

Effects of an Early Intervention for Second Grade Students At-risk for Mathematics Difficulties

Council for Exceptional Children

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The Meadows Center
FOR PREVENTING EDUCATIONAL RISK

THE UNIVERSITY OF TEXAS AT AUSTIN
COLLEGE OF EDUCATION

Background and Rationale

Prevalence

5% to 8% of school-age children exhibit some form of mathematics disability

RtI

Individuals with Disabilities Education Improvement Act (2004) emphasizes prevention and intervention

Prevention

Identification of students with MD
Validation of assessments and multi-tiered interventions aimed at prevention

Theoretical & Conceptual Framework

Number, Operation, and Algebra

- Number sense (e.g., numerical values of small quantities, basic counting skills, numeral recognition) develop informally prior to starting school and through more formal instruction in school (National Mathematics Advisory Panel [NMAP], 2008; National Research Council [NRC], 2001, 2009).
- Whole number concept development and proficiency should be the critical foundation of mathematics intervention for preventative intervention; foundation for algebra (NMAP, 2008)

Mathematical Models/Representations

- Representations (concrete, pictorial, symbolic/abstract) help students develop and build mathematical understanding of concepts, operations, relations, and properties (Bryant et al., 2008, in press; Gersten et al., 2009; NRC, 2001).

Research Question

- What are the effects of the Tier II Early Numeracy Booster (ENB) supplemental intervention delivered by trained tutors on the mathematics performance of at-risk second grade students when compared to the mathematics performance of at-risk students who are receiving “standard practice” mathematics instruction in general education classrooms?

Study Demographics (Two Cohorts, Years 1 and 2)

	Intervention (N = 108)	Comparison (N = 51)	Total (N = 1427)
Tested:			
Fall	108 = 100 %	51 = 100 %	1354 = 94.9 %
Winter	104 = 96.3 %	50 = 98 %	1360 = 95.3 %
Spring	105 = 97.2 %	50 = 98 %	1338 = 93.8 %
Gender:			
Male	42 = 38.9 %	29 = 56.9 %	733 = 51.4 %
Female	66 = 61.1 %	22 = 43.1 %	690 = 48.4 %
Missing			4 = .28 %
Ethnicity:			
Asian/Pacific Islander	4 = 3.7 %	2 = 3.9 %	163 = 11.4 %
African-American	29 = 26.9 %	9 = 17.6 %	280 = 19.6 %
Caucasian	40 = 37 %	15 = 29.4 %	538 = 37.7 %
Hispanic	35 = 32.4 %	25 = 49 %	424 = 29.7 %
Missing			19 = 1.3 %
Free/Reduced Lunch	52 = 48.1 %	24 = 47.1 %	505 = 35.4 %
English Language Learner	5 = 4.6 %	7 = 13.7 %	210 = 14.7 %

Measures: Texas Early Mathematics Inventories-PM (available free to Texas educators)

4 subtests: Magnitude Comparisons, Number Sequences, Place Value, Addition/Subtraction Combinations (2 minutes each)

Aggregate Total Score (TS) of four subtests used to measure fall, winter, and spring student performance –most robust indicator of performance of the four constructs

Alternate forms reliability - immediate test/retest: subtest coefficients ranged from .76 to .81, TS = .89

Number Sequences

- Placement
- Decade effects

297 298 _	_ 201 202	298 _ 300
335 _ 337	307 308 _	_ 429 430
336 337 _	_ 313 314	469 _ 471
406 _ 408	_ 500 501	554 555 _
_ 457 458	565 566 _	568 569 _



