Numbers and Operations

Module 2

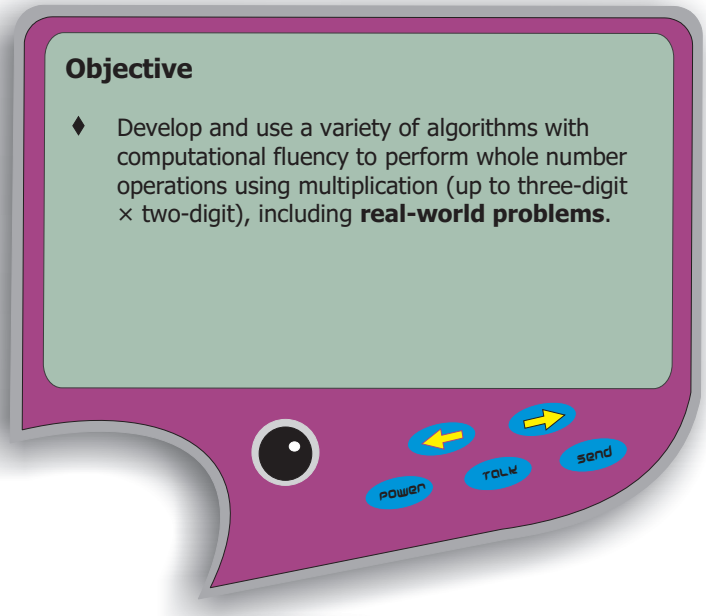
Whole Number Operations

Lesson 3
Large Numbers: Multiplication

Teacher Notes 2.3

Objective

- Develop and use a variety of algorithms with computational fluency to perform whole number operations using multiplication (up to three-digit × two-digit), including **real-world problems**.



Prerequisites

Adding multi-digit whole numbers
Multiplying one-digit whole numbers
Rounding whole numbers
Multiplying by powers of 10

Vocabulary

Rounding (1.5)
Estimate (1.5)
Partial products (1.4)
Algorithm
Multiple
Multiplicand
Multiplier
Product
Factor (1.2)
Partial Products Method
Standard Method of Multiplication

Get Started

- Have students to complete the product patterns below.

3 × 2 = **6**	3 × 6 = **18**	5 × 4 = **20**
30 × 2 = **60**	3 × 60 = **180**	5 × 40 = **200**
300 × 2 = **600**	3 × 600 = **1,800**	5 × 400 = **2,000**
3,000 × 2 = **6,000**	3 × 6,000 = **18,000**	5 × 4,000 = **20,000**
5 × 2 = **10**	2 × 4 = **8**	4 × 6 = **24**
50 × 2 = **100**	2 × 40 = **80**	4 × 60 = **240**
50 × 20 = **1,000**	20 × 40 = **800**	40 × 60 = **2,400**
500 × 20 = **10,000**	20 × 400 = **8,000**	40 × 600 = **24,000**
500 × 200 = **100,000**	200 × 400 = **80,000**	400 × 600 =**240,000**

- Ask students how they can use the basic fact $3 \times 4 = 12$ to multiply 300×400.
  Multiply $3 \times 4 = 12$. Count the zeros in the factors 300 and 400. Write that many zeros to the right of the product. 120,000
- Ask students how they can use the basic fact $5 \times 4 = 20$ to multiply 500×400.
  Multiply $5 \times 4 = 20$. Count the zeros in the factors 500 and 400. Write that many zeros to the right of the product. 200,000
- Ask students why the product of 500×400 had one more zero than the product of 300×400. **Because the basic fact $5 \times 4 = 20$ had a zero in the product.**

Subtopic 1 — Estimation and Multiplying with Zeros

Expand Their Horizons

In Subtopic 1, students round the factors of a multiplication problem, find an estimated product, find the exact product using a calculator, and then compare the two products.

