**Unit 2: Investigation 4 (4 Days)**

**Solving Equations Using the Distributive Property**

***CCSS: 8EE 7, A-SSE 3, A-CED 1, A-REI 1, A-REI 3***

**Overview**

Students write and solve multi-step linear equations using the distributive property in a number of different contexts. The investigation begins with an introduction to the distributive property and how it can be used in equation solving. Activities focus on solving equations containing fractions and solving multi-step equations in context, and reinforce student understanding of contradictions and identities.

**Assessment Activities**

**Evidence of Success: What Will Students Be Able to Do?**

Solve multi-step equations in a variety of contexts using the distributive property and combining like terms.

**Assessment Strategies: How Will They Show What They Know?**

* **Exit Slips 2.4.1 & 2.4.2** ask students to solve non-contextual equations using the distributive property.
* **Exit Slip 2.4.3** asks students to write an equation to model a situation and use the distributive property and combining like terms to solve the equation.
* **Journal Prompt** asks students to reflect on what they find difficult about solving multi-step equations and how they can overcome the difficulty.

**Launch Notes**

1. Introduce students to a real world problem which can be modeled by an equation that involves parenthesis. **Activity 2.4.1** begins with the problem “You and three friends go to the local fair. You each buy a $3 food ticket and a stamp for unlimited rides. If the total cost for the four of you is $32, how much does the stamp for unlimited rides cost?” Model this problem by the equation $4\left(u+3\right)=32$ and then use this equation to discuss the distributive property.

**Closure Notes**

The majority of the investigation involves contextual situations in which students may work in cooperative groups to explore different situations. Students should be asking questions and reporting answers and strategies to the class often. Therefore, the closure activity may consist of a summary of different strategies to ensure that all students are comfortable with the act of solving multi-step equations.

**Teaching Strategies**

1. In **Activity 2.4.1 Solving Problems using the Distributive Property**, students write expressions and equations to model real world situations and then solve the equations. Encourage students to write equations using parenthesis so they can apply the distributive property when solving the equations. In the first problem, the equation has the form $4\left(u+3\right)=32$ where *u* represents the cost of an unlimited ride stamp. At this point you may formally introduce the distributive property or break students into groups and ask the class to develop their own definition.

A formal statement of the *distributive property* is that if *a, b*, and *c* are any real numbers, then $a\left(b+c\right)=ab+ac$. Depending on your student’s backgrounds you, may choose to show this property with algebra tiles or an area model as shown below. A fuller description of the property is “the distributive property of multiplication over addition.”

**Group Activity**

Break students into groups of two or three and ask them to come up with a statement for the distributive property in their own words. Then, combine two groups, and have the two groups compare and agree upon a statement for the distributive property. Finally, have the groups share their definition and have the class agree on a statement for the distributive property.

 **Note**: If you still have students who use the flow-chart method for solving equations, that is fine. Make sure to advise them they can continue to use that method, but they must first simplify the equation (distribute, combine like terms, and get the variable on only one side of the equation) *before* they put the equation into the flowchart.

**Differentiated Instruction (Enrichment)**

The distributive property with which we are familiar relates multiplication and division. Students may want to explore whether there are other pairs of operations for which there is a distributive property? For example does multiplication distribute over subtraction? Does division distribute over addition? Does addition distribute over multiplication?

1. In **Activity 2.4.2 Distributive Property with Algebra Tiles**, students use algebra tiles to model expressions and equations, and to understand how the distributive property works. The last part of the activity asks students to identify whether or not the distributive property was used correctly to rewrite expressions.

**Differentiated Instruction (For Learners Needing More Help)**

Algebra tiles (**Activity 2.4.2**) provide students a visual understanding of the distributive property.

1. In **Activity 2.4.3** **Using the Distributive Property**, students use the distributive property to rewrite algebraic expressions.

**Differentiated Instruction (For Learners Needing More Help)**

**Activity 2.4.3** provides students an opportunity to practice using the distributive property.

1. You may pose a problem to the class which leads to an equation with parentheses on both sides, such as: “The menu at the food stand said that French fries cost $2 and onion rings cost $4. You couldn’t tell how much hot dogs cost because there were ketchup stains all over the menu. You were both very hungry after going on so many rides. You ordered three hot dogs, each with a serving of fries. Your friend ordered two hot dogs and two servings of onion rings. You each were charged the exact same price. How much did each hot dog cost?”

Allow students to think about this question for a while. Students should arrive at the equation $3\left(x+2\right)=2(x+4)$. You may use a diagram similar to the one below to model this equation. The diagram displays 3 groups of $(x+2)$ on the left side and 2 groups of $(x+4)$ on the right side.



Students should recognize that two *x*’s on the left side balance out with the two *x*’s on the right side. Also, the six ones on the left side balance with six of the ones on the right side. By removing what is equal from both sides, we are left with one *x* on the left side and two ones on the right side, meaning that *x* must equal two. Students can check that this solution byevaluating each expression when *x* = 2. Once students are comfortable with the fact that *x* equals two, ask them to solve the equation by applying the distributive property.

