

Why are Multiplication and Division Done before Addition and Subtraction?

Part 2 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

Students will understand the mathematical reason behind procedures that have you multiply before you add in a multistep problem.

By exploring a selection of examples in context, students see that we multiply before we add and subtract because we need to convert groups of items into single items before combining them. This builds a foundation of conceptual understanding for procedures they'll use later when they see numbers out of context.

Students will

- Understand that in adding two-digit numbers, one adds tens and tens, ones and ones. CCS 1.NBT.4
- Understand that in adding or subtracting three-digit numbers, one adds or subtracts hundreds and hundreds, tens and tens, ones and ones. CCS 2.NBT.7
- Explain ... using place value and the properties of operations. CCS 2.NBT.9
- Interpret 5×7 as the total number of objects in 5 groups of 7 objects each. CCS 3.OA.1
- Reason abstractly and quantitatively. CCS MP.2
- Look for and make use of structure. CCS MP.7
- Shift 2 – Coherence—“Coherence is about making math make sense. Mathematics is not a list of disconnected tricks or mnemonics. It is an elegant subject in which powerful knowledge results from reasoning with a small number of principles such as place value and properties of operations. The standards define progressions of learning that leverage these principles as they build knowledge over the grades.” (www.achievethecore.org)

Resources needed:

- PowerPoint Presentation "[Why are Multiplication and Division Done before Addition and Subtraction?](#)" (found on Google Drive)
- Video "[One is One... or is it?](http://ed.ted.com/lessons/one-is-one-or-is-it)" from TED-Ed (<http://ed.ted.com/lessons/one-is-one-or-is-it>) by Christopher Danielson
- 1 pencil per student
- 1 – 2 pieces of paper per student

Approximate time:

45-60 minutes

Instructions

Academic Vocabulary:

- *unit* – a fixed amount or measure used as a standard (related words: place value)
- *convert* – to change for something of equal value
- *like* – the same as (as in "like items")
- *expression* – a math phrase made of numbers, symbols, and operation signs grouped to show the value of something
- *equation* – a written statement showing equality between two expressions
- *context* – the circumstances that form the setting for a real-world math problem; the situation which presents a mathematical problem

1) Opening Discussion:

- a) Put up the PowerPoint Presentation, [Why are Multiplication and Division Done before Addition and Subtraction?](#) The title slide is purposely not first. Begin with the slide titled, "What is the total?" with this problem: $3 + 7 \cdot 5$.
 - Ask students, "How would you read this problem?" "What answer do you think the answer is?" (50 or 38)
 - "Instead of reading '3 plus 7 times 5,' what if we read '3 plus (or 'added to' or 'combined with') 7 sets of 5'?" Does that change your answer?"
 - Advance the slide to show the context. How much money would Luz have if she had 3 pennies and 7 nickels? "Now what answer do you think the

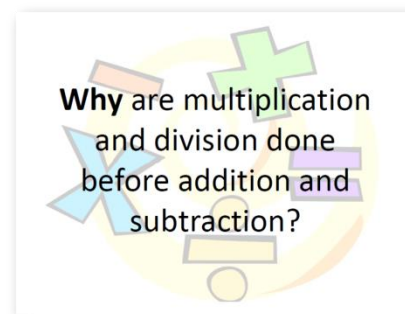
answer is?" (38) "Why?" Listen to participants' responses. "How did you know to convert the nickel into cents? How did you know how to do the multiplication, before the addition?" (unit conversion)

- "Using context is one way that we can arrive at a reasonable answer. It's easier to understand than 'naked numbers'." "So, did you have to do addition or multiplication first to get the right answer?"

2) Lesson:

- a) Click to the **title slide** of the presentation and tell students that this is the Essential Question that will be explored and answered during class. Ask them to jot down their initial thoughts. They don't need to share it and can make adjustments as they go.

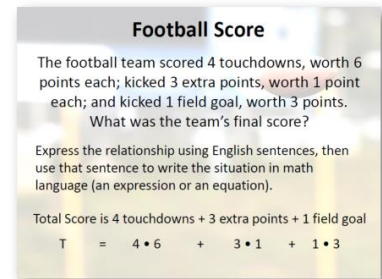
- The first piece of considering our essential question is to use context to explain how $2 + 8 = 28$ could be true in a context where each does not represent the number of ones. "When we look at $2 + 8$ as naked numbers, we automatically think of them as ones. If they are ones, they will never equal 28." "How can we turn this into a true equation? Two what-cha-ma-call-its added to 8 something-or-others makes 28 whose-a-majigs."



- Allow time for students to think of an idea; ask them to share contexts where $2 + 8$ could equal 28. Click through the next slides to show some possible answers. Use the animations to show a transition between the descriptive words used for the context and the letters used in algebra. Summarize this by pointing out that the 2 represents a group of something and the 28 represents single objects. (MP.7 Students are looking for structure.)
- b) Go now to the slide headed: '**How do you go about adding ...**' and ask the students, "How would you go about adding *two-thousand, four hundred sixteen* and *seven hundred fifty-three*?" Collect one to two student strategies.
- "Why do many of us rewrite the problem vertically?" "Why are you lining it up? Why do the 4 and the 7 have to be added together?" The 4 is actually

400 and the 7 is actually 700.

