

Cluster 2: Using Models to Explore Properties of Multiplication and Division

Duration: 4-5 weeks

Content Standards:

This list includes standards that will be addressed in this cluster, but not necessarily mastered, since all standards are benchmarks for the end of the year. Please note strikethroughs and recommendations in the Important Considerations section for more information.

NC.5.OA.2

Write, explain, and evaluate numerical expressions involving the four operations to solve up to two-step problems. Include expressions involving:

- Parentheses, using the order of operations.
- Commutative, associative and distributive properties.

NC.5.NBT.5

Demonstrate fluency with the multiplication of two whole numbers up to a three-digit number by a two-digit number ~~using the standard algorithm.~~

NC.5.NBT.6

Find quotients with remainders when dividing whole numbers with up to four-digit dividends and two-digit divisors using rectangular arrays, area models, repeated subtraction, partial quotients, and/or the relationship between multiplication and division. ~~Use models to make connections and develop the algorithm.~~

NC.5.MD.4

Recognize volume as an attribute of solid figures and measure volume by counting unit cubes, using cubic centimeters, cubic inches, cubic feet, and improvised units.

NC.5.MD.5

Relate volume to the operations of multiplication and addition.

- Find the volume of a rectangular prism with whole-number side lengths by packing it with unit cubes, and show that the volume is the same as would be found by multiplying the edge lengths.
- Build understanding of the volume formula for rectangular prisms with whole-number edge lengths in the context of solving problems.
- Find volume of solid figures with one-digit dimensions composed of two non-overlapping rectangular prisms.

Mathematical Practices:

- 1. Make sense of problems and persevere in solving them**
- 2. Reason abstractly and quantitatively**
3. Construct viable arguments and critique the reasoning of others
- 4. Model with mathematics**
- 5. Use appropriate tools strategically**
- 6. Attend to precision**
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

What is the mathematics?

- Students explore volume with multiple experiences building rectangular prisms with unit cubes (ex. cm. cubes, inch cubes, non-standard units - sugar cubes, wooden blocks, etc.). Through discussions of their buildings they develop a common language for describing their prisms (ex. Rows, columns, layers, length, width, base, height, etc.) and connect that language to symbolic notation (ex. A base of 3 rows and 4 columns with 5 layers can be written as $3 \times 4 \times 5$). Through these experiences students develop the formula for volume.
- Students model the associative property of multiplication by showing that the volume of a rectangular prism is the same no matter the orientation [ex. $(3 \times 4) \times 5 = 3 \times (4 \times 5)$ or a prism turned on the 3×4 base with 5 layers is the same when oriented to use the 4×5 as the base with 3 layers].
- Students review mental and alternative multiplication and division strategies from fourth grade (ex. Area models and length models; Strategies based on distributive, associative, commutative, and identity properties). They connect strategies based on the associative property to their work with volume.

Example: 14×5 using associative property to solve

- 14 can be decomposed into 7×2 so that the problem reads $(7 \times 2) \times 5$
- Grouping of factors can be rearranged to make the problem easier to solve mentally.
 $(7 \times 2) \times 5 = 7 \times (2 \times 5) = 7 \times 10 = 70$
- Students extend work to use models and strategies when solving real-world and word problems with bigger numbers in multiplication and division.
- Students develop an understanding of Order of Operations as they record their thinking symbolically.

Important Considerations:

- This cluster does not include developing the standard algorithms for multiplication and division. Algorithm development occurs in Cluster 6. However, if students have had previous experience with the algorithm use this as a point of discussion by asking them to show why the procedure works by using strategies including but not limited to partial products, area models, or other place value strategies.
- Beginning with volume with single digit side lengths allows for multiplication practice at the beginning of the year for students who have not yet mastered multiplication facts.
- Rather than memorizing the properties in generalized form, at this stage, students learn properties by solving multiplication and divisions problems in multiple ways and making connections among those strategies (ex. in a number talks, problem-solving in context, etc.) and the properties that allow them to work.
- Show the connection between multiplication and division. Strategies will be inverses to allow for conceptual understanding.

