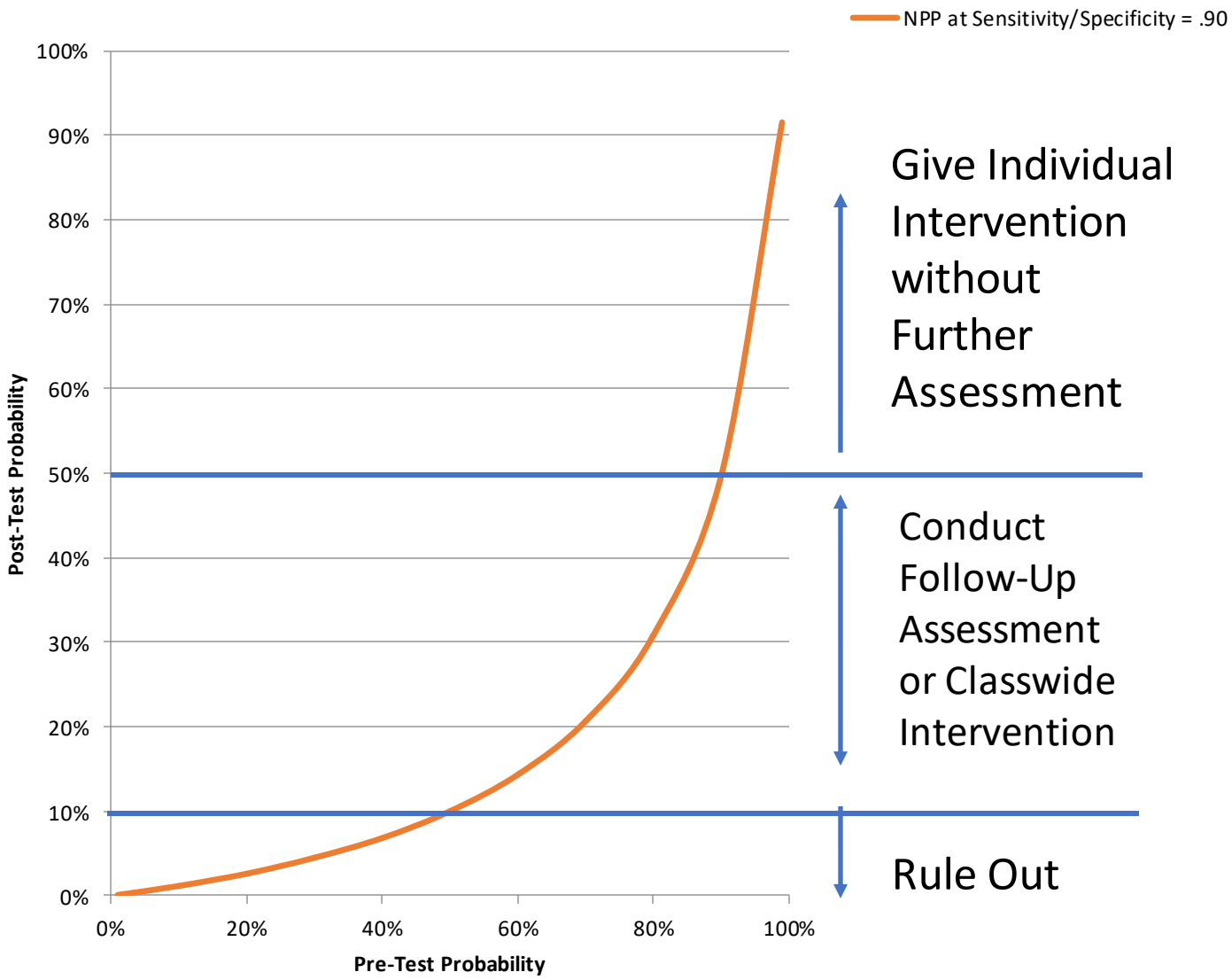
Your students' screening scores compared to the target score.



Classwide Intervention is Part of Screening

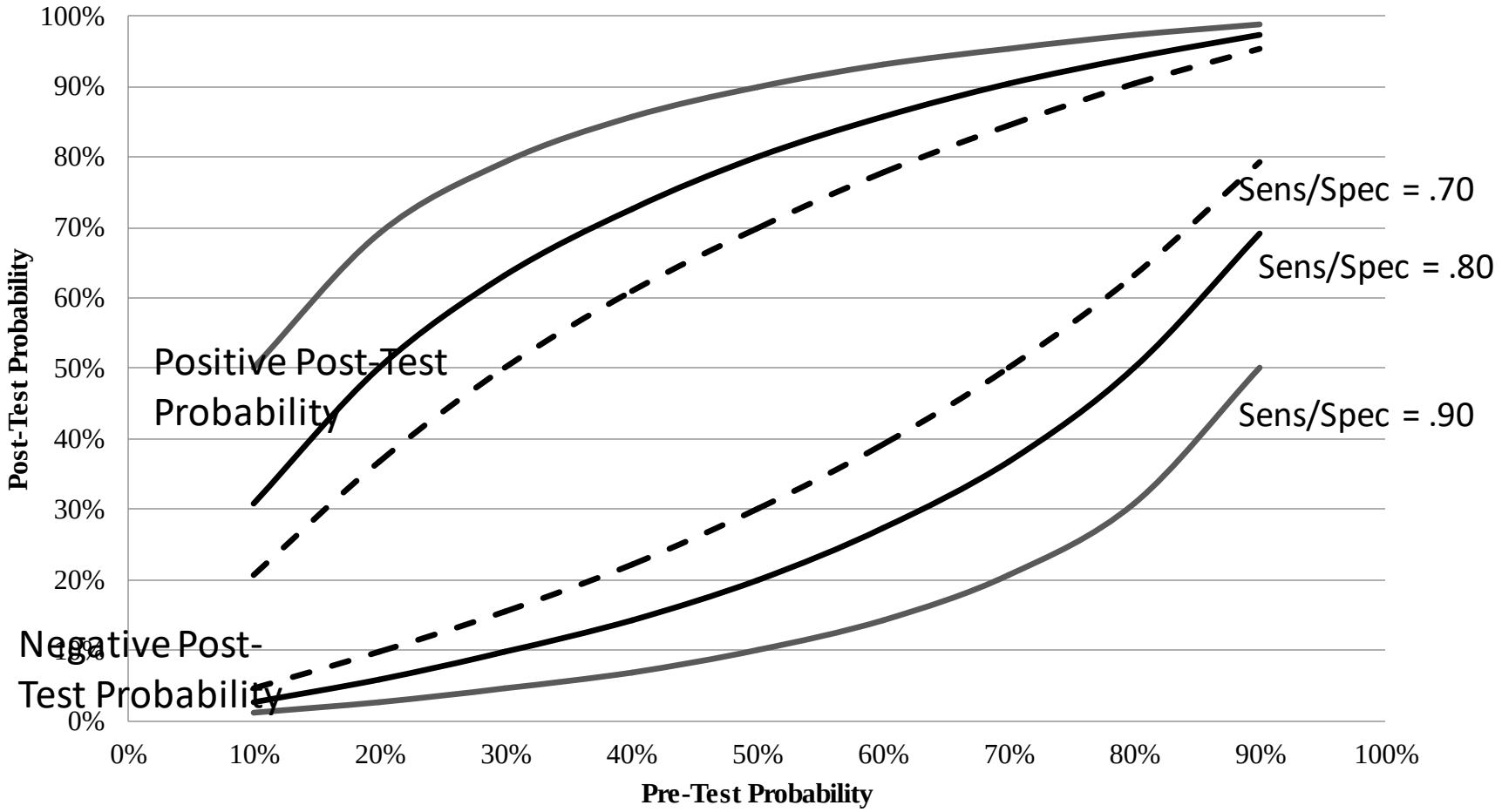


Screening Alone, When Risk is High, Causes Decision Errors



Negative Post-Test Probability (Orange Line) = the probability of a child who has PASSED the screening FAILING the year-end test.

The Effect of Prevalence



Here is a Class at Screening

Classwide Intervention | Screening | Students | Growth

Fall 2019-20 Screening Results

The results are in. Let's take a look...

Classroom Performance

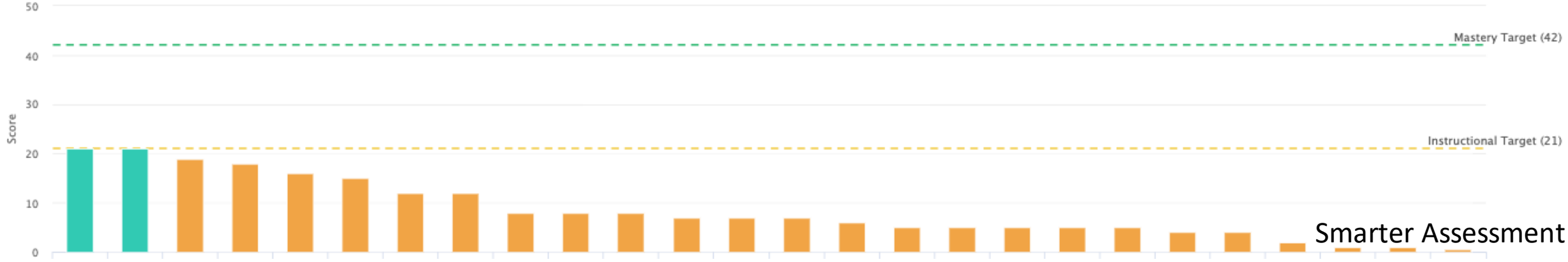
4% of your class reached the target on all of the screening assessments. Extra practice will help you reach mastery at this grade level.

The classwide intervention has already been started.

8%	19%	19%
Measure 1	*Measure 2*	*Measure 3*

Measure 1: Fact Families: Addition/Subtraction 0-20

Your students' screening scores compared to the target score.



