Spring Math®

Sourcewell Technology

Evidence for Intervention

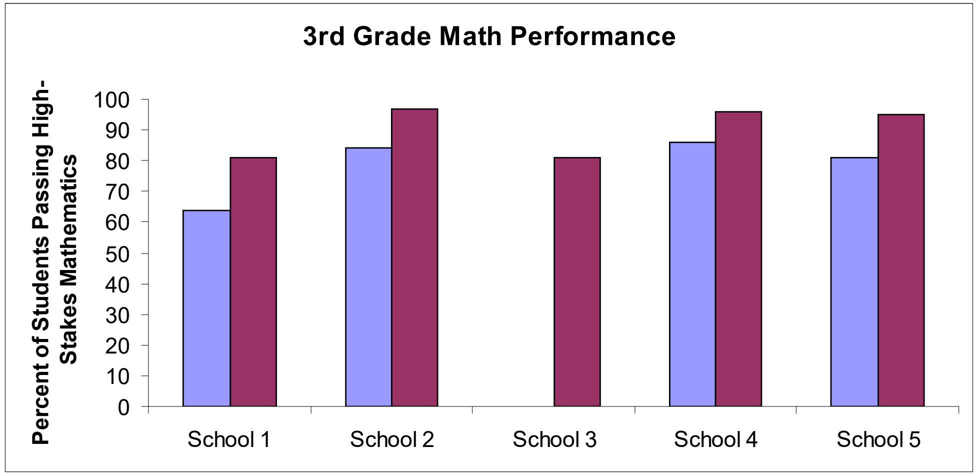
Outcomes

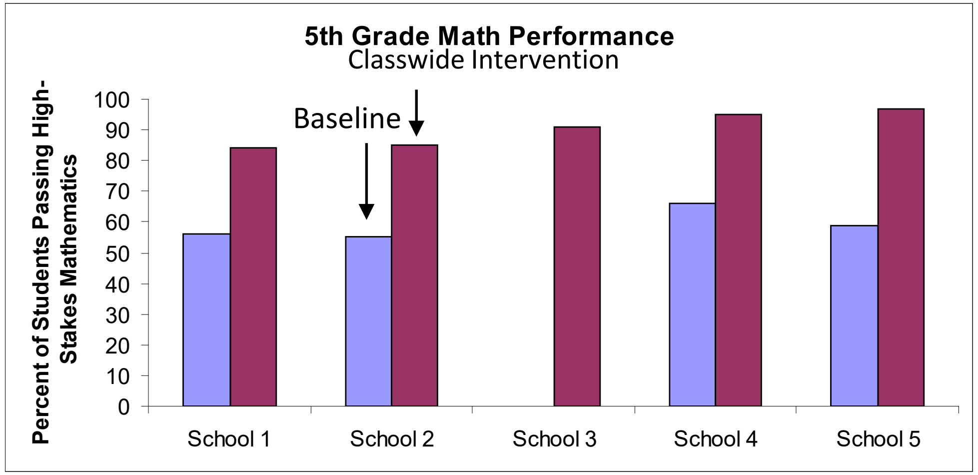
Equitable Decision Making

Evidence for Intervention

- In 2003, VanDerHeyden built and piloted the first version of classwide math intervention.
- CBM scores were higher following classwide intervention (effect sizes ranged from .49 - .97) and year-end scores on the SAT-9 were stronger following intervention compared to the preceding year before intervention was introduced (effect sizes ranged from .29-.45).
- These findings were promising, but really were not experimental.
- Subsequent studies have examined classwide intervention in a multiple baseline design and in two randomized controlled trials.

Evidence for Intervention





- These data were collected within a multiple baseline design.
- Data are shown here as pre and post percentage of students proficient on the year-end accountability test before (blue) and after (red) classwide math intervention.
- School 3 was a new school that opened in year 3 of the study and thus, had no baseline year.

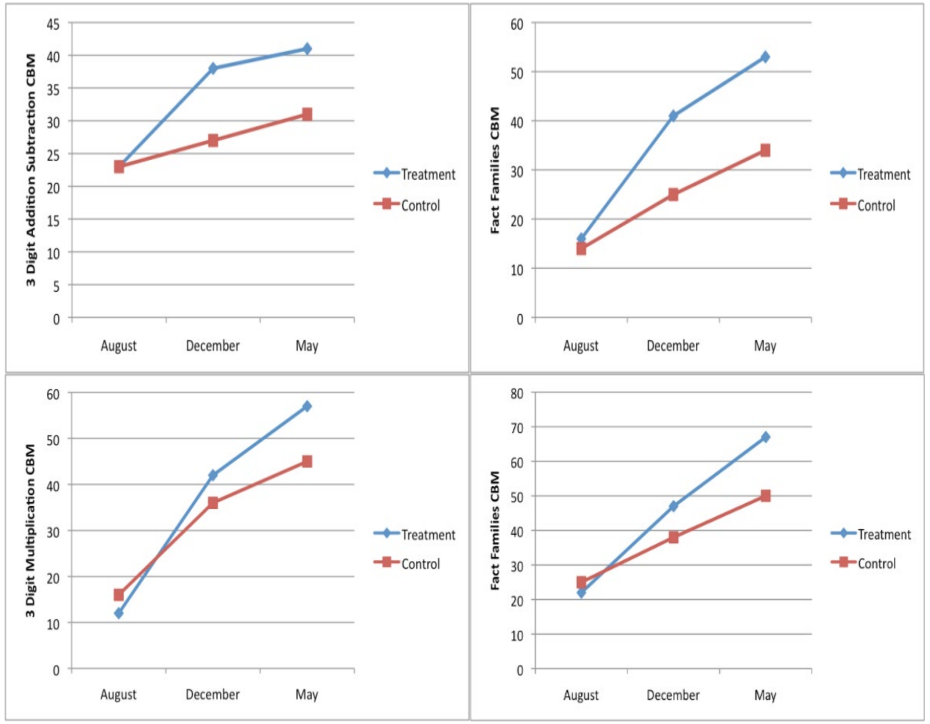
VanDerHeyden, A. M., Witt, J. C., & Gilbertson, D. A (2007). Multi-Year Evaluation of the Effects of a Response to Intervention (RTI) Model on Identification of Children for Special Education. *Journal of School Psychology, 45*, 225-256. http://dx.doi.org/10.1016/j.jsp.2006.11.004.