Magnitude Comparisons

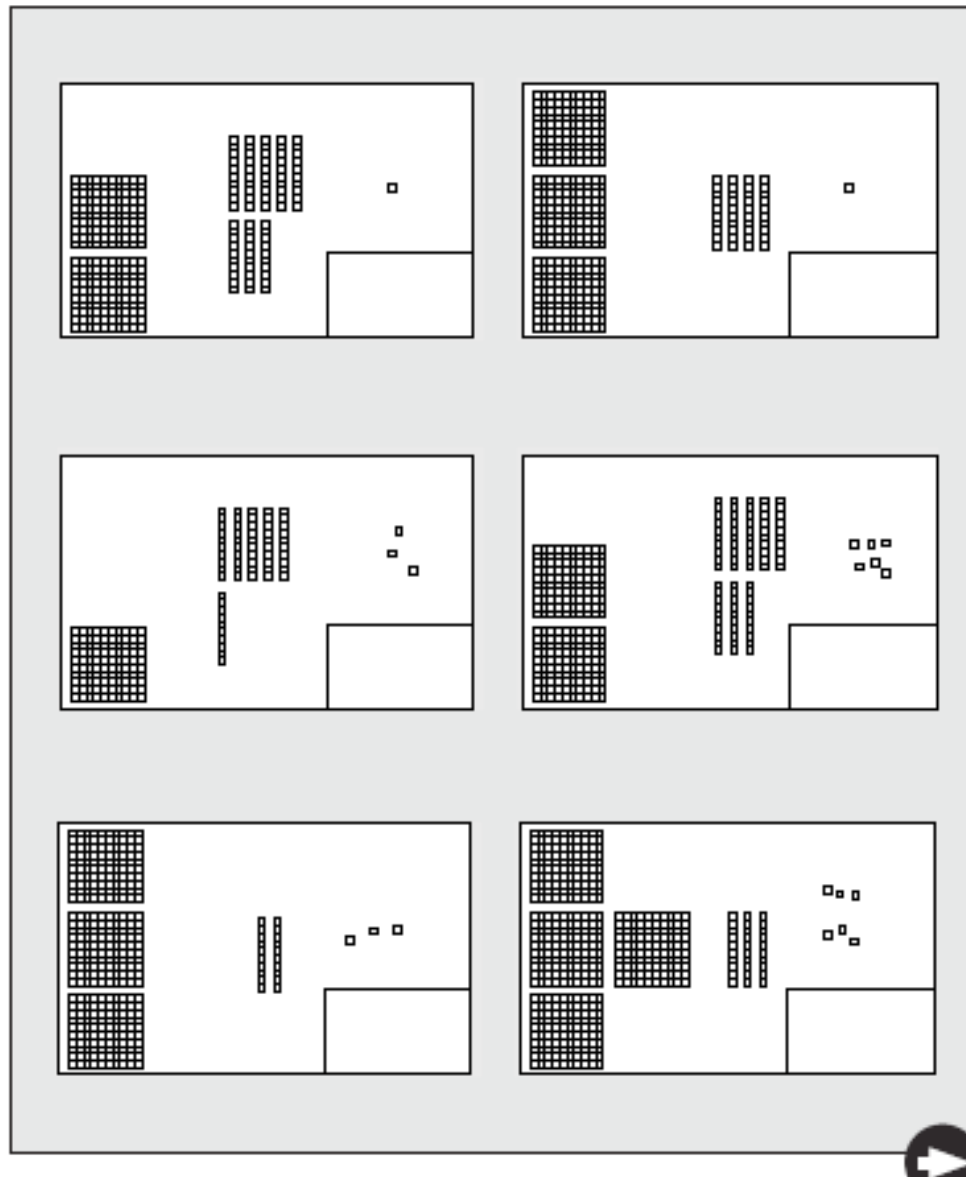
- Place value
- Distance effect
- Compatibility

62	69	47	17	53	482	241	270
207	424	431	428	440	318	166	213
433	291	104	841	145	729	381	531
641	135	610	278	945	945	467	524



Place Value

- Counting
- Subitizing
- Switching



Addition/Subtraction Combinations

- Fingers
- Strategies

$\begin{array}{r} 7 \\ - 3 \\ \hline \end{array}$	$\begin{array}{r} 10 \\ - 4 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ + 7 \\ \hline \end{array}$	$\begin{array}{r} 8 \\ + 4 \\ \hline \end{array}$
$\begin{array}{r} 6 \\ + 6 \\ \hline \end{array}$	$\begin{array}{r} 10 \\ - 5 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ - 5 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ + 7 \\ \hline \end{array}$
$\begin{array}{r} 7 \\ + 4 \\ \hline \end{array}$	$\begin{array}{r} 9 \\ - 8 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ + 8 \\ \hline \end{array}$	$\begin{array}{r} 15 \\ - 6 \\ \hline \end{array}$




How do we report Benchmark Check results?

Easy as A-B-C

Insert student TEMI-PM Total Scores.															
Student Name	MC			NS			PV			ASC			Total Score		
	Fall	Winter	Spring	Fall	Winter	Spring	Fall	Winter	Spring	Fall	Winter	Spring	Fall	Winter	Spring
Angelo	15	16	28	9	10	20	2	4	11	6	6	20	32	58	79
Christian	48	62	64	20	29	31	9	17	21	26	35	40	103	183	156
Emly	24	42	45	5	21	20	8	12	16	16	24	12	53	127	93
Haylee	22	35	39	5	16	21	5	8	9	5	15	13	37	100	82
Jamie	41	52	56	12	17	22	7	9	9	13	12	10	73	119	97
John	43	47	56	16	21	27	11	11	17	26	30	31	96	147	131
Jonathan	39	52	58	15	17	19	9	12	15	17	22	29	80	131	121
Julie	12	20	30	4	8	13	4	7	9	5	5	13	25	57	65
Kaithlyn	34	35	38	9	14	18	5	7	9	15	21	22	63	100	87
Mae	41	55	62	14	19	20	12	13	18	16	21	27	83	140	127
Michelle	20	25	42	2	10	16	1	6	9	8	15	26	31	73	93
Stepanie	27	40		13	20		8	12		19	29		67	109	
Steve	21	28	31	0	12	13	5	7	8	11	17	22	37	82	74
Tim	30	41	51	13	16	18	8	9	13	16	24	20	67	116	102
Victor	20	34	35	10	13	9	5	5	6	13	16	14	48	82	64
Class Averages	29	39	45	10	16	19	7	9	12	14	19	21	60	108	98
Total Students Tested	15	15	14	15	15	14	15	15	14	15	15	14	15	15	14
Number of Students Below 25th Percentile	2	3	3	5	4	3	3	6	9	0	2	2	3	2	3
% of Students Below 25th Percentile	13%	20%	21%	33%	27%	21%	20%	40%	64%	0%	13%	14%	20%	13%	21%
Weeks 32-40 25th Percentile Line	29		32	10		16	7		14	14		13	60		77

Reporting Results for Teachers

MS Access

Texas Early Mathematics Inventories		Name: Alex Vargas		
Student Report - Fall 2008		School: Example		
		Teacher: Sample		