Smarter Assessment

Students Show Rapid Growth

Classwide Intervention | Screening | Students | Growth

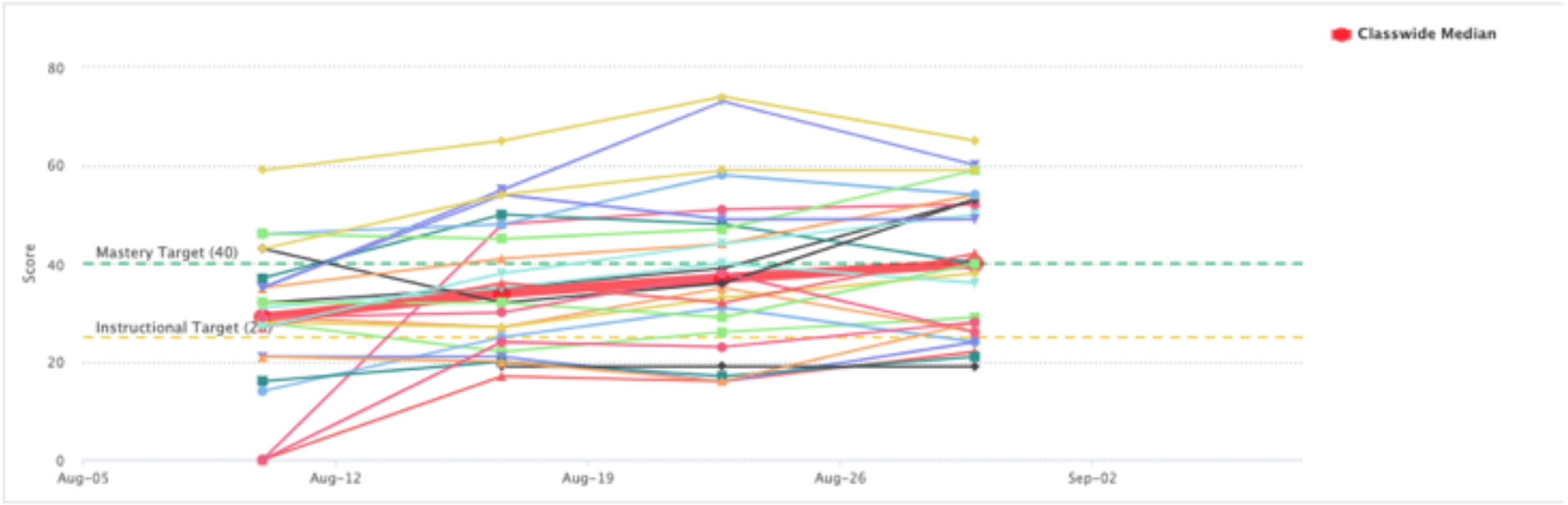
Your class is currently in class wide intervention. Complete intervention activities daily and enter progress monitoring scores weekly.

Mixed Addition/Subtraction 0-20

Create Intervention Materials to View or Print

Create Intervention Materials

Classwide Rate of Improvement: 3.8



Hide Students scores

Intervention Progress

- Mixed Addition/Subtraction 0-20
- Fact Families: Add/Subtract 0-9
- Fact Families: Addition/Subtraction 0-20
- Addition 3-Digit Numbers with & without Regrouping
- Subtraction 3-Digit Number with & without Regrouping
- Add/Subtract 3-Digit Numbers with & without Regrouping
- Multiplication 0-9
- Multiplication 5-9
- Division 0-9
- Fact Families: Multiplication/Division 0-9
- Multiplication 0-12
- Division 0-12
- Fact Families: Multiplication/Division 0-12

These Are the Students who Need Individual Intervention

Classwide Intervention | Screening | Students | Growth

Fall 2019-20 Screening Results

The results are in. Let's take a look...

Classroom Performance

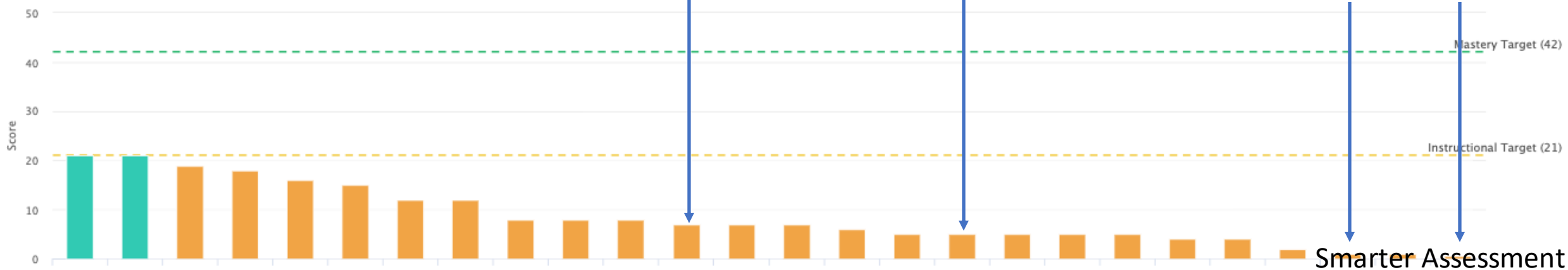
4% of your class reached the target on all of the screening assessments. Extra practice will help you reach mastery at this grade level.

The classwide intervention has already been started.

8%	19%	19%
Measure 1	*Measure 2*	*Measure 3*

Measure 1: Fact Families: Addition/Subtraction 0-20

Your students' screening scores compared to the target score.



Want to Know More About Academic Screening?

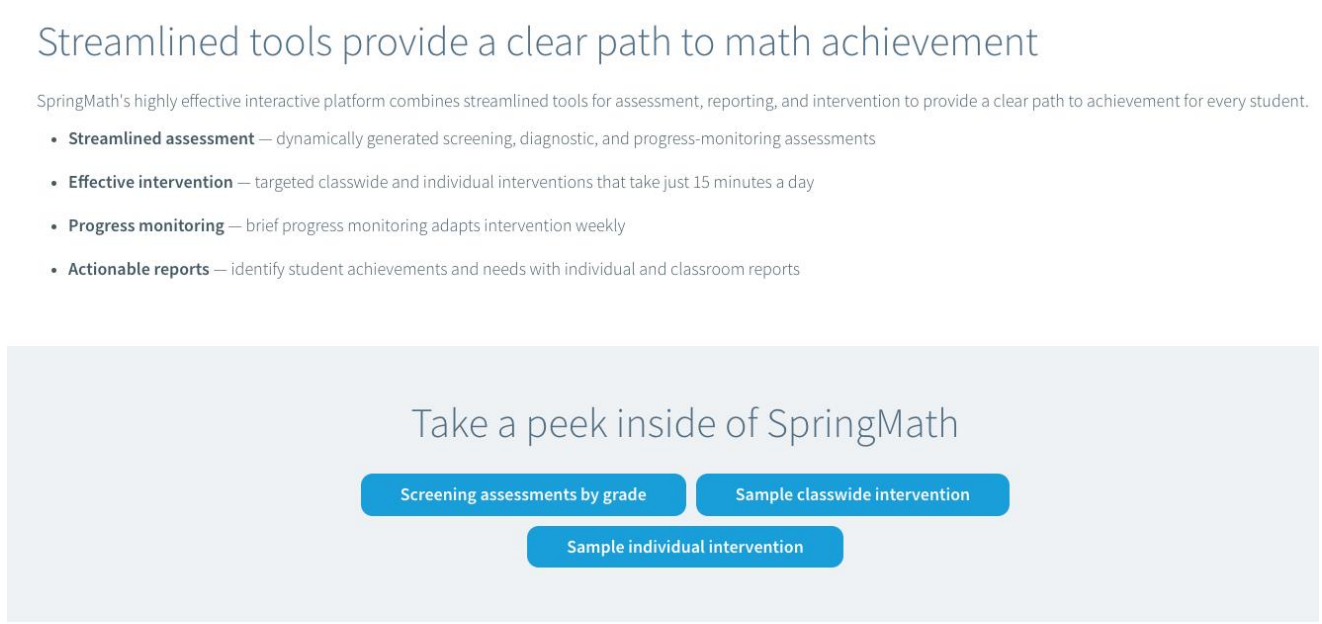
- https://youtu.be/lz18MC5mgkY
- https://www.nasponline.org/resources-and-publications/resources-and-podcasts/covid-19-resource-center/return-to-school/considerations-for-academic-screening-upon-the-return-to-school
- VanDerHeyden, Broussard, & Burns (2019). Classification Agreement for Gated Screening in Mathematics: Subskill Mastery Measurement and Classwide Intervention. Assessment for Effective Intervention.
- https://www.researchgate.net/publication/336702020_Classification_Agreement_for_Gated_Screening_in_Mathematics_Subskill_Mastery_Measurement_and_Classwide_Intervention
- https://charts.intensiveintervention.org/ascreening

- VanDerHeyden, A. M., Burns, M. K., Peltier, C., & Codding, R. S. (2021). The Science of Math – The Importance of Mastery Measures and the Quest for a General Outcome Measure. *Communique, 50* (5), p. 1.
  - https://www.researchgate.net/publication/357780016_The_Science_of_Math_-The_Importance_of_Mastery_Measures_and_the_Quest_for_a_General_Outcome_Measure
- VanDerHeyden, A. M., Codding, R., & Solomon, B. G. (2022). Reliability of Computer-Based CBMs Versus Paper/Pencil Administration for Fact and Complex Operations in Mathematics. *Remedial and Special Education*.
  - https://www.researchgate.net/publication/358868732_Reliability_of_Computer-Based_CBMs_Versus_PaperPencil_Administration_for_Fact_and_Complex_Operations_in_Mathematics
- Solomon, B., G., VanDerHeyden, A. M., Solomon, E. C., Korzeniewski, E. R., Payne, L. L., Campaña, K. V., & Dillon, C. R. (in press). Mastery Measurement in Mathematics and the Goldilocks Effect. *School Psychology*.
  - https://www.researchgate.net/publication/358004509_Mastery_measurement_in_mathematics_and_the_goldilocks_effect
- Ysseldyke, J., Chaparro, E., & VanDerHeyden, A. M. (in press). *Assessment in Special and Inclusive Education, 14th edition*. Pro-Ed.
- Kovaleski, J., VanDerHeyden, A. M., Runge, T., Zirkel, P., & Shapiro, E. (in press). *The RtI Approach to Evaluating Learning Disabilities, 2nd Edition*. NY: Guilford.

