Exploring Order in Mathematics: Part 1 of 6 from the Unit: Deepening Understanding of Order of Operations

A Common Core-Aligned Lesson Plan to use in your Classroom

Author
Connie Rivera, Capital City YouthBuild

The activity

In this beginning lesson, students will build their self-efficacy (belief that they can be successful) with mathematics. They will realize that they already know of circumstances where the order of operations feels natural, such as the operations it takes to drive to work. They will connect this with mathematical orders they already understand, such as the commutative properties of addition and multiplication. From there they will explore and understand other conditions where order matters and where it doesn’t matter in math.

This introductory activity connects students’ knowledge about the world and their prior mathematical knowledge to the concept of the order of operations that they need as a foundation for algebra. This lays the ground work for conceptual understanding of the order of operations, so it will not be just a procedure followed without understanding.

Students will

- Apply properties of operations as strategies to add and subtract. CCS 1.OA.3
- Apply properties of operations as strategies to multiply and divide. 3.OA.5
- Construct viable arguments and critique the reasoning of others. MP.3

Resources needed:
- PowerPoint Presentation “Exploring Order in Mathematics”
- Print-out of the Order Cards for each pair of students (cut out and shuffled)

Approximate time:
- 35 minutes
**Instructions**

**Academic Vocabulary:** What domain or academic-specific words will you use in the lesson?

- **Commutative property of addition** – changing the order of the numbers you are adding (addends) does not change the result (or sum)

- **Commutative property of multiplication** – changing the numbers you are multiplying (factors) does not change the answer (product)

- **Distributive property** – multiplying a sum by a number gives you the same result as multiplying each of the added numbers separately and then combining them

1) **Intro:** Before class begins, bring up the PowerPoint Presentation, “Exploring Order in Mathematics” on the front screen.

   - When students walk into class, partner them and ask them to put the steps for getting to work in order. Ask for a volunteer to read the order of their steps for getting to work. Everyone will have relatively the same answer. “Sometimes the order is just logical.”

   - “In this real-life example, the order in which we perform operations matters.”

   - Sometimes activities have steps where the order does not matter. “What steps can I add in to this sequence where order would not matter?” Ideas: If I put on my seatbelt before I start the engine or I put on my seatbelt after I start the engine, the result is the same – I have my seatbelt on before I start driving. If I bring my coffee from home or I stop for coffee, I still have coffee before I get to work.
2) **Opening Discussion:**

- Ask students to consider how they would mentally add $1+2+3+4+5+6+7+8+9$ and share strategies. If it’s not shared, show animations on the slide demonstrating the idea of using ten-pairs.

- Lead a discussion about when order matters and when order doesn’t matter in mathematics. “**Does Order Matter in Mathematics?**” If students identify a property with a description, supply the proper name of the property. Look for evidence of MP.3 (Construct viable arguments and critique the reasoning of others.) If students are not able to give answers to this slide yet, do not give them. Instead, come back to this question after exploring some specific questions.

3) **Lesson:**

   a. Using the PowerPoint Presentation, continue with The Fair slide.

   “Ms. Delores is taking her children and grandchildren to the fair. Tickets to get in cost $4 each. She paid for 5 grandsons, 2 daughters, and herself.”

   Allow students time to answer the first two questions individually:

   - How much did Ms. Delores spend on her grandchildren’s tickets? Write an equation and show or explain how you solved the equation.

   - How much did Ms. Delores spend on adult tickets? Write an equation and show or explain how you solved the equation.

   “Does it matter if you multiplied the cost of the tickets by the number of grandsons or the number of grandsons by the cost of the tickets?” Lead students to naming the commutative property of multiplication, that $4 \times 5$ is the same as $5 \times 4$.

   On the board, ask students to share ways that they showed that these are the same. (For example, a 4 by 5 array can be rotated to show that it is also a 5 by 4 array.)
Repeat this process with the adult tickets question.

- "Now, write a new equation to show the total amount Ms. Delores paid for tickets to go into the fair." Because of the two equations they just wrote, students will likely answer in this format: $4 \cdot 5 + 4 \cdot 3$. Challenge students to write the full equation in another way.

- If students don’t think of it, guide them to noticing that the 4 is in both original equations and therefore using the distributive property, $4(5 + 3)$ could be written to express that situation. Show that these two expressions are equal by writing this equation on the board: $4(5 + 3) = 4 \cdot 5 + 4 \cdot 3$.

- Look back at the expression $4(5 + 3)$. "Do you have to start solving that with what is in the parenthesis?" Show the distributive property in action. Mention that it’s important for algebra success that they be flexible and see that there are two ways to look at this problem.

b) Put up the **Weekend Laundry** slide. The equation without context will show at the bottom of the screen: $3 \cdot 4 + 2 \cdot 5 =$. “What is the answer to this question?” Let students work through possibilities.

- “How many different answers to this question can there be? Can more than one answer be correct here?”

- Look for evidence of MP.3 (Construct viable arguments and critique the reasoning of others.) Do not give students the answer; instead, put up the context by advancing the animation.

- Allow time for students to calculate a new answer or confirm the answer they gave. Discuss. “So, did the order matter here?”
c) Advance to the **Pay-Day Shopping Splurge** slide. Only the context will show at first.

- “Write an expression that shows how to solve this. I’m not interested in the answer, but instead, I want to see how you could set up to solve this all in one expression.”
- “Does the order matter here?”
- “What would you change about this shopping trip to make this an example where order does not matter?” (possible answer: buy only one lip gloss)

d) Move on to the **Buffet** slide. Again, only the context will show at first.

- “Write an expression, all in one line, that shows how to solve this.”
- “Does the order matter here?”
- “Use the context of this buffet to come up with an equation where order does not matter?” (possible answer: buy exactly one unit of each item)

e) Lastly, visit the **Payroll Costs** slide. This slide will take more time for students to figure out.

- “If I owned this company and I wanted to calculate payroll costs, what would I need to do?”
- “Would order matter? In which parts would order matter?”
4) **Wrap Up:**

a) Revisit the question, “Does Order Matter in Mathematics?” This can be asked as a journal entry to assess students’ understanding. Ask for examples (subtraction, multiplication before addition, etc.) and non-examples (addition, multiplication, etc.) of order in mathematics. Review the properties of operations, such as the commutative properties of addition and multiplication and the distributive property. Look for evidence of MP.3 (Construct viable arguments...)

**Differentiated Instruction**

You can challenge more advanced learners to come up with multiple ways to write an expression for each scenario. They can be asked to change something in the scenario that would mean that the order would matter where it previously did not matter, or vice versa. Advanced learners could be challenged to create their own scenario.

**Success Tips**

- Avoid mentioning “the Order of Operations” or “PEMDAS (Please Excuse My Dear Aunt Sally)” so that students who do not make the connection will not rely on past habits that have not been beneficial to full understanding.

- Don’t be tempted to provide students with “the answer.” This is the time to hang back, expose their misconceptions, and build a foundation. Don’t rush; allow time for discussion.

- Be sure to download the PowerPoint Presentation so that you see the notes section for your own use. Use it from PowerPoint with your class so that the animations are in place.

- Change the names (or even pictures) within the PowerPoint Presentation to the names of people in your program.