Schema-Based Instruction in Mathematics for English Language Learners

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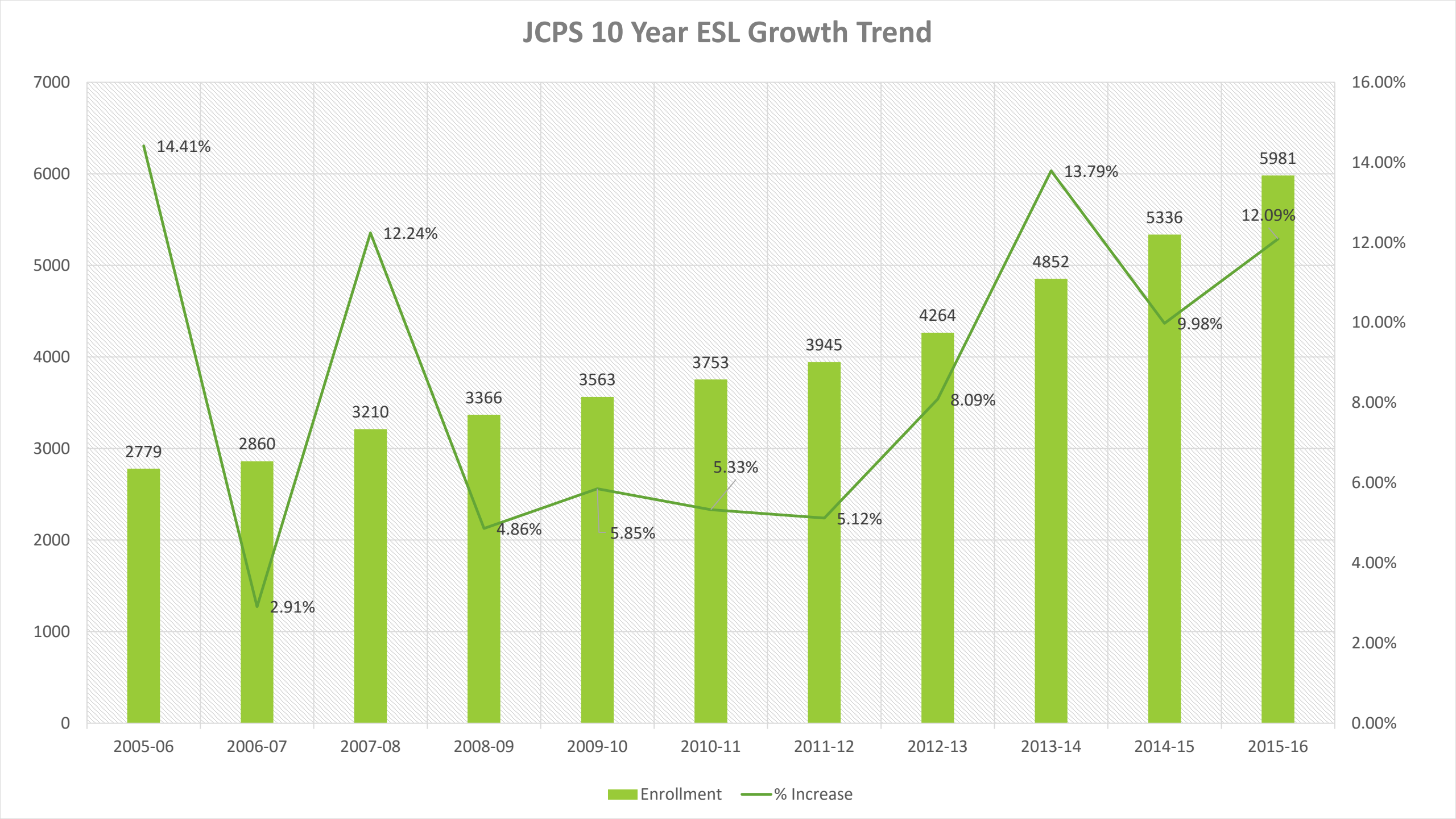
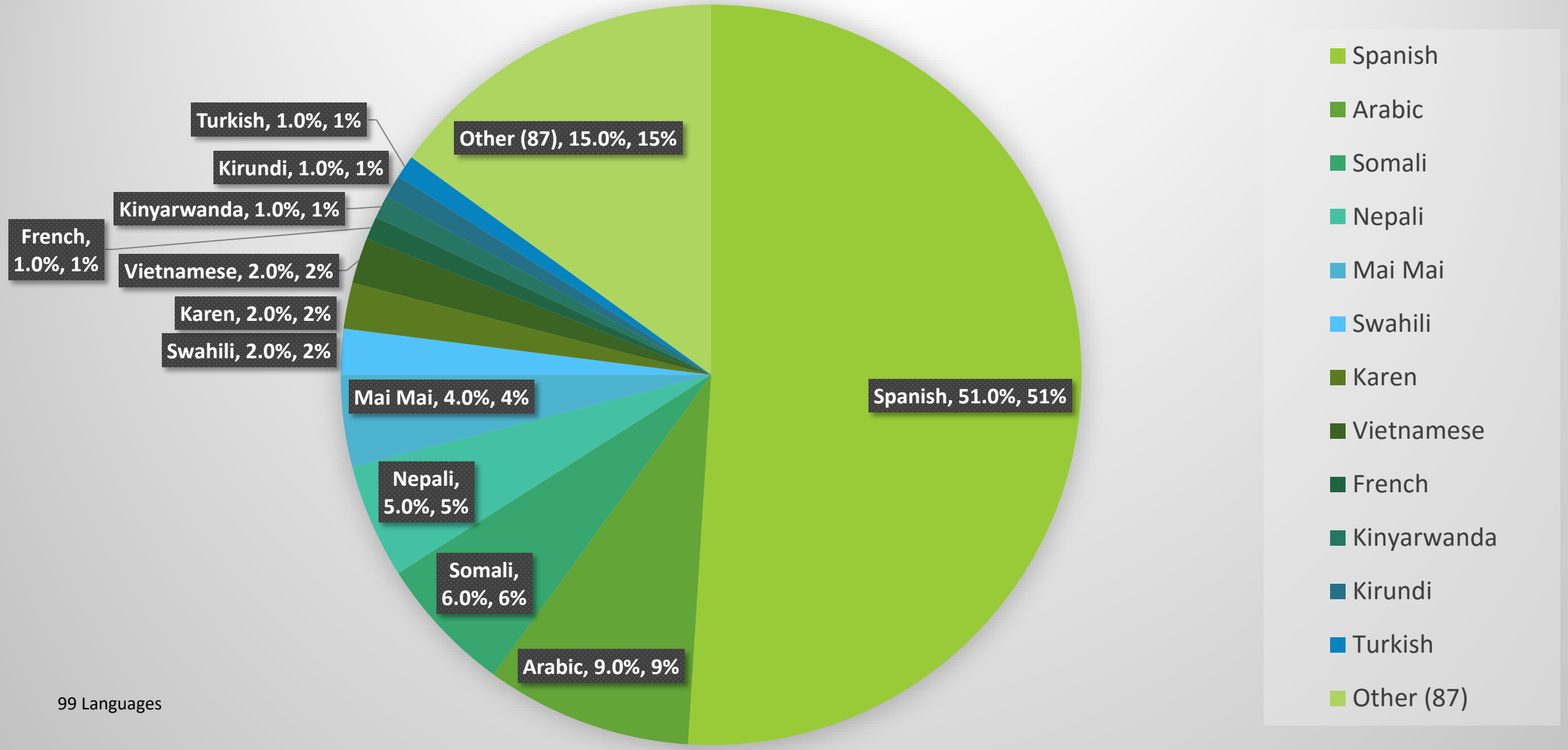