VanDerHeyden, A. M., & Burns, M. K. (2005). Using curriculum-based assessment and curriculum-based measurement to guide elementary mathematics instruction: Effect on individual and group accountability scores. Assessment for Effective Intervention, 30, 15-31. https://doi.org/10.1177/073724770503000302

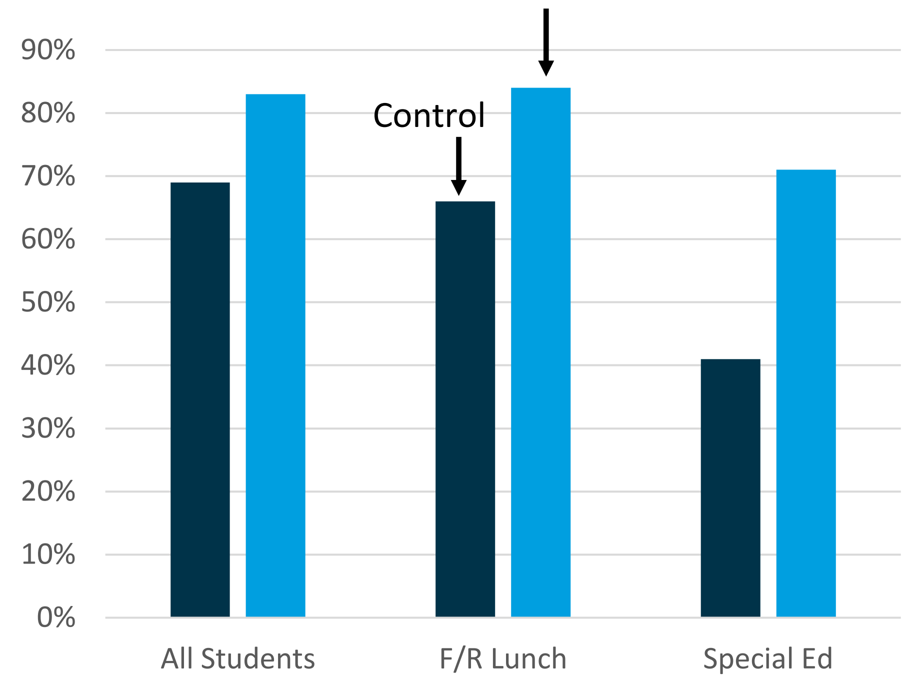
Evidence for Intervention

- VanDerHeyden directed a district-wide randomized controlled trial with fourth and fifth grade students in 2012 to examine the effects of classwide intervention.
- This study found strong gains on CBMs and moderate to strong gains on the year-end test scores at grade 4.
- Gains were stronger for students who had greater risk at baseline and integrity accounted for treatment outcomes in the treatment groups.

