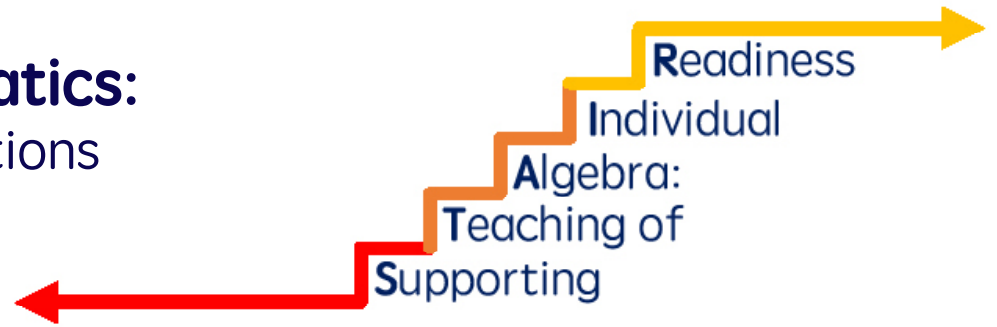# Ideas in Mathematics:
Properties of Operations

Did you know...
• A solid understanding of the properties of operations is necessary for the successful completion of problem-solving tasks!

Why?
• Understanding mathematical properties of operations enables students to generalize and apply their understanding of each type of operation to a variety of mathematical contexts.

• There are four basic operations that students must understand:

Addition Subtraction Multiplication Division

Ideas in Mathematics:
Properties of Operations

Readiness
Individual
Algebra:
Teaching of
Supporting

Let's take a closer look!

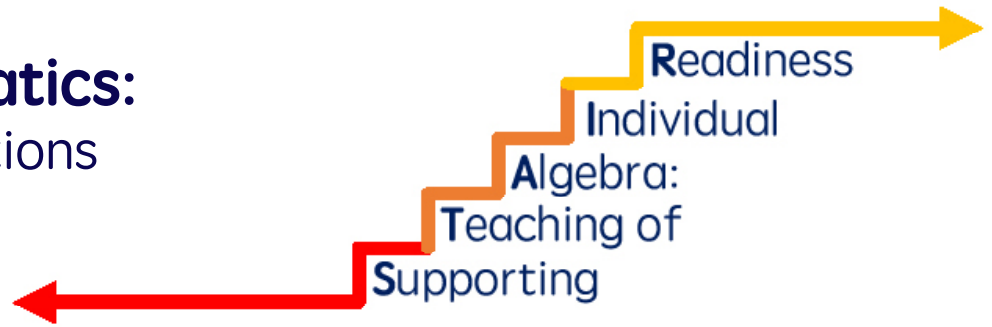| Property Type	Definition	Example
Associative property of addition	If three whole numbers (a,b,c) are being added: 1. The sum will be the same when the first two are added first and that sum is added to the third number, or 2. The second two numbers are added first and that sum is added to the first number $(a + b) + c = a + (b+c)$	Jenny has 2 pencils, 6 markers, and nine pieces of paper in her backpack. Mark has 9 pencils, 2 pieces of paper, and six markers in his backpack. Who has the most school supplies? $a=2, b=6, c=9$ $(2 + 6) + 9 = 2 + (9 + 6)$ $8 + 9 = 2 + 15$ $8 + 9 = 17$ $2 + 15 = 17$
Commutative property of addition	When we add whole (a,b) numbers in any order, the sum will not change $a + b = b + a$	$a = 8$ and $b = 3$ $8 + 3 = 3 + 8$ $8 + 3 = 11$ $3 + 8 = 11$
Additive identity property of 0	The whole number 0 is called the additive identity, because when we add 0 to any whole number, the sum is identical to that whole number. $a + 0 = a$ $0 + a = a$	$a = 13$ $13 + 0 = 13$ $0 + 13 = 13$
Existence of additive inverses *also called zero pair	For every a there exists −a so that: $a + (-a) = (-a) + a = 0$	$a = 6$ $6 + (-6) = (-6) + 6 = 0$

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Algebra:
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Supporting

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Property Type	Definition	Example
Associative property of multiplication	When we multiply three whole numbers, the product will be the same if: 1. The first two are multiplied first and that product is multiplied by the third, or 2. If the second two numbers are multiplied first and that product is multiplied by the third number. $(a \times b) \times c = a \times (b \times c)$	$a = 5, b = 3, c = 4$ $(5 \times 3) \times 4 = 5 \times (3 \times 4)$ $15 \times 4 = 12 \times 5$ $15 \times 4 = 60$ $12 \times 5 = 60$
Commutative property of multiplication	The product of two whole numbers is the same, no matter the order of the factors. $a \times b = b \times a$	$a = 9$ and $b =$ $9 \times 5 = 45$ $5 \times 9 = 45$
Multiplicative identity property 1	In multiplication, the whole number 1 is called the multiplicative identity. The product of a whole number multiplied by 1 is identical to that whole number. $a \times 1 = 1 \times a$	$a = 16$ $16 \times 1 = 16$ $1 \times 16 = 16$
Existence of multiplicative inverses	The multiplicative inverse of a number is such that the product of a and this number equals 1. It is the reciprocal of the number, $1/a$, because $a(1/a) = 1$	$a = -3$ $(-3)(-1/3) = 1$ Thus, the multiplicative inverse of -3 is $-1/3$

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Property Type	Definition	Example
Distributive property of multiplication over addition	The distributive property of multiplication over addition $a \times (b + c) = a \times b + a \times c$ *the letter a outside the ( ) gets multiplied by each letter inside the ( )*	$a = 5, b = 3, c = 4$ $5 \times (3 + 4) = 5 \times 3 + 5 \times 4$ $15 + 20 = 15 + 20$

Additional Resources:

https://iris.peabody.vanderbilt.edu/wpcontent/uploads/pdf_case_studies/ics_alg1.pdf

http://pressbooks-dev.oer.hawaii.edu/math111/chapter/properties-of-operations/

https://ies.ed.gov/ncee/wwc/Docs/PracticeGuide/MPS_PG_043012.pdf