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Fostering Pre-service Teachers' Understanding of Basic Arithmetic Principles

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FOSTERING PRE-SERVICE TEACHERS' UNDERSTANDING OF BASIC ARITHMETIC PRINCIPLES

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GOAL OF THE INSTRUCTION

- provide best quality education to the students
- teachers' mathematical understanding and knowledge has a profound impact on instruction and student achievement (NMAP, 2008; NCTQ, 2008; Hill et al., 2005).
- The most effective teachers have better conceptual understanding of the content they are teaching (Ball, Hill, & Bass, 2005; Kahan, Cooper, & Bethea, 2003; Ma, 1999)

ARITHMETIC PROPERTIES

- Rules of arithmetic for addition and multiplication are:
  - Commutative Property, $a + b = b + a$ [or $a \cdot b = b \cdot a$]
  - Associative Property, $a + (b + c) = (a + b) + c$ [or $a(b \cdot c) =$

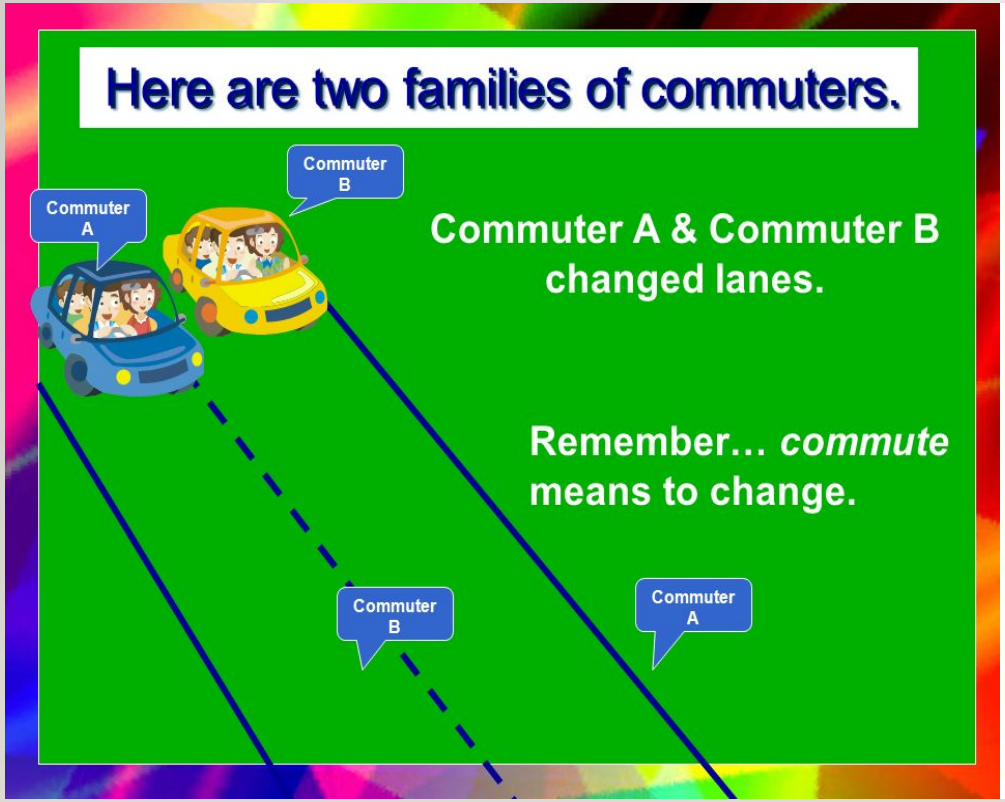
WHY LEARNING ARTHMEIC PROPERTIES IS IMPORTANT?