JCPS 10 Year ESL Growth Trend
7000
6000
5000
4000
3000
2000
1000
0
16.00%
14.00%
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
2779
2860
3210
3366
3563
3753
3945
4264
4852
5336
5981
14.41%
2.91%
12.24%
4.86%
5.85%
5.33%
5.12%
8.09%
13.79%
9.98%
12.09%
2005-06
2006-07
2007-08
2008-09
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
Enrollment
% Increase

2015-2016 EOY Languages Spoken by ESL Studets in JCPS



99 Languages

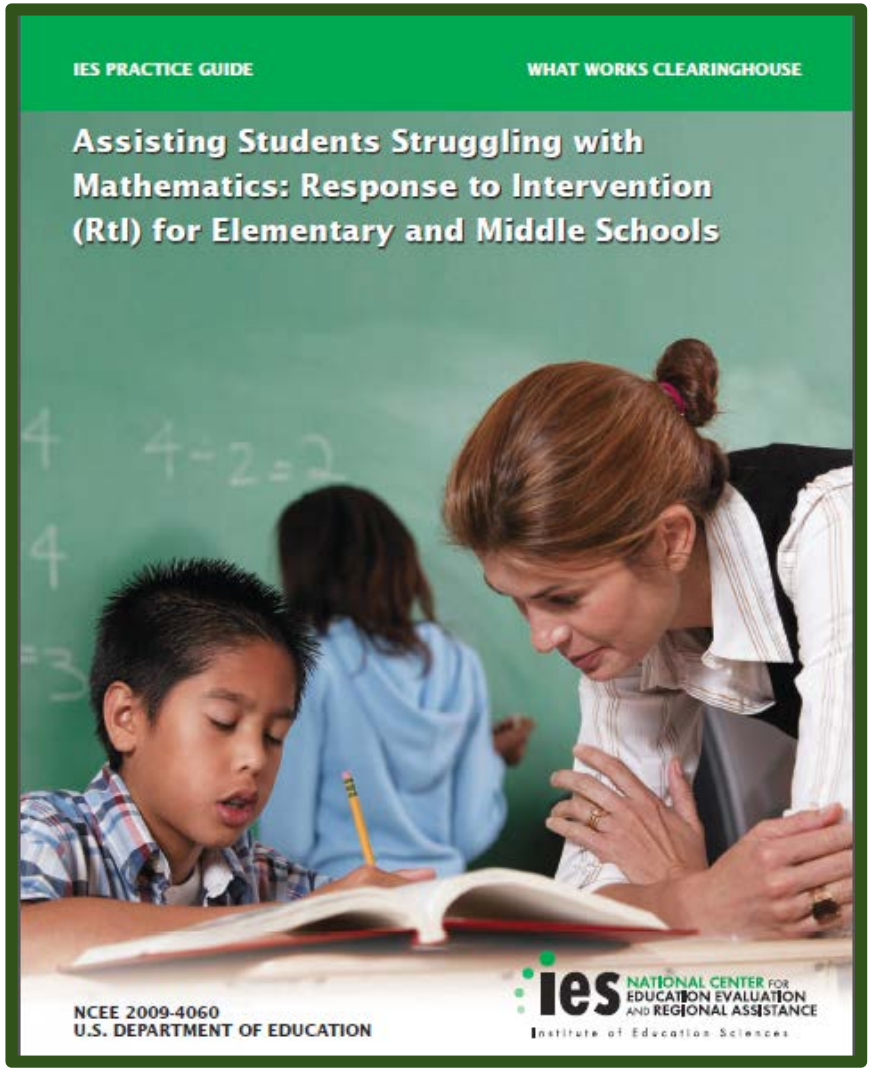
Schema Strategy Research

Recommendation 4

Interventions should include instruction on solving word problems that is based on common underlying structures.