Evidence for Intervention



Percent Proficient on Year-End Test
Classwide Intervention

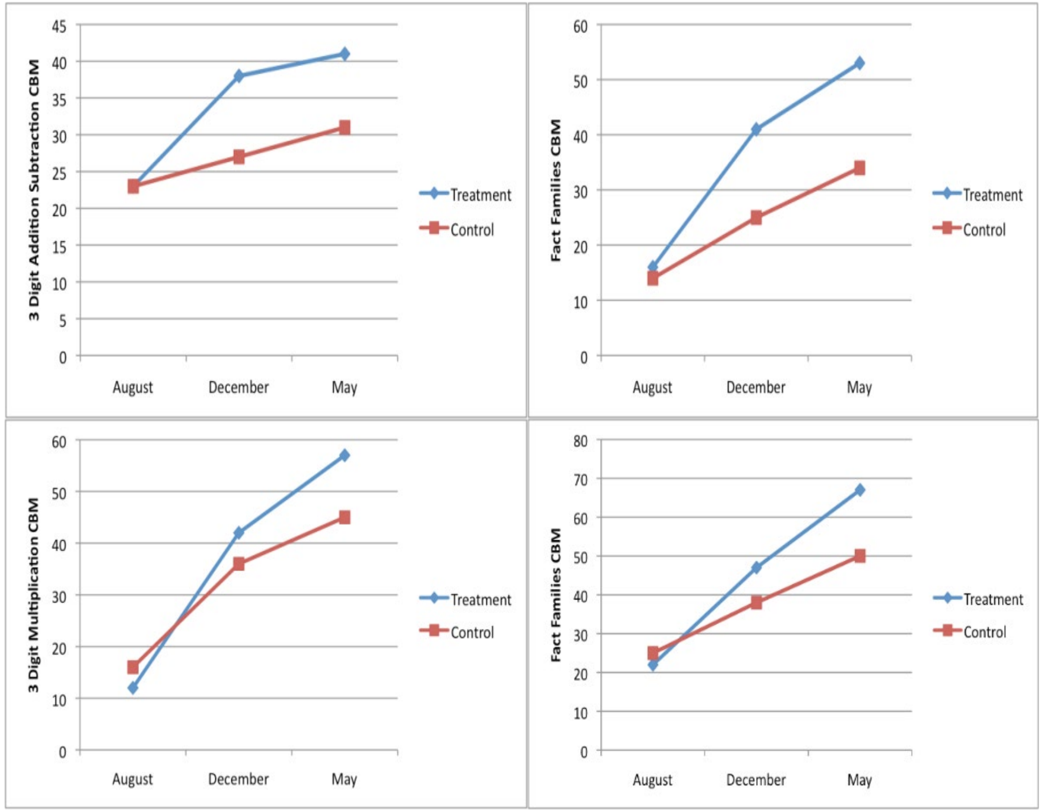


All	Title	Study	Study Type	Participants	Design	Fidelity of Impl.	Measures (Targeted)	Measures (Broader)
☐	Spring Math	Codding, VanDerHeyden, Martin, & Perrault (2016)	Group Design	●	◒	●	●	●
☐	Spring Math	VanDerHeyden, McLaughlin, Algina, & Snyder (2012)	Group Design	●	●	●	●	●

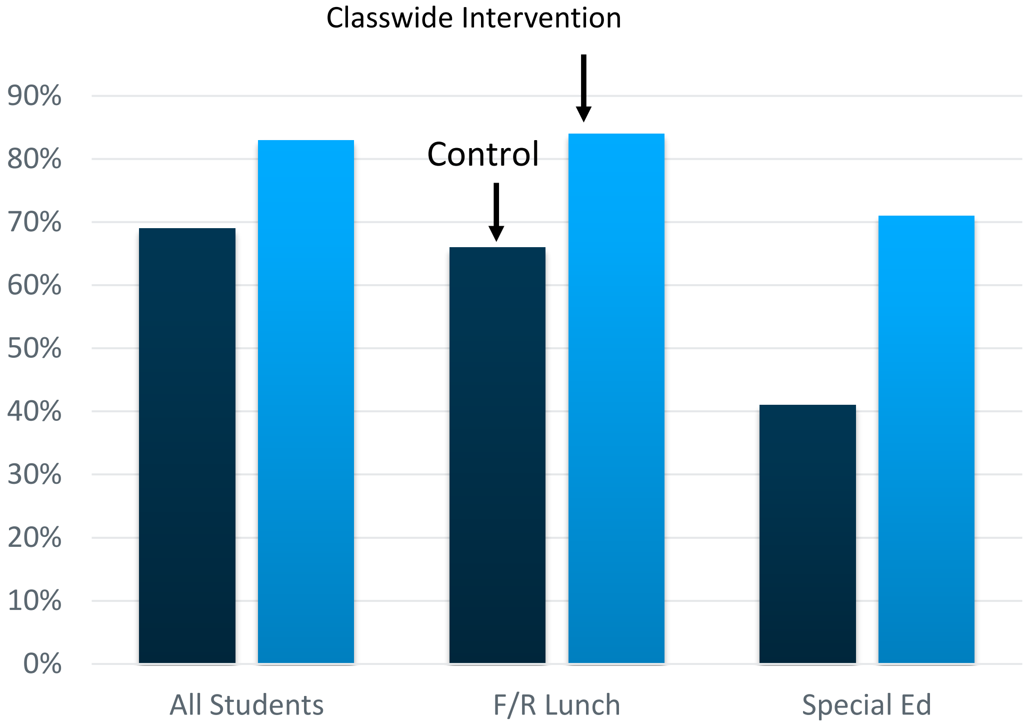
Median ES = .68 CBMs
ES = .18 Gr 4
ES = .66 for at-risk Gr 4
ES = .29 Number & Ops Gr 4
ES = 1.00 Number & Ops Gr 4

