Order Up!

Strand: Computation and Estimation

Topic: Exploring the order of operations and using it to evaluate numerical expressions

Primary SOL: 6.6 The student will
c) simplify numerical expressions involving integers

Materials
- Poster board
- Markers
- Order of Operations Recording Sheet (attached)
- Deck of cards with face cards removed
- Calculators

Vocabulary

area, expression (earlier grades)

absolute value, braces, brackets, evaluate, exponents, integers, order of operations, parentheses (6.6)

Student/Teacher Actions: What should students be doing? What should teachers be doing?

Before the lesson, draw on poster board three rectangles with the following dimensions: 9 by 5, 9 by 8, and 9 by 4. Make sure the rectangles are large enough for students to see during a class discussion. Draw the square units on the rectangles; then, cut out the rectangles.

1. Review with students the process of finding the area of rectangles.
2. Display the three rectangles you made, and write the dimensions under each one. Have students find the area of each rectangle and then share their answers.
3. Combine any two rectangles (e.g., the 9-by-4 and the 9-by-5), and ask students to find the area of the combined rectangles. Allow students time to work, and then have them share their answers. Put the two rectangles together, and have students count the squares to verify the total area.
4. Focus students' attention on the two separate rectangles making up the combined rectangle. Ask them how they can use the areas of each rectangle to find the combined area. After students share their thoughts, write: $9 \times 4 + 9 \times 5$. Ask students how to solve this expression to get the answer 81. Ask them whether they can solve it in any order or whether there is one order that must be used. This should lead students to describe completing the multiplication steps first and then doing the addition. Ask students if it mattered whether they did 9 x 4 or if they could have done 4 x 9. This should lead into a discussion about the commutative property of multiplication.
5. Extend the activity by combining all three rectangles to solve for the total area. Lead students in writing the steps to find the area, using the order of operations. Tell students that they are using the *order of operations.* Explain that the order of operations is a convention that defines the computation order to follow in evaluating an expression.
6. Share the order of operations with students, writing them on chart paper as you go. Make it clear to students that multiplication does not always come before division, nor does

addition always come before subtraction. Use this discussion to make sure students understand the meaning of exponents. You may want students to write the order of operations in their math journals for future reference.

7. Model evaluating an expression, using the order of operations. Write the expression $(4 + (-5)) \cdot 4 + 3^2 + 9 \cdot (-2)$ on the board. Make sure students understand that the dot (·) is a symbol for multiplication that has been represented with "x" (as in 3 x 4) in previous grades. Have them try following the order of operations on their own to find a value for the expression. Then, have them share their answers.
8. Model how to find a value for the expression, as shown below:

$$(4 + (-5)) \cdot 4 + 3^2 + 9 \cdot |-2|$$
$$\mathbf{-1} \cdot 4 + 3^2 + 9 \cdot \mathbf{2}$$
$$-1 \cdot 4 + \mathbf{9} + 9 \cdot \mathbf{2}$$
$$\mathbf{-4} + 9 + \mathbf{18}$$
$$\mathbf{-36} + 18$$
$$\mathbf{-18}$$

9. Ask students to rearrange the numbers in parentheses and see whether they get the same answer. This should lead into a discussion about the commutative property of addition.
10. Give students other expressions to evaluate by bringing the next step down and continuing to solve until a value results. Make sure to give students problems that include examples of other properties and discuss with the students how they can use the properties to help solve problems (e.g., 6(5 + 9) could also be 6(5) + 6(9) because of the distributive property).
11. Have student pairs play an order-of-operations game, as follows:
    - Give each student an Order of Operations Recording Sheet, and give each pair of students a deck of cards with face cards removed. Black cards will be positive numbers, and red cards will be negative numbers.
    - Have players draw six cards and record numbers in the blanks for Round 1 on the recording sheet. Players should record their opponents' rolls as well. Players may place their numbers in any blanks for that round, but they may not move a number to another blank once it has been placed.
    - Once all blanks are filled for Round 1, have players evaluate their expressions and their opponents' expressions, using the order of operations. Make sure students show each step of simplifying the expressions. Players should compare their answers. The player with the greatest value wins a point for that round.
    - The game continues in this manner until players have completed five rounds. The player with the most points after five rounds wins the game.
12. After students have finished the game, have the whole class discuss any strategies that were used to win points. Ask students to discuss how the game would be different if there were no order of operations.

Assessment

- **Questions**
    - What is the significance of the order of operations?
    - What would happen if people did not use the order of operations?

- Which of the following examples has an error in correctly applying the properties of real numbers?

