Reading & Math Skills: Using Data to Guide Evidence-Based Interventions

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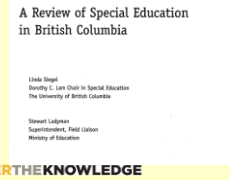
Special Education in British Columbia

- http://www.inclusionbc.org/about-us/history/1950s


A Review of Special Education in British Columbia

Linda Siegel
Dorothy C. Lam Chair in Special Education
The University of British Columbia

Stewart Ladyman
Superintendent, Field Liaison
Ministry of Education

BRITISH COLUMBIA

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The Ministry of Education should refrain from establishing new categories for funding students who have special educational needs.

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School boards must ensure that each student's educational program is based on educational needs of the student with special needs.

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Interventions for Children with LD

Reading comprehension	1.13
Direct instruction	.84
Psycholinguistic training	.39
Modality instruction	.15
Diet	.12
Perceptual training	.08

Kavale & Forness, 2000

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Individualized instruction, at no cost to the parents or guardians, to meet the unique needs of a child with a disability.

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British Columbians want an education system that reflects their belief that all students are unique, all students are to be valued, and all students can learn.

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MTSS

The systematic use of assessment data to most efficiently allocate resources in order to enhance learning for all students.

(Burns, Jimerson, VanDerHeyden, & Deno, 2016)

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The Minister of Education should direct school boards to report by how they are using classroom based early assessments to detect students' skill difficulties and determine appropriate teaching /learning strategies to correct learning difficulties in reading, writing, spelling and numeracy.

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Problem Solving

- Tier I – Identify discrepancy between expectation and performance for class or individual (Is it a classwide need?)
- Tier II – Identify discrepancy for individual. Identify category of problem. (What is the category of the problem?)
- Tier III – Identify discrepancy for individual. Identify causal variable. (What is the causal variable?)

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Four Purposes of Assessment

Program evaluation: How is the education system working for students overall?

- Foundation Skills Assessment, Graduation Assessments

Screening: Which of my students are not meeting grade level expectations given Universal Instruction?

- E.g., STAR, MAP

Diagnostic: What are the specific needs of students who struggle?

E.g., measures of specific skills

Monitoring Progress: What does the student's growth look like?

E.g., CBM

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Screener	MAP < 25th %ile	MAP ≥ 25th %ile	Total
Oral Reading Fluency (ORF)			
ORF < Benchmark Goal	276	145	421
	a	b	
ORF ≥ Benchmark Goal	46	501	547
	c	d	
Total	322	646	968
Informal Reading Inventory (RI)			
RI < Benchmark Goal	90	189	279
	a	b	
RI ≥ Benchmark Goal	200	367	567
	c	d	
Total	290	556	846

Sensitivity = a / (a + c)
.86 for ORF
.31 for F&P

Specificity = d / (b + d)
.78 for ORF
.66 for F&P,

Correct Classification = (a + d) / N
.80 for ORF
.54 for F&P

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Age Group	Reading	Writing	Math
Elementary			
Practices with Large Effects	• Repeated reading • Using easier reading material • Immediate performance feedback • Direct instruction • Phonemic awareness instruction • Explicit phonics instruction	• Strategy instruction for planning, editing, and paragraph structure • Peer assisted writing • Set clear and specific goals	• Drill techniques • Practice with modeling • Explicit instruction • Student verbalizations of their mathematical reasoning • Include a broad range of examples • Cross-age tutoring • Concrete-representational-abstract • Speed-based intervention
Practices with Small or Negative Effects	• Whole language approaches • Sentence combining	• Grammar instruction	• Problem structure representation
Adolescent			
Practices with Large Effects	• Comprehension strategies • Reciprocal teaching • Teaching vocabulary • Concept maps	• Self-regulation strategy development • Summarization • Setting product goals	• Using visual representations of problems • Self-monitor problem solving • Self-reflect on problem solving
Practices with Small or Negative Effects	• Fluency interventions	• Studying models of writing • Teaching grammar	• Technological enhanced instruction

(Burns, VanDerHeyden & Zaslofsky, 2014)

You've Got the Data – Now What?

- Data Management Team
  - Usually school psychologist and one other
  - Know data!
- PLC or Discipline Teams
- Get data to teachers within 2 to 3 days
- Lead data meeting

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What is the Class Median?

- Median: the middle value in a list of numbers when the values are arranged from lowest to highest.
- Finding the class median:
  - Order student scores from the lowest to highest value.
  - The score in the middle of the list is the median.
  - If there is an even number of scores, take the average of the middle two scores.

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What is the Class Median?

MODEL

Student	Grade	Winter Benchmark 101 ORF WRC	Errors
A	3	21	8
B	3	18	6
C	3	87	1
D	3	110	0
E	3	46	6
F	3	92	1
G	3	89	3
H	3	98	1
I	3	119	2
J	3	96	2
K	3	50	8
L	3	122	2
M	3	97	1
N	3	49	6
O	3	105	0
P	3	86	6
Q	3	89	2
R	3	76	3
S	3	112	3
I	3	119	2
L	3	141	1
U	3	94	2
Class Median			

Student	Grade	Winter Benchmark 101 ORF WRC	Errors
B	3	18	6
A	3	21	8
E	3	46	6
N	3	49	6
K	3	50	8
R	3	76	3
P	3	86	6
C	3	87	1
G	3	89	3
Q	3	89	2
F	3	92	1
U	3	94	2
J	3	96	2
M	3	97	1
H	3	98	1
O	3	105	0
D	3	110	0
S	3	112	3
I	3	119	2
L	3	122	2
T	3	141	1
Class Median		92	

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What is the Class Median?

MODEL

Student	Grade	Spring Benchmark 90 ORF WRC	Errors
A	2	64	5
B	2	22	5
C	2	77	0
D	2	68	4
E	2	21	1
F	2	18	2
G	2	60	0
H	2	70	2
I	2	84	0
J	2	77	0
K	2	26	4
L	2	89	1
M	2	54	0
N	2	46	8
O	2	70	3
P	2	75	0
Q	2	32	6
R	2	35	2
S	2	51	1
T	2	71	1
Class Median			

Student	Grade	Spring Benchmark 90 ORF WRC	Errors	
F	2	18	2	0
E	2	21	1	0
B	2	22	5	0
K	2	26	4	0
Q	2	32	6	0
R	2	35	2	0
N	2	46	8	1
S	2	51	1	1
M	2	54	0	1
G	2	60	0	1
A	2	64	5	2
D	2	68	4	2
H	2	70	2	2
O	2	70	3	3
T	2	71	1	4
P	2	75	0	4
C	2	77	0	5
J	2	77	0	5
I	2	84	0	6
L	2	89	1	8
Class Median		62		1.5

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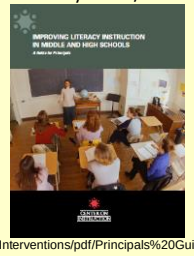
Literacy in MS/HS



http://www.fcrr.org/Interventions/pdf/Principals%20Guide-Secondary.pdf

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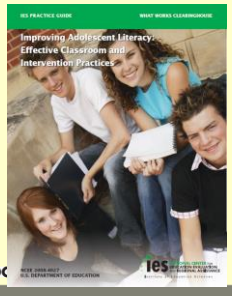

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Spring Benchmark		90	
		ORF	
Student	Grade	WRC	Errors
A	2	31	6
B	2	47	5
C	2	47	4
D	2	48	4
E	2	51	2
F	2	54	3
G	2	55	4
H	2	58	7
I	2	61	7
J	2	61	1
K	2	65	0
L	2	71	1
M	2	78	2
N	2	82	6
O	2	84	0
P	2	86	0
Q	2	95	0
R	2	98	2
S	2	108	1
T	2	121	2
U	2	141	3
Class Median			

Partner Reading Partnerships

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Procedure

Partner Reading	Paragraph Shrinking
1. Stronger reader reads aloud for 5 minutes 2. The weaker reader reads aloud the SAME text for 5 minutes 3. Weaker readers sequence the major events of what has been read for 1 minute	1. For 5 minutes the stronger read continues reading new text in the story, stopping after each paragraph to summarize 2. For 5 minutes the weaker reader continues with the new text, stopping after each paragraph to summarize

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Partner Reading

- **First Reader** reads for 5 minutes.
- **Second Reader** reads the **same** text for 5 minutes.
- **Second Reader retells** for 1 minute.