Progress Monitoring

Magnitude Comparisons		Benchmark	Score	Rating
<i>Comparing two numbers' quantity (0 to 999)</i>	Fall	27	32	Exceeded Benchmark - Average
	Winter	34		
	Spring			

Number Sequences		Benchmark	Score	Rating
<i>Identifying the missing number in a three number sequence (0 to 999)</i>	Fall	10	11	Exceeded Benchmark - Average
	Winter	15		
	Spring	15		

Place Value		Benchmark	Score	Rating
<i>Recognizing the value of stacks of hundreds, tens, and ones (0 to 999)</i>	Fall	6	8	Exceeded Benchmark - Average
	Winter	8		
	Spring	11		

Addition/Subtraction Combinations		Benchmark	Score	Rating
<i>Knowing the basic addition and subtraction facts</i>	Fall	14	16	Exceeded Benchmark - Average
	Winter	21		
	Spring	24		

TEMI-PM Total Score		Benchmark	Score	Rating
<i>Understanding number, quantity, and operations TEKS</i>	Fall	58	67	Exceeded Benchmark - Average
	Winter	80		
	Spring	92		

Objectives of Intervention by Area

Ordering and Comparing Numbers:

- ✓Students will identify, write, count and decompose numbers
- ✓Students will order (greatest- least & least-greatest) two & three-digit numbers
- ✓Students will identify and write the missing number
- ✓Students will identify numbers from a variety of representations (number line, hundreds chart, concrete, pictorial)

Place Value:

- ✓Students will identify, write, count and decompose numbers
- ✓Students will identify the number that is more than/less than/equal to, when given two numbers
- ✓Students will identify the ones , tens and hundreds place of two-digit numbers
- ✓Students will make numbers using a variety of representations (concrete, pictorial)

Addition & Subtraction Facts:

- ✓Students will identify, write and decompose numbers
- ✓Students will identify and define the operational signs in problems (+, - and =)
- ✓Students will identify the three-numbers in a fact family
- ✓Students will write number sentences for fact families
- ✓Students will identify the type of problem and solve using the appropriate strategy

Word Problem Solving:

- ✓Students will identify, write, count and decompose numbers
- ✓Students will identify important numbers and words needed to solve the problem
- ✓Students will identify the unit and write a number sentence to solve
- ✓Students will check work by writing and solving the related number sentence
- ✓Students will solve problems using a variety of representations (concrete, pictorial)

Unit: Instructional Content

- | | |
|----------|-----------|
| 1: 0-50 | 6: 0-500 |
| 2: 0-100 | 7: 0-700 |
| 3: 0-200 | 8: 0-800 |
| 4: 0-300 | 9: 0-900 |
| 5: 0-400 | 10: 0-999 |

Unit: Strategy

- | | |
|-------------------------|--------------------|
| 1: Part-Part-Whole | 6: Fact Families |
| 2: Count-on, zero rule | 7: Double Facts |
| 3: Count-on | 8: Doubles +1 |
| 4: Count-back | 9: Make Ten, Ten |
| 5: Count-back, n-n rule | +More |
| | 10: Make Ten +More |