Level of Evidence: **STRONG**

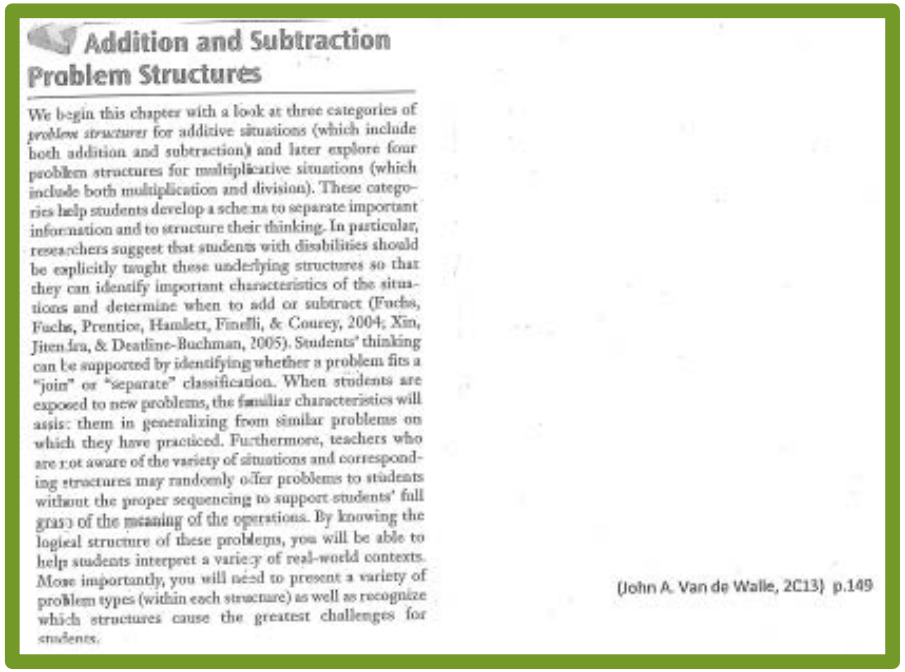
http://ies.ed.gov/ncee/wwc/practiceguide.aspx?sid=2



Schema Strategy Research

1. Read the selection carefully

2. Highlight any parts that are interesting or seem important to you



Addition and Subtraction Problem Structures

We begin this chapter with a look at three categories of *problem structures* for additive situations (which include both addition and subtraction) and later explore four problem structures for multiplicative situations (which include both multiplication and division). These categories help students develop a schema to separate important information and to structure their thinking. In particular, researchers suggest that students with disabilities should be explicitly taught these underlying structures so that they can identify important characteristics of the situations and determine when to add or subtract (Fuchs, Fuchs, Prentice, Hamlett, Finelli, & Courey, 2004; Xin, Jitendra, & Deatline-Buchman, 2005). Students' thinking can be supported by identifying whether a problem fits a "join" or "separate" classification. When students are exposed to new problems, the familiar characteristics will assist them in generalizing from similar problems on which they have practiced. Furthermore, teachers who are not aware of the variety of situations and corresponding structures may randomly offer problems to students without the proper sequencing to support students' full grasp of the meaning of the operations. By knowing the logical structure of these problems, you will be able to help students interpret a variety of real-world contexts. More importantly, you will need to present a variety of problem types (within each structure) as well as recognize which structures cause the greatest challenges for students.

(John A. Van de Walle, 2013) p.149

Addition and Subtraction Problem Structures

- Help students develop a schema to separate important information and to structure their thinking.
- Assist students in generalizing from similar problems when new problems are introduced.
- Support students to identify important characteristics of the situations and determine when to add or subtract.

General Strategy Instruction vs. Schema-Based Instruction

General Strategy Instruction	Schema-Based Instruction
• Read to comprehend	• Read to comprehend
• Identify key words	• Identify “signal” words or phrases to aid in identifying the problem structure
• Draw a picture / visual to represent the problem	• Identify the problem structure, and use the schema diagram to represent the problem
• Solve the problem	• Transform the diagram to a math sentence, and solve the problem

		RESULT UNKNOWN	CHANGE UNKNOWN	START UNKNOWN
CHANGE	ADD TO	K	1ST	2ND
	TAKE FROM	K	1ST	2ND

		TOTAL UNKNOWN	BOTH ADDENDS UNKNOWN	ADDEND UNKNOWN
COMBINE	PUT TOGETHER/ TAKE APART	K	K	1ST

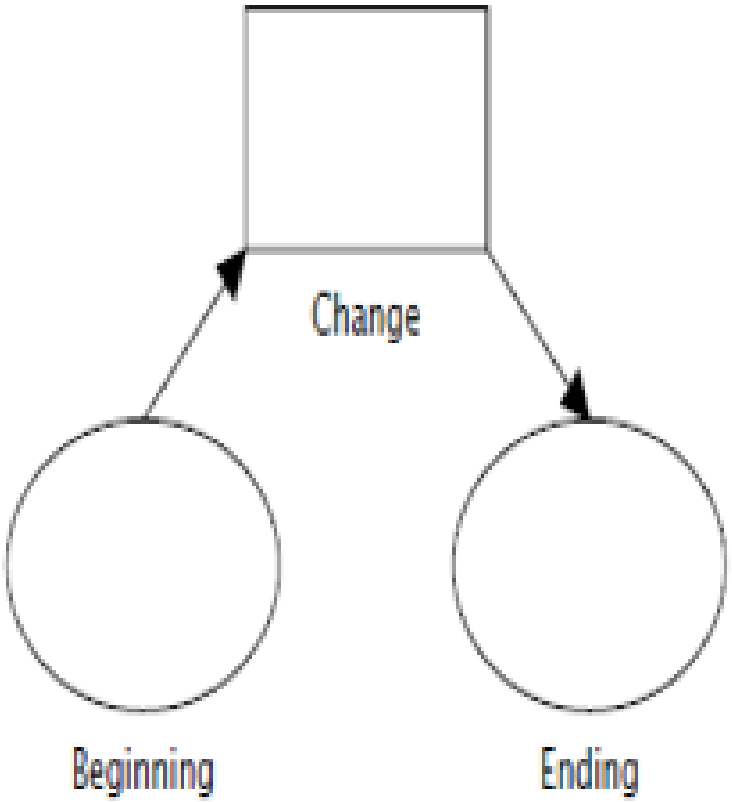
		DIFFERENCE UNKNOWN	BIGGER UNKNOWN	SMALLER UNKNOWN
COMPARE	COMPARE	1ST	1ST	1ST
	COMPARE	1ST	2ND	2ND