RULES

Talk only to your partner and only talk about Partner Reading

Keep your voice low

Help your partner

Try your best!

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Paragraph Shrinking

- Name the most important **who** or **what.**
- Tell the **most important thing** about the who or what.
- Say the main idea in **10** words or less.

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Correction Procedures

STOP. That word is_____

What word?
_____

Good Job!

Go back and read that line again.

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Timeline

Collect Data: Pre-test (fluency and comprehension)

- **Day 1:** Train Students on Set Up Procedures and Partner Reading, Practice Reading for 10 minutes, Error Correction
- **Day 2:** Train Students on Paragraph Shrinking, Practice Reading for 10 minutes
- **Day 3-10:** Partner Reading, Paragraph Shrinking 15 minutes every day

Collect Data: Post-test (fluency and comprehension)

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What we found: 3rd grade Partner Reading data

Third Grade			
Third Grade Benchmark	**91 Words Read Correctly (WRC)**		
	Pre Intervention Class Median (WRC)	**Post Intervention Class Median (WRC)**	**Slope (WRC)**
Class 1	81	104	11.5
Class 2	87	115	14

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	WRC	WRC after PALS
Student 1	48	92
Student 2	122	142
Student 3	126	147
Student 4	82	113
Student 5	102	117
Student 6	77	97
Student 7	51	70
Student 8	84	95
Student 9	80	82
Student 10	102	127
Student 11	83	106
Student 12	38	47
Student 13	104	115
Student 14	152	161
Student 15	143	158
Student 16	115	125
Student 17	142	160
Student 18	114	127
Student 19	13	40
Student 20	75	92
Student 21	141	136
Student 22	87	105
Student 23	49	47
Median	87	113

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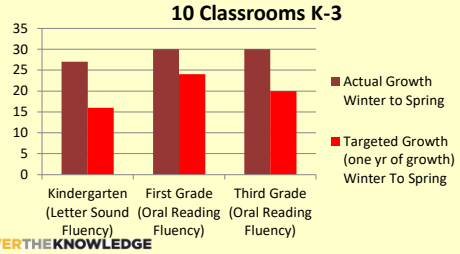
Growth from Winter to Spring Class-Wide Interventions 10 Classrooms K-3



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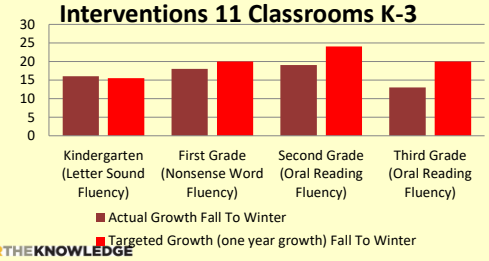
Growth from Winter To Spring NO Class-Wide Interventions 11 Classrooms K-3



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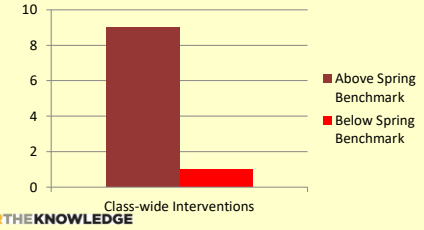
Class-wide Interventions Implemented in 10 of the 21 Classes Below Winter Benchmark:

9 of the 10 Above Spring Benchmark



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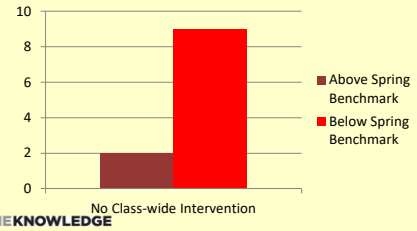
NO Class-wide Intervention Implemented in 11 Classes Below Winter Benchmark

2 of the 11 Above Spring Benchmark



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Science Project

- Approximately 140 4th and 5th graders
- Science content
- Readworks.org
- Grade level ORF and science MAZE
- 2 weeks

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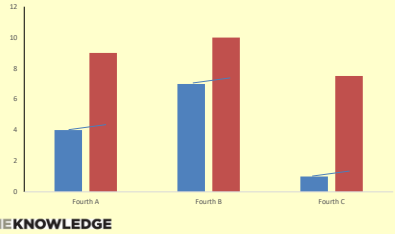
MAZE Growth 4th Grade



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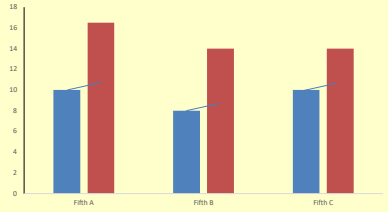
MAZE Growth 5th Grade



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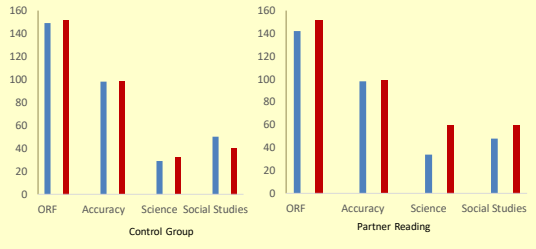

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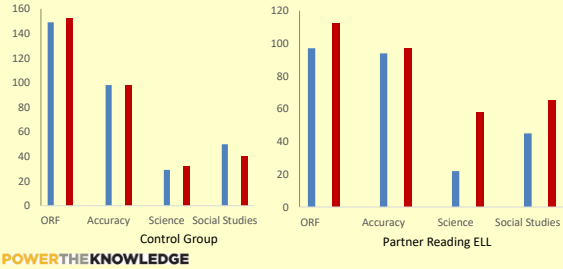

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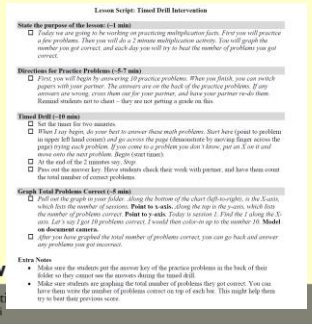

Lesson Script: Timed Drill Intervention

State the purpose of the lesson: (~1 min)

- ☐ *Today we are going to be working on practicing multiplication facts. First you will practice a few problems. Then you will do a 2 minute multiplication activity. You will graph the number you get correct, and each day you will try to beat the number of problems you got correct.*

Directions for Practice Problems (~5-7 min)

- ☐ *First, you will begin by answering 10 practice problems. When you finish, you can switch papers with your partner. The answers are on the back of the practice problems. If any answers are wrong, cross them out for your partner, and have your partner re-do them.* Remind students not to cheat – they are not getting a grade on this.