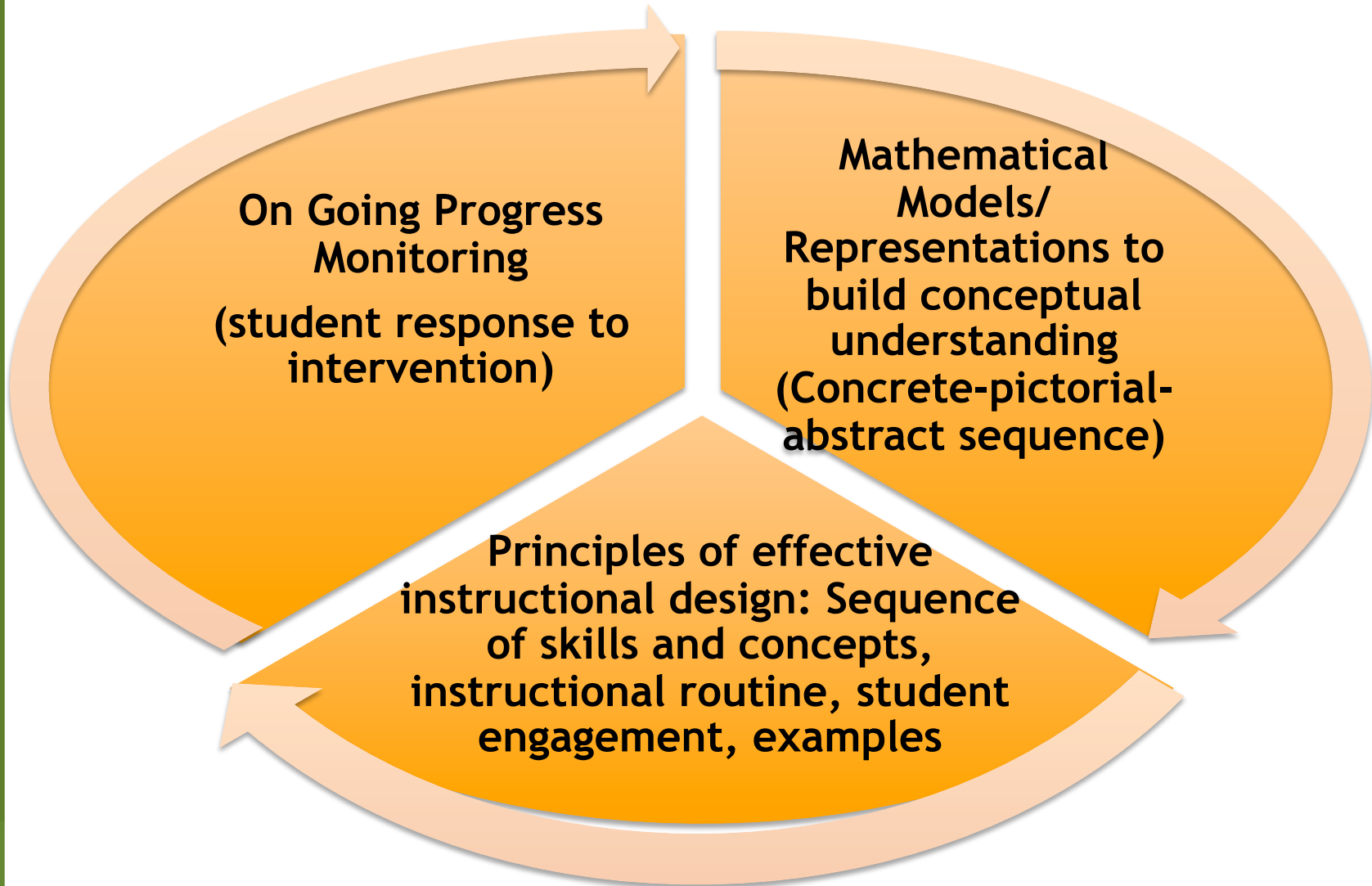
Unit: Type of Problem

- | | |
|--------------------------------------|------------------------------|
| 1: Strategy Instruction | change unknown |
| 2: Joining, result unknown | 6: Result and Change Unknown |
| 3: Separate, results unknown | 7: Beginning unknown |
| 4: Joining/Separate, results unknown | 8: Compare unknown, join |
| 5: Join/Separate, | 9: Compare unknown, separate |
| | 10: Review |

