

Progressing Through Equations

Strand: Equations and Inequalities

Topic: Solving multistep linear equations.

Primary SOL: A.4 The student will solve
a) multistep linear equations in one variable algebraically;
e) practical problems involving equations and systems of equations

Related SOL: A.1a, b

Materials:

- Sage and Scribe activity sheet (attached)
- Identifying Mistakes activity sheet (attached)
- Partner Walk: Practical Problems for Linear Equations activity sheet (attached)

Vocabulary

addition property of equality, associative property of addition, associative property of multiplication, commutative property of addition, commutative property of multiplication, division property of equality, inverse property of addition, inverse property of multiplication, multiplicative property of zero, multiplication property of equality, reflexive property, substitution, subtraction property of equality, symmetric property, transitive property of equality, zero product property

Student/Teacher Actions: What should students be doing? What should teachers be doing?

1. Display the following to students:

Given:	$-2(3x - 4) + x = -4x + 12$
Step 1:	$-6x + 8 + x = -4x + 12$
Step 2:	$-6x + x + 8 = -4x + 12$
Step 3:	$-5x + 8 = -4x + 12$
Step 4:	$-5x + 5x + 8 = -4x + 5x + 12$
Step 5:	$8 = x + 12$
Step 6:	$8 - 12 = x + 12 - 12$
Step 7:	$-4 = x$

Have students identify the properties used to solving the equation. Some example questions are as follows:

- a. Which property justifies step 1?
- b. Which property justifies step 2?
- c. Which property justifies step 5?

Sage and Scribe

2. Have students practice solving equations via justifying steps by using a sage-and-scribe technique. Place students in pairs (one will be partner A and the other will be partner B). Partner A will be the sage, while partner B will be the scribe. The sage will coach the scribe through solving a particular equation. The scribe can only write and must solve the problem the way in which the sage describes. For example, if the equations $2(3x - 5) - 4x = 26$ is presented, the sage would say, "Use the distributive property to simplify the left-hand side of the equation, yielding $6x - 10 - 4x = 26$." The sage would then continue from there. Once the problem is completed, the scribe will speak about whether they

would solve the equation in the same manner or whether they would have done it differently. The two will then switch roles.

- a. Option: You can add a level of competition by challenging students to use as many properties as they can. Each student could receive a point for every property they use in their explanation. When the sage is done explaining how to solve the problem, the scribe will have a chance to identify any steps where a property could have been used or make any corrections or adjustments to how the sage solved the problem. If the scribe is able to identify a property that the sage was not, then he/she receives a point.

Identifying Mistakes

3. Students will work on problems to identify errors.

Partner Walk: Practical Problems for Linear Equations

4. Ask students to stand up and push in their chairs. Play music while students walk around the room. When the music stops, students will collaborate with the person closest in proximity to them. Display a practical word problem to the class. One student will solve the problem algebraically, while the other writes in words how the properties of equality can be used to solve the problem. The two students will then compare their answers to see whether they derived at the same solutions. Repeat directions for next question.

Assessment

• Questions

- What is the difference between the associative property of addition and the commutative property of addition?
- When solving a system of linear equations graphically, where will you find the solution?

• Journal/writing prompts

- Provide a real-world example of when a system of linear equations would not have a solution.
- Compare and contrast a system of linear equations that has infinite solutions and no solution.
- Sarah and John both solved the equation $5x - 6 - 3x = 18$.

Sarah

$$5x - 6 - 3x = 18$$

$$5x - 3x - 6 = 18$$

$$2x - 6 = 18$$

$$2x - 6 + 6 = 18 + 6$$

$$2x + 0 = 24$$

$$2x = 24$$

$$(\frac{1}{2})2x = (\frac{1}{2})24$$

$$x = 12$$

John

$$5x - 6 - 3x = 18$$

$$2x - 6 = 18$$

$$2x - 6 + 6 = 18 + 6$$

$$\underline{2x = 24}$$

$$\frac{2}{2} \quad \frac{24}{2}$$

$$x = 12$$

Compare and contrast how Sarah and John solved the equation? Are both correct?

• Other Assessments (include informal assessment ideas)

- Have students use individual dry-erase boards to offer quick checks by teacher.

- In the Sage and Scribe activity, have students get their work and solution checked before moving on to the next question.

Extensions and Connections (for all students)

- Use algebra tiles to help students visualize solving equations.
- When solving systems of linear equations, refer to independent and dependent variables. Students have heard these terms used in science. In addition, this will help students draw connections when they learn direct and inverse variation.