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

Evidence for Intervention



Percent Proficient on Year-End Test



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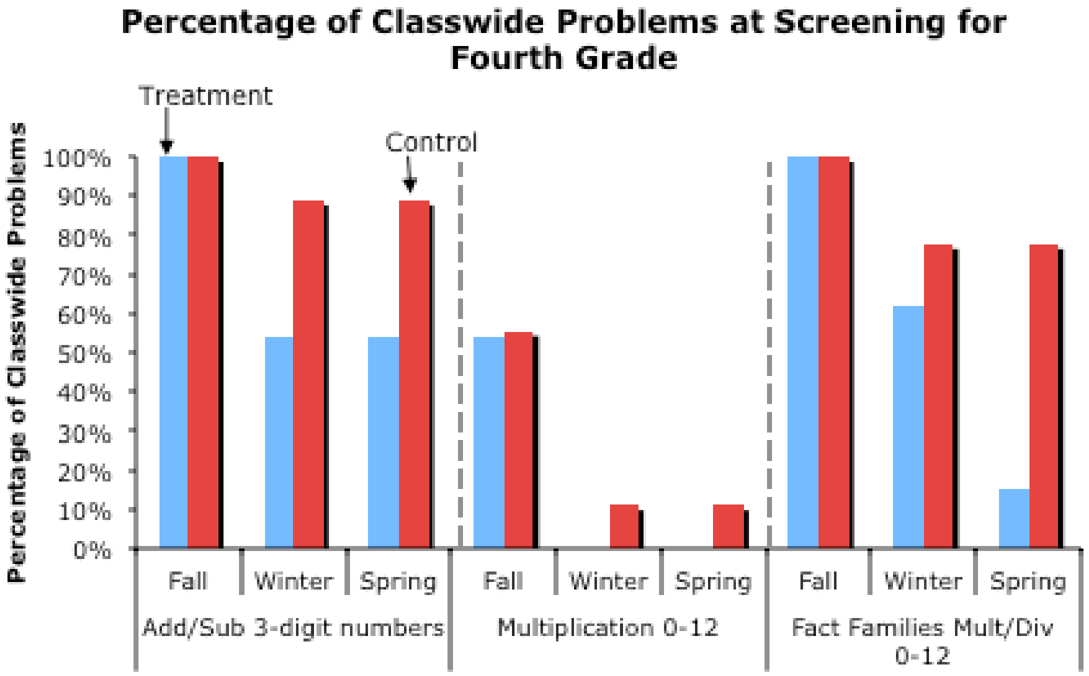
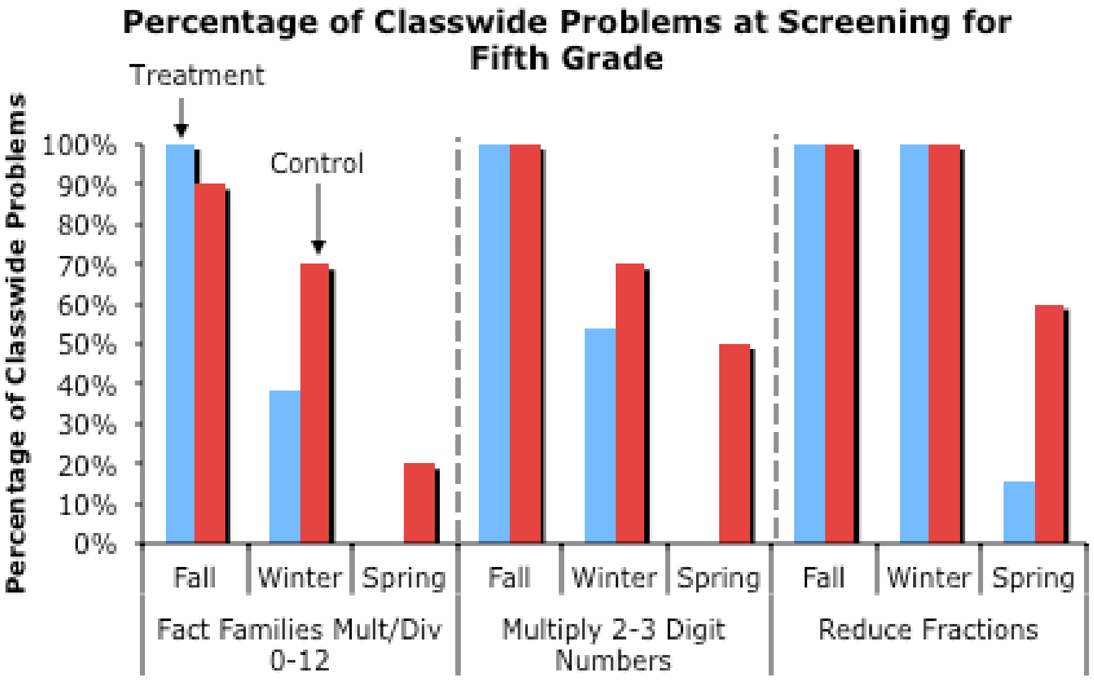




VanDerHeyden, A. M., McLaughlin, T., Algina, J., & Snyder, P. (2012). Randomized evaluation of a supplemental grade-wide mathematics intervention. *American Education Research Journal*, 49, 1251-1284. https://doi.org/10.3102/0002831212462736

Evidence for Intervention

- In a secondary analysis of the RCT data from the 2012 study, VanDerHeyden and Codding (2015) examined the intervention effects on risk reduction and equity in the fourth grade sample.
- They found very strong risk reduction for all students and especially pronounced risk reduction where risk was elevated at baseline.
- Specifically, they found that for every 7 students who participated in classwide intervention, 1 of those students was prevented from failing the year-end test of math.
- For students who scored below the 25^{th} percentile on the preceding year-end test, the number needed to treat was 2, meaning for every two students who scored below the 25^{th} percentile on the preceding year-end test and received classwide math intervention in the current year, one of those students was prevented from failing the current-year's test.

