RAFT IDEAS

Topics: Algebraic Terminology, Equations, Variables

Materials List

- ✓ 5 Portion cups, black, 2 oz. w/opaque lids
- ✓ Blank playing cards, 1 deck (at least 50 cards)
- ✓ 300 Game tokens, any color
- ✓ 5 boxes, 9cm x 14 cm (~3.5" x 5.5")
- ✓ Paper, 11" x 17"
- ✓ Equation Tables, see page 3

This activity can be used to teach:

- Algebra (Common Core Math Standards: Operations & Algebraic Thinking, Grade 3, 3, 4, & 6; Grade 4, 1, 2, & 3; Grade 5, 1 & 2)
- Equations (Common Core Math Standards: Expressions & Equations, Grade 6, 2-8; Grade 7, 1, 3, 4)
- Problem Solving and Reasoning (Common Core Math Standards: Mathematical Practices Grades 3 - 9)

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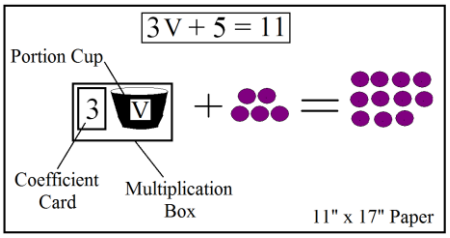
Modeling Simple Equations

Seeing Mathematical Statements in 3-D!



Work as a team to understand variables, coefficients, and constants by modeling and solving equations to find the mystery value of the cup!

Assembly

1. Separate cards into stacks of 10 cards each. Number cards in each stack from 1 to 10. Shuffle each stack.
2. Count out and enclose 60 tokens in each portion cup.
3. Copy and cut out Equation Tables.

To Do and Notice (10 people working in pairs)

Set up

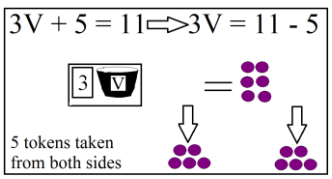
1. Each pair receives: 1 portion cup, 1 card stack, 1 box, 10 sheets paper, and an Equation Table.
2. Place the cards number-side down on table. Flip the top card over into box and put box onto a sheet of paper (see above).
3. Find an equation in Equation Table that has the coefficient shown on the card.
4. Take the tokens out of portion cup and set aside. Put lid back on cup.
5. Put empty portion cup in the box to the right of the coefficient card.

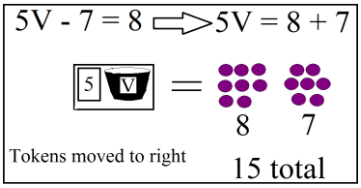
Model the Equation

6. Count out the number of tokens needed to finish the left-hand side of the equation. In the illustration above there are five tokens needed because the left-hand expression is 3V + 5.
7. Count out the tokens needed for the right-hand side of the equation.
8. Arrange the box and tokens according to the equation from the Equation Table, writing in the operation occurring between terms. In the example above, addition occurs between the variable term 3V and the constant 5.

Using the Model to Solve the Equation

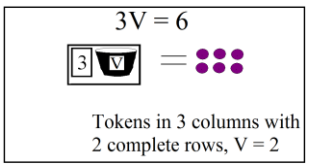
9. If addition occurs between the two terms, subtract the constant term from each side of the equation by removing that number of tokens from each side of the model. Five tokens would be removed from each side of the equation shown below, leaving only six tokens on the right-hand side (11 – 5 = 6).
10. If subtraction occurs between the variable and constant terms, move the tokens on the left side of equation to the right side. For example, in 5V – 7 = 8, the seven tokens on the left would be moved to the right making the right-hand total 8 + 7 = 15 tokens (shown below).

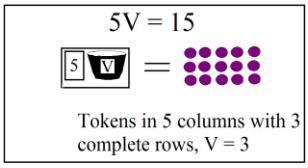




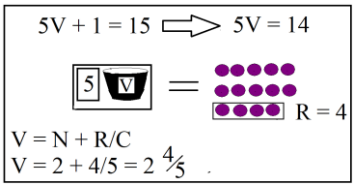
Created and written by Eric Welker (RAFT)

11. The "multiplication box" contains the coefficient card and the portion cup, so the coefficient and the variable are multiplied. Arrange the tokens on the right side of the equation into columns, (the number of columns should be equal to the coefficient value. The number of completely filled rows indicates the value of V. The mystery of the cup is solved!





12. Rewrite the equation with the value of V. For example, 3V + 5 = 11 is rewritten as (3 x 2) + 5 = 11.
13. Draw more cards and continue to model and solve the remaining equations on the Equation Table. Use a new sheet of paper for each equation modeled.
14. If desired, have pairs exchange equation tables and model new equations.
15. Optional- create more single-variable equations using blank equation tables. Note depending on the equations used – there may be a remainder. That is, the number on the right in the equation may not be divided evenly by the number of columns. The remainder R equals the number of tokens in the incomplete row.
16. To find V for equations having remainders, write a fraction with the remainder R as the numerator and the coefficient C as the denominator. Add the fraction to the number of complete rows N, that is, V = N + R/C. In the picture below, R/C = 4/5 and N = 2, so V = 2 + 4/5 = 2 4/5.