Change	Combine	Compare
Three quantities involved: a start amount, a change amount, and the resulting amount.	Two parts that are combined into one whole.	Comparison of two quantities.
Any of these three quantities can be unknown in a problem.	Structure links to the idea that numbers are embedded in other numbers	The third amount does not actually exist but it is the difference between the two amounts.
Change amount is the amount being added to or taken away from the start amount.	Missing whole or missing parts must be found.	Three ways to present compare problems: smaller, larger, or difference.

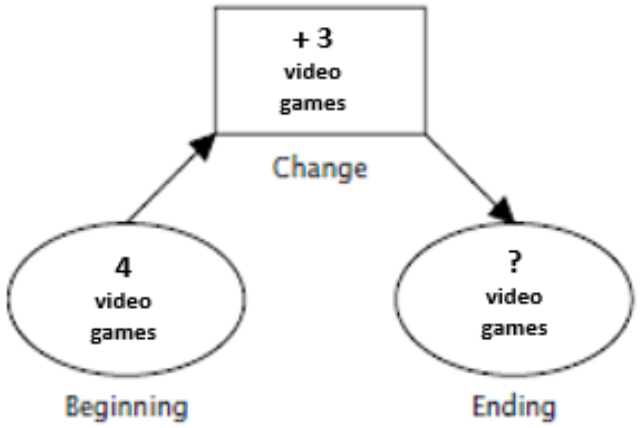
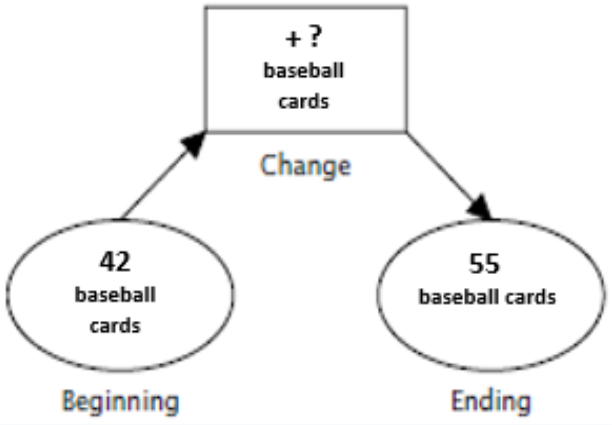
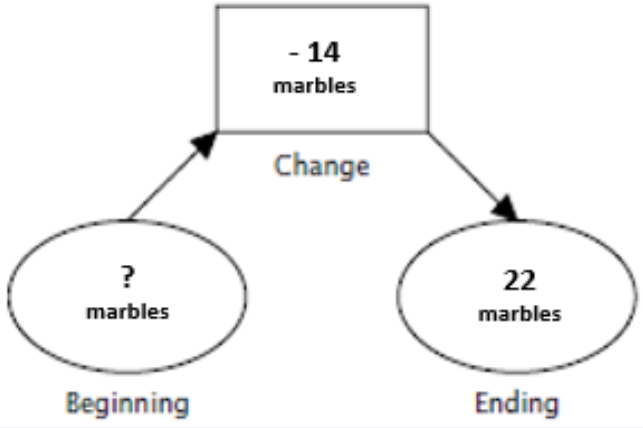
A., V. D., Karp, K. S., & Bay-Williams, J. M. (2012). *Elementary and middle school mathematics: Teaching developmentally*. Boston, MA: Allyn & Bacon

CHANGE Schema Structure

- There is a noun that is repeated in the beginning, change and ending parts of the problem.
- Change problems always include a time element indicated by past and present tense verbs.
- Verbs are critical to determine the change (increase or decrease).
- A change is applied to a given amount.