Classwide Intervention (Tier 1.5)

How To Get Started:

- Intervention protocol.
  - Here is one to try: https://www.sourcewelltech.org/sites/tech/files/2020-12-31/SpringMath_SampleClassIntervention_0819.pdf
  - www.springmath.org > How it Works > 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

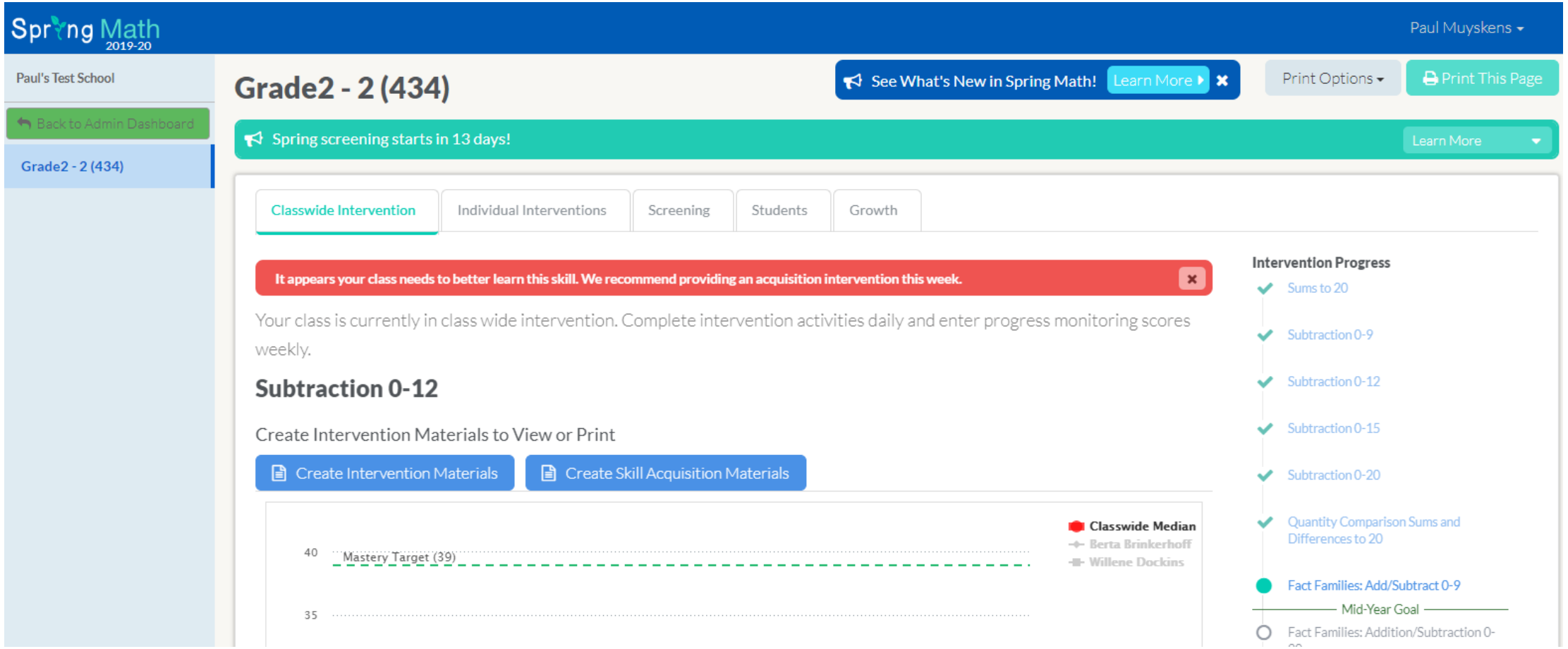
Adams, Maximus	Goyette, Dangelo
Homenick, Darrin	Rolfson, Keegan
Lehner, Salvador	Blick, Jerald
Collins, Lamont	Waelchi, Jacinthe
Reichert, Marlen	Skiles, Daphnee
Greenholt, Clovis	Kozey, Monserrat
Kreiger, Selena	Turcotte, Kayleigh
Larson, Kobe	Champlin, Gertrude

Close

6TH GRADE

1. 2-Digit Addition with & without Regrouping
2. 2-Digit Subtraction with & without Regrouping
3. Multi-Digit Multiplication with & without Regrouping
4. Multi-Digit Division with & without Remainders
5. Order of Operations
6. Find Least Common Denominator
7. Simplify Fractions (A)
8. Simplify Fractions (B)
9. Simplify Fractions (C)
10. Add & Subtract Fractions with Unlike Denominators
11. Add & Subtract Mixed Numbers with Like Denominators and Regrouping
12. Convert Improper Fractions to Mixed Numbers
13. Multiply & Divide Proper and Improper Fractions
14. Convert Mixed Numbers to Improper Fractions
15. Multiply & Divide Mixed Numbers
16. Mixed Fraction Operations
17. Distributive Property of Expression
18. Collect Like Terms
19. Substitute Whole Number to Solve Equations
20. Find Percent of a Whole Number
21. Add & Subtract Decimals to the Hundredths
22. Multiply & Divide Decimals
23. Multiply 2-Digit by 2-Digit with Decimals
24. Quantity Comparison with Integers
25. Graph in a Coordinate Plane

If Needed, Use an Acquisition Lesson First



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.

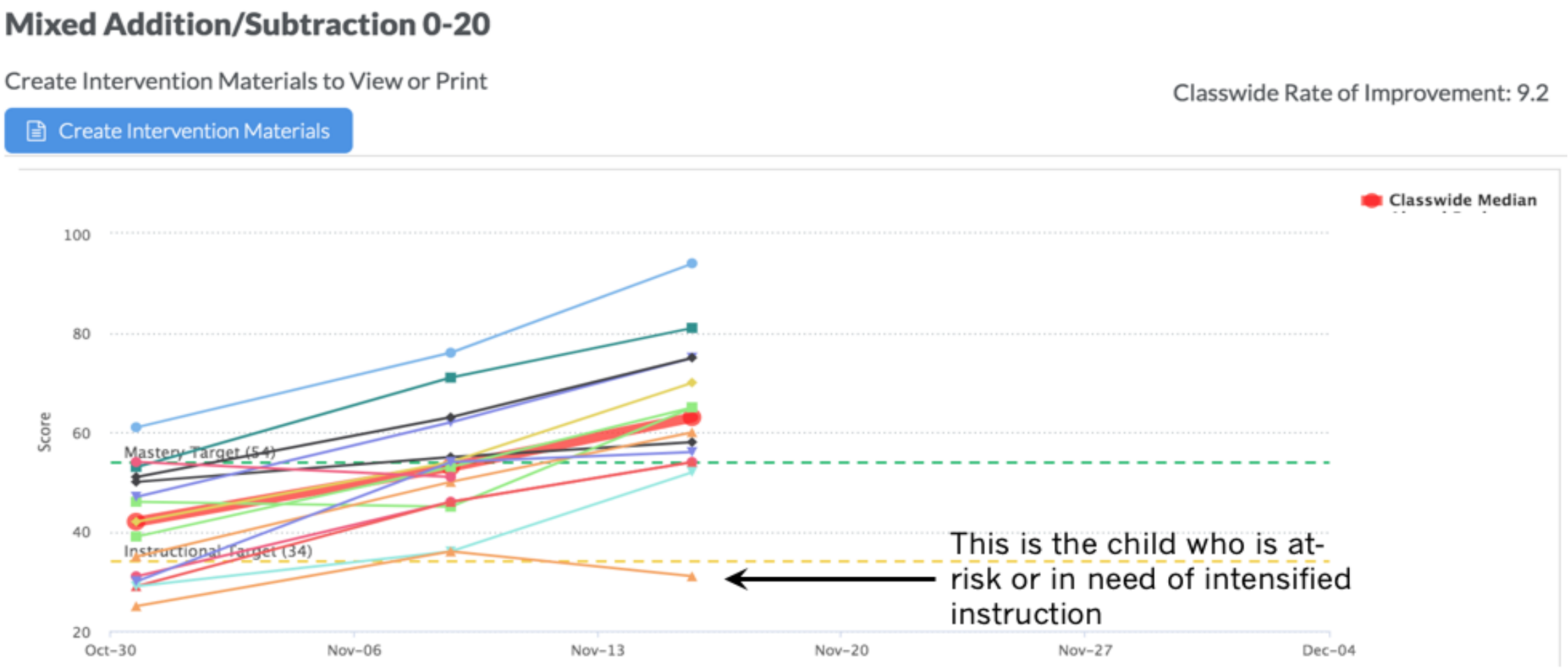
Classwide Intervention

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

Classwide Intervention

Use Classwide Intervention to Improve Learning & Determine Risk



Take-Aways

Classwide intervention is a fluency-building intervention

Sequence essential skills such that success on early skills positions students for gains on subsequent skills

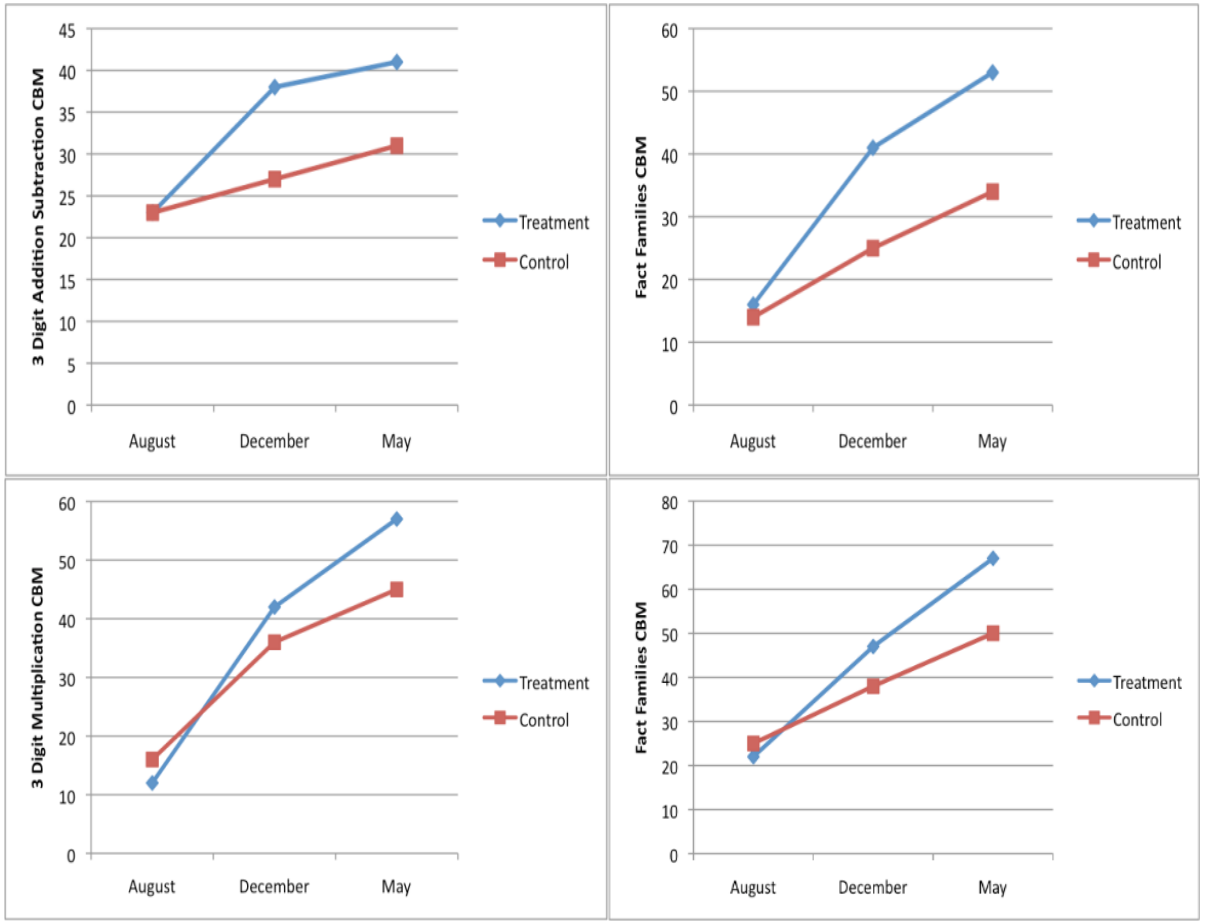
Active ingredient is opportunities to respond