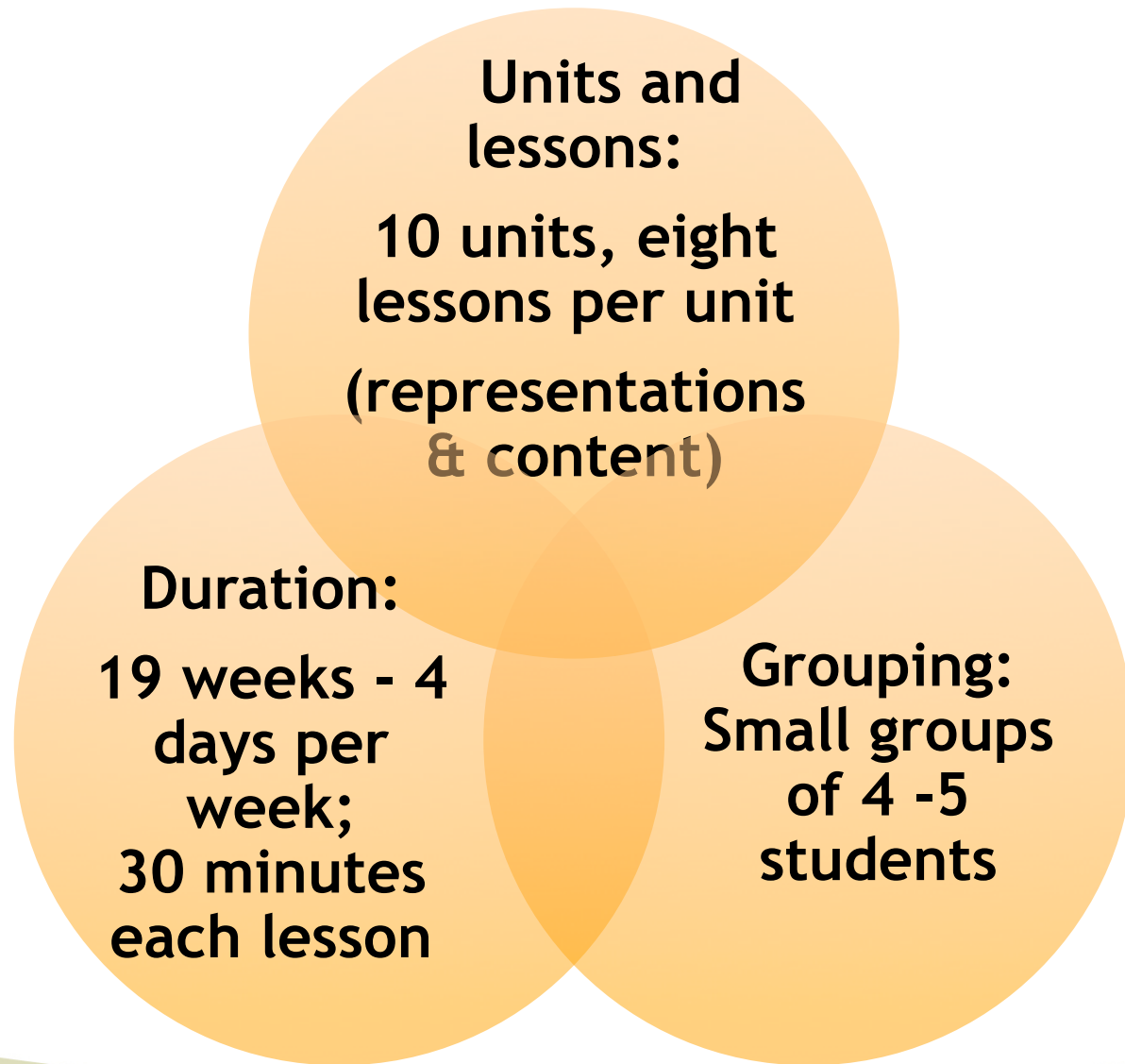
Multiple Visual Representations

- Concrete: Interactive Modeling/Guided Practice
 - Cubes
 - Counters
 - Base-ten/Place value materials (units, rods, flats)
 - Dot cubes
- Pictorial: Guided Practice/Independent Practice
 - Five frames
 - Ten frames
 - Hundreds charts
 - Number lines
- Abstract/Symbolic: Guided Practice/Independent Practice
 - Numbers & Symbols
- Mats (can be used across all representations)
 - Part-part-whole
 - Fact family
 - Strategy mats

Intervention Components



Implementation Components



Lesson Components Warm-Up



Units 1 & 2 Warm-Up

$\begin{array}{r} 5 \\ +0 \\ \hline \end{array}$	$\begin{array}{r} 1 \\ +9 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ -1 \\ \hline \end{array}$	$\begin{array}{r} 0 \\ +1 \\ \hline \end{array}$	$\begin{array}{r} 10 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} 8 \\ +1 \\ \hline \end{array}$	$\begin{array}{r} 1 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ -1 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} 10 \\ -1 \\ \hline \end{array}$	$\begin{array}{r} \\ \hline 10 \end{array}$
$\begin{array}{r} 8 \\ +0 \\ \hline \end{array}$	$\begin{array}{r} 1 \\ +6 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ -1 \\ \hline \end{array}$	$\begin{array}{r} 0 \\ +9 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ +1 \\ \hline \end{array}$	$\begin{array}{r} 2 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} 9 \\ -1 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ -1 \\ \hline \end{array}$	$\begin{array}{r} \\ \hline 10 \end{array}$
$\begin{array}{r} 4 \\ -4 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ +2 \\ \hline \end{array}$	$\begin{array}{r} 0 \\ +8 \\ \hline \end{array}$	$\begin{array}{r} 9 \\ -8 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ +1 \\ \hline \end{array}$	$\begin{array}{r} 8 \\ +3 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 2 \\ -1 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ -3 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} \\ \hline 10 \end{array}$
$\begin{array}{r} 10 \\ -10 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ +2 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ +0 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ -6 \\ \hline \end{array}$	$\begin{array}{r} 1 \\ +7 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ +3 \\ \hline \end{array}$	$\begin{array}{r} 8 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ -1 \\ \hline \end{array}$	$\begin{array}{r} 10 \\ -9 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} \\ \hline 10 \end{array}$

My Progress - Unit 1

10	
9	
8	
7	
6	
5	
4	
3	
2	
1	

Problems

My Progress - Unit 2

10	
9	
8	
7	
6	
5	
4	
3	
2	
1	

Problems

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Ordering and Comparing Numbers

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

- | | | | | | | | |
|---|----|-------|----|----|----|-------|----|
| 1 | 24 | _____ | 26 | 2 | 15 | _____ | 17 |
| 3 | 46 | _____ | 48 | 4 | 39 | _____ | 41 |
| 5 | 4 | _____ | 6 | 6 | 68 | _____ | 70 |
| 7 | 71 | _____ | 73 | 8 | 94 | _____ | 96 |
| 9 | 82 | _____ | 84 | 10 | 79 | _____ | 81 |

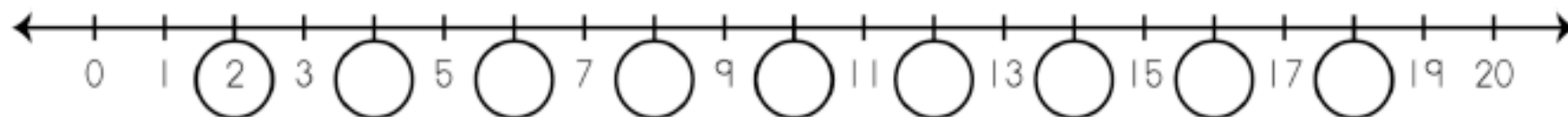
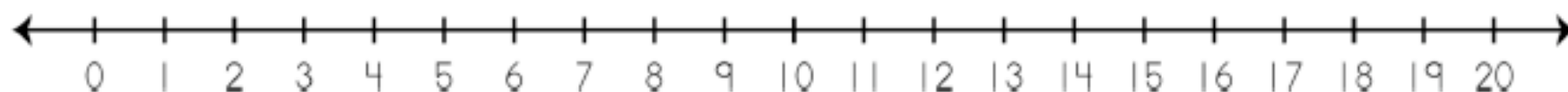
Addition/Subtraction Facts: Part-Part-Whole-Break-Apart

- Modeled Practice: Concrete Representations/
Models





Double Time and Back Again!



