Go Ahead, Make My... Number

Order of Operations

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Grade Level	6th – 7th Grade	**Time Frame**	2-3 class period(s)
Subject	Mathematics	**Duration**	90 minutes
Course	Middle School Mathematics		

Essential Question

Why does order of operations matter in mathematics?

Summary

This lesson uses mathematical manipulatives to engage students in learning how to use order of operations for finding solutions to simple expressions. Students will explore concepts by playing three games to work with order of operations and to help develop computational fluency.

Snapshot

Engage

Students engage in the game Four 4's where they are asked to use four 4's and any operations they wish to obtain a whole number between 0 and 20.

Explore

Students use dice as a manipulative to explore and better understand order of operations and build computational fluency.

Explain

Students trade problems with a partner to check for accuracy and clarify misconceptions.

Extend

Students extend their learning by playing the game Target Number, which is similar to Four 4's but with more variation.

Evaluate

Students use the I Think/We Think strategy to make sense of order of operations while watching a short clip of Ma and Pa Kettle.

Standards

Oklahoma Academic Standards for Mathematics (Grade 5)

5.A.2.1: Generate equivalent numerical expressions and solve problems involving whole numbers by applying the commutative, associative, and distributive properties and order of operations (no exponents).

Oklahoma Academic Standards for Mathematics (Grade 5)

6.A.2.1: Generate equivalent expressions and evaluate expressions involving positive rational numbers by applying the commutative, associative, and distributive properties and order of operations to solve real-world and mathematical problems.

Oklahoma Academic Standards for Mathematics (Grade 5)

7.A.4.1: Use properties of operations (limited to associative, commutative, and distributive) to generate equivalent numerical and algebraic expressions containing rational numbers, grouping symbols and whole number exponents.

Attachments

- I Think, We Think - Spanish.docx
- I Think, We Think - Spanish.pdf
- I Think, We Think.docx
- I Think, We Think.pdf
- Parentheses.docx
- Parentheses.pdf

Materials

- Random polyhedral dice
- Operations dice
- Parentheses attachment, printed and each parenthesis cut out individually (You'll need one set of parentheses for each pair of students.)
- Pencils and paper
- I Think, We Think handouts
- Internet access

Engage

Ask a student to pick a whole number between 0 and 20. Write the number on the board.

Let students know that they will be working with their neighbor on this task.

Explain to students that their goal is to use four 4's and any operations they wish (addition, subtraction, multiplication, division) to make the number on the board.

For example, if the number is 15, students could take 4*4 - 4/4. This would give them 16 - 1 = 15. If the number is 0, students could use 4+4-4-4=0.

In each example, four 4's were used and the chosen number was obtained.

Play a few rounds of this game to get students in the mindset of arranging the number 4 in different ways to get the target number.

Guidance

Some students might ask if they can use radicals, exponents, parentheses, etc. These can all be permissible, but the exact rules that you employ are up to your discretion. Also, some numbers are more challenging to get to than others. If you notice students getting frustrated, feel free to pause and work out the solution as a whole class.

Once a few student pairs find a solution, ask one or two representatives to come to the board to write out their solutions.

With the solutions on the board, you will next add parentheses or brackets around students' operations so that they can begin seeing how order of operations works.

For example, if a student comes to the board and writes out 4+4/4+4 = 1, bracket (4+4) and (4+4) in order to make this equation true. Explain that without the parentheses if you used order of operations, you'd have to divide 4/4 first to get 1. Then 4+1+4 would actually be 9. Adding brackets or parentheses allows us to prioritize certain operations over others. The operation enclosed in parentheses takes precedence in the order of operations.

Explore

Explore/explain Spiral

This lesson's Explore phase will consist of three rounds. Each round will be followed by an Explain phase. In other words, you'll have students play one round of the game, and then follow it with one round of explaining (described below).

Students will continue working with their partner on this exploration.