This subtopic also introduces students to the terms *multiplicand* (the number that is to be multiplied by another) and *multiplier* (a number by which another number is multiplied). Encourage students to become comfortable with these terms by using them throughout the lesson.

Remind students that a multiple of a number is the product of that number and any whole number. To multiply by a multiple of 10, like 10, or 20, or 30, they should write a zero in the ones column and then multiply by the digit in the tens column.

Before viewing Lesson Notes Problems 1 and 2, remind students that they are not to find the exact product first. After they have found the estimated product, they will find the exact product using a calculator, and then compare the two answers.

Common Error Alert:

Students may round all one-digit multipliers greater than or equal to five up to 10. If the multiplicand is rounded and multiplied by the original one-digit multiplier, the estimated product will be closer to the actual product.

1 Notice that the multiplier was not rounded. A one-digit multiplier is often not rounded if the multiplicand is easily multiplied by that one-digit number. The estimated product 2,400 is reasonably close to the exact answer of 2,430.

2 Remind students that when multiplying factors that have zeros, they can multiply the non-zero numbers first. Then, they can add the number of zeros that are in the factors. That is the number of zeros that should follow the initial product:
200 · 8 = (2 · 8) · 100 = 16 · 100 = 1,600. The exact product is 1,664.

Additional Examples

1. Estimate before multiplying.
579 × 4

Round the multiplicand but do not round the multiplier. Find the product. Then, find the exact answer and compare the two products.

579 → 600

600 × 4 = 2,400
≈ 2,400
= 2,316

2. Estimate before multiplying.
722 × 7

Round the multiplicand but do not round the multiplier. Find the product. Then, find the exact answer and compare the two products.

722 → 700

700 × 7 = 4,900
≈ 4,900
= 5,054

Subtopic 2 Partial Products Method of Multiplication

Expand Their Horizons

In Subtopic 2, students use the Partial Products Method of Multiplication. The problems presented are real life scenarios. For example, find the total amount paid in 48 payments of $376 each. For each problem, the product is first estimated. Then, the exact answer is found using partial products.

The Partial Product Method is presented in two different ways. The first way asks the students to begin with the ones digit of both factors. The second way asks the students to begin with the largest digit of both factors.

3 Caution the students to keep the digits lined up according to place value and to put the number with the most digits on top. In expanded form, 25 = 20 + 5. Begin with the tens digit of the multiplier: 10 · 20 = 200, 10 · 5 = 50. Move to the ones digit of the multiplier: 6 · 20 = 120, 6 · 5 = 30. The sum of these partial products is 400.

It is a good practice to find a range of values the answer must fall between. For example, the product in this example must fall between 10 · 25 = 250 and 20 · 25 = 500.

4 Remind students to estimate the product first and to compare their exact answer with their estimated answer. In expanded form, 125 = 100 + 20 + 5. Begin with the tens digit of the multiplier: 30 · 100 = 3,000, 30 · 20 = 600, 30 · 5 = 150. Move to the ones digit of the multiplier: 6 ·100 = 600, 6 · 20 = 120, 6 · 5 = 30. The sum of the partial products is 4,500.

Common Error Alert:

Students sometimes forget what place value they are using when multiplying using partial products. For example, if they are in the tens place and the digit is a four, they will sometimes multiply by four rather than 40.

Additional Examples

1. Use the Partial Products Method.

The factory in Jason's city has 82 business divisions. In each division, there are 29 employees. How many employees are there in all?

First, find the estimated product. Next, find each partial product beginning with the tens place. Then, add the partial products.

$80 \cdot 30 \approx 2{,}400$

$$\begin{array}{rl} 82 & \\ \times\ 29 & \\ 40 & \rightarrow 20 \cdot 2 = 40 \\ 1{,}600 & \rightarrow 20 \cdot 80 = 1{,}600 \\ 18 & \rightarrow 9 \cdot 2 = 18 \\ +\ 720 & \rightarrow 9 \cdot 80 = 720 \\ 2{,}378 & \end{array}$$

2,378 employees

2. Use the Partial Products Method.

There are 67 rectangles on the wall mural. Inside each rectangle, there are 205 dots. What is the total number of dots in the wall mural?