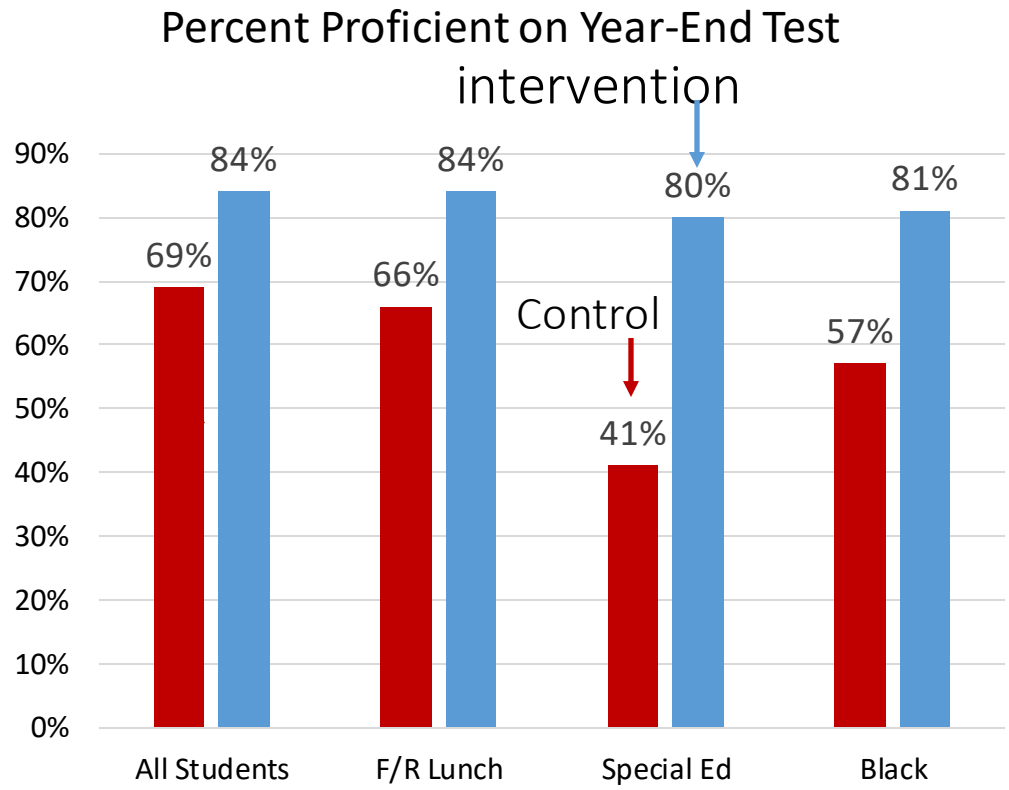
Use resulting data to determine the need for intensified instruction

More info here:
https://www.researchgate.net/publication/357779924_The_science_of_math_and_classwide_math_intervention

Add a Layer to Your MTSS Model
Classwide Intervention = Tier 1.5 (and It Works)

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

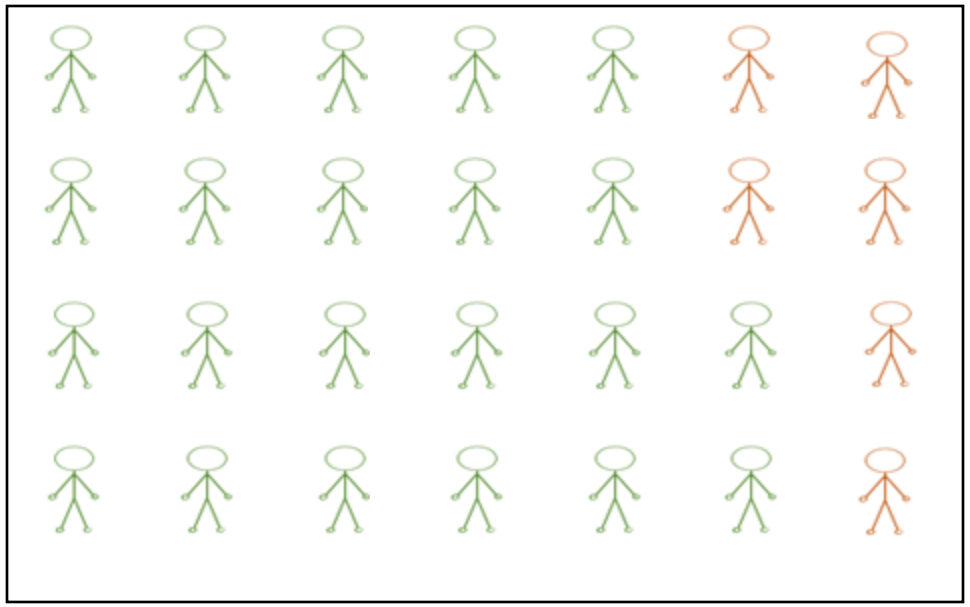




http://www.intensiveintervention.org/chart/instructional-intervention-tools (NCII)

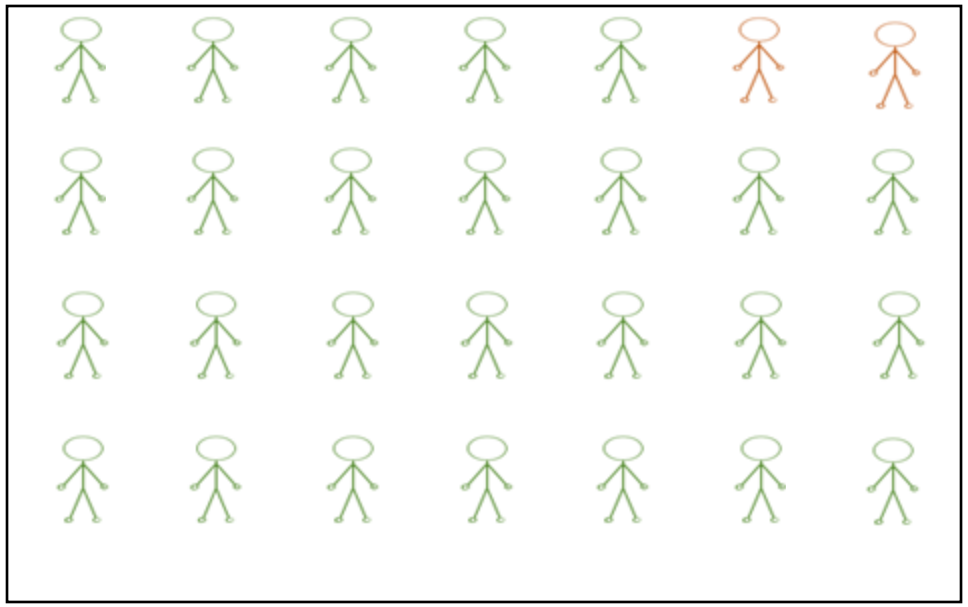
Classwide Intervention

Without Intervention 22% of Students "Fail" the Year-End Test. In a class of 28 students, this is about 6 failures.



Classwide Math Intervention

With SpringMath Classwide Intervention, 4 of these failures are prevented.