1 $9 + 9 = \underline{\quad}$

$\underline{\quad} - 9 = \underline{\quad}$



2 $6 + 6 = \underline{\quad}$

$\underline{\quad} - 6 = \underline{\quad}$



3 $8 + 8 = \underline{\quad}$

$\underline{\quad} - 8 = \underline{\quad}$



4 $7 + 7 = \underline{\quad}$

$\underline{\quad} - 7 = \underline{\quad}$



5 $10 + 10 = \underline{\quad}$

$\underline{\quad} - 10 = \underline{\quad}$



6 $6 + 6 = \underline{\quad}$

$\underline{\quad} - 6 = \underline{\quad}$





Double Time!

1 $5 + 5 = \underline{\quad}$
 $\underline{\quad} - 5 = \underline{\quad}$

2 $8 + 8 = \underline{\quad}$
 $\underline{\quad} - 8 = \underline{\quad}$

3 $7 + 7 = \underline{\quad}$
 $\underline{\quad} - 7 = \underline{\quad}$

4 $10 + 10 = \underline{\quad}$
 $\underline{\quad} - 10 = \underline{\quad}$

5 $6 + 6 = \underline{\quad}$
 $\underline{\quad} - 6 = \underline{\quad}$

6 $9 + 9 = \underline{\quad}$
 $\underline{\quad} - 9 = \underline{\quad}$

7 $7 + 7 = \underline{\quad}$
 $\underline{\quad} - 7 = \underline{\quad}$

8 $9 + 9 = \underline{\quad}$
 $\underline{\quad} - 9 = \underline{\quad}$

9 $8 + 8 = \underline{\quad}$
 $\underline{\quad} - 8 = \underline{\quad}$

10 $6 + 6 = \underline{\quad}$
 $\underline{\quad} - 6 = \underline{\quad}$

Addition/Subtraction Facts: Pictorial-Doubles + 1 & Count Back

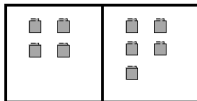


Doubles + 1

Unit 8 • Lesson 5
ASF • GP

1

$$4 + 4 = \underline{\quad}$$



$$4 + 5 = \underline{\quad}$$

2

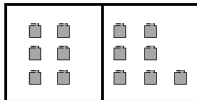
$$5 + 5 = \underline{\quad}$$



$$6 + 5 = \underline{\quad}$$

3

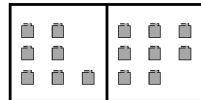
$$6 + 6 = \underline{\quad}$$



$$6 + 7 = \underline{\quad}$$

4

$$7 + 7 = \underline{\quad}$$



$$7 + 8 = \underline{\quad}$$

5

$$8 + 8 = \underline{\quad}$$



$$9 + 8 = \underline{\quad}$$

6

$$9 + 9 = \underline{\quad}$$



$$10 + 9 = \underline{\quad}$$



Count-Back

Unit 5 • Lesson 23
ASF • IP



1

$$\begin{array}{r} 9 \\ - 3 \\ \hline \end{array}$$

2

$$1 - 1 = \underline{\quad}$$

3

$$6 - 3 = \underline{\quad}$$

4

$$\begin{array}{r} 4 \\ - 3 \\ \hline \end{array}$$

5

$$\begin{array}{r} 7 \\ - 7 \\ \hline \end{array}$$

6

$$5 - 3 = \underline{\quad}$$

7

$$\begin{array}{r} 10 \\ - 3 \\ \hline \end{array}$$

8

$$\begin{array}{r} 7 \\ - 3 \\ \hline \end{array}$$

9

$$4 - 4 = \underline{\quad}$$

10

$$8 - 3 = \underline{\quad}$$

Addition/Subtraction Facts: Make 10 + More

Modeled Practice (My Turn, Your Turn)

1. Place the Modeled Practice sheet on the table. Have students look at their Modeled Practice sheets. Introduce the Make 10 + More strategy, using the fact $9 + 4$.

There are 3 steps to remember.

Step 1: Check the fact; is there a 7, 8, or 9 in it? (yes)

There is a 9 in this fact.

Step 2: Make 10.

9 plus what equals 10? (1)

My Turn: I take 1 chip from the group of 4 to put with the group of 9. (Move the counter from the dotted circle along the dotted arrow to the empty box in the top ten frame.)

I know that $9 + 1 = 10$. I made 10!

Your Turn: Make 10.

Step 3: 10 + More.

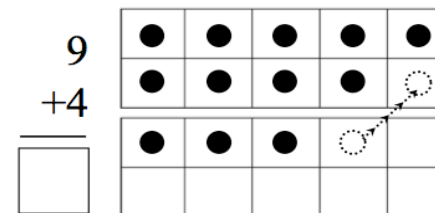
I have 10 in 1 frame, plus 3 remaining chips.

What is $10 + 3$? (13)

So $9 + 4 = 13$.

What is the turnaround fact? ($4 + 9 = 13$)

Unit 9
Booster Lesson 1
ASC Day 1
Modeled Practice
Strategy Time



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Mathematics Institute for Learning Disabilities and Difficulties: The University of Texas at Austin
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Addition & Subtraction Facts



Unit 7 • Lesson 11
ASF • GP

Make 10+ More

1 7 →

+ 4 →

 +

_____ so 7 + 4 = _____

2 9 →

+ 6 →

 +

_____ so 9 + 6 = _____

3 8 →

+ 5 →

 +

_____ so 8 + 5 = _____

4 9 →

+ 7 →

 +

_____ so 9 + 7 = _____

Place Value: Pictorial

Expanded Form



What's The Number?