First, find the estimated product. Next, find each partial product beginning with the ones place. Then, add the partial products.

$70 \cdot 200 \approx 14{,}000$

$$\begin{array}{rl} 205 & \\ \times\ 67 & \\ 35 & \rightarrow 7 \cdot 5 = 35 \\ 0 & \rightarrow 7 \cdot 0 = 0 \\ 1{,}400 & \rightarrow 7 \cdot 200 = 1{,}400 \\ 300 & \rightarrow 60 \cdot 5 = 300 \\ 0 & \rightarrow 60 \cdot 0 = 0 \\ +\ 12{,}000 & \rightarrow 60 \cdot 200 = 12{,}000 \\ 13{,}735 & \end{array}$$

13,735 dots

Expand Their Horizons

In Subtopic 3, students multiply using the Standard Multiplication Algorithm. Initially, the students use base ten blocks to help with regrouping. Then, they multiply using place value charts to help reinforce place value.

The standard algorithm has only as many partial products as there are digits in the multiplier. First, multiply the entire multiplicand by the ones digit of the multiplier. Then, multiply the entire multiplicand by the tens digit of the multiplier and so on until every digit of the multiplier has been used.

5 The product of the ones digit of the multiplier and the multiplicand is 280. The product of the tens digit and the multiplicand is 2,240. The answer is the sum of the two partial products which is 2,520.

6 The product of the ones digit of the multiplier and the multiplicand is 1,981. The product of the tens digit and the multiplicand is 8,490. The answer is the sum of the two partial products which is 10,471.

Common Error Alert:

Students will sometimes lose track of the digit that they "carried" as they regroup. Encourage them to develop a way that works for them and helps them to recall those digits as they multiply step by step.

Additional Examples

1. Solve.

142 × 32

Multiply 142 by the ones digit of the multiplier. Next, multiply 142 by the tens digit of the multiplier. Last, add the two partial products.

$$\begin{array}{rl} 142 & \\ \times\ 32 & \\ \hline 284 & \rightarrow\ 2\times 142 \\ +\ 4{,}260 & \rightarrow 30\times 142 \\ \hline 4{,}544 & \end{array}$$

2. Solve.

208 × 45

Multiply 208 by the ones digit of the multiplier. Next, multiply 208 by the tens digit of the multiplier. Last, add the two partial products.

$$\begin{array}{rl} 208 & \\ \times\ 45 & \\ \hline 1{,}040 & \rightarrow\ 5\times 208 \\ +\ 8{,}320 & \rightarrow 40\times 208 \\ \hline 9{,}360 & \end{array}$$

Look Beyond

Learning to estimate a product is a valuable skill in mathematics, whether in the classroom or in everyday life. Estimating will help students catch careless place value errors when they are solving problems. This skill is used in everyday life, such as when working in a place of business or when shopping. Give the students real life examples of using estimation, such as comparing prices of items to decide which items are the best buy.

Students will also be asked to check the reasonableness of their answer throughout their mathematics career. If this strategy becomes second nature to them, they will avoid many careless errors. When students are more accurate, they become more confident and more successful in mathematics. Estimating to see if their answer is logical will in turn cause them to think about what the problem is asking and if their answer fits into the framework of the problem. A high emphasis is placed on standardized testing, and estimating is a skill that is linked to higher test scores. It gives the test taker the ability to eliminate answers that are not close to an acceptable range.

Connections

Multiplication can be used in the transportation of packaged goods to find the number of an item that is being transported. For example, on a full semi truckload of a particular brand of soda, there are 22 pallets (storage beds used by fork lifts) that each hold 120 cases of soda. A case of soda contains 12 bottles. So, the number of bottles of soda in the truckload is $22 \times 120 \times 12 = 31{,}680$.