Evidence for Intervention

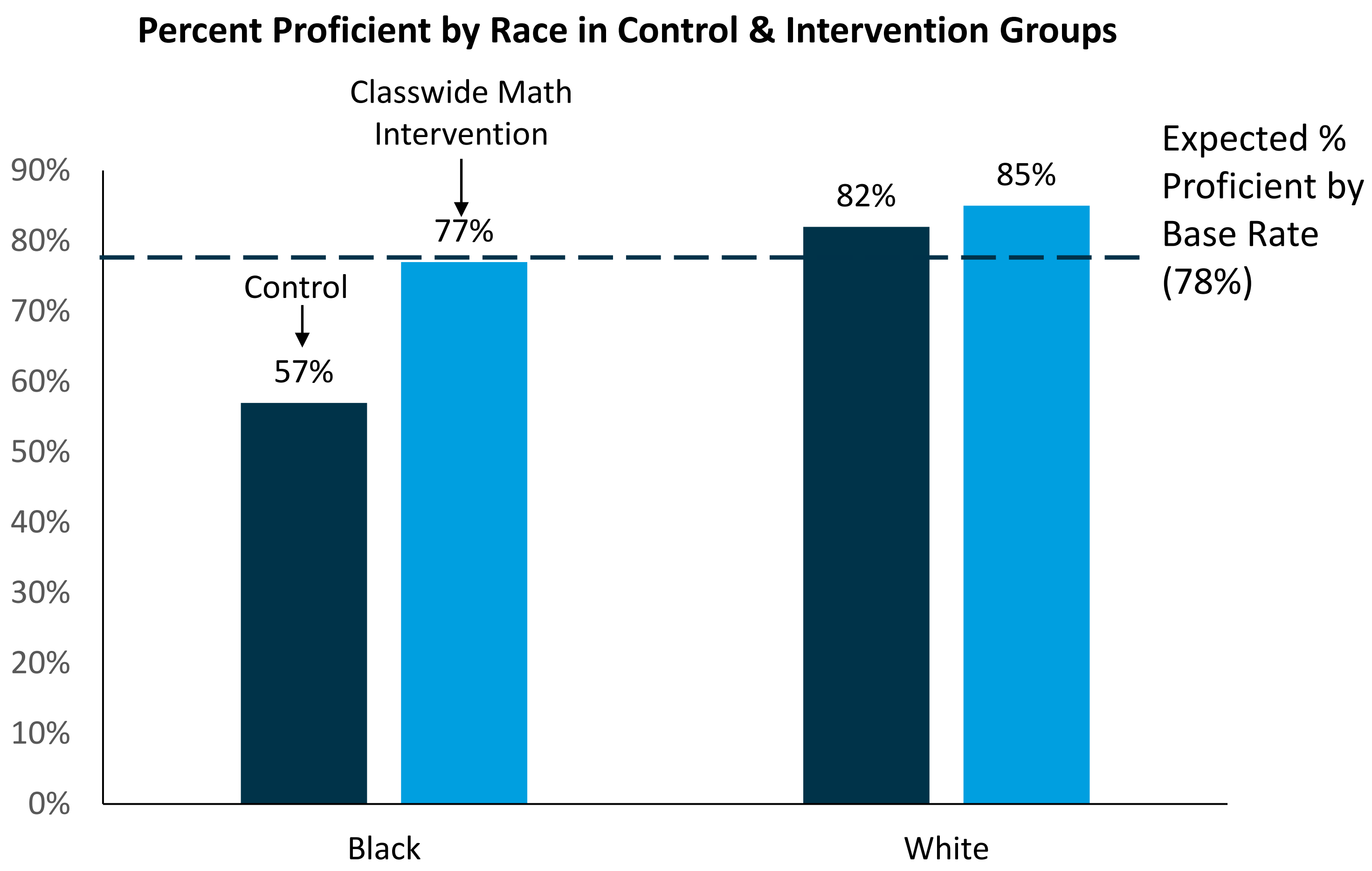
	Absolute Risk Reduction	Number Needed to Treat
All Students	15%	7
Students receiving F/R Lunch	18%	6
Students receiving Special Education Services	39%	3
Low-Performing Students	44%	2

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

Evidence for Intervention

- Strong equity effects were also found, favoring intervention.
- Achievement was disproportionate by race at baseline.
- In the intervention classes, achievement was proportionate by race following intervention.
- In the control classes, achievement remained disproportionate by race, with Black students performing much lower than White students.
- Importantly, because race was comparably disproportionate in both control and intervention classrooms before intervention, this study provided experimental evidence that intervention produces equitable achievement.

Evidence for Intervention



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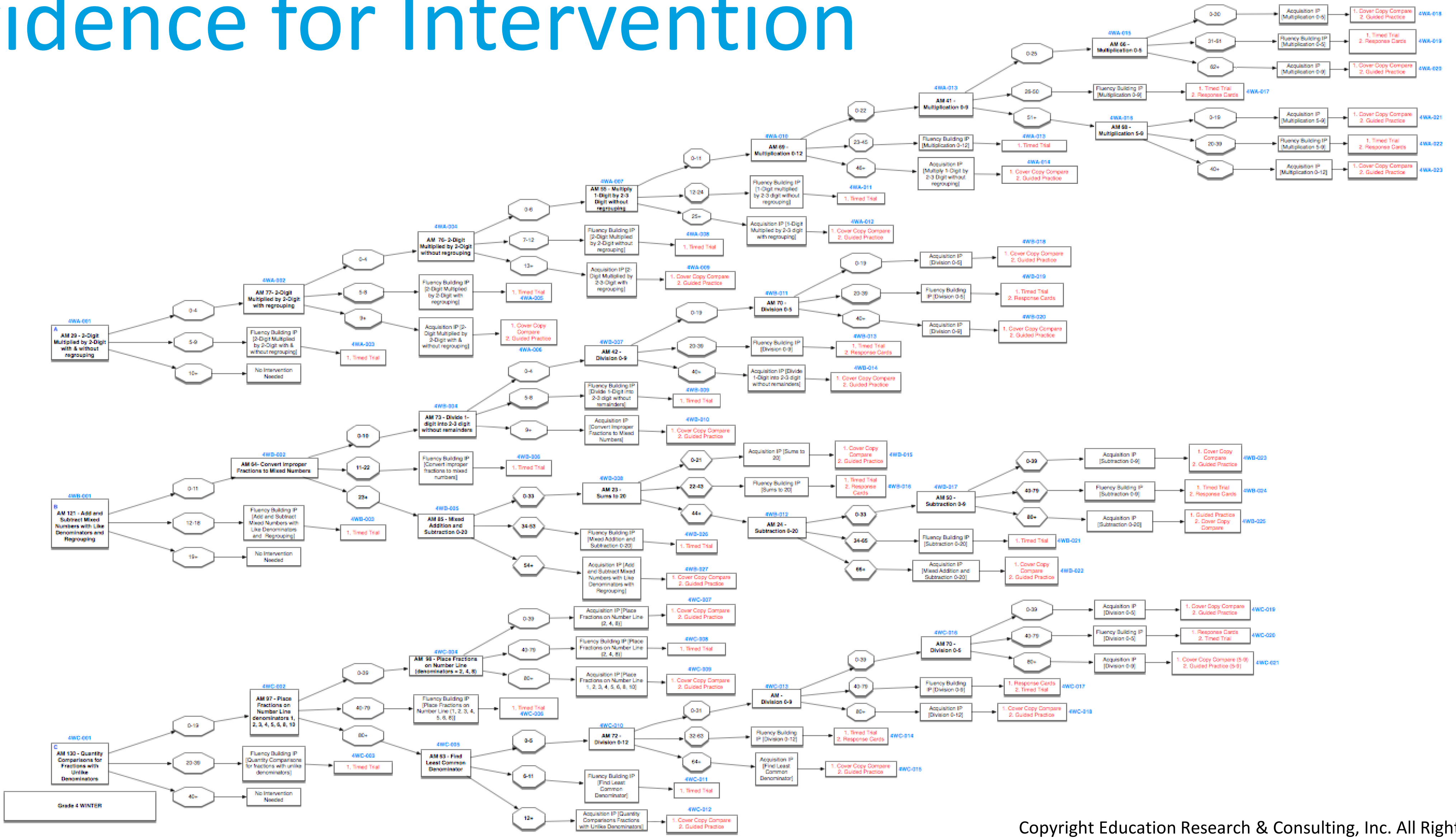
Evidence for Intervention