Timed Drill (~10 min)

- ☐ Set the timer for two minutes.
- ☐ *When I say begin, do your best to answer these math problems. Start here* (point to problem in upper left hand corner) *and go across the page* (demonstrate by moving finger across the page) *trying each problem. If you come to a problem you don't know, put an X on it and move onto the next problem. Begin* (start time!).
- ☐ At the end of the 2 minutes say, *Stop.*
- ☐ Pass out the answer key. Have students check their work with partner, and have them count the total number of correct problems.

Graph Total Problems Correct (~5 min)

- ☐ *Pull out the graph in your folder. Along the bottom of the chart (left-to-right), is the X-axis, which lists the number of sessions.* **Point to x-axis.** *Along the top is the y-axis, which lists the number of problems correct.* **Point to y-axis.** *Today is session 1. Find the 1 along the X-axis. Let's say I got 10 problems correct, I would then color-in up to the number 10.* **Model on document camera.**
- ☐ *After you have graphed the total number of problems correct, you can go back and answer any problems you got incorrect.*

Extra Notes

- Make sure the students put the answer key of the practice problems in the back of their folder so they cannot see the answers during the timed drill.
- Make sure students are graphing the total number of problems they got correct. You can have them write the number of problems correct on top of each bar. This might help them try to beat their previous score.

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Timed Drill Student Directions

Practice

- ☐ Work on the 10 practice target problems by yourself.
- ☐ Review problems with answer key with your partner.
- ☐ If they are any incorrect answers, have your partner cross out the incorrect answer and write the correct answer.
- ☐ Cover practice problems.

Timed Drill

- ☐ Start the problems by yourself when the teacher says begin.
- ☐ Stop when the timer stops.
- ☐ Use the answer key to check answers. If there are any incorrect answers, have your partner cross out the incorrect answer and you write the correct answer.
- ☐ Count the total number of problems correct.
- ☐ Graph the total problems correct.

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Tech Options

- Math Facts in a Flash
- Reflex Math
- Xtramath.org
- Thatquiz.org

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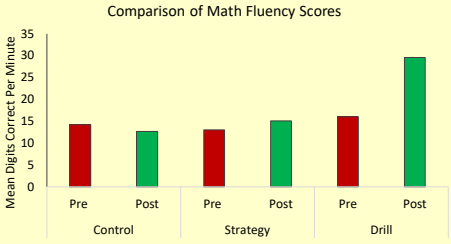

$F = 32.11$, $p < .001$, $\eta^2 = 0.52$

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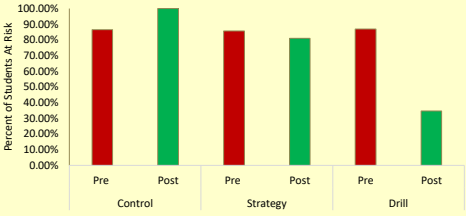

$X^2 = 24.76$, $p < .01$, From 20 (of 23) dyads to 8!!

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Aptitude by Treatment Interaction (ATI)

- Differential intervention effectiveness based on student aptitudes (cognitive processes).
- Chronbach, 1957
- Makes intuitive sense – popular.

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Meta-analyses for ATI Interventions

Kavale & Forness, 2000

Psycholinguistic training	.39
Modality instruction	.15
Perceptual training	.08
Auditory Sequential Memory	.32
Visual Sequential Memory	.27

The original architects of ATI concluded that cognitive abilities alone did not explain individual differences in intervention effectiveness (Cronbach & Snow, 1977).

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Resurgence in ATI

- RTI – tier 3
- Measures of cognitive processes:
  - abilities would predict student outcomes better than CBM (Hale, 2006)
  - Provide data useful for designing interventions (Fiorello et al, 2006; Floyd et al., 2003; Hale et al., 2001).
- Current measures of underlying aptitudes are more sophisticated than those used in Cronbach's research (Swanson, 1987).

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Merge Neuropsych and RTI (Feifer, 2008)

- We should assess cognitive constructs such as verbal IQ, executive functioning, working memory, attention, and reading fluency.
- "Specifying the underlying linguistic and cognitive factors associated with poor reading comprehension skills may be helpful toward developing more effective intervention strategies to assist children" (p. 824), especially for those receiving a Tier 3 intervention.

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Table 2
Median Effect Sizes for Each Variable

Variable	*k*	Median *g*	95% CI	Fail-safe *N* for a small effect	Fail-safe *N* for a large effect
Use of data					
Screening	30	.41	.31–.51	32	15
Designing interventions	4	.42	−.05–.89	4	2
Tier of intervention					
Small group	15	.30	.18–.42	8	9
Individual	16	.44	.28–.60	19	7
Type of assessment					
Cognitive function	8	.17	−.07–.41	NA	6
Phonological/phonemic awareness	13	.50	.34–.66	20	5
Reading fluency	11	.43	.29–.57	13	5
Mixed	2	.26	.12–.40	1	1

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Executive Function

Table 7
Predictive Power of Full Executive Function (EF) Scale

Model	R^2	*df1*	*df2*	*F* change	Significant *F* change	R^2 change (effect size)
Kindergarten reading						
Intelligence, gender	0.20	1	214	26.02	<.001*	0.20
Intelligence, gender, full EF Scale	0.23	4	210	2.04	.090	0.03
Kindergarten math						
Intelligence, gender	0.22	2	214	30.62	<.001*	0.22
Intelligence, gender, full EF Scale	0.29	4	210	5.25	<.001*	0.07
First grade reading						
Intelligence, gender, kindergarten reading	0.30	3	200	28.12	<.001*	0.30
Intelligence, gender, kindergarten reading, full EF Scale	0.35	4	196	3.86	.005	0.05
First grade math						
Intelligence, gender, kindergarten math	0.53	3	200	74.68	<.001*	0.53
Intelligence, gender, kindergarten math, full EF Scale	0.56	4	196	2.93	.022	0.03

* $p < .001$.

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(Sadeh, Burns, & Sullivan, 2013)

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Executive Functioning (EF)

- Jacob and Parkinson (2015s) - 67 Studies
- Most of studies occurred in 2010 or later
- EF and academic skills are correlated (equal for reading and math)
- Changing skills in EF **did not** lead to increased skills in reading and math
- No evidence for causal link between EF and reading or math

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Working Memory

Melby-Lervag & Hulme, 2012

- Verbal Ability .13
  - Comprehension and problem solving
  - Children (-.05) and young children (.03)
- Word Decoding .13
- Arithmetic .07

"There was no convincing evidence of the generalization of working memory training to other skills."