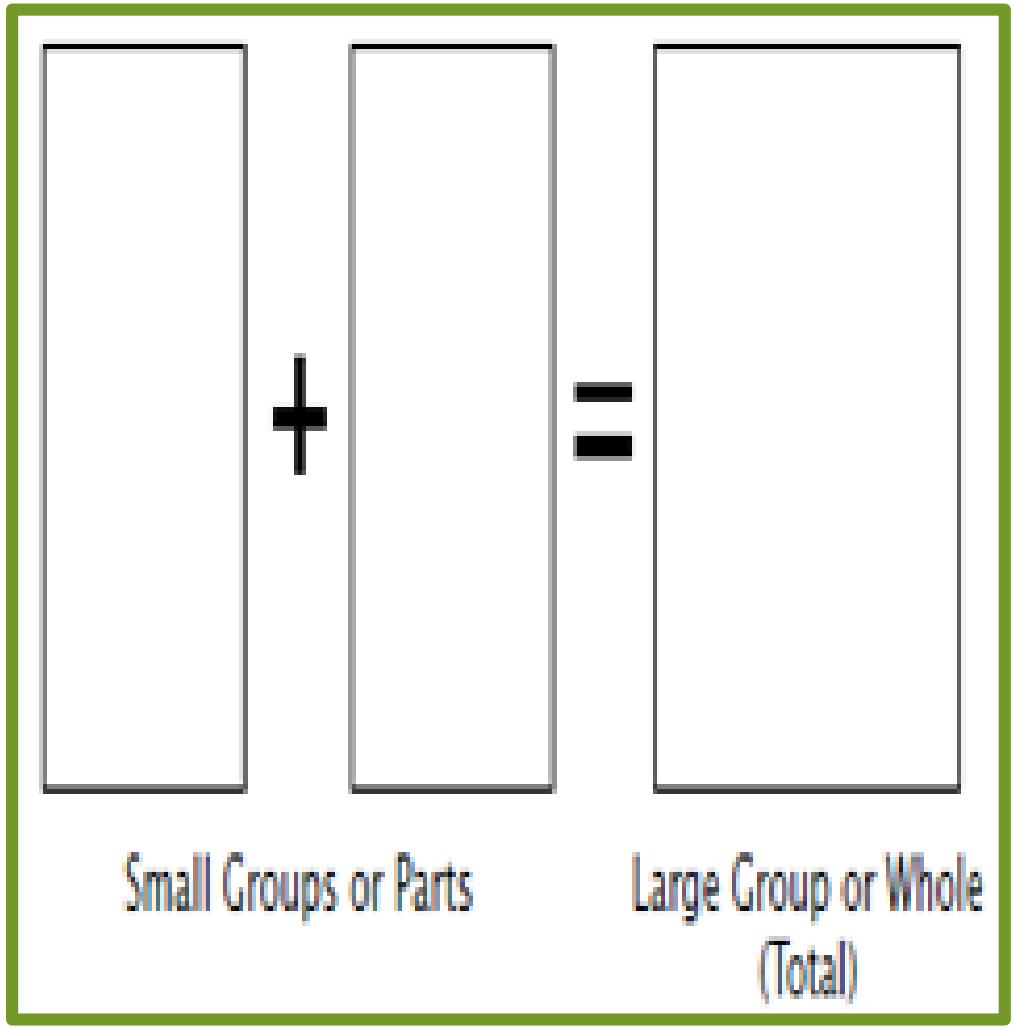


CHANGE Schema Structure

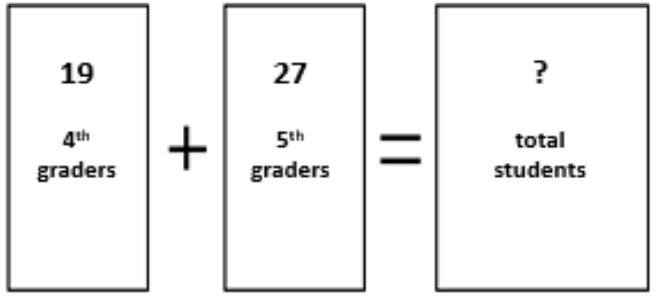
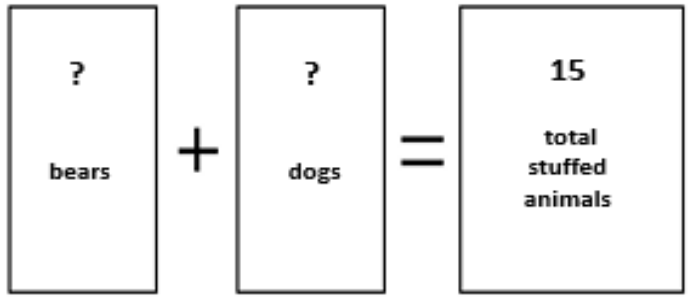
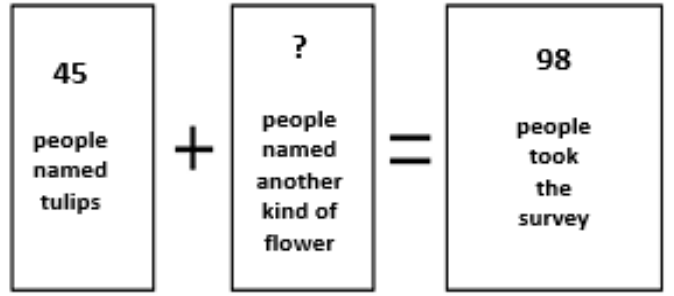
Result Unknown **4 + 3 = ?**	**Change Unknown** **42 + ? = 55**	**Start Unknown** **? – 14 = 22**
Jane had 4 video games. Then her mother gave her 3 more video games for her birthday. How many video games does Jane have now?	Tom had 42 baseball cards. He brought some at the store and now he has 55 baseball cards. How many cards did he buy?	James has a marble collection. He gives away 14 marbles and now he has 22 marbles. How many marbles did James have before he gave some away?
		

COMBINE Schema Structure

- Information is given about two or more groups.
- Items in the groups are static and usually use forms of the verb “to be”.
- The groups are put together for a total.