The Math Behind the Activity

Solving equations is a crucial skill in many fields. Physics, biology, chemistry, social science, and the humanities all require the use of equations. Equations such as y = 8V + 3 can be viewed as prescriptions used to determine a particular number given a value for the variable V. In this activity, learners create models of equations using simple manipulatives to develop a concrete understanding of equations using variables, coefficients, and constants. Visualizing variables as containers that hold values helps students understand how and why variables are used in equations. Portion cups can contain objects, just as variables can stand for a number.

Solving equations requires identifying the correct order of operations to perform based on the terms and their arrangement in the equation. For example, y = 8V + 5 prescribes that the quantity "8 times a number", when added to 5, equals y. The operation between the coefficient 8 and the variable V in this equation is multiplication. Using a box to represent this multiplication helps learners keep the terms in a single-variable equation separate and aids in recognizing the correct operation to be performed between them. PEMDAS (**P**arentheses, **E**xponents, **M**ultiplication, **D**ivision, **A**ddition, **S**ubtraction) is a useful acronym for remembering order of operations.

Rewriting the multiplication portion(s) of an equation using parentheses can help learners practice appropriate usage of the associative property of multiplication. For example, in writing y = 8V + 5 as y = (8 x V) + 5, it is less likely that a learner will mistakenly multiply 8 by V + 5. This also serves as a way to check a solution for V in the activity. For example, modeling and solving the equation 8V + 5 = 21 yields 16 tokens arranged in eight columns with two tokens each, so V = 2 is the solution. 8V + 5 = 21 then becomes (8 x 2) + 5 = 21 with the result 16 + 5 = 21, a true mathematical statement.

Taking it Further

- Write modeled equations as word problems

Web Resources (Visit www.raft.net/raft-idea?isid=660 for more resources!)

- 4th Grade math resources - http://www.elcerritowire.com/4/algebra.htm
- Lesson on variables - http://www.nctm.org/resources/content.aspx?menu_id=598&id=12152
- Khan Academy– https://www.khanacademy.org/math/algebra/solving-linear-equations-and-inequalities
- Teacher designed math courses – https://njctl.org/courses/math

Equation Table 1	
V = 56	6V – 20 = 4
2V + 13 = 25	7V + 16 − 10 = 34
3V + 17 = 32	8V + 5 − 2 = 19
4V − 13 = 47	9V + 2 = 29
5V − 60 = 0	10V – 11 = 49

Equation Table 2	
V + 4 = 7	6V + 10 = 40
2V − 6= 8	7V + 16 − 3 = 34
3V + 9 = 18	8V − 13 = 19
4V + 16 - 3 = 21	9V + 7 = 25
5V − 17 = 13	10V – 2 = 28

Equation Table 3	
V = 12	6V – 10 = 14
2V + 7 = 29	7V − 6 = 43
3V − 10 = 32	8V + 7 = 31
4V − 8 = 20	9V − 7 = 20
5V + 14 = 34	10V – 5 = 25

Equation Table 4	
V + 8 = 20	6V – 7 = 11
2V + 11= 31	7V + 14 − 10 = 32
3V − 8 = 10	8V + 3 = 27
4V + 13 = 33	9V − 5 = 31
5V − 3 = 18	10V + 3 = 33

Equation Table 5	
V + 7 = 33	6V – 11 = 25
2V + 5 = 25	7V + 4 = 39
3V + 3 = 36	8V − 18 = 14
4V + 7 = 47	9V + 5 = 32
5V + 9 = 19	10V – 4 = 26

Equation Table			
V	=	6V	=
2V	=	7V	=
3V	=	8V	=
4V	=	9V	=
5V	=	10V	=

Equation Table			
V	=	6V	=
2V	=	7V	=
3V	=	8V	=
4V	=	9V	=
5V	=	10V	=

Equation Table 6	
V = 7	6V – 14 = 4
2V + 13= 17	7V + 9 = 44
3V + 14 = 38	8V + 7 − 3 = 28
4V + 7 = 47	9V − 8 = 28
5V − 28 = 2	10V – 11 = 29

Equation Table 7	
V − 14= 7	6V – 30 = 12
2V + 7 = 25	7V + 10 = 31
3V − 17 = 7	8V + 5 = 29
4V − 14 = 4	9V − 7 = 29
5V − 15 = 20	10V – 3 = 17

Equation Table 8	
V + 5 = 14	6V + 10 = 28
2V + 8 = 18	7V + 16 = 30
3V − 14 = 13	8V − 4 = 28
4V+ 5 = 21	9V + 1 = 20
5V − 20 = 0	10V – 7 = 33

Equation Table 9	
V – 6 = 16	6V + 5 = 29
2V + 5= 19	7V + 7 − 4 = 24
3V − 5 = 13	8V − 2 = 14
4V − 3 = 21	9V − 6 = 26
5V − 15 = 10	10V + 6 = 36

Equation Table 10	
V = 10	6V – 5 = 13
2V – 7 = 15	7V + 7 − 5 = 30
3V − 6 = 33	8V + 4 = 20
4V − 10 = 34	9V − 15 = 3
5V − 8 = 32	10V + 9 = 39

Equation Table			
V	=	6V	=
2V	=	7V	=
3V	=	8V	=
4V	=	9V	=
5V	=	10V	=

Equation Table			
V	=	6V	=
2V	=	7V	=
3V	=	8V	=
4V	=	9V	=
5V	=	10V	=