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| **GRADE: 6th** | | |
| **Unit Title: Order of Operations with Exponents**  **Lesson Title:** A Chat with Ms. Crabtree  “Understanding PEMDAS”  **Estimated Duration:** 90 minutes. (Approximately 1-2 days) | | **Real-World Purpose:** This is a foundational skill needed in order to perform future mathematical operations. For example, when you calculate the area of any square. If you say "My room is twelve foot by twelve foot square", you're meaning your room is 12 feet × 12 feet — 12 feet multiplied by itself — which can be written as (12 ft.)2. And that simplifies to 144 square feet. |
| ***I Can:***  **Standard(s):** SMP.2, SMP.3, SMP.4, SMP.7   * I can evaluate numerical expressions involving whole-number exponents. I can identify changes occurring in a video and in word problems and be encouraged to determine the reasonableness of their solutions. * I can use order of operations to solve numerical expressions involving whole numbers. * I can evaluate the placement of parentheses in numerical expressions as they affect the value of the expression. | | |
| **Performance Objective: (Evidence of Learning)** A. The students will evaluate the placement of parentheses, exponents, multiplication, division, addition and subtraction in numerical expressions as they affect the value of the expression with **70% accuracy**.   * B. Students will be introduced to academic vocabulary and will use it when discussing patterns of change. Students will identify changes occurring in a video and in word problems and will be encouraged to determine the reasonableness of their solutions. Using their understanding of change. Students will determine output values when given an input. | | |
| **Prerequisite Skills: Students have a general mastery of the four operations addition, subtraction, multiplication and division. Charts may be provided if needed.** | | |
| **Materials/Resources:**  PEMDAS Power point\*Chart paper • White boards-1 per student • Dry erase markers-1 per student • Markers • Copy paper for Exponent Vocabulary 6-Door Foldable or vocabulary notebook • Index cards • Handout 3.1: Watch Out for Parentheses Task • Order of Operations Expressions Game: http://www.shodor.org/interactivate/activities/OrderOfOperationsFou/ • My Favorite No: https://www.teachingchannel.org/videos/class-warm-up-routine • Watch Out for Parentheses Task: https://www.illustrativemathematics.org/content-standards/tasks/1136 | | **Key Vocabulary:**   * Evaluate         • Exponent  • Numeric expression  • Order of operations |
| **Elements of Rigor:**   * **Conceptual understanding of key concepts** * **Procedural skill and fluency** * **Rigorous application of mathematics in real-world contexts** | | |
| **Lesson Introduction** | | |
| **How will you introduce the lesson?**  **Student Exploration Activity**  **Anticipatory Set/Introduction to the Lesson:** **The students will review PEMDAS by watching the PowerPoint “A Chat with Ms. Crabtree”. The students will also have a hard copy for their notes.**  Students will be introduced to simplifying expressions with exponents using the order of operations. Display the following on the board before students arrive: Sam and Julio both found the value of the expression 3 + 62 .  Sam: 3 + 62=3+36=39  Julio: 3 + 62 =3+12=15  Ask students who is correct, Sam or Julio? Let students discuss their answers and conclude who is correct by comparing the work of Sam and Julio (SMP.3) The students may refer back to their PowerPoint notes for examples and the correct procedures to use. | | |
| **Lesson Activities** | | |
| **Activity 1**: Order of Operations Introduce new vocabulary words and have students create a vocabulary foldable (see lesson 2, activity 1 for instructions) or record new vocabulary words in their vocabulary notebook. • Evaluate: to find the value of an algebraic expression by replacing variables with numbers. • Order of Operations: the rules that tell which operation to perform first when more than one operation is used (see above). T: If we want to solve 3+ 25 − 4 ÷ 2 using the order of operations, when do you think we need to evaluate the 25?” Note: Students should make the connection that exponents must be evaluated before adding and subtracting because students multiply to find the value of the number with an exponent. T: An exponent applies to its