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Table 1. summary of Meta-Analyses Regarding Cognitive Processes and Academic Interventions

Study	Description	k	d
Burns et al. (In press)	Academic interventions from cognitive processing measures	37	0.17
Kearns & Fuchs (2013)*	Academic outcomes of cognitively focused intervention	34	0.44
	matched to cognitive deficits	5	0.48
	Compared to no intervention	11	0.58
	Compared to academic interventions	34	0.26
Melby-Lervag & Hhulme, (2013)	Working memory training and academic outcomes	8	0.11
	mathematics	7	0.07
	Decoding	7	0.13
	Verbal ability (comprehension)	8	0.13
Scholin & Burns (2012)	Predicting response to intervention for reading with IQ	18	0.27
Stuebing et al. (2009)	Relationship between IQ and academic outcomes	22	0.32
Stuebing et al. (2015)	Cognitive characteristics and response to intervention	54	0.46
	baseline characteristics and growth curves	36	0.65
	baseline characteristics and gain scores	30	0.43
	baseline characteristics and posttest	54	0.30
Schwaighofer et al. (2015)	Near and far transfers for working memory training	47	0.15
	mathematics	15	0.09
	Decoding	14	0.15
	Verbal ability (comprehension)	29	0.21
Total		203	0.27

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Skill-By-Treatment Interaction

- Burns, Codding, Boice, & Lukito, 2008
- Interventions selected based on student functioning in the specific skill
- Systematically identify and manipulate environmental conditions that are directly related to a problem
- Isolate target skill deficits

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Assess 4 NRP Areas

- Phonemic Awareness
  - Phoneme segmentation fluency
- Phonics
  - Nonsense word fluency (WJ Pseudoword)
- Fluency
  - Oral reading fluency (TOSCRF)
- Vocabulary/Comprehension
  - Measures of Academic Progress or STAR Reading

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Grade	Phonemic Awareness	Phonics	Fluency	Vocabulary	Comprehension
Kindergarten	EIR – K	EIR – K	NA	Text Talk	NA
First Grade	Road to the Code	Road to the Code	NA	Text Talk	NA
Second Grade	Fast Forward	Corrective Reading	Six Minute Solution	Building Vocabulary Skills	Comprehension Plus
Third Grade	Fast Forward	Corrective Reading	Six Minute Solution	Building Vocabulary Skills	Comprehension Plus
Fourth Grade	NA	REWARDS	Six Minute Solution	Building Vocabulary Skills	Comprehension Plus
Fifth Grade	NA	REWARDS	Six Minute Solution	Building Vocabulary Skills	Comprehension Plus

Category of Problem MN HS

- 9-12 with approximately 1600 students
- 69.2% pass reading
- 9th-10th grade
- 28% low on MAP (~225)
- 45% Low on TOSCRF (~100)
  - 64% low on phonics (~65)
  - 36% acceptable phonics (~36)

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Groups

- Randomly assigned to two groups
  - Read 180
  - Targeted (phonics – REWARDS, fluency – Read Naturally, comprehension – Read 180
- Wait list control group
- 20 minutes each day for 13 weeks in addition to reading and study skills

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	Targeted Interventions		Control		Waitlist Control	
Variable	Mean	SD	Mean	SD	Mean	SD
Fluency Pretest	90.17	7.65	89.88	9.73	na	na
Fluency Posttest	98.33	7.27	94.32	8.77	na	Na
MAP Fall	206.00	9.25	211.00	10.11	210.37	6.56
Map Winter	217.21	7.56	212.40	8.06	212.78	6.04

ANCOVA for fluency F (1, 42) = 4.98, $p < .05$, $d = .50$
ANCOVA for MAP F (2, 74) = 5.84, $p < .05$, partial eta squared = .14.

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Comparison of Targeted and Comprehensive

- 306 second-grade and 303 third-grade students
- Attended one of six elementary schools in an urban school district
- 51.4% females, 14% white students, and 80% were eligible for the FRPL
- Leveled Literacy Intervention
- PRESS Interventions (comprehension, fluency, decoding, phonemic awareness)

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Results

Table 1. *Mean Oral Reading Fluency (ORF) and Measures of Academic Progress (MAP)*

	Targeted	Comprehensive	Tier 1
Second Grade	*N* = 80	*N* = 38	*N* =188
ORF	1.33	1.07	1.25
MAP	0.56	0.40	0.39
Third Grade	*N* =95	*N* =177	*N* = 31
ORF	1.23	.94	1.03
MAP	.37	.42	.35

Targeted Intervention Grade 2 MANOVA *F* (4, 602) = .965, p < .05
Targeted Intervention Grade 3 MANOVA *F* (4, 596) = .958, p < .05

Table 2. *Percentage of Students Making One Year's Growth on CBM-R and/or MAP*

	Tier 1		Targeted		Comprehensive	
	Neither Measure	At Least 1 Measure	Neither Measure	At Least 1 Measure	Neither Measure	At Least 1 Measure
2nd Grade	38%	62%	30%	70%	45%	55%
3rd Grade	30%	70%	27%	73%	52%	48%

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Meta-Analysis

- 24 studies of K-8 small-group reading interventions
  - 26 effects
- Median *g* = .50
- Age
  - K-2 = .66
  - 3-8 = .22
- Targeted (comprehension, fluency, vocabulary, decoding, phonemic awareness)
  - 13 effects, *g* = .65
- Comprehensive
  - 13 effects *g* = .26

Hall & Burns (2017)

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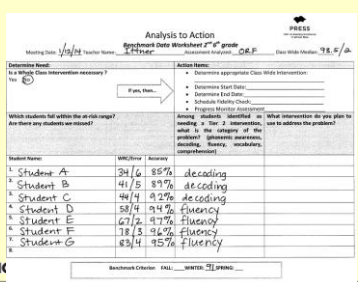

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Analysis to Action

Benchmark Data Worksheet 2nd 6th grade

Meeting Date: 1/13/14 Teacher Name: Ethner Assessment Analyzed: ORF Class Wide Median: 98.5/2

Determine Need:
Is a Whole Class Intervention necessary?
Yes: No

If yes, then...

Action Items:
- Determine appropriate Class Wide Intervention:
- Determine Start Date:
- Determine End Date:
- Schedule Fidelity Check:
- Progress Monitor Assessment:

Which students fall within the at-risk range? Are there any students we missed?

Among students identified as needing a Tier 2 intervention, what is the category of the problem? (phonemic awareness, decoding, fluency, vocabulary, comprehension)

What intervention do you plan to use to address the problem?

Student Name:	WRC/Error	Accuracy	
1. Student A	34/6	85%	decoding
2. Student B	41/5	89%	decoding
3. Student C	44/4	92%	decoding
4. Student D	58/4	94%	fluency
5. Student E	67/2	97%	fluency
6. Student F	78/3	96%	fluency
7. Student G	83/4	95%	fluency
8.			

Benchmark Criterion: FALL: ___ WINTER: 91 SPRING: ___

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Strands of Proficiency	Instructional Implication
Conceptual Understanding	Fosters the developmental knowledge of relationships and ideas that underlie the problem.
Procedural Knowledge	Fosters the developmental understanding of the steps needed to solve a problem.
Strategic Competence	Fosters the development of learning to flexibly solve problems using multiple strategies.
Adaptive Reasoning	Fosters the development of learning to justify the correct answer and demonstrate reasoning.
Productive Disposition	Fosters the development of viewing math as useful and worthwhile, while increasing students' confidence.