Unit 4 • Lesson 6
PVMC • GP

1				_____ + _____ + _____ - <input type="text"/>
2				_____ + _____ + _____ - <input type="text"/>
3				_____ + _____ + _____ - <input type="text"/>

**Place
Value:
Symbolic**

**Expanded
Form**

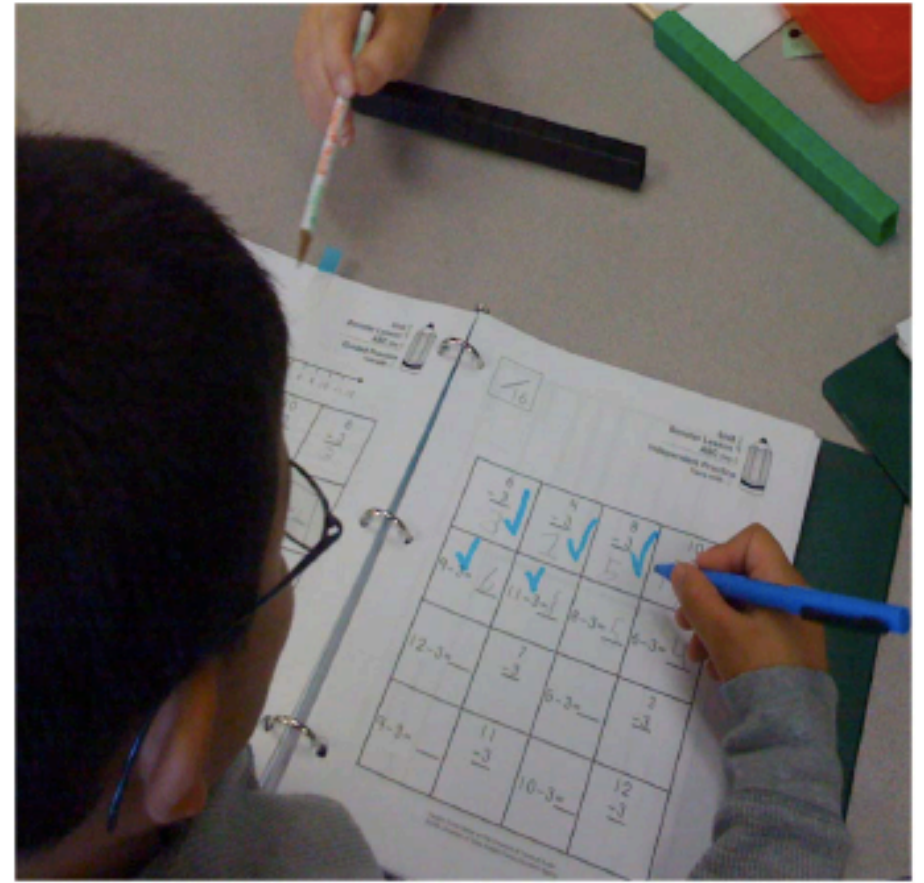
**Base Ten
Form**



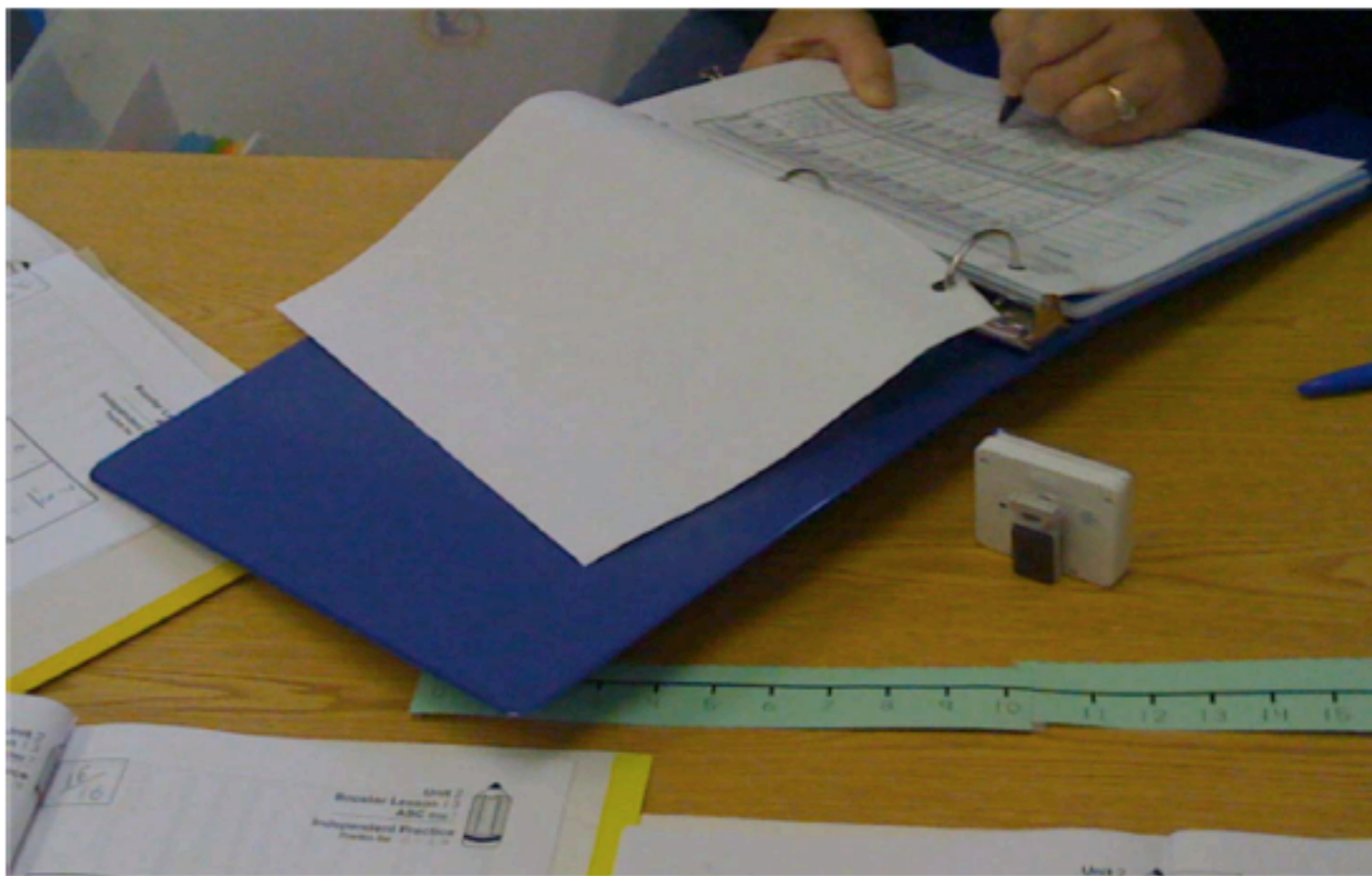
Unit 4 • Lesson 12
PVMC • GP

Compare: Which is Less?

1	$300 + 20 + 5$ <input type="text"/>	<input type="text"/>	$200 + 50 + 6$ <input type="text"/>
2	4 hundred 4 tens 6 ones <input type="text"/>	<input type="text"/>	2 hundreds 8 tens 4 ones <input type="text"/>
3	2 hundreds 6 tens 3 ones <input type="text"/>	<input type="text"/>	2 hundreds 3 tens 6 ones <input type="text"/>
4	$400 + 30 + 8$ <input type="text"/>	<input type="text"/>	$300 + 10 + 8$ <input type="text"/>
5	$200 + 90 + 9$ <input type="text"/>	<input type="text"/>	$300 + 0 + 0$ <input type="text"/>
6	4 hundreds 0 tens 1 one <input type="text"/>	<input type="text"/>	4 hundreds 1 tens 0 ones <input type="text"/>



Students completing Independent Practice and checking their work.



Using daily progress monitoring to track student responses.

Fidelity

- An observation rating scale was used for data-collection purposes ranging from 3 for *Most of the Time* to 0 for *Not at All*.
- Overall = 2.82
- Intervention = 2.95
- Instruction = 2.85
- Monitoring and Managing Behavior = 2.65

Instruction for Comparison Students

- No explicit, systematic mathematics instruction was observed with the comparison students.
- Teachers focused on completing the whole-class assignment in a smaller group, through centers, or by reviewing for upcoming assessments.
- A variety of groupings and instructional materials were observed:
 - small-group instruction to work with the comparison students
 - group size varied from pairs of students, to small groups of three to five students, to larger groups of seven or more
 - manipulatives, worksheets

Analyses