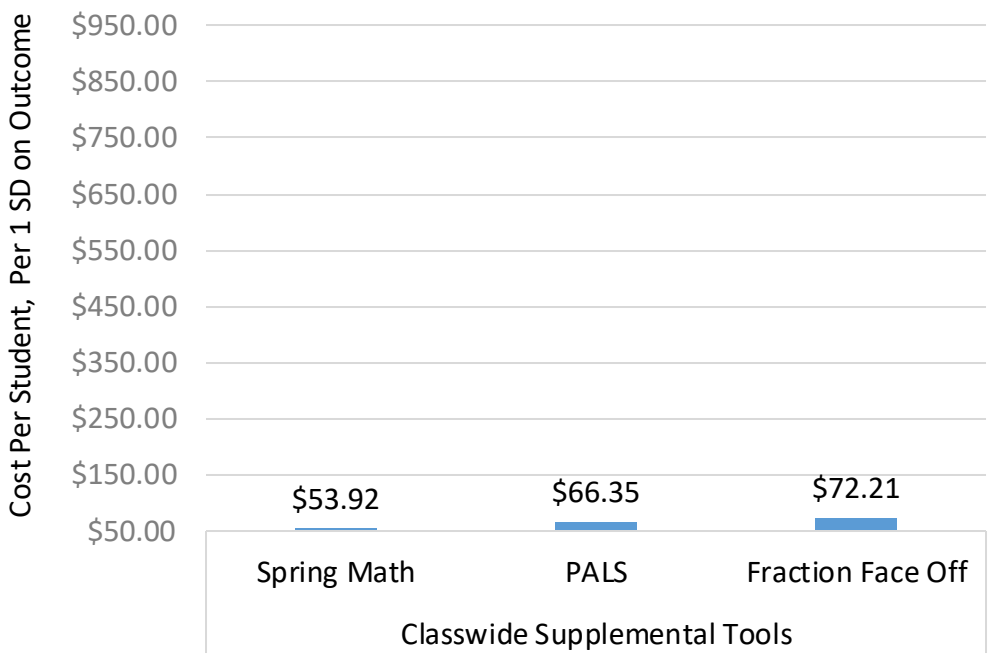


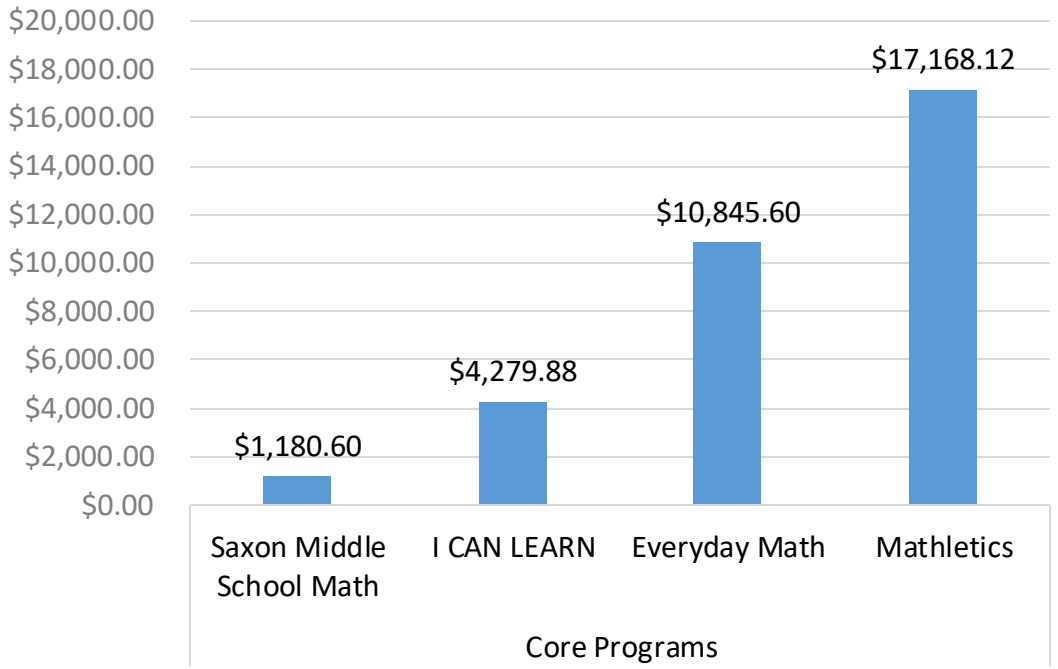
VanDerHeyden, A. M. & Codding, R. (2015). Practical effects of classwide mathematics intervention. *School Psychology Review, 44*, 169-190. http://dx.doi.org/10.17105/spr-13-0087.1

Classwide Intervention Gives You a Strong ROI

Cost Per Student, Per 1 SD gain in outcome

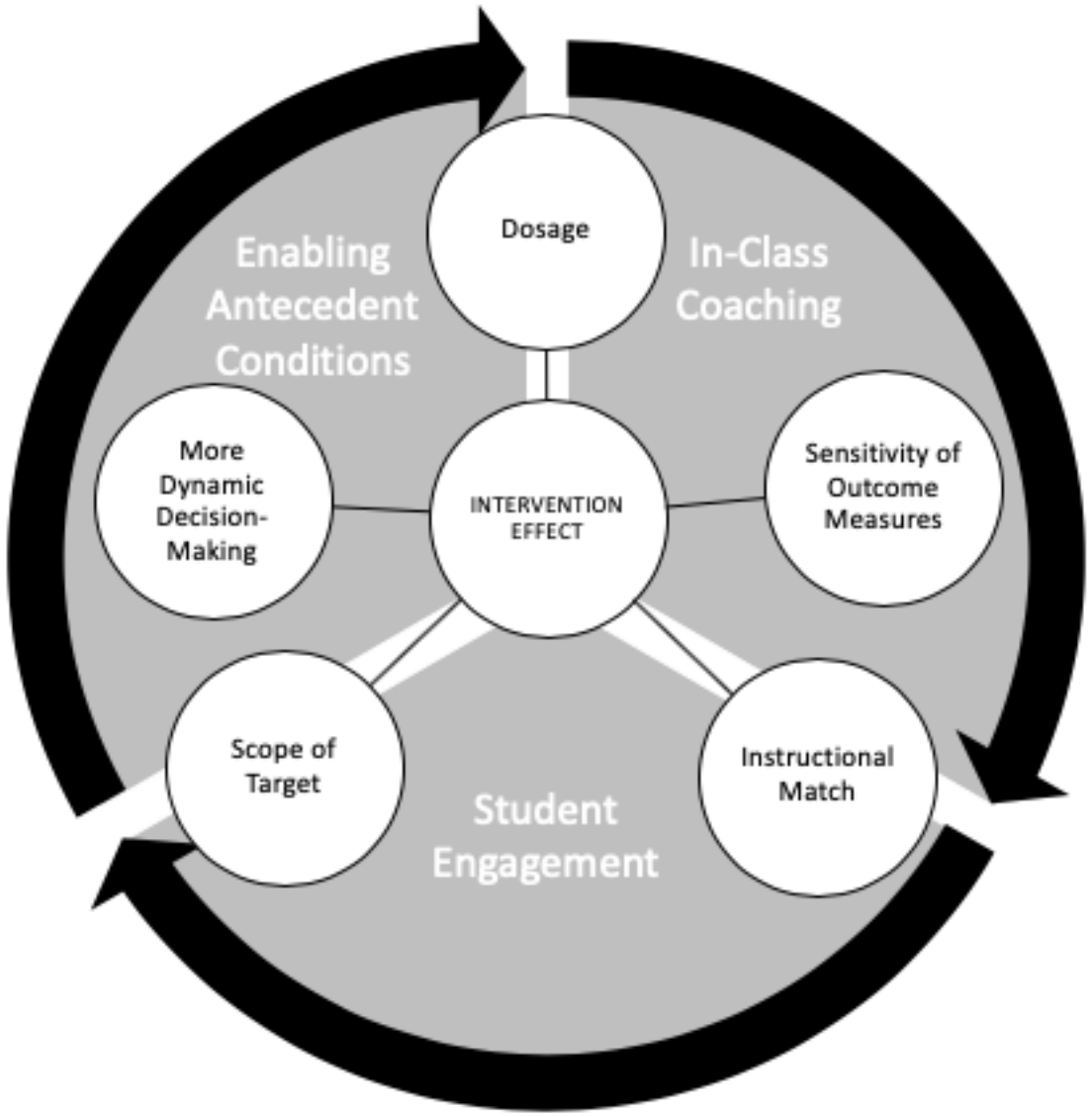
Lower is Better





"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



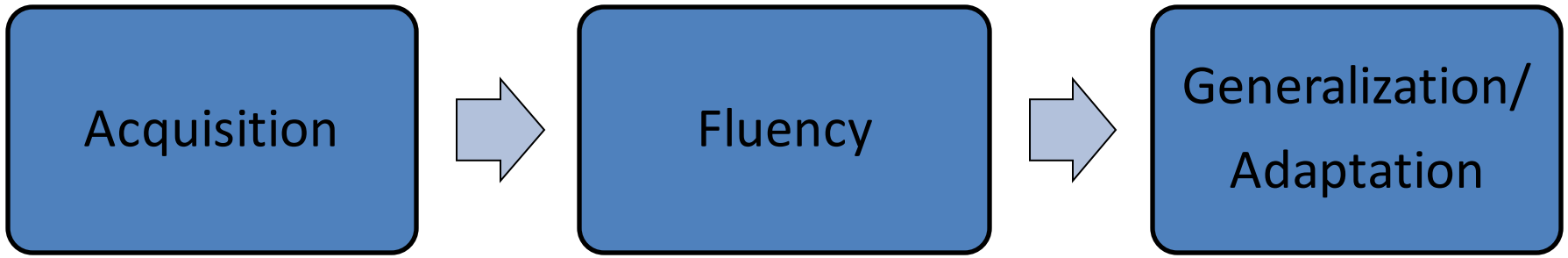
How to Intensify Instruction

Stages of Learning

New understanding. Child cannot accurately respond without help.

Child performance is accurate, but response is labored.

Skill is fluent.

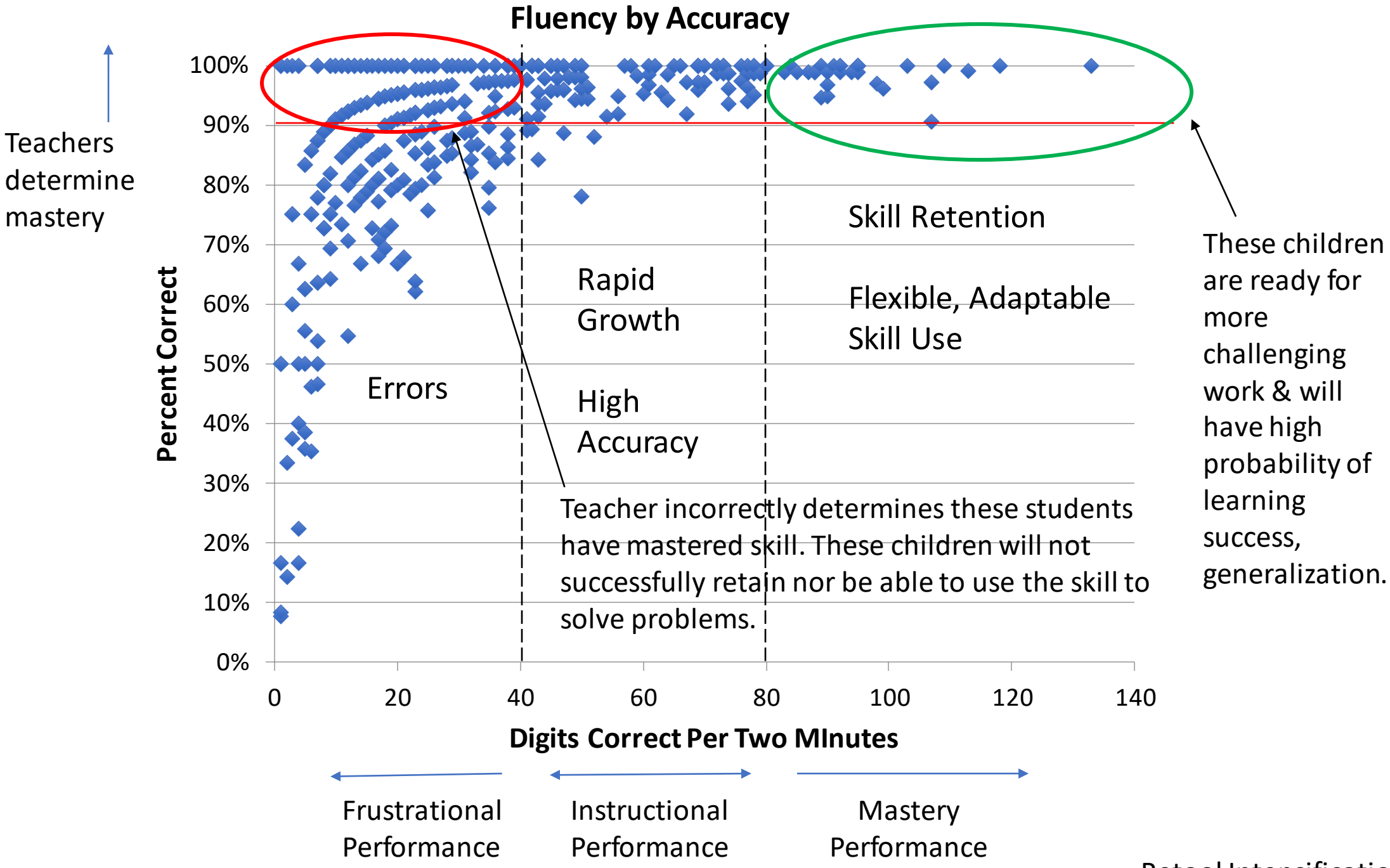


Goal of instruction is Discrimination.