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Intervention	Mathematical Proficiency Strands				
	Conceptual Understanding	Procedural Fluency	Strategic Competence	Adaptive Reasoning	Productive Disposition
Cover, Copy, Compare		X			
Flashcard Interventions		X			
Goal Setting					X
Great Leaps	X				X
Math to Mastery		X			X
Mnemonic Instruction		X			
Schema-Based Instruction	X	X	X	X	
Self-Monitoring				X	X
Taped Problems		X			
Think Alouds	X			X	

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Math

- Elementary
  - Work backwards in curriculum to find instructional skill
  - Practice with procedural

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Table 7 Skill sequence 2003–2004

2nd Grade	3rd Grade
1. Addition facts 0–20	1. Addition and subtraction facts 0–20
2. Subtraction facts 0–9	2. Fact families addition and subtraction 0–20
3. Subtraction facts 0–12	3. Three-digit addition without and with regrouping
4. Subtraction facts 0–15	4. Three-digit subtraction without and with regrouping
5. Subtraction facts 0–20	5. Two- and three-digit addition and subtraction with and without regrouping
6. Mixed subtraction/addition 0–20	6. Multiplication facts 0–9
7. Fact families addition and subtraction 0–20	7. Division facts 0–9
8. Two-digit addition without regrouping	8. Fact families multiplication and division 0–9
9. Two-digit addition with regrouping	9. Add/subtract fractions with like denominators
9. Two-digit subtraction without regrouping	10. Single-digit multiplied by double/triple digit
11. Two-digit subtraction with regrouping	11. Without regrouping
12. Three-digit addition without and with regrouping	12. Single-digit multiplied by double/triple digit with regrouping
13. Three-digit subtraction without and with regrouping	13. Single-digit divided into double/triple digit without remainders
14. 2nd Grade monthly math probe	14. Add and subtract decimals to the hundredths

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4th Grade	5th Grade
1. Multiplication facts 0–12	1. Multiplication facts 0–12
2. Division facts 0–12	2. Division facts 0–12
3. Fact families multiplication/division 0–12	3. Fact families multiplication/division 0–12
4. Single-digit multiplied by double-digit with and without regrouping	4. Multiply two- and three-digit with and without regrouping
5. Double-digit multiplied by double-digit without regrouping	5. Single-digit divisor divided into double-digit dividend with remainders
6. Double-digit multiplied by double-digit with regrouping	6. Single-digit divisor divided into double- and triple-digit dividend with remainders
7. Single-digit divisor into double-digit dividend without remainders	7. Reduce fractions to simplest form
8. Single-digit divisor into double-digit dividend with remainders	8. Add/subtract proper fractions/mixed numbers with like denominators with regrouping
9. Single-and double-digit divisor into single- and double-digit dividend with remainders	9. Add/subtract decimals
10. Add/subtract fractions with like denominators no regrouping	10. Multiply/divide decimals
11. Multiply multi-digit numbers by two numbers	11. Double-digit divisor into four-digit dividend
12. Add and subtract decimals to the hundredths	12. Multiply and divide proper and improper fractions

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Kindergarten. 1st Semester

1. Fluently count in sequence
2. Fluently count forward and backward from a fixed position between 1 and 20
3. Count object sets and identify the corresponding amount 0-20
4. Fluent number naming 0-20
5. Identify object set with larger size
6. Arrange object sets by size
7. Put numbers in order 1-20
8. Fill in the missing number 1-20
9. Combine object sets to reach sums to 20 using manipulatives.
10. Remove objects from set to identify remaining amount 0-10.
11. Add and subtract 1 from or to numbers 1-5 using numbers.
12. Write numbers 1-20
13. Verbally add 1 to numbers 0-19

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Standard

- Instructional Level
  - 14 DCPM among 2nd and 3rd graders
  - 24 DCPM among 4th and 5th graders
- Proficiency
  - 17 DCPM among 2nd and 3rd graders
  - 29 DCPM for 4th and 5th graders
- 25th or 40th percentile

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Small Group

- **Procedures** (conduct these steps every day):
- Get out materials.
- Write name and date on math sheet.
- Work all the problems above the line on the worksheet with your teacher's or tutor's help.
- Set timer for 2 minutes. Cover the practice problems above the line.
- Work problems below the practice line for 2 minutes.
- When timer rings, stop working.
- Score your paper with the answer key or teacher's help.
- Count number of problems you got right. Write the correct answer for the problems you missed.
- Write score at the top of math sheet.
- Write score on your monitoring chart.
- Did you beat your score? Circle yes or no on the monitoring chart.

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Accelerated Math

Table 2
Mean Percentage of Students Who Scored in the Proficient Range on State Accountability Tests

	Control Schools $n = 120$			AM 1–4 Years $n = 120$			AM 5 Years or More $n = 120$			Total $n = 360$		
	Mean (*SD*)	Skew	Kurtosis	Mean (*SD*)	Skew	Kurtosis	Mean (*SD*)	Skew	Kurtosis	Mean (*SD*)	Skew	Kurtosis
Math	64.03 (17.64)	.65	.28	72.49 (15.52)	.71	.71	76.22 (13.28)	.35	.80	70.91 (16.35)	.73	.23
Reading	68.23 (17.69)	.54	.73	73.62 (16.22)	.72	.42	78.71 (12.76)	.34	.44	73.52 (16.23)	.70	.17

Note. ANCOVA with percentage of students who scored proficiently on reading tests as covariate $F(3, 357) = 19.27$, $p < .001$.

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Burns, Klingbeil, & Ysseldyke, 2010

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Tier 2 Problem Solving

- Check student's attendance – Does the student attend school regularly
- Observe the student – Are behavioral difficulties interfering with the interventions?
- Incentivize the intervention – Is the student sufficiently motivated?
- Examine intervention fidelity – Is the intervention occurring as it should?
- Examine the accuracy within skill and GOM data – Are the students receiving a proficiency intervention when they should be focusing on acquisition?
- Compare skill and GOM data – Are students not generalizing (skill data are going up but GOM are not)

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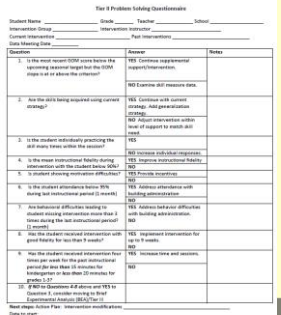

Tier II Problem Solving Questionnaire

Student Name _____ Grade _____ Teacher: _____ School: _____
Intervention Group _____ Intervention Instructor _____
Current Intervention _____ Past Interventions: _____
Data Meeting Date _____

Question	Answer	Notes
1. Is the most recent ODM score below the upcoming seasonal target but the ROM slope is at or above the criterion?	YES Continue supplemental support/intervention. NO Examine skill measure data.	
2. Are the skills being acquired using current strategy?	YES Continue with current strategy. Add generalization strategy. NO Adjust intervention within level of support to match skill need.	
3. Is the student individually practicing the skill many times within the session?	YES NO Increase individual responses.	
4. Is the mean instructional fidelity during intervention with the student below 90%?	YES Improve instructional fidelity NO	
5. Is student showing motivation difficulties?	YES Provide incentives NO	
6. Is the student attendance below 95% during last instructional period (1 month)	YES Address attendance with building administration NO	
7. Are behavioral difficulties leading to student missing intervention more than 3 times during the last instructional period? (1 month)	YES Address behavior difficulties with building administration. NO	
8. Has the student received intervention with good fidelity for less than 9 weeks?	YES Implement intervention for up to 9 weeks. NO	
9. Has the student received intervention four times per week for the past instructional period (for less than 15 minutes for kindergarten or less than 20 minutes for grades 1-3)?	YES Increase time and sessions. NO	
10. If NO to Questions 4-9 above and YES to Question 3, consider moving to Brief Experimental Analysis (BEA)/Tier III		

Next steps: Action Plan: Intervention modifications _____
Date to start _____
Date to review (6 weeks) _____
Date _____ Was there satisfactory improvement YES: Continue NO: Go to Tier III (conduct BEA)

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Instructional Hierarchy:
Stages of Learning

	Acquisition	Proficiency	Generalization	Adaption
Learning Hierarchy	■Slow and inaccurate	■Accurate but slow	■Can apply to novel setting	■Can use information to solve problems
Instructional Hierarchy	■Modeling ■Explicit instruction ■Immediate corrective feedback	■Novel practice opportunities ■Independent practice ■Timings ■Immediate feedback	■Discrimination training ■Differentiation training	■Problem solving ■Simulations

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: Charles E. Merrill.