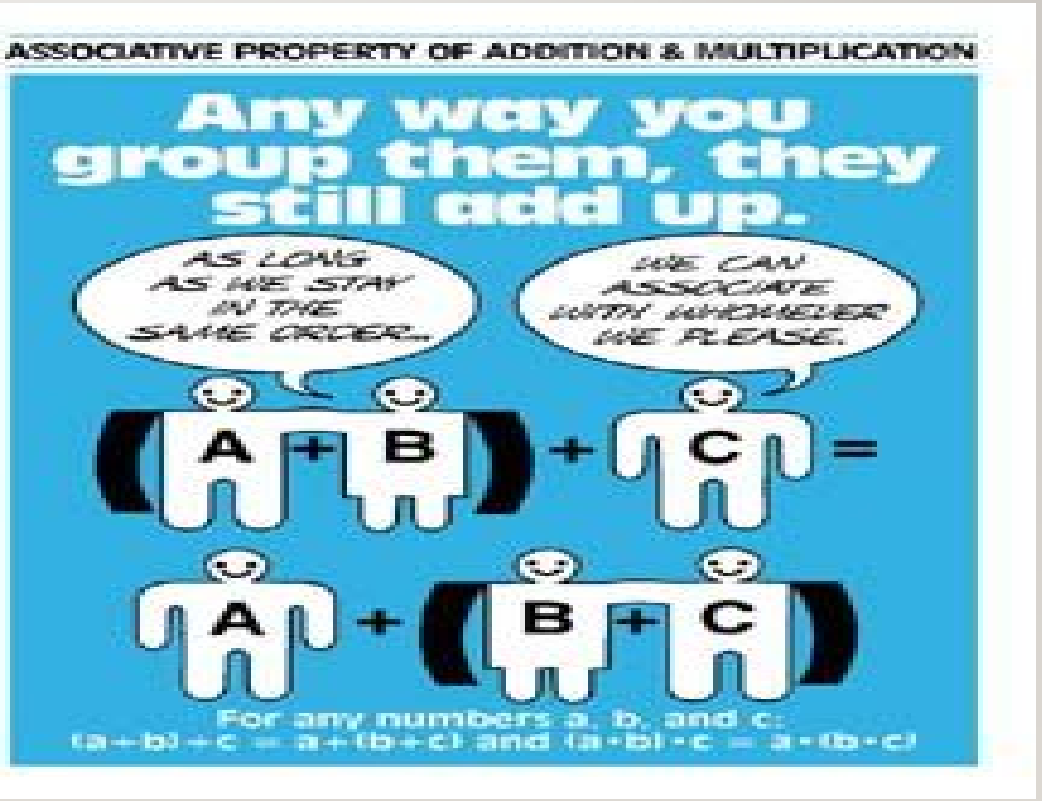
- Arithmetic properties provide one of the most critical avenues to higher-level thinking and conceptual understanding.
- These properties aid in simplifying computation, understanding mathematical structure, problem-solving, and developing multiple representation of a problem.
- Goal of various national and state level standards (e.g., common core).

COMMUTATIVE AND ASSOCIATIVE PROPERTY

- Commutative comes from the word ”commute” meaning changing, replacing, or exchanging. Changing the order does not change the result. For example, $6 \times 9 = 9 \times 6$.
- Associative comes from the word “associate” meaning joining or grouping. This means, under given operation same result is obtained by grouping, as long as their order remains the same. For example, $(18 + 24) + 6 = 18 + (24 + 6)$.

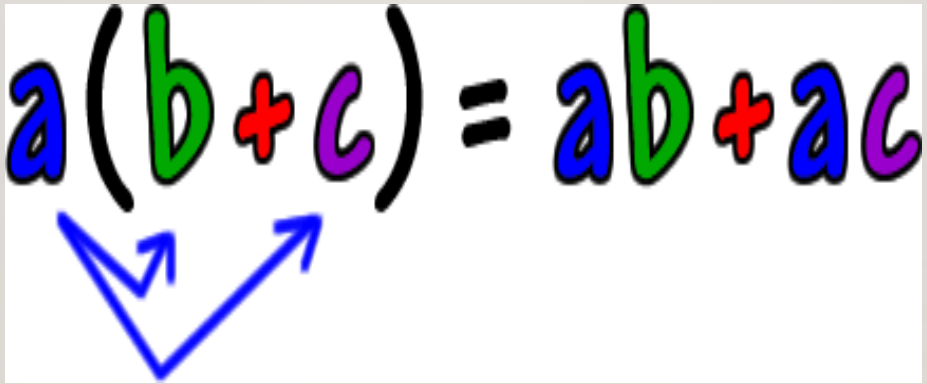
COMMUTATIVE AND ASSOCIATIVE PROPERTY





DISTRIBUTIVE PROPERTY

- Distributive comes from the word "distribute" meaning to pass-out or divide in shares. For example, $2 \times (6 + 9) = 2 \times 6 + 2 \times 9$.



COMMON MISCONCEPTIONS

- Commutative property can only be applied to two addends (or factors) and associative property is applicable only in the cases of three addends (or factors).
  - $a + (b + c) = (b + c) + a$
  - $a + (b + c) + d = a + b + (c + d)$
- Distributive property holds when addition is replaced by subtraction, but situation is more complex when multiplication is replaced by division. For example, holds true for $\frac{(b+c)}{a} = \frac{b}{a} + \frac{c}{a}$, but is not true for $\frac{a}{(b+c)} = \frac{a}{b} + \frac{a}{c}$.

DESIGN AND INTERVENTION

- A pretest and a posttest design was used.
- The participants (65 pre-service teachers) received intervention after the pretest to
  - Develop a thorough understanding of the basic properties
  - Using basic properties as a tool for problem-solving.
  - Build preservice teachers confidence in using the basic properties.