Goal of instruction is Fluency (rapid and accurate responding).

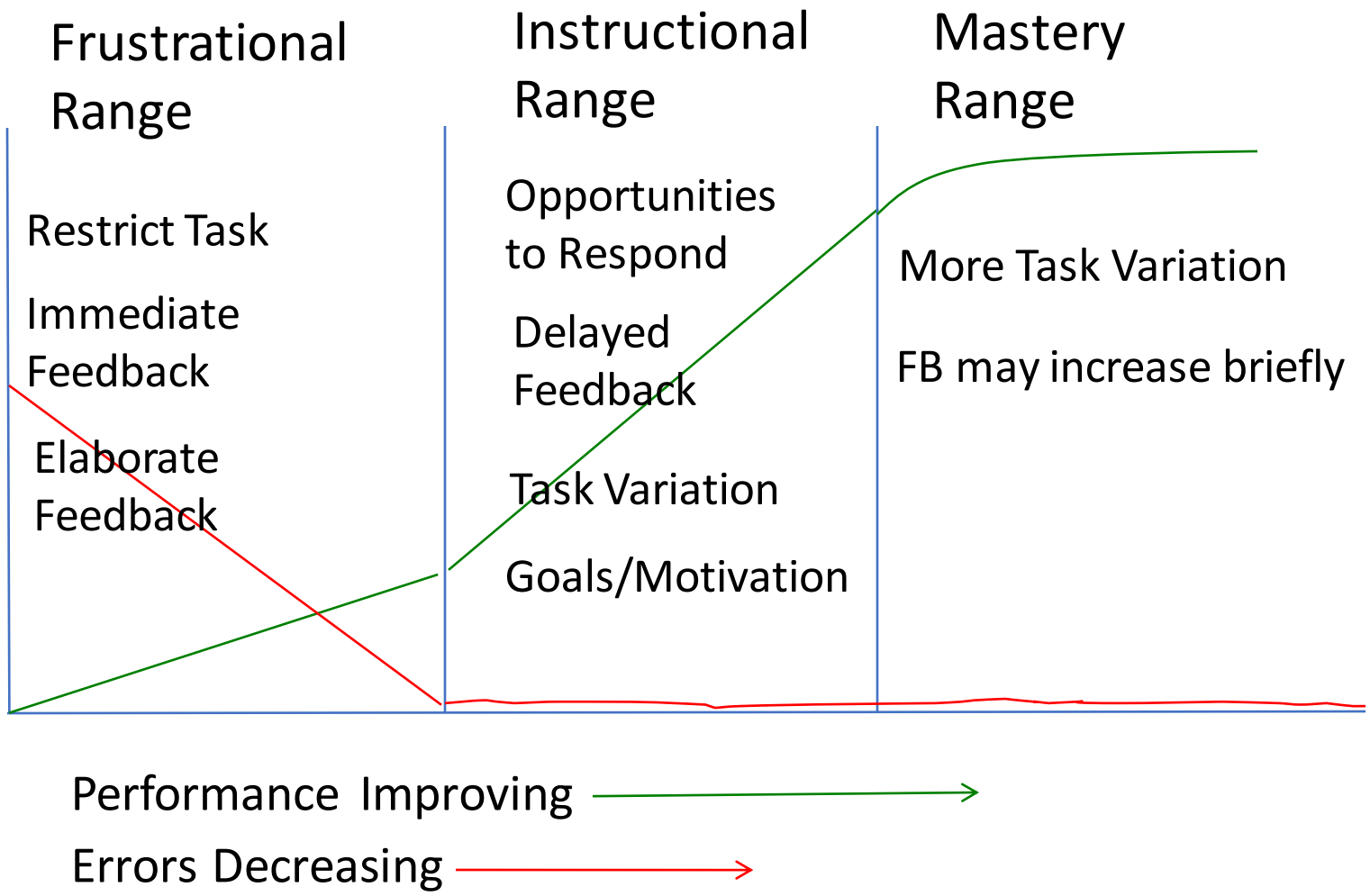
Goal of instruction is to increase the conditions under which the child can respond correctly (stimulus generalization) & alteration of the skill to solve new problems (response adaptation)

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.