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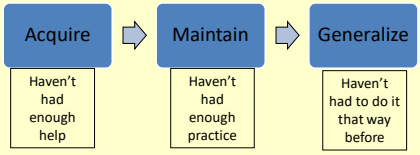
Learning Process



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- Acquire
  - Acquisition rate (less targets per sessions with more sessions)
  - Make stimuli more salient and errorless
- Retain
  - Increased repetition within lesson (IR)
  - Increased repetition across lessons (same number of targets with more intervention sessions)
  - Frequent review (same number of intervention sessions, but daily review)
- Generalize
  - Integrate a variety of forms of the letters, words, numbers etc., including those similar to how they are presented during assessment into intervention sessions

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Accuracy

- Contextual Reading
  - 93% - 97% known material
- Everything Else
  - 90% known

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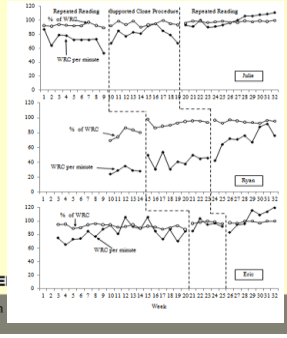
Acquire

- Acquisition rate (less targets per sessions with more intervention sessions)
- Make stimuli more salient and errorless
  - Bigger, color, contextualized (e.g., Zoo Phonics)



Listening Passage Preview

1. Select a passage to student that he/she will read for class
2. Present the text and tell him or her that you will read aloud while he or she follows along. This will help him or her read the page better.
3. Tell the student to follow along with finger
4. Read the text at a comfortable rate while monitoring if child is following
5. Have the student read the passage aloud

Phase Drill

- Encourages words by word reading
- Strong error correction technique
- Likely to generalize learned words
- Takes more time than other approaches to error correction

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Phase Drill

1. Have the student read a text while you highlight errors on an examiner copy
2. After reading the text, show the student your copy
3. Read the error word correctly to the student
4. If more than one error in a sentence, read the error words and model reading the sentence
5. Have the student read the sentence/phrase that contains the word three times

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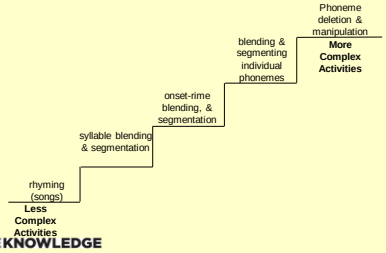
Phonological Awareness Continuum



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Types of Math Knowledge

- Conceptual - the understanding that math involves an interrelated hierarchical network that underlies all math-related tasks
- Procedural - the organization of conceptual knowledge into action to actually perform a mathematical task (Hiebert & Lefevre, 1986).

Correlations for Above 25th Percentile

	MAP	DCPM	Conceptual	WPS
1. MAP Math RIT	1.00	.46*	.10	.52*
2. Procedural MF DCPM		1.00	.11*	.43*
3. Conceptual Probe			1.00	.24*
4. Application WPS				1.00

*p< .05
493 students in 3rd grade

Correlations for Below 25th Percentile

	Map	DCPM	Conceptual	WPS
1. MAP Math RIT	1.00	.78*	.61*	.50*
2. Procedural MF DCPM		1.00	.15	.57*
3. Conceptual Probe			1.00	.83*
4. Application WPS				1.00

*p < .05

Instructional Hierarchy for Conceptual Knowledge

Phase of Learning	Acquisition	Proficiency	Generalization	Adaption
Examples of appropriate instructional activities	Explicit Instruction in basic principles and concepts Modeling with math manipulatives Immediate corrective feedback	Independent practice with manipulatives Immediate feedback on the speed of responding, but delayed feedback on the accuracy. Contingent reinforcement for speed of response.	Instructional games with different stimuli Provide word problems for the concepts	Use concepts to solve applied problems

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Instructional Hierarchy for Procedural Knowledge

Phase of Learning	Acquisition	Proficiency	Generalization	Adaption
Examples of appropriate instructional activities	Explicit instruction in task steps Modeling with written problems Immediate feedback on the accuracy of the work.	Independent practice with written skill Immediate feedback on the speed of the response, but delayed feedback on the accuracy. Contingent reinforcement	Apply number operations to applied problems Complete real and contrived number problems in the classroom	Use numbers to solve problems in the classroom

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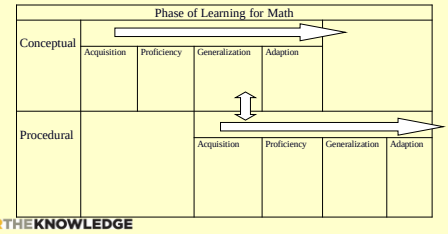

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Assessing Conceptual Knowledge
Concept Oriented CBM

- *Monitoring Basic Skills Progress-Math Concepts and Applications* (Fuchs, Hamlett, & Fuchs, 1999).
- 18 or more problems that assess mastery of concepts and applications
- 6 to 8 minutes to complete

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Conceptual Assessment

- Ask students to judge if items are correct
  - 10% of 5-year-old children who correctly counted did not identify counting errors in others (Briars & Siegler, 1984).
- Provide three examples of the same equation and asking them to circle the correct one
- Provide a list of randomly ordered correct and incorrect equations and ask them to write or circle "true" or "false" (Beatty & Moss, 2007).

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Conceptual Intervention

- Jessica – 8th grade African-American female
- History of math difficulties (6th percentile)
- Could not learn fractions

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Assessment

- 0 correct on adding fractions probe
- Presented sheet of fractions with two in each problem and asked which was larger (47% and 45% correct)
- 0% reducing

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Step 1 – size of fractions

- 1. I do
- 2. We do
- 3. You do
- Comparing fractions with pie charts

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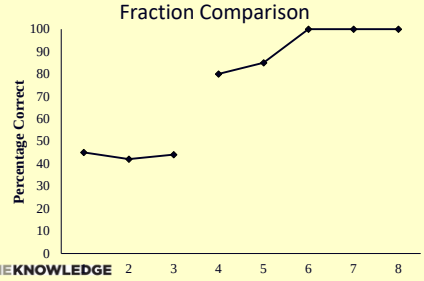

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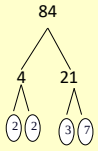
Step 2 – Reducing Fractions

- Factor trees (I do, we do, you do)



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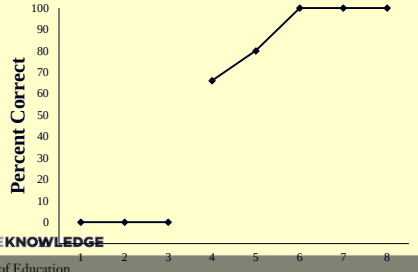
Reducing Fractions