Strategies for Differentiation

- When identifying properties of real numbers and properties of equality, underline and circle aspects of the equation that have stayed the same and/or have changed. This will help students better understand what is occurring within the problem. For example:

$$\begin{array}{l} \text{Given:} \quad -2(3x - 4) + x = -4x + 12 \\ \text{Step 1:} \quad -6x + 8 + x = \underline{-4x + 12} \\ \text{Step 2:} \quad -6x + x + 8 = \underline{-4x + 12} \\ \text{Step 3:} \quad -5x + 8 = -4x + 12 \\ \text{Step 4:} \quad -5x + 5x + 8 = -4x + 5x + 12 \\ \text{Step 5:} \quad 8 = x + 12 \\ \text{Step 6:} \quad 8 - 12 = x + 12 - 12 \\ \text{Step 7:} \quad -4 = x \end{array}$$

When asked which property justifies the work between steps 1 and 2, students should underline $-4x + 12$ because no change occurred and circle $8 + x$ and $x + 8$ because the two terms moved their position by applying the commutative property of addition.

Note: The following pages are intended for classroom use for students as a visual aid to learning.

Sage and Scribe

Directions:

1. Decide who will be partner A and partner B. Partner A will be the *sage* first, and partner B will be the *scribe*. The *sage* can only speak, and the *scribe* can only write. Switch roles after each equation.
2. The *sage* is to tell the *scribe* how to solve the equation. They must use the properties of real numbers and the properties of equality in their explanation. The more properties you can use, the better. Below is a bank of properties you may use:

<i>Commutative property of addition/multiplication</i>	<i>Reflexive property</i>
<i>Associative property of addition/multiplication</i>	<i>Symmetric Property</i>
<i>Identity property of addition/multiplication</i>	<i>Transitive property of equality</i>
<i>Inverse property of addition/multiplication</i>	<i>Addition property of equality</i>
<i>Multiplicative property of zero</i>	<i>Subtraction property of equality</i>
<i>Zero product property</i>	<i>Multiplication property of equality</i>
<i>Substitution</i>	<i>Division property of equality</i>

1. $8(x - 1) = 4x + 12$ 2. $4(n - 1) = n + 11$ 3. $5(2x + 6) = -4(-5 - 2x) + 3x$

4. $-5(4x - 2) = -2(3 + 6x)$ 5. $8(5x + 1) + 5 = 13 + 5x$ 6. $-11 - 5x = 6(5x + 4)$

Identifying Mistakes

Directions: Identify the mistake within the problem and then make the appropriate corrections.

Given Problem	Correction
<p>1. $2(3x - 4) + 12 - 3x = 5x + 20$ $6x - 8 + 12 - 3x = 5x + 20$ $6x - 3x - 8 + 12 = 5x + 20$ $3x + 4 = 5x + 20$ $+3x \qquad \qquad +3x$ <hr style="width: 100%;"/> $4 = 8x + 20$ $-20 \qquad \qquad -20$ <hr style="width: 100%;"/> $-16 = 8x$ $-16(1/8) = 8x(1/8)$ <hr style="width: 100%;"/> $-2 = x$</p>	
<p>2. $12x - 8 - 7x = 7 - (2x + 6)$ $5x - 8 = 7 - 2x + 6$ $5x - 8 = 13 - 2x$ $+2x \qquad \qquad +2x$ <hr style="width: 100%;"/> $7x - 8 = 13$ $+8 \qquad +8$ <hr style="width: 100%;"/> $\underline{7x} = \underline{21}$ $7 \qquad 7$ $x = 3$</p>	
<p>3. Sarah and Kayla both solved the problem below. Who solved it correctly? Identify the mistake for the person who solved it incorrectly.</p>	

Sarah

$$5x - 15 - 3x = 10 - (-3x + 20)$$

$$2x - 15 = 10 + 3x - 20$$

$$2x - 15 = -10 + 3x$$

$$\begin{array}{r} -3x \qquad \qquad -3x \\ \hline -1x - 15 = -10 \\ +15 \quad +15 \\ \hline -1x = 5 \\ x = -5 \end{array}$$

Kayla

$$5x - 15 - 3x = 10 - (-3x + 20)$$

$$2x - 15 = 10 + 3x - 20$$

$$2x - 15 = -10 + 3x$$

$$\begin{array}{r} +3x \qquad \qquad +3x \\ \hline 5x - 15 = -10 \\ +15 \quad +15 \\ \hline 5x = 5 \\ x = 1 \end{array}$$

Partner Walk: Practical Problems

1. Megan baby-sat this weekend. She earned \$12 an hour plus an additional \$32. If she made a total of \$140, how long did she work for?
2. Sunnie had a birthday party where she received three gifts from every guest that came. Her family also gave her an additional 12 gifts before her party. If she received 57 gifts, how many guests were at her party?
3. DaMontre is at basketball practice, where he takes 30 shots a minute. He also took an extra 70 shots before practice. If DaMontre took 1,870 shots, how long did he practice for?
4. Josh and Scott had a football game this weekend. Josh had twice as many tackles as Scott. If together they had 15 tackles, how many did Josh have? Scott?
5. The length of a rectangle is three times its width. If the perimeter is 120 inches, what is the length? The width?
6. If the length of a rectangle is five less than three times its width and the perimeter is 105 inches, what is its width? Length?