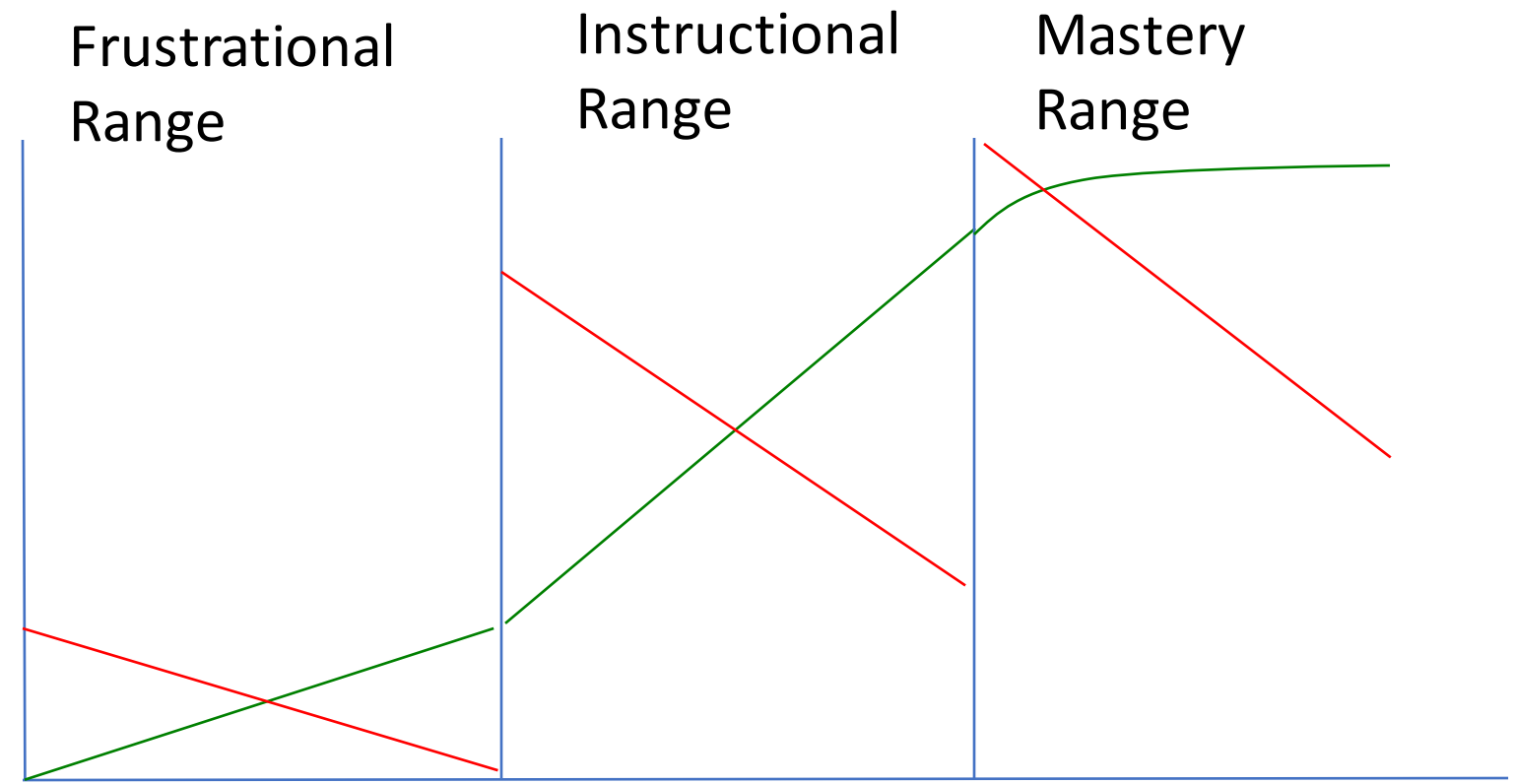


Retool Intensification

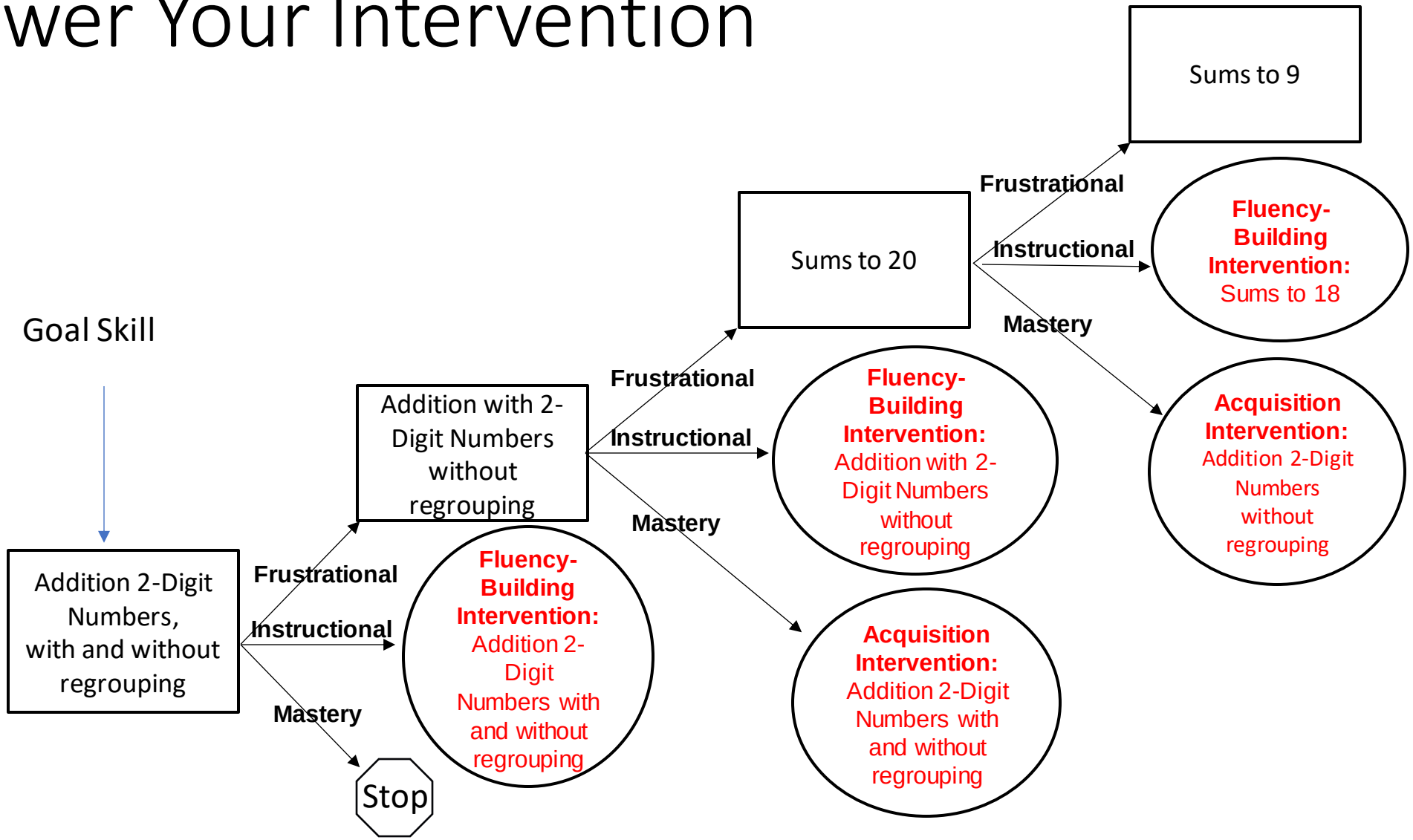
The Instructional Hierarchy: How it Works

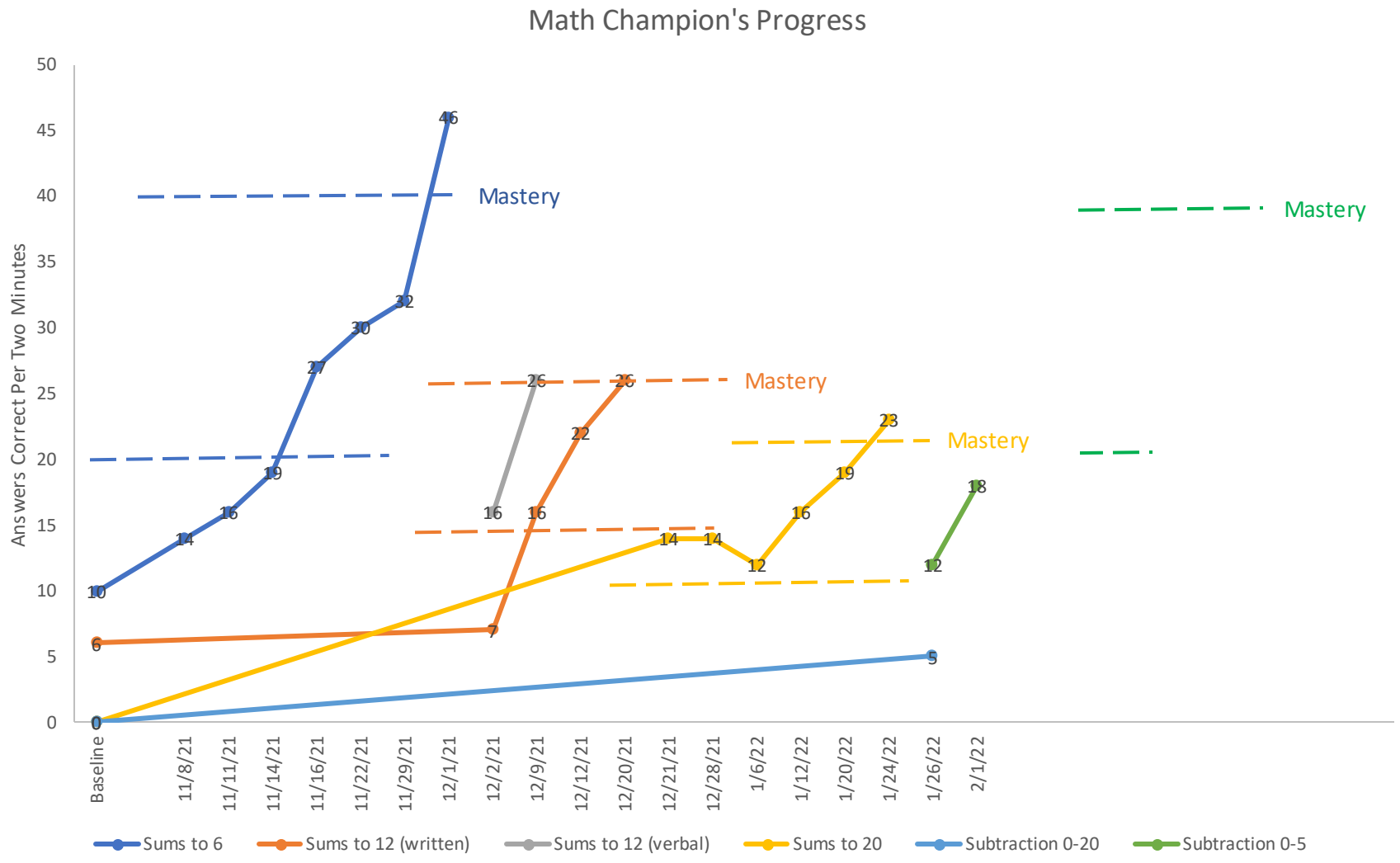


Skill x Treatment Interaction



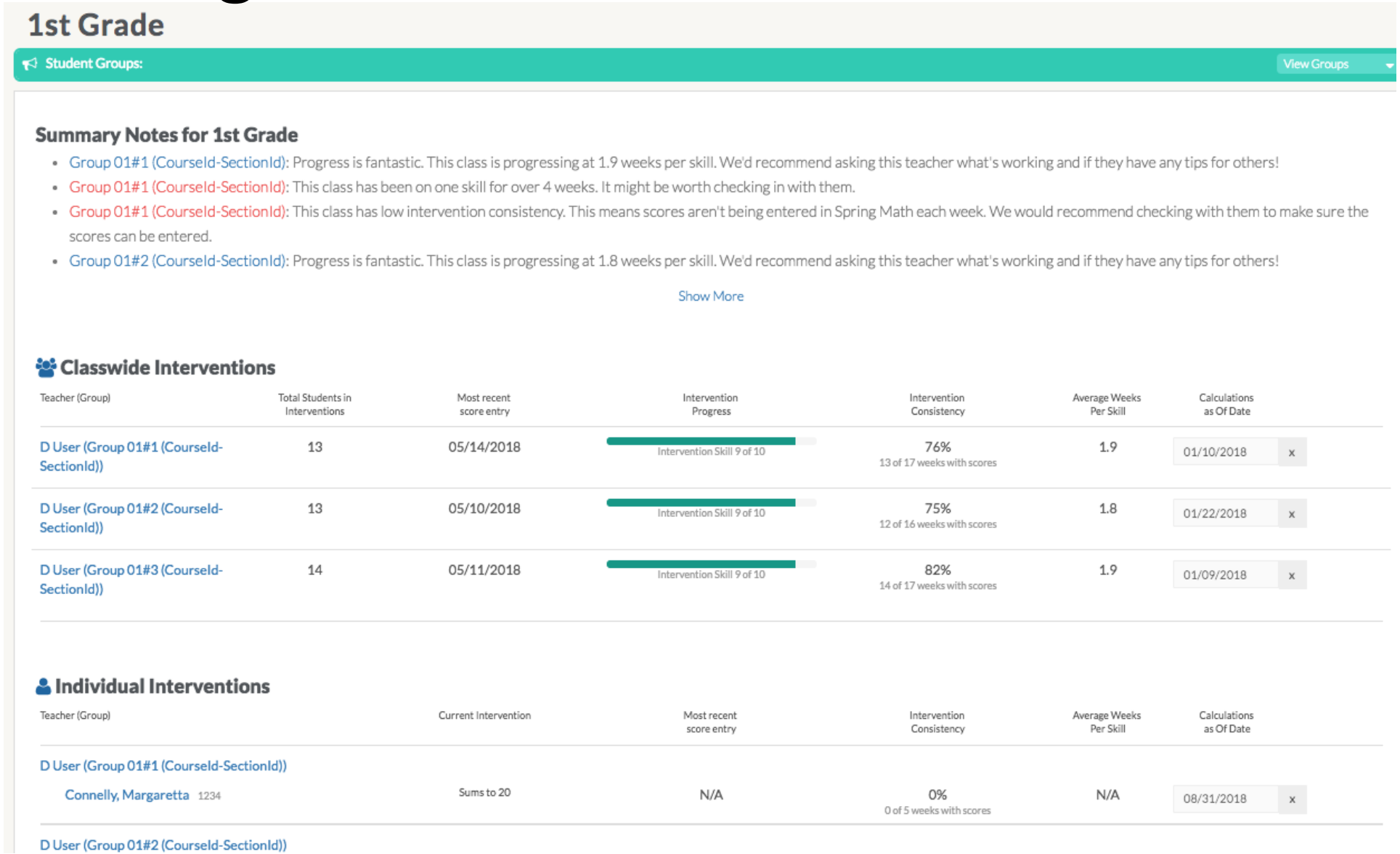
Use the Instructional Hierarchy to Power Your Intervention




Math Champion's Progress
Answers Correct Per Two Minutes
50
45
40
35
30
25
20
15
10
5
0
Mastery
Mastery
Mastery
Mastery
10
14
16
19
27
30
32
46
6
7
16
26
22
26
0
14
14
12
16
19
23
12
18
5
Baseline
11/8/21
11/11/21
11/14/21
11/16/21
11/22/21
11/29/21
12/1/21
12/2/21
12/9/21
12/12/21
12/20/21
12/21/21
12/28/21
1/6/22
1/12/22
1/20/22
1/24/22
1/26/22
2/1/22
Sums to 6
Sums to 12 (written)
Sums to 12 (verbal)
Sums to 20
Subtraction 0-20
Subtraction 0-5

Program Evaluation

- What actions are underway?
- What are the results right now?
- Where is support needed?
- Are proximal indicators headed in the right direction?
- What are the barriers we can troubleshoot?