- The Spring Math fall and winter screenings, and classwide intervention response data have been examined for bias and submitted to the NCII Tool's Chart.
- A series of binary logistic regression analyses were conducted for subgroups. Scoring below 20th percentile on AZ year-end test was the outcome criterion.
- Interaction terms were tested for each subgroup & screening scores for fall, winter, and classwide intervention.
- None of the interaction terms were significant at any grade level for sex, race, free or reduced lunch status, or special education status.
- These findings replicate all the earlier studies demonstrating screening and intervention is a more equitable basis for determining risk than teacher referral and other forms of assessment (i.e., year-end tests) alone.

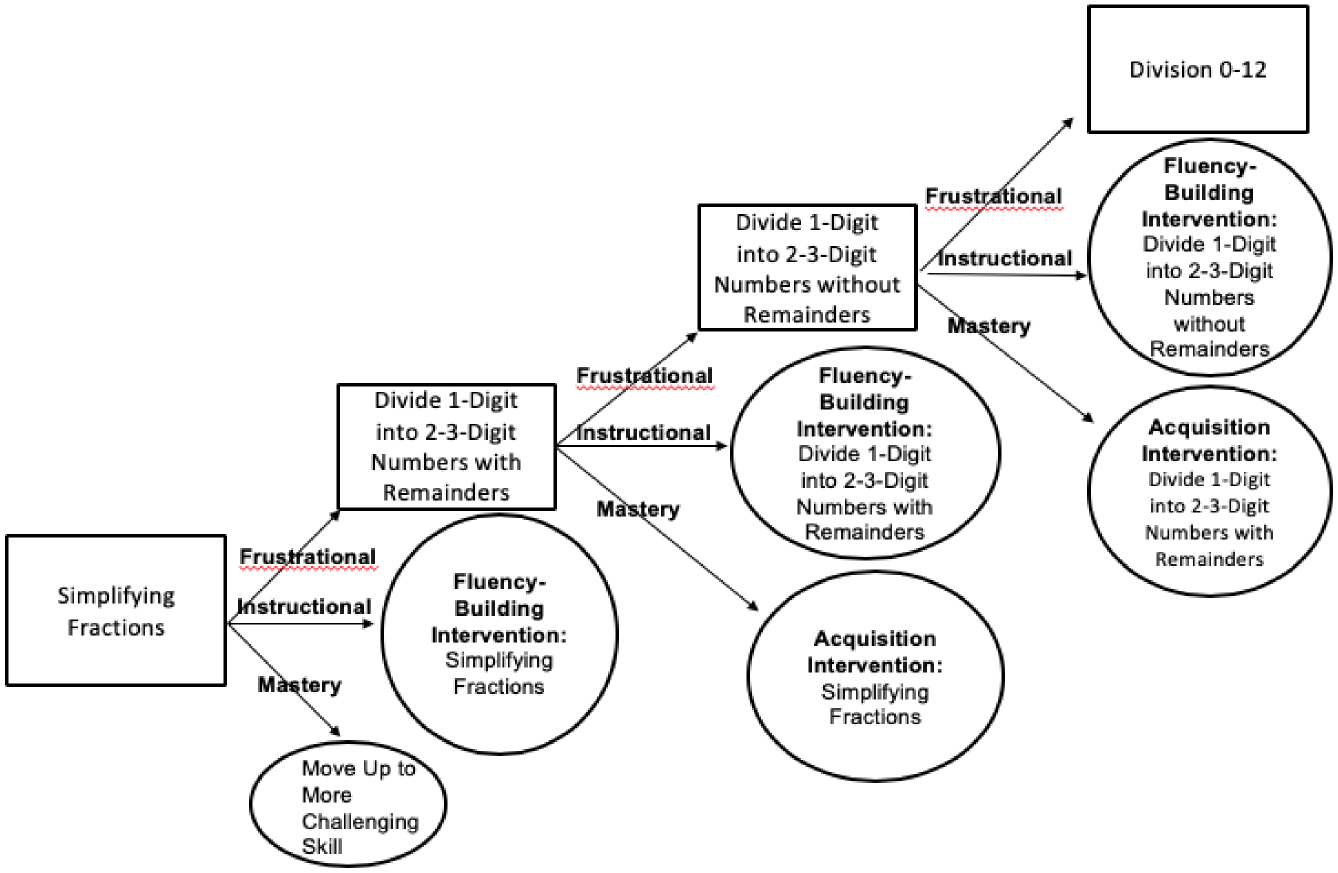
Evidence for Intervention

- Spring Math begins with screening at each grade level connected to grade-level content and learning expectations.
- If there is a base rate issue, Spring Math addresses that via a classwide math intervention.
- Once children are identified for individual intervention, Spring Math directs the drill-down assessment to select the right intervention.
- The decision trees that direct all actions within Spring Math are grounded in the assessment and intervention research just described.