immediate base. How would you evaluate 25? (2 x 2 x 2 x 2 x 2 = 32) Note: A misconception students have about exponents is that they multiply the base times the exponent (2x5). Remind students that the exponent indicates how many times the base is used as a factor in a repeated multiplication problem. Display: Example 1: 2 + 5 3 Example 2: € (2 + 5) 3 T: Do you think these two expressions have the same value? Why or why not? Turn and Talk to your partner to respond. ⎫ Have students work with partners to discuss the differences in the two examples, evaluate the expressions, and decide on an answer (SMP.2). Demonstrate how to solve each example and answer any questions. Present additional examples to clarify student understanding. Allow students to use response boards to display answers. Note: Teachers often refer to the saying “Please Excuse My Dear Aunt Sally” when teaching order of operations. It is risky to use this phrase because students will look at it as a six-step process, when really it is only four steps.  Tell students the following order is preferred over the expression Please Excuse My Dear Aunt Sally: 1. Grouping symbols (parentheses), [brackets], {braces} – from the inside out 2. Exponents 3. Multiplication and division – from left to right in the order they appear 4. Addition and subtraction – from left to right in the order they appear. Create an anchor chart for the order of operations as it appears above and have students copy the order of operations in their math notebook. Write the following on the anchor chart: 2+ (3-1) x 32 Demonstrate how to evaluate the expression following the order of operations: Numerical Expression 2+ (3-1) x 32  Step 1: (3 - 1) = 2 so 2 + 2 x 32  Step 2: 32 = 9 so 2 + 2 x 9  Step 3: 2 x 9 = 18 so 2 + 18  Step 4: 2 + 18 = 20 so 20  20 is the value of the expression 2+ (3-1) x 32.  Re Note: A common mistake would be to add 2 + 2 before multiplying 2 x 9. T: Would we get the same value if we do the addition before the multiplication? What value would we get if we did the addition first? (36) Why is it important to have an order of operations? (answers will vary)  Write the following on the board: [8(4 - 1) + 2] + 33 ÷ 3. Explain that since there are brackets with multiple computations, we must use the order of operations within the brackets first. Demonstrate how to evaluate the expression following the order of operations: Numerical Expression [8(4 - 1) + 2] + 33 ÷ 3 Step 1: (4 - 1) = 3  [8(3) + 2] + 33 ÷ 3  Step 2: 8(3) = 24  [24 + 2] + 33 ÷ 3  Step 3: [24+2] = 26  26 + 33 ÷ 3  Step 4: 33 = 27  26 + 27 ÷ 3  Step 5: 27 ÷ 3 = 9  26 + 9  Step 6: 26 + 9 = 35  35  The value of the numerical expression [8(4 - 1) + 2] + 33 ÷ 3 is 35.  **Activity 2:** Parentheses in Expressions – “My Favorite No” Note: To prepare for this activity, watch a video that demonstrates My Favorite No being used. Distribute index cards or half sheets of paper. Display this expression: 46 – (26 - 2 + 8) ÷ 23 x 3. Give students 5 minutes to evaluate the expression. Instruct students to show each step of their calculations. At the end of the time collect the students’ work being careful not to reveal the students’ names. Go through the cards identifying those that have the work done correctly as “Yes” and those that have errors as “No”. Look for misconceptions (these will be called “My favorite no”) such as the following: • Adding 2 + 8 before you subtract 2 from 26 • Exponent: Multiplying 2 x 3 instead of 2x2x2 • Subtracting 24 from 46 before adding 8 • Subtracting 32 from 46 before doing exponents then division and multiplication • Multiplying before dividing • Not understanding that the last operation they will do is subtracting from 46. Select one card solved using a misconception to be your “Favorite No.” Copy the incorrect work for the problem on the board without changing it. Facilitate an open discussion about why the work is not correct. If a student says the work or answer you displayed is incorrect, have them offer a reason why it is incorrect and have them tell how they would correct it (SMP.3).  Note: If time allows, show more than one misconception.  **Activity 3**: Watch Out for Parentheses Distribute Handout 3.1: Watch Out for Parentheses Task. Instruct students to work independently to evaluate each expression and explain if any parentheses can be removed from the expressions without changing the values. Tell students to discuss their answers with their elbow buddy and critique their responses (SMP.3). Put students in groups to create a poster displaying their work for finding the value of each numerical expression and their answer and justification for the question (SMP.4). Tell students they will use the posters for a Gallery Walk in tomorrow’s lesson. Note: Students should be able to recognize the structure of the expressions and understand the purpose of the parentheses (SMP.7).  **Prompting Questions**:  • Why do we need a specific order to solve numerical expressions?  • What are the steps in the order of operations?  • Does the placement of parentheses in an expression affect the value of the expression? | | |
| **Lesson Closure** | | |
| Reflection and Closing: Review Activity 3 with the class using prompting questions. Prompting Questions: • Does moving the parentheses in a numerical expression change the value of the expression? • Why is it important to have a standard order for evaluating numerical expressions? • What is the Order of Operations? Distribute 2 index cards to each student. Instruct students to create 2 numerical expressions with multiple operations using parentheses and exponents. Instruct students to write each expression on a separate index card and write their name on the card. Tell students to exchange one card with a Crosstown Companion and then exchange the other card with a different Crosstown Companion.  On the index cards students received from their two crosstown companions, have students find the value of the 2 numerical expressions showing all the steps they used to solve the expression on the card. Have students write their name on the card  ***Exit Ticket: The students will create and solve his/her own problem using the order of operations correctly.*** | | **Essential Questions: Review at the end of the lesson**  • Why do we need a specific order to solve numerical expressions?  • What are the steps in the order of operations?  • Does the placement of parentheses in an expression affect the value of the expression? |
| **Standards for Mathematical Practice** (select all that apply) | | |
| * Make sense of problems and persevere in solving them. * Reason abstractly and quantitatively. * Construct viable arguments and critique the reasoning of others. * Model with mathematics. * Use appropriate tools strategically. * Attend to precision. * Look for and make use of structure.   * Look for and express regularity in repeated reasoning. | | |
| **Supplemental Activities** | | |
| **Intervention**   * Supply students with multiplication charts to assist with applying the operations. * Students will use an order of operations card during the activity. * **Extra Resources**   [*E:\Summer Lesson Plan Order of Operations\order of operations.ppt*](file:///E:\Summer%20Lesson%20Plan%20Order%20of%20Operations\order%20of%20operations.ppt)  **Interactive game for practice**  [*http://www.mathopolis.com/*](http://www.mathopolis.com/)  [*http://www.purplemath.com/*](http://www.purplemath.com/) | | **Enrichment**   * Allow students to play an Order of Operations Expressions Game if they finish their work early. This game can be used as an enrichment tool in this lesson for the students who have a strong foundation in the skill and can move forward. The game can also be used to differentiate presentation of the lesson. Before students begin the activity, set it up to your specifications. * **Interactive game for practice**   [*http://www.mathopolis.com/*](http://www.mathopolis.com/)  [*http://www.purplemath.com/*](http://www.purplemath.com/) |
| **Performance Based Assessment Task** | | |
| **Math Task**  The students will evaluate the placement of parentheses, exponents, multiplication, division, addition and subtraction in numerical expressions as they affect the value of the expression with 70% accuracy utilizing practice problems.  **Handout 3.1**  [*E:\Summer Lesson Plan Order of Operations\order of operations.ppt*](file:///E:\Summer%20Lesson%20Plan%20Order%20of%20Operations\order%20of%20operations.ppt)  **Interactive game for practice**  [*http://www.mathopolis.com/*](http://www.mathopolis.com/)  [*http://www.purplemath.com/*](http://www.purplemath.com/) | **Rubric/ Plausible Student Response(s)**  **Handout 3.1:** Watch Out for Parentheses Task – Key  sample problems to work | |