1st Grade

Student Groups: View Groups

Summary Notes for 1st Grade

- Group 01#1 (CourseId-SectionId): Progress is fantastic. This class is progressing at 1.9 weeks per skill. We'd recommend asking this teacher what's working and if they have any tips for others!
- Group 01#1 (CourseId-SectionId): This class has been on one skill for over 4 weeks. It might be worth checking in with them.
- Group 01#1 (CourseId-SectionId): This class has low intervention consistency. This means scores aren't being entered in Spring Math each week. We would recommend checking with them to make sure the scores can be entered.
- Group 01#2 (CourseId-SectionId): Progress is fantastic. This class is progressing at 1.8 weeks per skill. We'd recommend asking this teacher what's working and if they have any tips for others!

Show More

Classwide Interventions

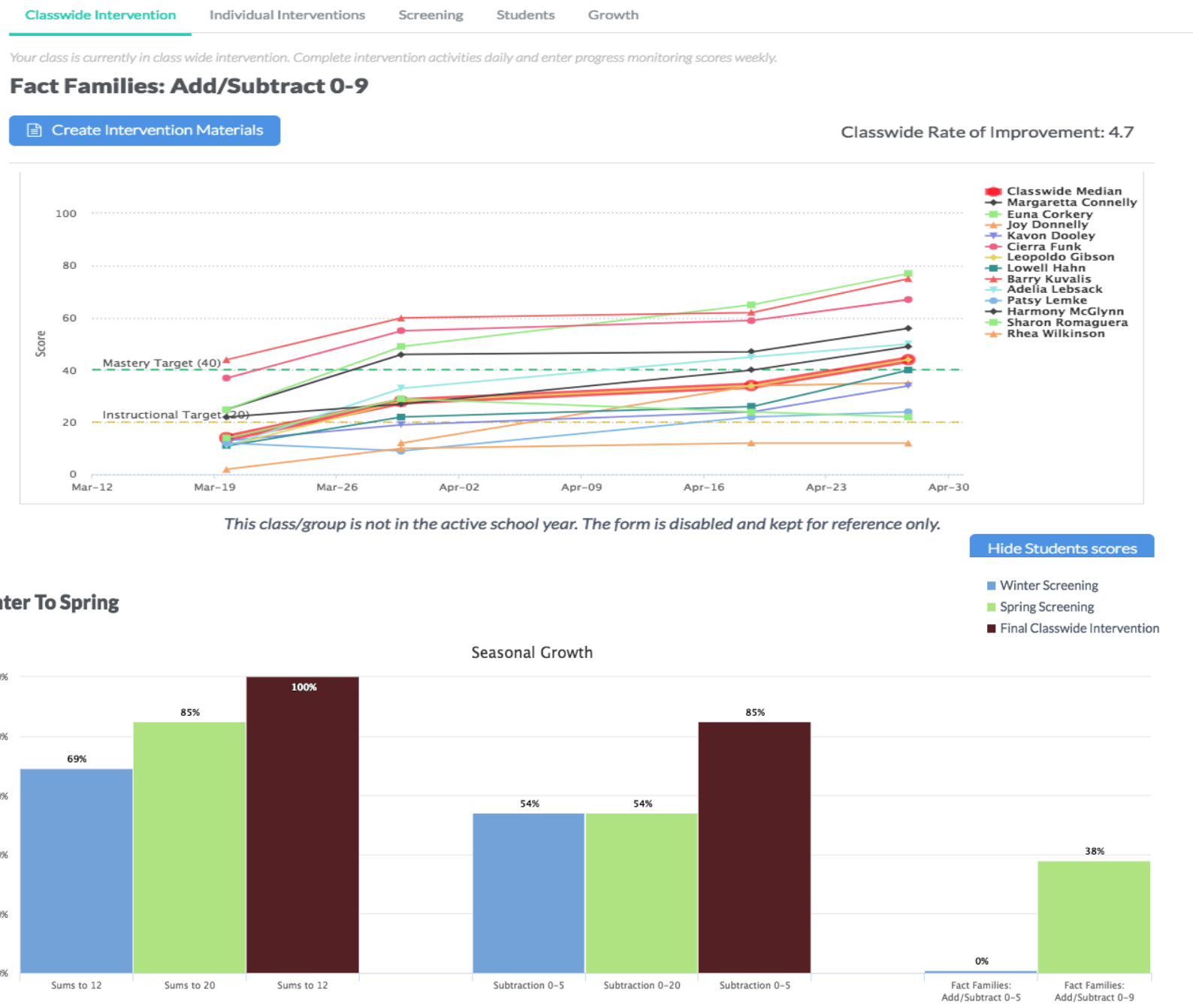
Teacher (Group)	Total Students in Interventions	Most recent score entry	Intervention Progress	Intervention Consistency	Average Weeks Per Skill	Calculations as Of Date
D User (Group 01#1 (CourseId-SectionId))	13	05/14/2018	Intervention Skill 9 of 10	76% 13 of 17 weeks with scores	1.9	01/10/2018 x
D User (Group 01#2 (CourseId-SectionId))	13	05/10/2018	Intervention Skill 9 of 10	75% 12 of 16 weeks with scores	1.8	01/22/2018 x
D User (Group 01#3 (CourseId-SectionId))	14	05/11/2018	Intervention Skill 9 of 10	82% 14 of 17 weeks with scores	1.9	01/09/2018 x

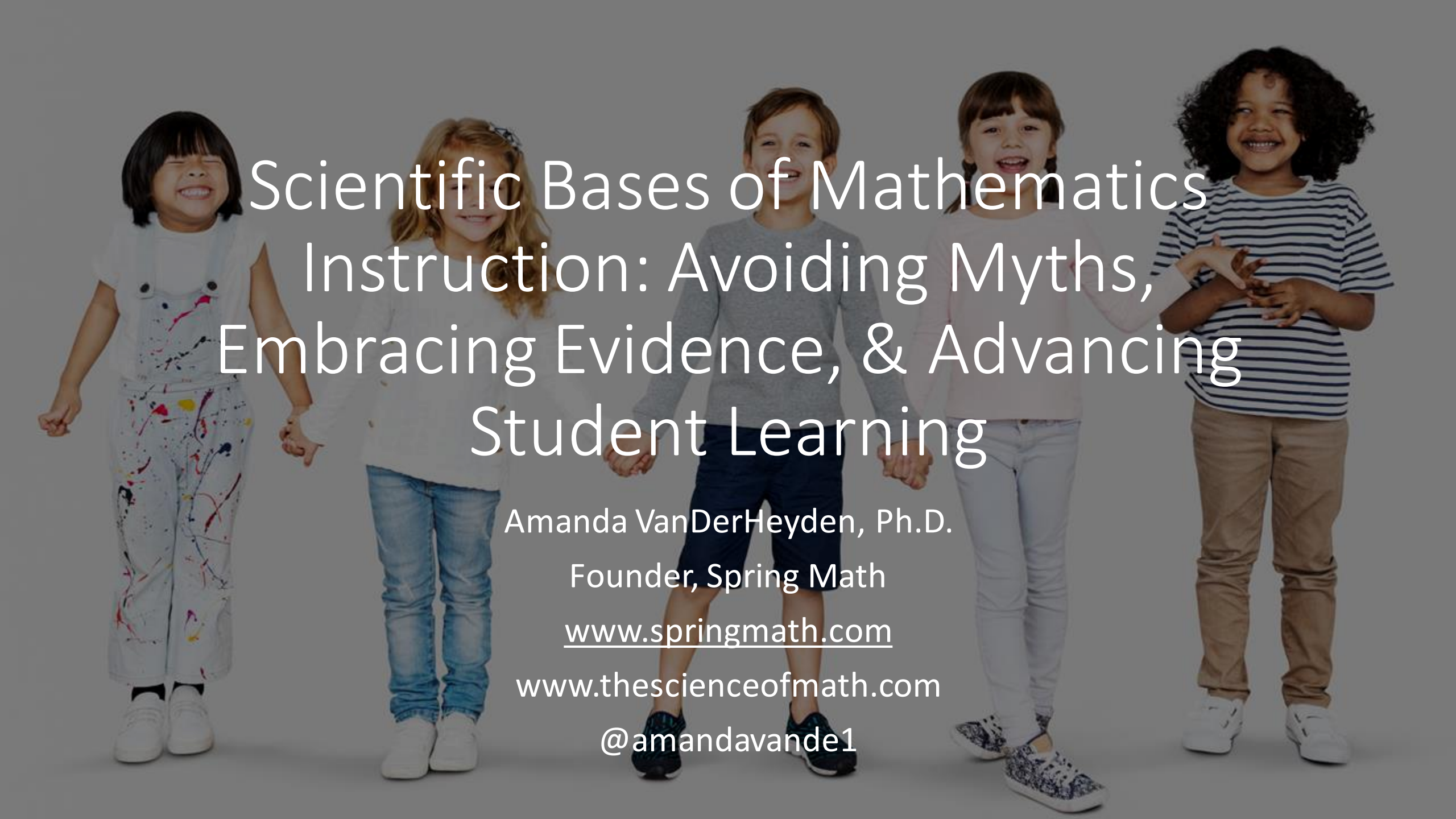
Individual Interventions

Teacher (Group)	Current Intervention	Most recent score entry	Intervention Consistency	Average Weeks Per Skill	Calculations as Of Date
D User (Group 01#1 (CourseId-SectionId))					
Connelly, Margaretta 1234	Sums to 20	N/A	0% 0 of 5 weeks with scores	N/A	08/31/2018 x
D User (Group 01#2 (CourseId-SectionId))					

Teacher: Are Students Growing?

Teacher: Does Growth Transfer?





Scientific Bases of Mathematics Instruction: Avoiding Myths, Embracing Evidence, & Advancing Student Learning

Amanda VanDerHeyden, Ph.D.

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