$-8 + 9(1 + -4)$ $-8 + (9 \cdot 1) + (9 \cdot -4)$ $-8 + 9 + (-36)$ $1 + (-36)$ -35	$-17 - (-9 + 5)$ $-17 + 9 + 5$ $-8 + 5$ -3	$-[-6(-3 + 5)] - 7$ $-[-6(-3) - 6(5)] - 7$ $-(18 - 30) - 7$ $-(-12) - 7$ $12 - 7$ 5

- **Journal/Writing Prompts**
  - Write a story to illustrate the importance of sequencing in your everyday life.
  - Describe why using the order of operations is important.
- **Other Assessments**
  - Use the Order of Operations Recording Sheet as an assessment.
  - Have students use only the number 4, the operation symbols, and knowledge of the order of operations to make an expression for each of the target numbers 1 through 12. For example, an expression for the target number 20 could be $\left(4 + \frac{4}{4}\right) \cdot 4$.

Extensions and Connections (for all students)

- Put random rational numbers on the board, and have students use them to make their own expressions.
- Divide students into groups, and give each group a number. Have the group derive an expression for which the given number is the answer.
- Discuss with students other types of actions that must happen when doing a process in sequential steps. Talk about what might happen if the steps were not followed in the proper order. Relate this to the order of operations.

Strategies for Differentiation

- Provide students with the order of operations written out to use throughout the lesson.
- Allow students to use a calculator when completing activities throughout the lesson.
- Share the mnemonic device GEMDAS with students as a way to remember the order of operations:

  G Grouping Symbols
  E Exponent
  $\overrightarrow{\text{MD}}$ Multiplication *or* division from left to right
  $\overrightarrow{\text{AS}}$ Addition *or* subtraction from left to right

Note: The following pages are intended for classroom use for students as a visual aid to learning.

Order of Operations Recording Sheet

Name ___________________________________ **Date** ______________________

Round	**Player 1**	**Player 2**	**Point**
Example	$(\_\_\_ + \_\_\_) \cdot \_\_\_ + \_\_\_^2 + \_\_\_ \cdot \_\_\_$ Cards: -3, 3, -4, 4, 1, -1 $(-3 + 3) \cdot 4 + (-4)^2 + 1 \cdot (-1)$ $\mathbf{0} \cdot 4 + (-4)^2 + 1 \cdot (-1)$ $0 \cdot 4 + \mathbf{16} + 1 \cdot (-1)$ $\mathbf{0} + 16 + \mathbf{(-1)}$ $\mathbf{16} + (-1)$ **15**	$(\_\_\_ + \_\_\_) \cdot \_\_\_ + \_\_\_^2 + \_\_\_ \cdot \_\_\_$ Cards: 3, -2, 4, 1, -1, 6 $(3 + (-2)) \cdot 4 + 1^2 + (-1) \cdot 6$ $\mathbf{1} \cdot 4 + 1^2 + (-1) \cdot 6$ $1 \cdot 4 + \mathbf{1} + (-1) \cdot 6$ $\mathbf{4} + 1 + (\mathbf{-6})$ $\mathbf{5} + (-6)$ **-1**	Player 1
1	$\_\_\_ \cdot \_\_\_ + \_\_\_ + \_\_\_ \cdot \_\_\_ + \_\_\_$	$\_\_\_ \cdot \_\_\_ + \_\_\_ + \_\_\_ \cdot \_\_\_ + \_\_\_$	
2	$(\_\_\_ + \_\_\_) \cdot (\_\_\_ + \_\_\_) - \_\_\_ + \_\_\_^2$	$(\_\_\_ + \_\_\_) \cdot (\_\_\_ + \_\_\_) - \_\_\_ + \_\_\_^2$	
3	$\_\_\_ \cdot \_\_\_ \cdot \_\_\_ \div \_\_\_ - \lvert\_\_\_\rvert - \_\_\_$	$\_\_\_ \cdot \_\_\_ \cdot \_\_\_ \div \_\_\_ - \lvert\_\_\_\rvert - \_\_\_$	
4	$\_\_\_ \cdot (\_\_\_ + \_\_\_ \cdot \_\_\_ + \_\_\_) \cdot \_\_\_$	$\_\_\_ \cdot (\_\_\_ + \_\_\_ \cdot \_\_\_ + \_\_\_) \cdot \_\_\_$	
5	$(\_\_\_ \cdot \_\_\_ \cdot \_\_\_ + \_\_\_) \div \_\_\_ + \_\_\_^3$	$(\_\_\_ \cdot \_\_\_ \cdot \_\_\_ + \_\_\_) \div \_\_\_ + \_\_\_^3$	