Evidence for Intervention

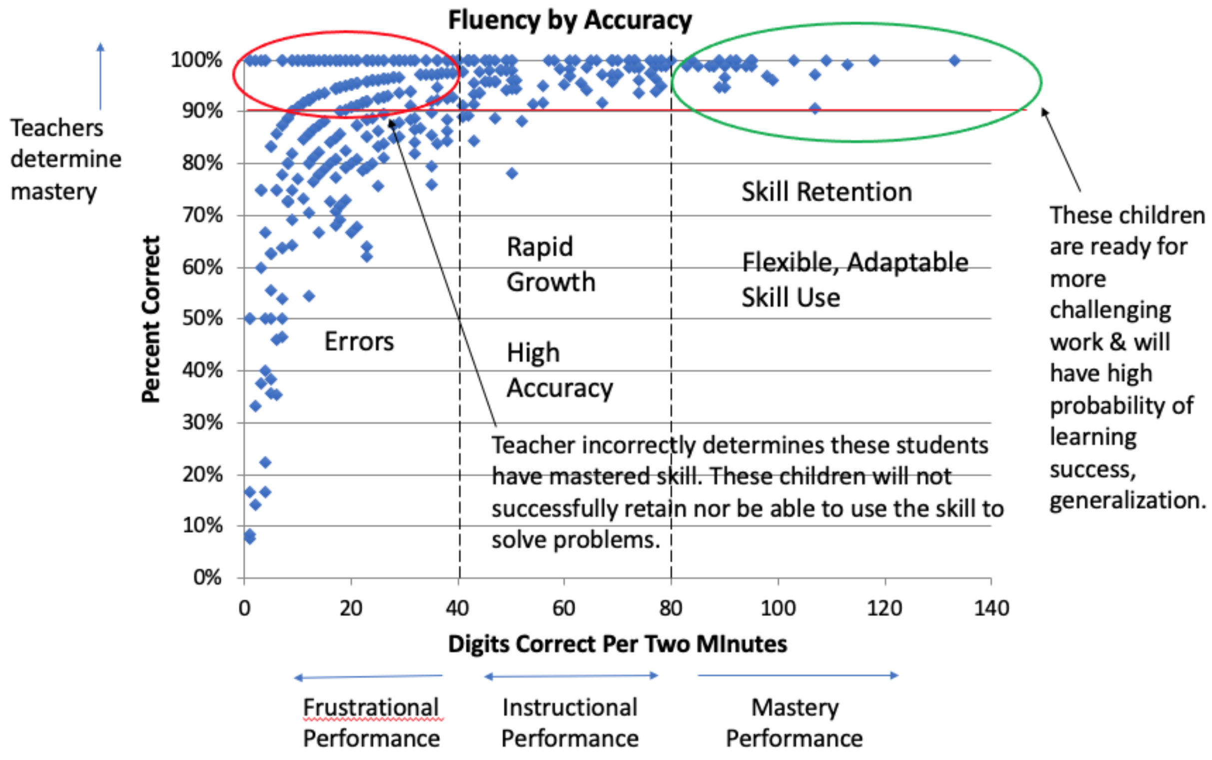


In Spring Math, the decision trees begin with grade-level fall, winter, or spring learning expectations. Student performance is assessed on key skills. If a classwide problem is detected, classwide intervention (a fluency-building intervention) is initiated. Student response to classwide intervention is then used to determine the need for more intensive individual intervention. If intensive intervention is needed, the decision trees specify the "drill-down" diagnostic assessment and cut scores to identify the skill gaps and the instructional tactic that will most benefit the student. Ongoing progress monitoring data during intervention are used to adjust intervention materials and tactics until the child reaches mastery on the grade-level screening skills.



The Instructional Hierarchy

The Instructional Hierarchy details the progression of student learning from acquisition to fluency-building to generalization. Student proficiency, which can be characterized in terms of accuracy and the ease with which the student responds (typically latency or fluency of responding) indicates the stage of learning in which the student is functioning. Different instructional tactics are needed at each stage of learning. Frustrational range performance indicates the need for acquisition support. Instructional range of performance indicates the need for fluency-building instruction. Mastery range performance indicates the need for generalization opportunities and support.



Effective instructional tactics

Effective instructional tactics differ by stage of learning. When the tactic is aligned with learner proficiency, learning accelerates. When the tactic is misaligned, learning decelerates, demonstrating a classic “skill by treatment” interaction as demonstrated in a meta-analysis conducted by Burns et al., 2010. Effective tactics for frustration-level skills include providing immediate, high-quality corrective feedback and antecedent supports for correct responding (cues, restricted task presentations with fading across trials). Effective fluency-building tactics include high dosage of opportunities to respond with goal-setting and task variation. Corrective feedback can be slightly delayed in fluency-building instruction. Generalization tactics include presentation of novel tasks or response opportunities with corrective feedback.

Acquisition

Child response is inaccurate: Frustrational Performance.

Goal of instruction is to build accurate understanding. Tactics should include: salient cues, frequent & high-level prompting, immediate feedback, more elaborate feedback, sufficient exemplars of correct/incorrect responses, controlled task presentation.

Fluency

Child response is accurate but slow: Instructional Performance

Goal of instruction is to build fluency (accuracy + speed). Tactics should include: intervals of practice, opportunities to respond, delayed feedback, goals & reinforcement for more fluent performance.

