Sample Activity: Bowling With Numbers

Instructor Notes A3

	Simplifying using the order of operations is a skill thatis necessary for becoming proficient with algebra.
	Note how most students will likely anticipate the solution as a single number. However, they may not anticipate that the solution will be a fraction or decimal.
	The distributed practice approach is particularly effective with developing skill with order of operations as students will encounter several problems employing this skill.
	Ask: "Why do you think we have order of operations?" "Do you think there is a mathematical reason for the rules for the order of operations or were they arbitrarily decided?" "How do you remember the order of operations?" "What does it mean that multiplication and division happen in the same order and that addition and subtraction happen in the same order?" "Why do we work from left to right? Do we always need to work from left to right?"

TWA - A3

Order of Operations

There are conventions or rules for simplifying computation problems that must be followed known as the order of operations. The order of operations indicate that computations must be done in the following order: parenthesis (or grouping symbols), exponents, multiplication and division, and addition and subtraction. This order is often abbreviated as **PEMDAS**.

The order is an agreed upon convention. One way to think about order of operations is that order of operations is followed so that answers to computation problems will be the same. While there is some disagreement about the rationale for the order of operations, our perspective is there is no mathematical reason for the order of operations. In this view, people doing mathematics were getting different answers to the same problem like 12 + 3 x 2, and they decided to come to an agreement so that everyone would get the same answer. Students must memorize the order and how to apply them. There is no mathematical justification for doing one operation before another.

To remember the order, people often use the mnemonic **PEMDAS** (pronounced "pem-dass,""pem-dozz," or "pem-doss"). People remember one of the following phrases to memorize the order: **P**lease **E**xcuse **M**y **D**ear **A**unt **S**ally or **P**urple **E**lves **M**arching **D**own **A**lfalfa **S**treet.

Another confusing aspect of the order of operations is even though M comes before D, multiplication and division are done during the same order and should be done from left to right. Likewise, even though A is before S, addition and subtraction are done during the same order and should be done from left to right.

While homework problems may involve multiple calculations, problems often arise with basic expressions like:

$24 - 8 + 2$ or $6 \div 3 \times 2$

In the first problem, addition and subtraction should be done from left to right. In the second expression, multiplication and division should be done from left to right. Following this rule, the solutions are:

$24 - 8 + 2$	$6 \div 3 \times 2$
$16 + 2$	2×2
18	4

Common errors are: 1) computational errors, 2) forgetting to write down or “bring” down part of the problem, 3) losing a negative sign, or 4) applying the order of operations in the wrong order.

Here is a worked-out example involving multiple calculations with the order calculation written to the right:

$17 - (7 - 5)^2 \times 12 \div 6 + 1$	Parenthesis
$17 - 2^2 \times 12 \div 6 + 1$	Exponents
$17 - 4 \times 12 \div 6 + 1$	Multiplication and Division (left to right)
$17 - 48 \div 6$	Multiplication and Division
$17 - 8 + 1$	Addition and Subtraction (left to right)
$9 + 1$	Addition and Subtraction
10	

Activity A3- Bowling with Numbers

Students will have opportunities to practice computation mentally. The activity lends itself to the idea of grouping symbols and the application of parentheses. The activity can be extended to work with exponents.

Directions:

Display the game sheet using a projector, a smart board, a document camera, a sketch of the game sheet on a board, or similar tool. Play the game once with the class.

The pair work expectations are slightly different with this activity. **Each student should get one game sheet.** They are not playing against their partner but they must rely on their partner. Each student will roll three dice. Each will work individually to knock down the pins. Before they go on, each student must trade papers with their partner to see if they can find more solutions. After they have checked each other, they can roll again. When they are finished, they again check each other's game sheets and then can get another game sheet.

Students must use all three numbers rolled and they cannot use double digits. For example, if a student rolls a 2, 4 and 4, they CANNOT use $24 \div 4 = 6$.

Strikes are very difficult to get. Decide if you will allow exponents. Without exponents, there is only one combination of numbers that yield a strike. With exponents, there are several combinations that give a strike.

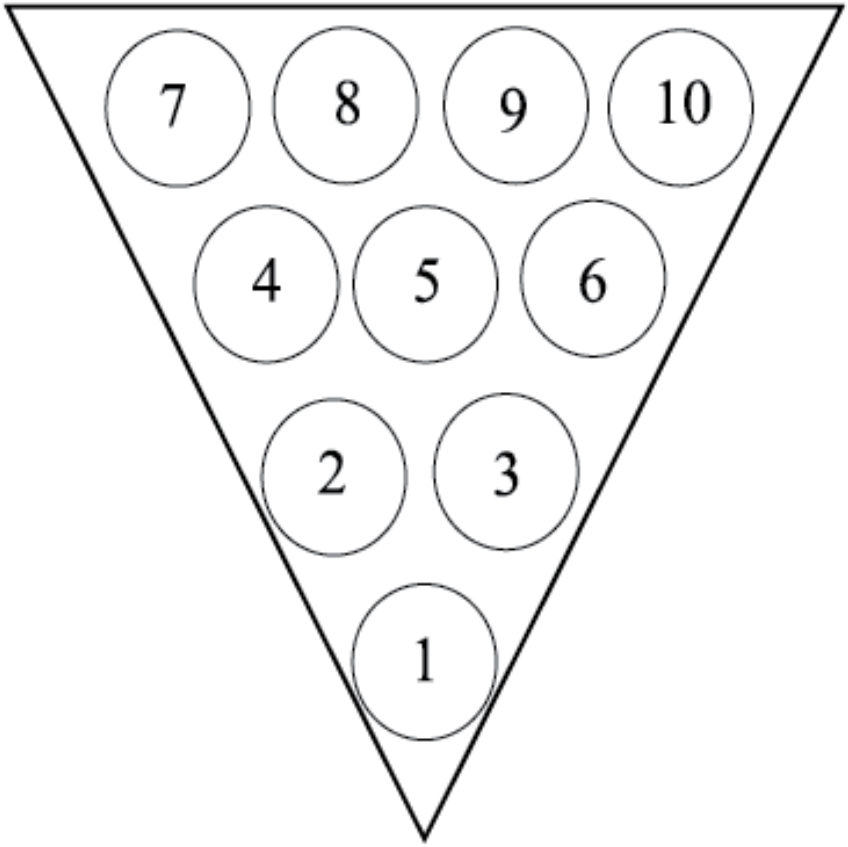
Suggestion give the class the numbers: 1, 2, and 4 instead of rolling three dice.

TWA-A3

Bowling with Numbers

Roll 3 dice. Write down the three numbers you rolled. Use addition, subtraction, multiplication, and/or division to equal the numbers 1 through 10. You must use all 3 numbers each time. Write down each way you made the numbers 1-10 on the 10 blank lines. Cross out each number after you make it.

What are your three rolls? _____ _____ _____



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If you did not get a strike, roll again. ___ ___ ___