- Validated early numeracy timed progress-monitoring measures were used to identify students with risk status and to monitor mathematics performance across the year (fall, winter, spring).
- We combined 2nd graders in cohort 1 and cohort 2 to increase the power of the treatment effect analysis.
- ANCOVA was used to evaluate group differences in the spring of 2nd grade.
- Benjamani-Hochberg was applied to control for Type 1 error rate.
- Fall scores were used as covariates.

Overall Findings

Data Analysis

Scale	F-M	F-SD	S-M	S-SD	F	<i>p</i>	ES*
TEMI-MC	29.75 29.26	5.472 4.189	42.20 38.76	10.047 8.019	3.24	.075	.678
TEMI-NS	9.58 9.89	2.097 2.024	16.16 13.78	5.229 3.409	6.98	.009	.500
TEMI-PV	6.32 6.18	2.307 2.680	13.77 9.11	3.826 3.089	44.27	.000	1.280
TEMI-ASC	13.91 13.39	4.261 4.957	23.76 21.89	7.340 6.372	1.36	.246	.263
TEMI-Tot	59.57 58.74	5.384 6.566	95.90 83.54	19.034 15.038	11.49	.001	.687
SAT-10 MPS	NA	NA	88.94 88.08	9.930 10.079	0.11	.738	.085
SAT-10 MP	NA	NA	91.29 80.27	9.460 12.965	0.56	.455	.187
SAT-10 Tot	NA	NA	89.15 87.70	9.600 10.338	0.33	.564	.146

* Unbiased Hedges *g*

Results

Overall Findings

- The treatment group outperformed the comparison on all TEMI-PM measures.
- The differences were statistically significant for number sequences ($p < .009$), place value ($p < .001$), and the PM total score ($p = .001$).
- The Benjamani-Hochberg procedure did not alter the pattern of significant findings.
- There were no statistical differences on the Stanford Achievement Test - 10.

Discussion & Implications for Instruction

Struggling students can benefit from a supplemental intervention that focuses on important foundational concepts and skills (NCTM, 2006; NMAP, 2008).

Future research should examine how to achieve more robust findings with addition and related subtraction facts.

Future research should focus on how enhancements in number and operation can translate to improved performance in other mathematical areas.

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