- Summarize what students have said, or finish the slide by saying: "We have to add ones with ones, tens with tens, etc. We must add *like things*." Click to the animation that to show place value view.
- c) On the next slide, **Football Score**, read the situation for the students. Ask them to "Express the relationship using English sentences and then use that sentence to write the situation in math language (an expression or an equation)."
- Many students will want to just get to the answer. Insist that they write English sentences first! This is not about finding the correct answer; it's about building a foundation for algebra through understanding and writing expressions.
 - The animation on this slide will give an example of how this can be done. If the class needs to see a sample, run through these pieces together instead of giving them time to complete it individually.
 - Address the fact that the touchdown and the field goal had to be converted to points (like items) before the subtotals could be combined for the final score, given in the unit – points.
- d) There are several more word problems on the next slides (**Christmas Shopping**, **Back to School Shopping**, and **Basketball Score**).



Football Score

The football team scored 4 touchdowns, worth 6 points each; kicked 3 extra points, worth 1 point each; and kicked 1 field goal, worth 3 points. What was the team's final score?

Express the relationship using English sentences, then use that sentence to write the situation in math language (an expression or an equation).

Total Score is 4 touchdowns + 3 extra points + 1 field goal

$T = 4 \cdot 6 + 3 \cdot 1 + 1 \cdot 3$

- Decide which ones are appropriate for your students and how many examples they need to feel comfortable with the concept that multiplication is done to convert items to like units before combining them.



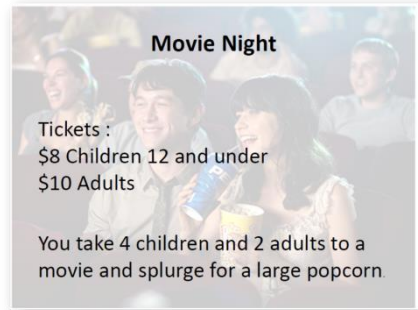
Back to School Shopping

You buy your son a pair of pants for \$15 and five uniform shirts that are \$12 each. You have a coupon for \$5 off pants.

Express the relationship using English sentences, then use that sentence to write the situation in math language (an expression or an equation).

e) Continue with the **Movie Night** slide.

- “The context here is Movie Night. What story can you give this to create a series of operations?” Write up a situation in English sentences, and then write it in math language.” Click for an English example on this animated slide.
- Ask several students to share their English sentences and ask other students to give the math sentences that would match up. *For example, if a student shares the English: 4 children at \$8 each and 4 adults at \$10 each and drinks are \$2 per person, the math may look like this: $4(8) + 4(10) + 2(8)$.*
- Use an opportunity such as this to say something like: “The number 8 in the expression means two different things. What does it mean to multiply a person and a dollar value?” “What is our unit?” Dollars per person. “Can we add a person to a dollar?” No, we are converting everything to dollars.

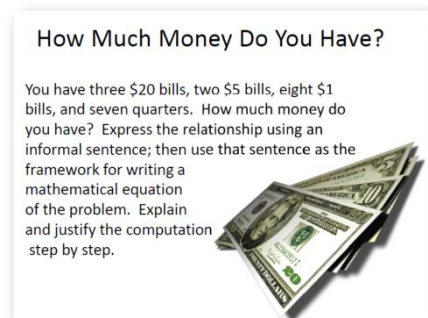


f) Show **Multiply and then Add** slide. “So, we’ve established that we must multiply before we add. Notice that in our traditional algorithm for multiplication we also multiply before we add.”

g) With the next slide, **We need to Add and Subtract LIKE Items**, review a few of the past examples to drive home the point that the units must be the same.

h) Play the [One is One... or is it?](#) TED-Ed video by Christopher Danielson.

i) For one last concrete example, practice using the slide: **How Much Money Do You Have?**



3) **Wrap Up:**

- a) Click to the next slide. "This was our essential question today. On your paper, put into words an explanation to the question: **Why Are Multiplication and Division Done before Addition and Subtraction?**"

- Collect these papers to review and respond to students. Students should have answered something in their own words that gets across the concept: Multiplication and division are done before addition and subtraction in order to convert *groups of items* into *subtotals of like items* that can be combined for the total.

- 4) **Evidence of Success (Formative Assessments):** What exactly are students expected to be able to do by the end of the lesson, and how will mastery be measured? What would outsiders see that would convince them that students have developed a deep understanding?

- Students will answer the essential question at the end of the lesson. They will answer the question in writing so that the teacher may review and respond to it.

Differentiated Instruction

Many opportunities for exploring the essential question exist within the lesson. If a student is finishing these accurately at a faster pace than other students, as you circulate you might challenge them to write the same expression in a different order (commutative property) or to apply the distributive property to their expression (if applicable) to write it in a new way.

If a student is struggling, be sure to relate the essential question back to the specific contexts. "Why did we multiply the number of shirts by the cost of one shirt? Why can't we multiply the number of shirts by the cost of the pants?" Revisit several examples before asking students to generalize with the essential question.

If you removed some of the examples from the slides for the whole class, consider using them to reinforce concepts for any students who are still unsure of the answer to the essential question.

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.
- 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 rather than from Google Drive 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.