PRETEST AND POSTTEST

- The pretest and posttest were identical and involved deciding which of the five arithmetic properties, if any, apply to each of the 15 equations and then rating the confidence in the answer (rating based on 3 means *certain*, 2 means *somewhat certain*, 1 means *somewhat unsure*, and 0 means *unsure*).

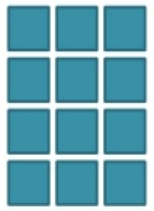
INTERVENTION

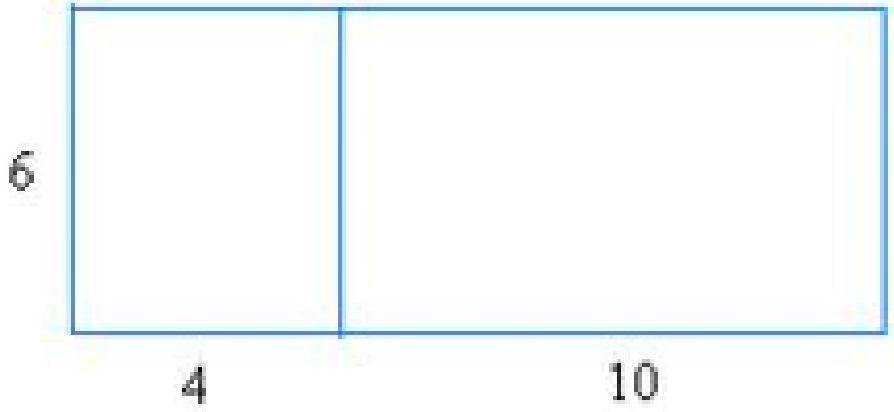
- Understanding properties by rewriting many equations, using base-10 blocks and manipulatives, word problems, and looking at examples and non-examples.
- Explaining and defining the properties used
  - For example, solving $2 \times 16 \times 2 = \ 2 \times 2 \times 16 = 4 \times 16 = 4 \times 10 + 4 \times 6 = 40 + 24 = 64$

INTERVENTION

Commutative Property

- Two numbers can be multiplied in any order and the product (answer) will be the same
- Example
- 4x3=12 3x4=12



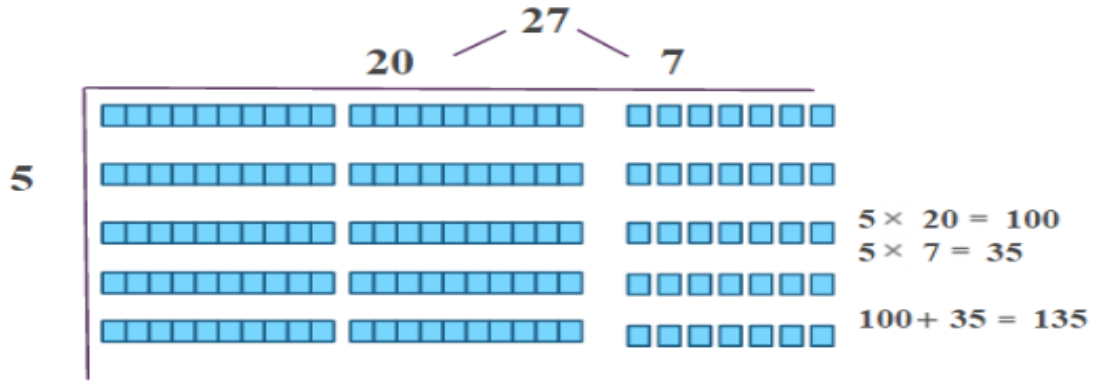


$$\text{Area} = 6*(4+10) = 6*4+6*10$$

Distributive property

INTERVENTION

Creating arrays with base ten blocks helps us think about place value, so we multiply multi-digit numbers more efficiently.



We can solve multiplication problems using place value decomposition and the distributive property.

RESULTS

- A comparison pf participants performance in the pretest and posttest using t-test revealed
- Significant difference between the pre-and post-test for problems involving use of the commutative, associative, and identity properties with $t(64)=1.8$, $t(64)=1.93$, $t(64)=1.97$ respectively.
- For the distributive property, there was marginally significant difference between participants responses with $t(64)=1.6$.
- Participants' confidence level was also compared for the four properties and it improved by at least one point for all the problems from pre-test to post-test

CONCLUSION AND SIGNIFICANCE OF THE RESULTS

- The results reveal efficacy of the intervention in imparting knowledge and understanding of the commutative, associative, and identity properties.
- Importance of active-learning.
- The results for the pretest reveal that more than half of the participants did not answer the basic properties used correctly. This suggest that there is an urgent need for pre-service teacher training programs to focus on the content knowledge and identify the areas where content knowledge is lacking and needs to be improved.

QUESTIONS?

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