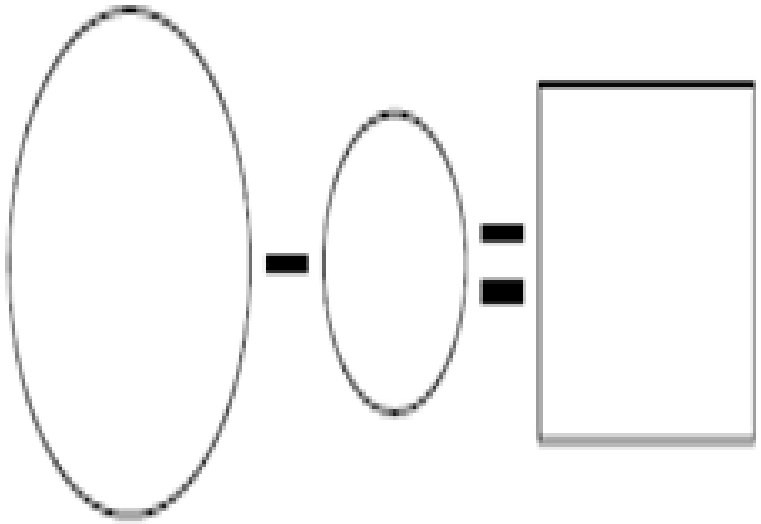


COMBINE Schema Structure

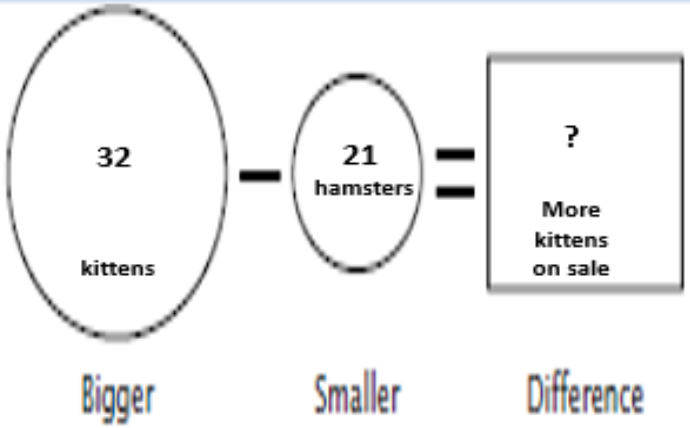
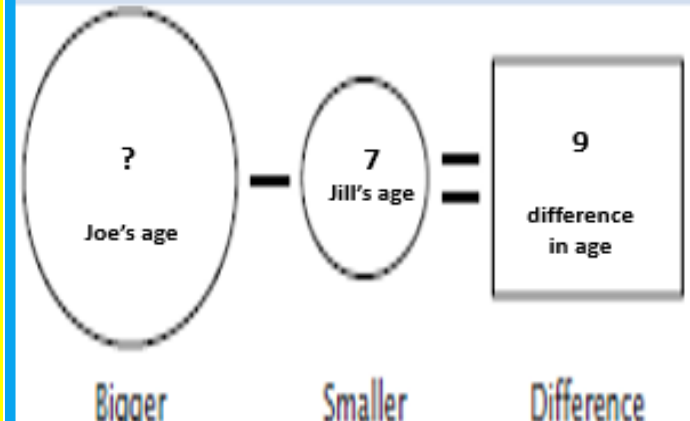
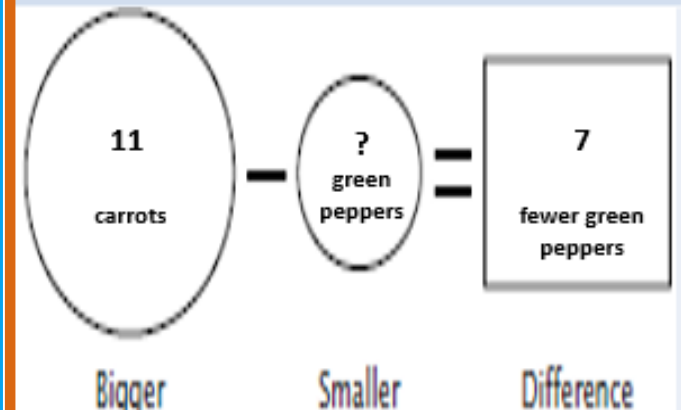
Total Unknown **19 + 27 = ?**	**Both Addends Unknown** **? + ? = 15**	**Addend Unknown** **45 + ? = 98**
Students at Hillcrest Elementary took part in the school play. There were 19 fourth graders and 27 fifth graders in the play. How many students total were in the play?	Eleanor has 15 stuffed animals. Some are bears and some are dogs. How many of each kind of stuffed animal could she have?	In a survey, 98 people were asked what their favorite flower is and 45 named tulips. How many named another kind of flower?
		

COMPARE Schema Structure

- Two amounts or items are compared to determine the sameness or difference.
- Compare problems have no time element.
- Items in the groups are static.
- The word problem has compare words (taller than, more than, less than, etc.)



COMPARE Schematic Structure

Difference Unknown 32 – 21 = ?	Bigger Unknown ?-7=9	Smaller Unknown 11 - ? = 7
The pet store is having a sale of 21 hamsters and 32 kittens. How many more kittens are on sale than the hamsters?	Jill is 7 years old. Joe is 9 years older than Jill. How old is Joe?	Steve picked 11 carrots. He picked 7 fewer green peppers than carrots. How many green peppers did Steve pick?
		

What We Know…

- There are 3 problem structures.
- Each problem structure has unique language characteristics to signal the type of structure.
- Within each structure there are different problem situations as defined by CCSS.
- There is a scope and sequence in which the structures and situations should be introduced.
- If students know these structures they become better problem solvers.

Sort and Solve

Work with a partner to complete the following task:

1. Label the problem situations with the correct structure: change, combine, or compare

2. Solve one problem per structure using the appropriate schematic diagram

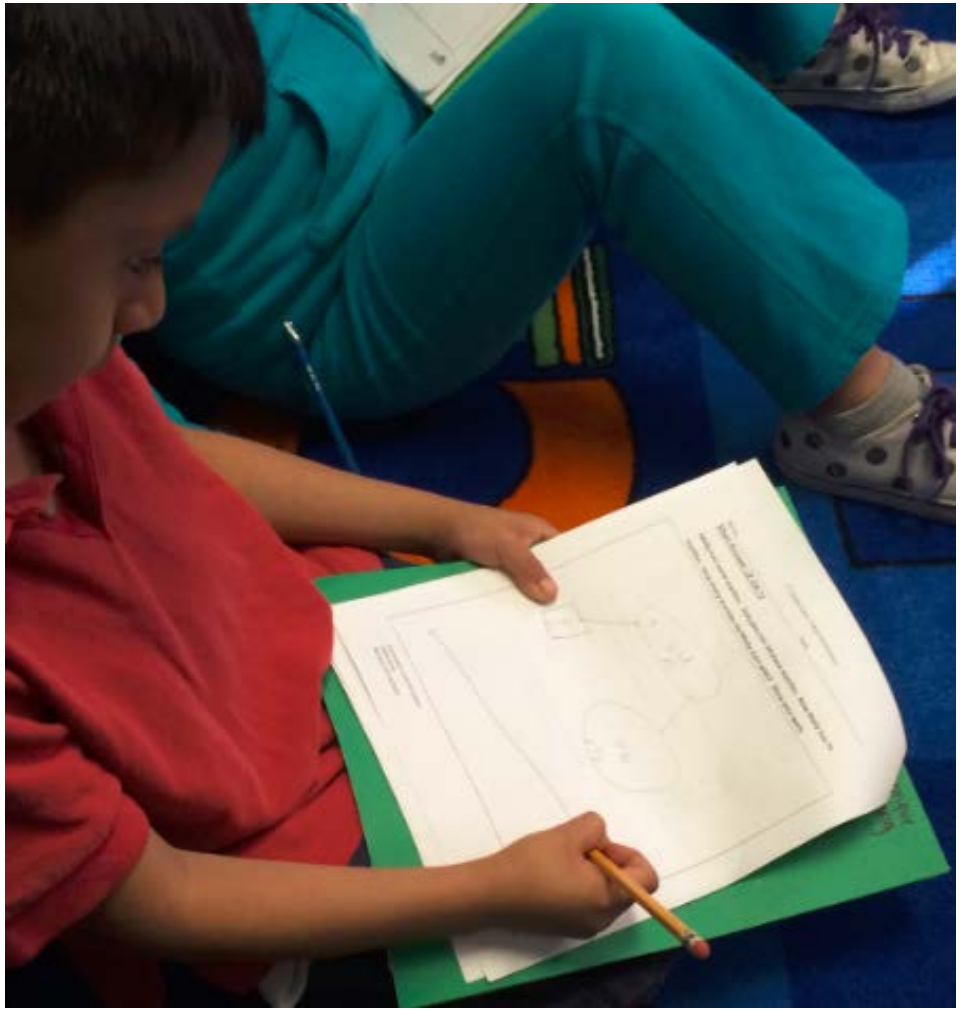
George and Sandra put 12 pennies into the piggy bank. George put in 4 pennies. How many pennies did Sandra put in? Combine	Sandra has 4 fewer pennies than George. George has 12 pennies. How many pennies does Sandra have? Compare	George has 12 coins. How many could be pennies and how many could be nickels? Combine
George has 12 pennies. Sandra has 8 pennies. How many fewer pennies does Sandra have than George? Compare	Sandra had some pennies. George gave her 4 more. Now Sandra has 12 pennies. How many pennies did Sandra have to begin with? Change	George has 4 more pennies than Sandra. Sandra has 8 pennies. How many pennies does George have? Compare
Sandra had 8 pennies. George gave her some more. Now Sandra has 12 pennies. How many did George give her? Change	George has 4 pennies, and Sandra has 8 pennies. They put their pennies into a piggy bank. How many pennies did they put into the piggy bank? Combine	Sandra had some pennies. She gave 4 to George. Now Sandra has 8 pennies. How many pennies did Sandra have to begin with? Change

Comparative Data: Pre-Test and Post-Test

Whole Class	Pre-Test	Post-Test
1 (Compare)	57.1%	70%
2 (Change)	0%	50%
3 (Combine)	81%	80%
4 (Compare)	52.4%	75%
5 (Change)	47.6%	60%

LEP	Pre-Test	Post-Test
1 (Compare)	40%	55.5%
2 (Change)	0%	22.3%
3 (Combine)	80%	77.8%
4 (Compare)	60%	55.6%
5 (Change)	30%	33.3%