Generalization & Adaptation

Child response is fluent: Mastery Performance

Goal is to promote generalization. Tactics should include: cues to generalize, corrective feedback for application and problem-solving, systematic task variation, fading of support.

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.

Contemporary studies testing the Instructional Hierarchy that were especially influential to the development of Spring Math include:

Burns, M. K., Codding, R. S., Boice, C. H., & Lukito, G. (2010). Meta-analysis of acquisition and fluency math interventions with instructional and frustration level skills: Evidence for a skill-by-treatment interaction. *School Psychology Review, 39*, 69-83. This meta-analysis demonstrated that when instructional tactics were aligned with student proficiency, learning improved and when instructional tactics were mis-aligned with student proficiency, learning declined. Burns and colleagues called this the “skill-by-treatment” interaction which is, in effect, an empirical demonstration of the Instructional Hierarchy.

Burns, M. K., VanDerHeyden, A. M., & Jiban, C. (2006). Assessing the instructional level for mathematics: A comparison of methods. *School Psychology Review, 35*, 401-418. In this study, Burns and colleagues demonstrated that attaining mastery level performance was associated with skill retention over time, generalization, and faster learning of more complex, related skills.

Evidence for Intervention

- Grounded in the science of the Instructional Hierarchy, the diagnostic assessment connects the child to the right difficulty level and tactic for intervention.
- Interventions contain specific evidence-based active ingredients and scripted activities to build conceptual understanding.
- Procedural knowledge and conceptual understanding are targeted daily in intervention in an interleaved fashion.
- Weekly progress monitoring data are used to adjust the intervention and provide new materials to the teacher each week.

Fluency-Building			Acquisition			
Classwide Math Intervention	Timed Trial	Response Cards	Cover Copy Compare	Guided Practice	Incremental Rehearsal	Bingo

Math intervention research studies that were especially influential in the development of Spring Math interventions include:

Bryant, D. P., Bryant, B. R., Gersten, R. M., Scammacca, N. N., Funk, C., Winter, A. J., Shih, M., & Pool, C. (2008). The effects of tier 2 intervention on the mathematics performance on first-grade students who are at risk for mathematics difficulties. *Learning Disability Quarterly, 31*, 47 – 63.

Fuchs, L. S., Schumacher, R. F., Long, J., Namkung, J., Hamlett, C. L.,Cirino, P. T., Jordan, N. C., Siegler, R., Gersten, R., Changas, P. (2013). Improving at-risk learners' understanding of fractions. Journal of Educational Psychology, 105, 683-700. http://dx.doi.org/10.1037/a0032446

Fuchs, D., Fuchs, L. S., Mathes, P. G., & Simmons, D. C. (1997). Peer-assisted learning strategies: Making classrooms more responsive to diversity. American Educational Research Journal, 34, 174-206. http://dx.doi.org/10.3102/00028312034001174

Gersten, R., Chard, D. J., Jayanthi, M., Baker, S. K., Morphy, P., & Flojo, J. (2009). Mathematics instruction for students with learning disabilities: A meta-analysis of instructional components. Review of Educational Research, 79, 1202-1242. http://dx.doi.org/10.3102/0034654309334431

Harniss, M. K., Stein, M., & Carnine, D. (2002). Promoting Mathematics Achievement. In M. R. Shinn, H. M. Walker & G. Stoner (Eds.), *Interventions for academic and behavior problems II: Preventive and remedial approaches* (pp. 571-587). Washington, DC: National Association of School Psychologists.

Joseph, L. M., Konrad, M., Cates, G., Vajcner, T., Eveleigh, E., & Fishley, K. M. (2012). A meta-analytic review of the cover-copy-compare and variations of this self-management procedure. *Psychology in the Schools*, *49*(2), 122-136.

Jordan, N. C., Kaplan, D., Ramineni, C., & Locuniak, M. N. (2009). Early math matters: Kindergarten number competence and later mathematics outcomes. *Developmental Psychology, 45*, 850-867. doi:10.1037/a0014939

Mayfield, K. H., & Chase, P. N. (2002). The effects of cumulative practice on mathematics problem solving. *Journal of Applied Behavior Analysis, 35*, 105-123. doi:10.1901/jaba.2002.35-105

National Mathematics Advisory Panel (2008). *Foundations for Success: The Final Report of the National Mathematics Advisory Panel*, U.S. Department of Education: Washington, DC.

National Research Council. (2001). *Adding it up: Helping children learn mathematics*. J. Kilpatrick, J. Swafford, and B. Findell (Eds.). Mathematics Learning Study Committee, Center for Education, Division of Behavioral and Social Sciences and Education. Washington, DC: National Academy Press.

Rittle-Johnson, B. (2017). Developing mathematics knowledge. *Child Development Perspectives*, *11*, 184–190. doi:10.1111/cdep.12229

Siegler, R. S., Fazio, L. K., Bailey, D. H., & Zhou, X. (2012). Fractions: The new frontier for theories of numerical development. *Trends in Cognitive Sciences*, 1-7.

Skinner, C. H., Turco, T. L., Beatty, K. L., & Rasavage, C. (1989). Cover, copy, and compare: A method for increasing multiplication performance. *School Psychology Review*.

Wu, H. (1999). Basic skills versus conceptual understanding: A bogus dichotomy in mathematics education. *American Educator*, Fall 1999, 1-7.

More references (located at www.springmath.com) can be found here:
https://static1.squarespace.com/static/57ab866cf7e0ab5cbba29721/t/591b4cf6ebbd1a48e6e6b589/1494961399231/SpringMath_InterventionStudies_line.pdf