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Teaching Addition and Subtraction Word Problems

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Connecting Math Concepts (Carnine and Engelman, 1992) is a complete basal program, for first through fourth grade, that is designed so *all* students learn to compute, problem solve and think mathematically. Traditional basal programs fail to teach students to mastery because they err in several ways. First, they use a spiral curriculum where tasks are introduced and after a few lessons, these tasks often disappear from the curriculum. Second, they teach too much too fast. Third, they rely heavily on a discovery learning approach that masks the lack of coherent, effective instruction. Fourth, after students are introduced to a concept, they are expected to work problems on their own. Fifth, because of the spiral curriculum and the attempt to expose students to so many concepts, practice and review are limited. *Connecting Math Concepts* avoids these mistakes by: 1) using a track curriculum which distributes a concept across many lessons, 2) introducing new material gradually, 3) providing clear and useful explanations, 4) providing guided practice for students as they work problems with a teacher before they work independently, and 5) ensuring that the practice is extensive and review is cumulative throughout the program. It is the application of these 5 principles to teaching word problems that is the focus of this discussion.

The organization of *Connecting Math Concepts* is such that the component tasks related to solving word problems are tracked throughout the program. They do not appear solely in one set of lessons. At the Cache Valley Learning Center, we have reviewed the *Connecting Math Concepts* Level 3 program and isolated the word problem tracks, so we could use these instructional sequences for our students who only required instruction in word problems.

Instruction on word problems begins with teaching about number families. Students learn that a number family is made of two small numbers and a big number. Each number family generates four facts (unless the addends are the same as in 2 + 2 = 4, 5 + 5 = 10, etc.). Students learn to write a number family given 3 numbers. For example, the number family for 4, 5, and 9 is:

$$4 + 5 = 9$$
$$5 + 4 = 9$$
$$9 - 4 = 5$$
$$9 - 5 = 4$$

Students then learn to find a missing number wherever it is in the number family. The basic rule is that if only one number is missing in a family, that number can be found through either addition or subtraction. The missing number is represented by a box (❑). If a student sees ❑___5___> 9, s/he would know a small number is missing, and the calculation is subtraction. If s/he sees 4___5___>❑ the student knows the big number is missing, and the calculation is addition.

Once students are firm on identifying the missing number and the appropriate calculation, they learn to substitute letters in place of numbers. This skill enables them to write a number family from reading a word problem sentence. Students learn to translate sentences like the following into a number family.

Word problem sentence:
John is 24 inches shorter than Mark.

Number family:
24___J___>M

From here they progress to adding one more piece of information, so they have a number family with only one missing value.

Word problem:
John is 24 inches shorter than Mark.
Mark is 65 inches tall.

Number family:
65
24___J___>M

Students now can write a subtraction equation to solve for John's height: 65 - 24 = 41. All of the previous steps focused solely on the arrangement of the equation. Students do not proceed to the point where they solve the story problem until they have mastered the steps in setting up the equation.

The program teaches three types of word problems. The above word problem is an example of a comparison problem where one is comparing the height of two people.

All classification problems involve binary sets, two parts that equal the whole. For example: There were 75 cars in the lot. 42 cars were dirty. How many were not dirty?

The number family where **D** is dirty and **N** is not dirty:

42 75
D___**N**___> **ALL**

The calculation:
75 - 42 = 33
33 cars were not dirty.

Temporal sequence problems involve things that happen first, next, and last. The first value named in the problem is the first value written in the number family. The values go forward along the arrow if the problem involves getting more. The values go backward along the arrow if the problem involves getting less. In the problem below, the values go backward starting with the box (for the sum she started with).

The word problem:

Jane had some stamps. She sold 45 stamps. She ended up with 31 stamps. How many did she start out with?

The number family:

31 45 ——>❑

The calculation:

31 + 45 = 76

She started out with 76 stamps.

The same strategy is used in solving word problems that involve addition and subtraction of fractions. The number family and calculation strategy remain the same whether the problem involves whole numbers or fractions. The following is an example of a comparison word problem.

The word problem:

John ran 5/3 fewer miles than Meg. John ran 14/3 miles. How far did Meg run?

The number family and calculation:

14/3

5/3 ↓ ——>M 5/3 + 14/3 = 19/3.

Meg ran 19/3 miles.

The number family strategy is also applied to solving table problems. Students treat the rows and columns in the table as number families.

	Men	Women	Adults
Kate's Cafe		81	209
Joe's Grill		94	
Total	213		

To solve for the number of men that ate at Kate's Cafe the students write the family: ❑ 81 ——>209. Since a small number is missing, the students know this is a subtraction problem and perform the calculation. To find out how many women ate at both restaurants, the students write the family: 81 94 ——>❑. Since a big number is missing, the students add to find the answer. Filling in the missing values is an easy task for the students, since they are skilled at setting up a number family and performing the appropriate calculation given two values and an unknown. The table is nothing more than a series of number families.

Once again Engelmann and Carnine have designed a program that will teach all students. I have been teaching Direct Instruction programs for over a decade, and I never cease to be amazed at their brilliance and caring. However, anyone who is familiar with Direct Instruction knows that students can work through programs and not be successful if the teacher does not teach

each format until "the students are firm." Without objective measurement about students' fluency, teachers often proceed through the curriculum even though students have not mastered previous tasks. Precision Teaching has much to offer students and teachers in objectifying the decision about whether students are firm. At the Cache Valley Learning Center we are developing Precision Teaching materials that allow students to become fluent on each step in the *Connecting Math Concepts* word problem instructional sequence.

I strongly encourage any teacher to adopt the *Connecting Math Concepts* program in his/her classroom. However, anyone who is working in a tutorial setting or wishes to teach this word problem strategy in conjunction with any current mathematics text, may contact the author at the Cache Valley Learning Center, 146 North 100 East, Logan, Utah, 84321.

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