A Problem Solving Approach to Mathematics for Elementary School Teachers

Thirteenth Edition



Chapter 3 Numeration Systems and Whole Number Operations

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Section 3-3 Subtraction of Whole Numbers

- The meaning of subtraction by studying various models.
- The inverse relationship between addition and subtraction.
- Subtraction algorithms, including the standard algorithm, and how to use them.
- Subtraction with number bases other than ten.
- Mental subtraction computational skills and estimation techniques.

Subtraction Models (1 of 2)

Subtraction of whole numbers can be modeled in several different ways:

- Take-Away Model views subtraction as a second set of objects being taken away from the original set
- Number-Line Model subtraction is represented by moving left on the number line a given number of units.

Subtraction Models (2 of 2)

 Missing Addend Model – an algebraic-type of reasoning is used where students compute a difference by determining the value of an "unknown" addend.



Subtraction of Whole Numbers (1 of 4)

Take-Away Model





Subtraction of Whole Numbers (2 of 4)

Number-Line (Measurement) Model



5 - 3 = 2



Subtraction of Whole Numbers (3 of 4)

Missing-Addend Model

This can be thought of as the number of blocks that must be added to 3 in order to get 8.

The number 8 - 3 is the missing addend in the equation





Subtraction of Whole Numbers (4 of 4)

Missing-Addend Model



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Definition of Subtraction of Whole Numbers

For any whole numbers *a* and *b*, such that $a \ge b$, a - b is the unique whole number *c* such that b + c = a.



Subtraction of Whole Numbers

Comparison Model

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Juan has 8 blocks and Susan has 3 blocks. How many more blocks does Juan have than Susan? 8-3=5

Properties of Subtraction

It can be shown that if a < b, then a - b is not meaningful in the set of whole numbers. Therefore, subtraction is not closed on the set of whole numbers.

Introductory Algebra Using Whole-Number Addition and Subtraction



If the value that is used makes the equation true, it is a solution to the equation.

Subtraction Algorithms (1 of 3)

Concrete model



Represent 243 with 2 flats, 4 longs, and 3 units, as shown. To subtract 61 from 243, we try to remove 6 longs and 1 unit from the blocks shown in the figure. We can remove 1 unit, but to remove 6 longs, we have to trade 1 flat for 10 longs.

Subtraction Algorithms (2 of 3)

Concrete model (continued)



Now we can remove, or "take away," 6 longs and 1 unit, leaving 1 flat, 8 longs, and 2 units, or 182.

Subtraction Algorithms (3 of 3)

Concrete model (continued)





Equal-Addends Algorithm

The equal-additions algorithm for subtraction is based on the fact that the difference between two numbers does not change if we add the same amount to both numbers.



Counting-Up Algorithm (1 of 2)

This algorithm can be best described as the "making change" method. It is the way that cashiers and tellers give change for purchases. Today, with calculators and computerized cash registers, it has become sort of a lost art. However, it is a way to do subtraction "in your head." It uses the idea of the missing addend model for subtraction. Students are encouraged to count up to nice numbers, which are multiples of 10, 100, 1000, etc.

Counting-Up Algorithm (2 of 2)

For example, subtract 100 - 31 using the countingup algorithm for subtraction.

$$31 + 9 = 40$$

40 + 60 = 100
69



Example 8 (1 of 2)

Noah owed \$11 for his groceries. He used a \$50 bill to pay. While handing Noah the change, the cashier said, "11, 12, 13, 14, 15, 20, 30, 50." How much change did Noah receive?

What the cashier said	\$11	\$12	\$13	\$14	\$15	\$20	\$30	\$50
Amount of money Noah received	0	\$1	\$1	\$1	\$1	\$5	\$10	\$20



Example 8 (2 of 2)

The total amount of change that Noah received is

1+1+1+1+5+10+20=39

Thus 50 - 11 = 39 because 39 + 11 = 50.



Trades-First Algorithm

This algorithm is very similar to the standard algorithm, except that all regrouping is done before any of the subtraction is carried out. Using base-ten blocks may help with students understanding how to subtract.

Understanding Addition and Subtraction in Bases Other Than Ten (1 of 4)

432_{five}	+	0	1	2	3	4
-43_{five}	0	0	1	2	3	4
$432_{c} + 2$	1	1	2	3	4	10
$-(43_{c} + 2)$	2	2	3	4	10	11
	3	3	4	10	11	12
432_{five}	4	4	10	11	12	13
_100						

-100_{five}

 334_{five}



Understanding Addition and Subtraction in Bases Other Than Ten (4 of 4)



Fives	Ones		Fives	Ones	$- \frac{21}{32}$
3	2	- 	2	12	$p \mathcal{L}_{\text{five}}$
- 1	4		- 1	4	-14_{five}
		-	1	3	13_{five}



1

Mental Mathematics: Subtraction

1. Breaking up and bridging

- $74 \rightarrow 74 20 = 54$
- $-26 \rightarrow 54 6 = 48$

2. Trading off

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 $74 \rightarrow 74 + 4 = 78$ $-\underline{26} \rightarrow 26 + 4 = 30$ 78 - 30 = 48

3. Drop the zeros $7400 \rightarrow 74-6=68$ $-\underline{600} \rightarrow 7400-600=6800$