MA.5.AR.2.2

Overarching Standard: *MA.5.AR.2 Demonstrate an understanding of equality, the order of the operations and equivalent numerical expressions.*

Benchmark of Focus

MA.5.AR.2.2: Evaluate multi-step numerical expressions using order of operations.

Examples: Patti says the expression 12 ÷ 2 × 3 is equivalent to 18 because she works each operation from left to right. Gladys says the expression 12 ÷ 2 × 3 is equivalent to 2 because first multiplies 2 × 3 then divides 6 into 12. David says that Patti is correctlyusing order of operations and suggests that if parentheses were added, it would give more clarity.

Benchmark Clarifications

Clarification 1: Multi-step expressions are limited to any combination of arithmetic operations, includingparentheses, with whole numbers, decimals and fractions.

Clarification 2: Within this benchmark, the expectation is not to include exponents or nested groupingsymbols.

Clarification 3: Decimals are limited to hundredths. Expressions cannot include division of a fraction bya fraction.

Related Benchmark/Horizontal Alignment

- MA.5.NSO.1.1
- MA.5.NSO.1.2
- MA.5.NSO.1.3
- MA.5.NSO.1.4
- MA.5.NSO.1.5
- MA.5.NSO.2.3
- MA.5.NSO.2.4
- MA.5.NSO.2.5
- MA.5.FR.1.1
- MA.5.FR.2.1

Vertical Alignment

Previous Benchmarks	Next Benchmarks
MA.4.AR.2.1	MA.6.NSO.2.3
MA.4.AR.2.2	MA.6.AR.1.3

Terms from the K-12 Glossary

- Expression
- Order of Operations

Purpose and Instructional Strategies

The purpose of this benchmark is for students to use the order of operations to evaluate numerical expressions. In Grade 4, students had experience with numerical expressions involving all four operations (MA.4.AR.2.1/2.2), but the focus was not on order of operations. InGrade 6, students will be evaluating algebraic expressions using substitution and these expressions can include negative numbers (MA.6.AR.1.3).

- Begin instruction by exposing student to expressions that have two operations without any grouping symbols, before introducing expressions with multiple operations. Use thesame digits, with the operations in a different order, and have students evaluate the expressions, then discuss why the value of the expression is different. For example, have students evaluate $6 \times 3 + 7$ and $6 + 3 \times 7$.
- In Grade 5, students should learn to first work to simplify within any parentheses, if present in the expression. Within the parentheses, the order of operations is followed. Next, while reading left to right, perform any multiplication and division in the order inwhich it appears. Finally, while reading from left to right, perform addition and subtraction in the order in which it appears.
- During instruction, students should be expected to explain how they used the order of operations to evaluate expressions and share with others. To address misconceptions around the order of operations, instruction should include reasoning and error analysistasks for students to complete (MTR.3.1, MTR.4.1, MTR.5.1).

Common Misconceptions or Errors

- When students learn mnemonics like PEMDAS to perform the order of operations, theycan confuse that multiplication must always be performed before division, and likewiseaddition before subtraction. Students should have experiences solving expressions with multiple instances of procedural operations and their inverse, such as addition and subtraction, so they learn how to solve them left to right.
- Copy bullet points, screen shot any images if necessary

Questions to ask students:

- How can you use the order of operations to solve $24 \div 6 \times 2$?
- Sample answer that indicates understanding: multiplication and division are interchangeable (because division is the opposite of multiplication) in order of operations, so we work left to right. In this example we should first divide $24 \div 6 = 4$, then multiply $4 \times 2 = 8$.
- Sample answer that indicates incomplete understanding or misconception: multiplication has to be done before division, (often students memorize the acronym PEMDAS or “My Dear Aunt Sally) so $6 \times 2 = 12$, then $24 \div 12 = 2$.

- How does changing the position of the parenthesis change the order in which the operations are solved?
- Sample answer that indicates understanding: The operation that is in the parenthesis will always be solved first.

- Write an example of a word problem that represents the expression $24 \div 6 \times 2$.
- Sample answer that indicates understanding: There were 24 apples. They were separated equally into 6 different bags. The number of apples in each bag was then doubled. How many apples were there altogether?

Instructional Tasks

Instructional Task 1

The two equations below are very similar. Are both equations true? Why or why not?

Equation One: $4 \times 6 + 3 \times 2 + 4 = 34$

Equation Two: $4 \times (6 + 3 \times 2 + 4) = 64$

Instructional Task 2

Part A. Insert one set of parentheses around two numbers in the expression below. Then evaluate the expression.

$40 \div 5 \times 2 + 6$

Part B. Now insert one set of parentheses around a different pair of numbers. Then evaluatethis expression.

$40 \div 5 \times 2 + 6$

Instructional Items

Instructional Item 1

What is the value of the numerical expression below:

$(2.45 + 3.05) \div (7.15 - 2.15)$

Instructional Item 2

A numerical expression is evaluated as shown.

$\frac{1}{2} \times (3 \times 5 + 1) - 2$

In which step does the first mistake appear?

a. Step 1: $\frac{1}{2} \times (15 + 1) - 2$

b. Step 2: $\frac{1}{2} \times 14$

c. Step 3: $\frac{14}{3}$

d. Step 4: 7

Achievement Level Descriptors

Benchmark	Context	Assessment Limits
MA.5.AR.2.2 Evaluate multi-step numerical expressions using order of operations.	Mathematical	Items containing fractions will not include decimals. Items containing decimals

Example: Patti says the expression 12 ÷ 2 × 3 is equivalent to 18 because she works each operation from left to right. Gladys says the expression 12 ÷ 2 × 3 is equivalent to 2 because first multiplies 2 × 3 then divides 6 into 12. David says that Patti is correctly using order of operations and suggests that if parentheses were added, it would give more clarity. Clarification 1: Multi-step expressions are limited to any combination of arithmetic operations, including parentheses, with whole numbers, decimals, and fractions. Clarification 2: Within this benchmark, the expectation is not to include exponents or nested grouping symbols. Clarification 3: Decimals are limited to hundredths. Expressions cannot include division of a fraction by a fraction.			will not include fractions. Expressions will not exceed three operations. Denominators will be limited to 1–10, 12, 16, 20, 50, and 100.

ALD 2	ALD 3	ALD 4	ALD 5
Evaluates a two-step expression involving adding and subtraction using order of operations.	Evaluates multi-step expressions using order of operations but no use of parentheses	Evaluates multi-step numerical expressions using order of operations	Uses error analysis for determining whether a given evaluated expression includes an error at any given step in the evaluation process and evaluates multi-step numerical expressions using order of operations.

Additional Resources:
CPALMS Resources

Khan Academy: Order of Operations

Blog Post: A World Without Order (of Operations)

Resources/Tasks to Support Your Child at Home:

Khan Academy: Evaluating Expressions with and without Parenthesis

Order of Operations Quiz