Ask students to take out a sheet of paper to record their work. Distribute to each pair four random polyhedral dice, a set of parentheses (printed and individually cut from the lesson attachment), and three operational dice. Try not to distribute any red dice, as these will be used later in the Extend activity.

Explain to students that they will taking turns rolling dice and creating expressions for their partner to solve.

Ask students to determine which partner is number 1 and which is number 2.

Directions for student 1:

1. Roll one random polyhedral die.
2. Roll an operation die, placing it to the right of the first polyhedral die.
3. Roll another polyhedral die and place it to the right of the operation die.
4. Continue this process until all dice have been rolled.
5. If students wish, they can insert the parentheses anywhere in the expression.

Once all dice are rolled and arranged by student 1, ask student 2 to find the solution to the expression. Student 1 can help if needed.

After student 2 has found a solution to the expression, move to the Explain activity. Once students have completed the Explain phase, you'll then have them switch roles and repeat the Explore/Explain cycle.

Explain

Ask both students to look at the solution by student 2 to check for accuracy.

If there are mistakes, ask both students to figure out where they are and help one another clarify misconceptions that they might have had about how the expression could be solved. To help keep this process positive, ask students to use I Notice/I Wonder language. So, instead of saying something to the effect of, "That's wrong, do this!" Students would instead say, "I notice you did _____, I wonder what would happen if you tried_____."

Once students have agreed that the solution is accurate, have them go back to the Explore activity and switch roles. Student 2 will now roll the dice, and student 1 will solve the equation.

Continue this process for three or four rounds, or until you feel like students are grasping the concept.

Extend

To extend their understanding of order of operations, students will now play a game called *Target Number.* This game combines and builds upon ideas from the previous activities in this lesson.

Have students remain with their partner to play the game. They will keep all the dice and parentheses they already have, and you will distribute one additional red die to each pair. Explain to students that this red die represents their target number.

An Extra Challenge

If you have additional dice left over, feel free to add more operations and more numbers for an extra challenge—especially if you feel like students could use an extra push in their learning.

Instruct students to roll the red target number die and set it to the side.

Next, students will roll their remaining dice.

The goal for students is to rearrange the numbers and use operations in any form to get as close to the target number as possible. Students can also use their parentheses if they choose to do so.

Play at least three or four rounds of *Target Number*. Feel free to play longer if you think students need more practice or if you sense that they are enjoying the activity.

Evaluate

To evaluate students' understanding of order of operations, show a short video of Ma and Pa Kettle. As students watch, their goal is to figure out what Ma and Pa Kettle are doing and determine if Ma and Pa Kettle are correct in their thinking.

Pass out a copy of the I Think/We Think handout to each student. Or, ask students to make their own I Think/We Think chart by drawing a line down the middle of a sheet of paper and labeling the left side "I think" and the right side "We think."

Explain to students that they will watch a clip of Ma and Pa Kettle two times. After the clip is shown one time, ask students to individually write down, on the "I Think" side of their papers, what they think is happening in the clip without talking to their partner. You can prompt students with the following questions:

- What did you notice in the clip?
- What did Ma and Pa Kettle do?
- Why do you think they did this?

The clip of Pa and Ma Kettle is linked here.

Once students finish writing, show the clip one more time. Ask students to pay attention to Ma and Pa Kettle's reasoning.

After the clip plays through a second time, have students work with their partner to complete the "We Think" portion of their evaluation. Here, students can talk freely to their partner about what they think is happening.

Solicit some responses from the class.

Ask students to turn in their "I Think/We Think" reflections before they leave class.

Resources

- AllThingsScience (2011). Ma & Pa Kettle math [Video file]. Retrieved from https://www.dailymotion.com/video/xhp3ac
- Boaler, J. (2018). The four 4's. Retrieved from https://www.youcubed.org/tasks/the-four-4s/
- K20 Center. (n.d.). I notice, I wonder. Strategies. Retrieved from https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f507d1a7
- K20 Center. (n.d.). I think/we think. Strategies. Retrieved from https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f5065bfd