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Conceptual Assessment

Problem 1
Please use a picture to solve the problem

3 x 4 = ____

Problem 2
Please use a picture to solve the problem

5 x 6 =____

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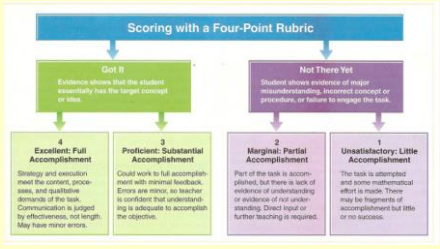

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Vandewalle, 2008

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Ratings for Problem 2

- Counts with understanding 4
- Understands number sign 2
- Understands the facts of adding/ subtraction or multiplication/division of whole numbers 2
- Uses visual model (Correct relationship between diagram and problem) 2
- Uses an identifiable strategy 1
- Answers the problem correctly 4

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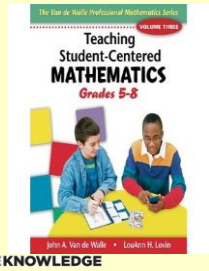

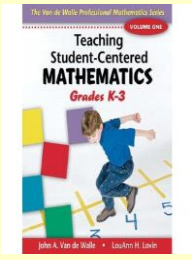

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From Objects to Numbers

- Make Sets
- Count the number write the number
- Part-Part-Whole
- Fill the Chutes
- Broken Calculator Key
- Algebra – Pattern Match
- Algebra – Tilt or Balance

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ACTIVITY 9.3

Fill the Chutes

Create a simple game board with four "chutes." Each consists of a column of about twelve 1-inch squares with a star at the top. Children take turns rolling a die and collecting the indicated number of counters. They then place these counters in one of the chutes. The object is to fill all of the chutes with counters. As an option, require that the chutes be filled exactly. A roll of 5 cannot be used to fill a chute with four spaces.

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ACTIVITY 9.18

Build It in Parts

Provide children with one type of material, such as connecting cubes or squares of colored paper. The task is to see how many different combinations for a particular number they can make using two parts. (If you wish, you can allow for more than two parts.) Each different combination can be displayed on a small mat, such as a quarter-sheet of construction paper. Here are just a few ideas, each of which is illustrated in Figure 9.8.

- Use two-color counters such as lima beans spray painted on one side (also available in plastic).
- Make bars of connecting cubes. Make each bar with two colors. Keep the colors together.
- Color rows of squares on 1-inch grid paper.
- Make combinations using two dot strips—strips of poster board about 1 inch wide with stick-on dots. (Make lots of strips with from one to four dots and fewer strips with from five to ten dots.)
- Make combinations of "two-column strips." These are cut from tagboard ruled in 1-inch squares. All pieces except the single squares are cut from two columns of the tagboard.

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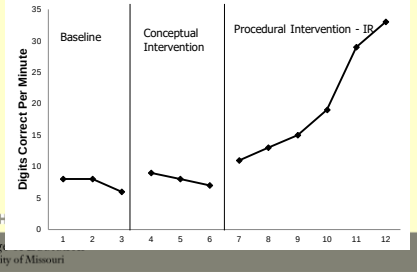
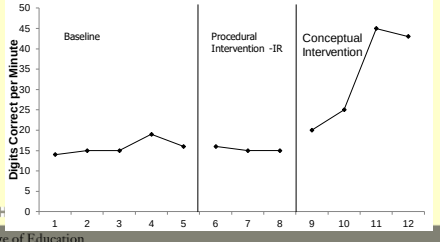
Broken Multiplication Key

Directions: Partners pretend that one of the number keys on the calculator is broken. One partner says a number, and the other tries to display it on the calculator without using the "broken" key.

Keeping Score: an extended challenge (optional): A player's score is the number of keys entered to obtain the goal. Scores for five rounds are totaled, and the player with the lowest total wins.

Example: If the 8 key is "broken," a player can display the number 18 by pressing 9 [+] 7 [+] 2 (score 5 points); 9 [x] 2 (score 3 points); or 72 [÷] 4 (score 4 points).





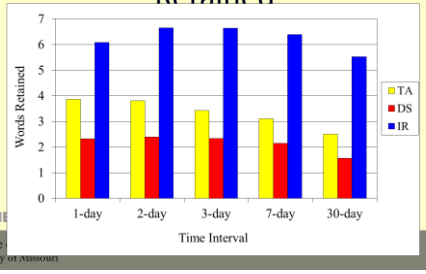
Retain

- Increased repetition within lesson (IR)
- Increased repetition across lessons (same number of targets with more intervention sessions)
- Frequent review (same number of intervention sessions, but daily review)

Incremental Rehearsal

- Developed by Dr. James Tucker (1989)
- Folding in technique
- Rehearses one new item at a time
- Uses instructional level and high repetition

Mean Number of Word Retained



Incremental Rehearsal Effectiveness

Bunn, R., Burns, M. K., Hoffman, H. H., & Newman, C. L. (2005). Using incremental rehearsal to teach letter identification with a preschool-aged child. *Journal of Evidence Based Practice for Schools, 6,* 124-134.

Burns, M. K. (2007). Reading at the instructional level with children identified as learning disabled: Potential implications for response-to-intervention. *School Psychology Quarterly, 22,* 297-313.

Burns, M. K. (2005). Using incremental rehearsal to practice multiplication facts with children identified as learning disabled in mathematics computation. *Education and Treatment of Children, 28,* 237-249.

Burns, M. K., Dean, V. J., & Foley, S. (2004). Preteaching unknown key words with incremental rehearsal to improve reading fluency and comprehension with children identified as reading disabled. *Journal of School Psychology, 42,* 303-314.

Burns, M. K., Zaslofsky, A. F., Kanive, R., & Parker, D. C. (2012). Meta-analysis of incremental rehearsal: Using phi coefficients to compare single-case and group designs. *Journal of Behavioral Education, 21,* 185-202.

Codding, R. S., Archer, J., & Connell, J. (2010). A systematic replication and extension of using incremental rehearsal to improve multiplication skills: An investigation of generalization. *Journal of Behavioral Education, 19,* 93-105.

Matchett, D. L., & Burns, M. K. (2009). Increasing word recognition fluency with an English language learner. *Journal of Evidence Based Practices in Schools, 10,* 194-209.

Nist, L. & Joseph L. M. (2008). Effectiveness and efficiency of flashcard drill instructional methods on urban first-graders' word recognition, acquisition, maintenance, and generalization. *School Psychology Review, 37,* 294-208.

Peterson, M., Brandes, D., Kunkel, A., Wilson, J., Rahn, N., Egan, A., & McComas, J. J. (2014). Teaching letter sounds to kindergarten English language learners using Incremental Rehearsal. *Journal of School Psychology, 52,* 97-107.