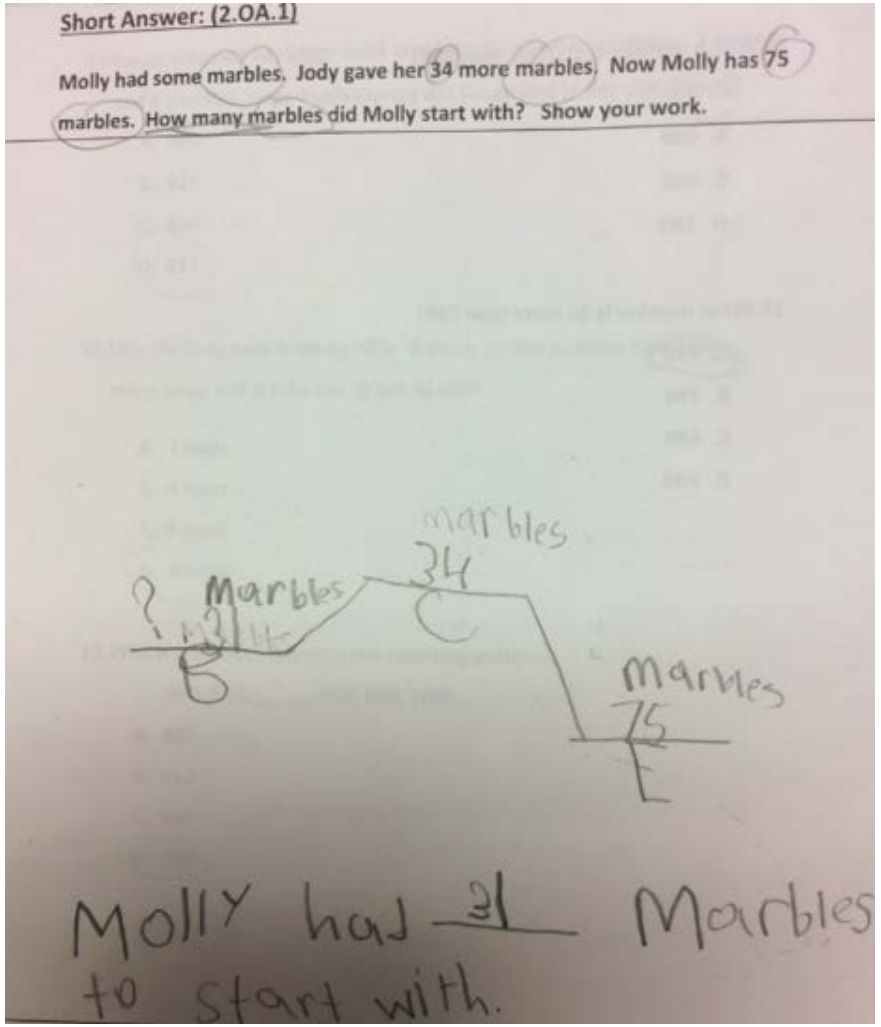
Comparative Data: Change Unknown



2nd grade	
Whole Class	
Before	After
0%	75%

2nd grade	
LEP	
Before	After
0%	70%

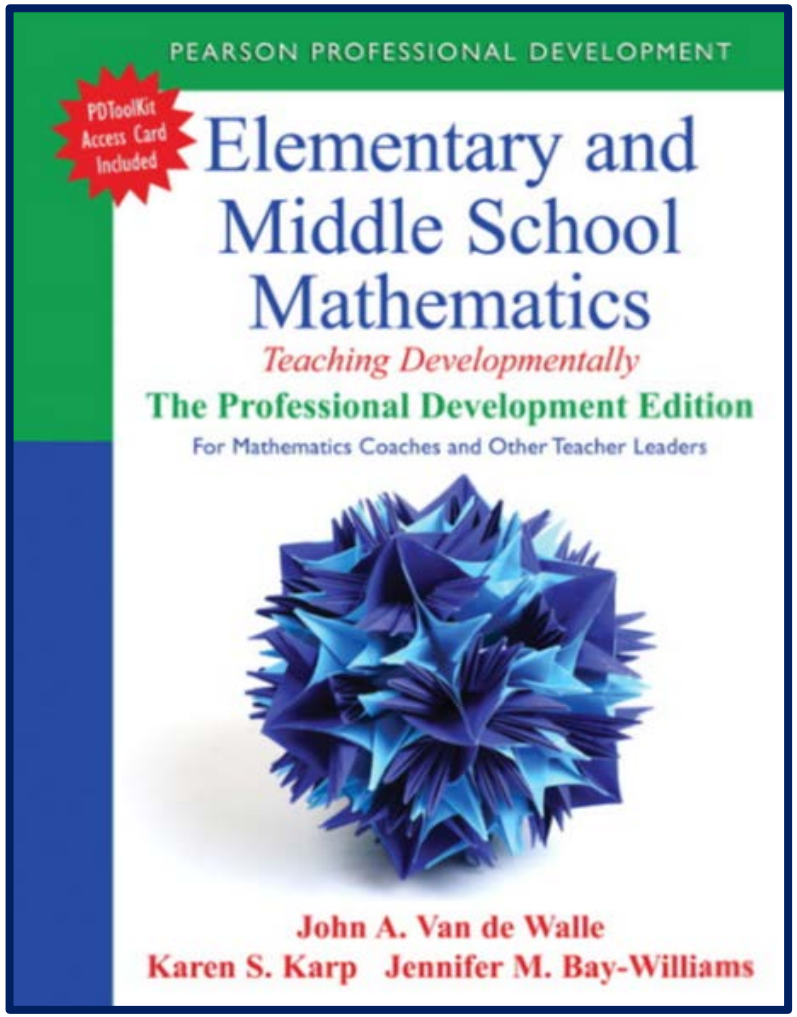
Comparative Data: Start Unknown

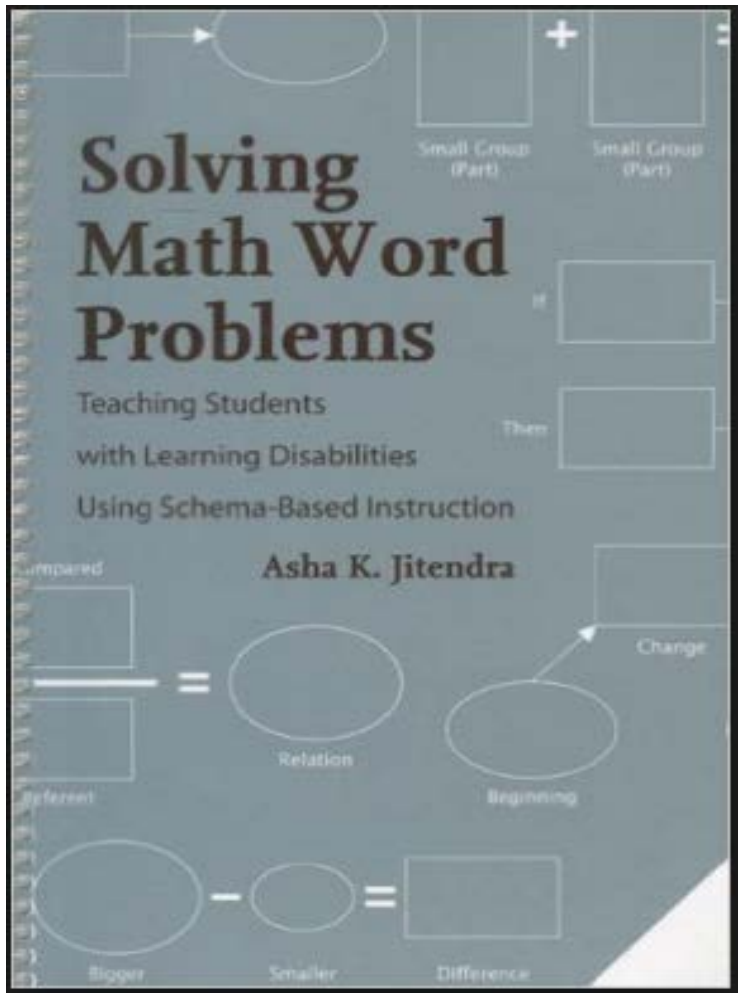


2nd grade	
Whole Class	
Before	After
48%	52%

2nd grade	
LEP	
Before	After
30%	50%

Resources for Schema Based Instruction





Thank You!

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