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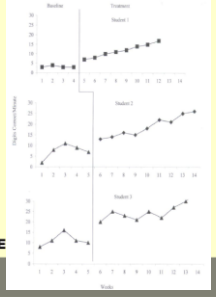
IR and Math LD



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Repeated Readings

- One of the oldest and most well-researched interventions
- High OTR
- Generalizes to passage and similar ones

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Repeated Reading

Objective: To increase fluent reading on passages for students who
- read with high accuracy
- show benefit from repeated practice on the same passage

Materials: 2 copies each of texts that the student can read with at least 95% accuracy
Stop-watch
Pencil/pen for teacher to mark errors

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Sequence:

1. Teacher explains that students will be reading a passage multiple times to work on increasing fluency (fluency is rate and accuracy and expression – not just speed)
2. Teacher gives copies of passages to student
3. (Optional Step) Student whisper reads passage to him/herself while tracking with his/her finger to figure out unknown words. Students may ask about any unknown words.
4. Teacher explains that for the first reading out-loud, the student will read for 1 minute.
5. Teacher says "Begin" (not "Start") and starts stop-watch.
6. Student reads passage out-loud.
7. Teacher marks errors and monitors stopwatch. At one minute, teacher says "Stop" and marks the last word read by the student.
8. Teacher records number of correct words per minute and graphs results, showing the graph to the student.
9. Teacher provides standard error correction for each word the student read in error. ("That word is _____. What word?" The student repeats the word. Teacher says, "Yes. That word is _____." Student goes back to the beginning of the sentence to begin again.)
10. Repeat steps 5-9 at least two more times for a minimum of 3 timed readings (student reads, teacher times, words read correctly are recorded, and errors are corrected). Additional repetitions may be completed if student's fluency continues to improve through these readings.

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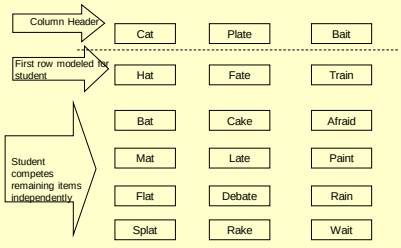

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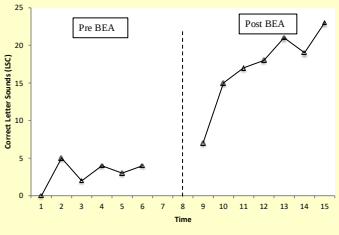
Retention Intervention

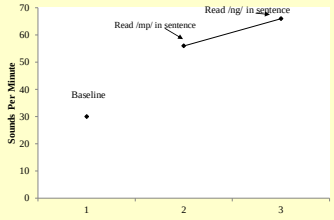
- Short sessions
- Twice per day
- Test retention at the end of each day
- Start with review

Generalization

- Integrate a variety of forms of the letters, words, numbers etc., including those similar to how they are presented during assessment into intervention sessions



Generalization



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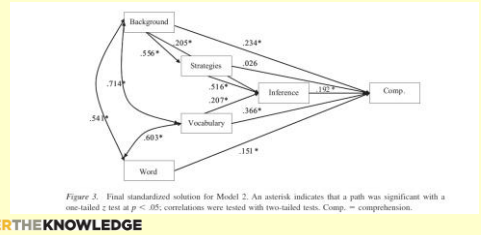

Figure 3. Final standardized solution for Model 2. An asterisk indicates that a path was significant with a one-tailed *z* test at $p < .05$; correlations were tested with two-tailed tests. Comp. = comprehension.

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Comprehension is affected by

1 & 2) Background knowledge and vocabulary

3) Correct inferences about reading

4) Word reading skill

5) Strategy use

(Cromley & Azevedo, 2007)

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Previewing (Graves et al., 1983)

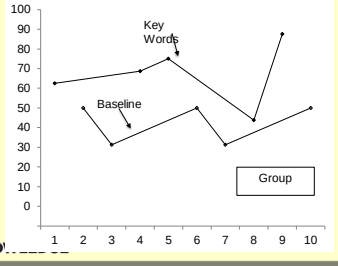
1. Provide each student the text
2. Provide a synopsis
3. Ask questions about the topic
4. Describe major story elements: setting, characters, point of view (narration), and description of the plot.
5. Present the names and descriptions of main characters

About 15 minutes

Preteach Keyword (Burns et al., 2004)

- Keywords - "central to understanding the meaning of the reading passage" (Rousseau & Yung Tam, 1991, p. 201)
- Preteach with Incremental Rehearsal (Tucker, 1989)

About 7 minutes



Strategies

What was Taught	Materials	How it was Taught
Reciprocal Teaching (Palinscar& Brown, 1984) •Activate Prior knowledge •Predict •Summarize •Generate Questions •Clarify	4th grade Read Naturally passages and questions	Each individual strategy was taught by: Modeling Working with the student Having the student work independently

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Inference

What was Taught	Materials	How it was Taught
Teaching inferential questions (Carnine et al., 2004) Determining relationships Relationship stated Relationship not stated Generalize inference rules into reading passages	4th grade Read Naturally passages and comprehension questions	Students independently read passages and answered comprehension questions with support from interventionist Interventionist discussed answers using corrective feedback on errors

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Inference – Relationship Stated

1. Provide a rule
   - e.g. the more milk you drink, the stronger your bones
2. Provide questions for which the rule is required to find the answer
   - Chris drank one glass of milk. Jeff drank 3 glasses of milk. Who is more likely to have stronger bones?
3. Model, lead, and test stating the rule and relating the answer to the rule

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Inference – Relationship Not Stated

1. Give a series of questions based on prior knowledge
   - e.g., The snow was falling as Cho walked home from school. How do you think Cho felt: a. hot, b. cold, or c. tired?
2. Model finding clues to help
   - e.g., It's snowing, what do we know about the temperature when it snows?

Inference – Relationship Deduced

- Nicole had oatmeal and a banana for breakfast and a salad for lunch. What do you think Nicole will choose for dinner, chicken and vegetables or a McDonald's hamburger?

1. Model finding information to induce a rule
   - e.g. Nicole likes healthy foods
2. Answer the question
3. Model, lead, & test

Concept Maps

- http://www.schrockguide.net/concept-mapping.html
- https://www.eduplace.com/graphicorganizer/
- https://www.teachervision.com/graphic-organizers/printable/6293.html

Generalization

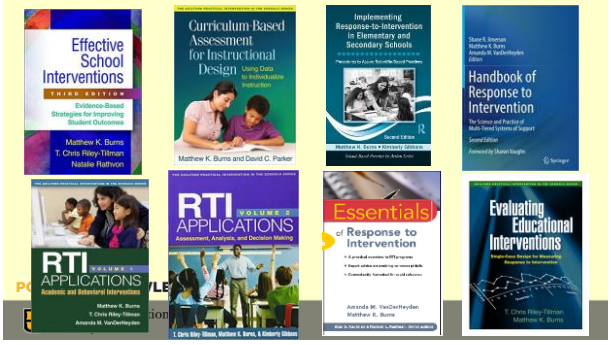
- http://ebi.missouri.edu/wp-content/uploads/2014/02/EBI-Brief-Template-Graphic-Organizer-.pdf
- http://ebi.missouri.edu/wp-content/uploads/2013/08/EBI-Brief-Template-Schema-Based-Instruction-add-FINAL1.pdf

Say-Ask-Check (Montague, 1992)

Steps	Prompt Sample
1. Read	I will read the problem and reread what I don't understand. Do I fully understand it?
2. Paraphrase	I will highlight key words and restate it in my own words. Did I highlight the most important words?
3. Draw	I will draw a picture of the problem. Does the drawing contain the important parts?
4. Plan	I will make a plan to solve the problem. What is the first step? What is the second step?
5. Predict	I will predict what I think the answer is. What numbers should be used to estimate?
6. Compute	I will compute the answer. Does my answer sound right?
7. Check	I will check the steps of my answer. Did I go through each step and check my work?

Summary

- Classwide interventions
- Match tier 2 intervention to student need
- Skill-by-treatment interaction
- Tier 3 – acquire, retain, & generalize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Using Data to Individualize Instruction
Matthew K. Burns and David C. Parker
Implementing Response-to-Intervention in Elementary and Secondary Schools
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