**Activity 2.4.4 Walk-A-Thon** poses several problems that lead to equations with parentheses. The last two problems in the activity incorporate the use of graphing calculators.

1. **Activity 2.4.5 Epic Win, Epic Fail** introduces students to the Pan Balance – Expressions applet at NCTM Illuminations. Students use the pan balance to solve equations and develop a graphical understanding of the solution of a linear equation. <http://illuminations.nctm.org/ActivityDetail.aspx?ID=10>

**Activity 2.4.5a Practice Solving Equations** provides students practice solving a variety of multi-step equations. To solve the equations, students must combine like terms, use the distributive property, and execute multiple steps. The equations include identities and contradictions.

**Differentiated Instruction (For Learners Needing More Help)**

**Activity 2.4.5a Solving Equations Skill Practice** may be particularly helpful to students who need sequential step-by-step instruction.

**Group Work**

You can use **Activity 2.4.5a Solving Equations Skill Practice** as a group activity. Have the students break into pairs. They can each solve different problems, then swap papers and check their partners work by substituting the solution back into the equation. Doing the activity this way cuts down on the number of problems each student has to do themselves and provides an opportunity for students to help each other out and to analyze and discuss errors in each other’s work.

1. In **Activity 2.4.6a Pizza Party**, students construct and solve equations which involve parenthesis. The activity begins with the problem: “For Raul’s birthday, his girlfriend Jessica invited some of their friends to the fair. They got a picnic table and she ordered 6 large pizzas. Luckily, she had a coupon for $3 off each pizza. If the bill came to $38.94, how much was each large pizza?”

The activity contains scaffolding to assist students develop the equation. Once the equation $6\left(x-3\right)=38.94$ is developed, ask students what happens if we first divide both sides by 6 instead of distributing first. This may lead to an interesting discussion regarding the different ways to “undo” an equation involving parenthesis.

The second problem asks students to create an equation that involves parenthesis and combining like terms. The problem states: “What if Jessica bought small pizzas instead? She decides to buy 7 small pizzas, but she only has four coupons. Each coupon reduces the cost by $2. She bought four small pizzas at the discounted price and paid full price for the other three. If the bill came to $44.50, how much was each small pizza?” If *p* equals the price of a small pizza, the resulting equation is

$4\left(p-2\right)+3p=44.50$.

**Differentiated Instruction (Enrichment)**

**Activity 2.4.6b Pizza Party** does not contain scaffolding. This version could be used with students who are more comfortable constructing equations.

**Activity 2.4.7 Multi-Step Equation Challenge** provides students additional practice solving multi-step equations, some of which are identities and contradictions. You may want to complete the first problem with the whole class to model the steps needed to solve the equation. For additional practice, students may go to the site <http://www.algebralab.org/lessons/lesson.aspx?file=Algebra_OneVariableMultiStep.xml> and solve the multi-step equations listed there. They can check their answers and see how multi-step equations are solved. You may ask students to print out their answers and bring them into class to show you.

1. In **Activity 2.4.8 Fraction Busters**, students learn how to remove fractions from an equation by multiplying both sides of the equation by the lowest common denominator of any fractions in the equation.
2. In **Activity 2.4.9 Geometry and Sports**, students create and solve equations that model sports related problems and geometrical figures.

**Differentiated Instruction (Enrichment)**

**Activity 2.4.9 Geometry and Sports** is an activity for students needing more of a challenge. The problems provide strong independent learners an opportunity to use their problem-solving skills. Use some of this material with all students if time permits.

In **Activity 2.4.10 Arithmetic Sequences Revisited**, students use the formula for the *n*th term of an arithmetic sequence to solve problems.

**Differentiated Instruction (Enrichment)**

**Activity 2.4.10 Arithmetic Sequences Revisited** can be used for students ready for a bigger challenge. This activity revisits arithmetic sequences, this time using the formula for finding the *n*th term.

**Differentiated Instruction (For Learners Needing More Help)**

Encourage students who are struggling solving multi-step linear equations to visit the following websites to see examples and videos.

<http://www.yourteacher.com/algebra1/multistepequations.php>

http://www.onlinemathlearning.com/solving-multi-step-equations.html

**Journal Prompt**

What do you find most difficult about solving multi-step equations? How do you plan on overcoming this difficulty?

**Group Activity**

**Activity 2.4.11 Big Brain Contest** is a power point presentation which contains 15 multi-step equations. Each slide displays one equation that awards a certain number of points. You can divide the class into two teams, having each team sit on opposite sides of the room. Have both teams solve the equation for a set amount of time. Set up a timer. (3 minutes per problem may be a good place to start, depending on the class and the equation’s level of difficulty.) Tell students to stand up when they’ve completed the problem and have an answer, but wait for the timer to expire before asking students for an answer (allowing more students to finish). You may want to extend the time if there are only a few students standing. You can award points either by issuing them to the team with the first correct answer or by issuing them to each person who was able to get the correct answer (the more students with the correct answer, the more points for the team.) Reserve 10 minutes at the end of class to review any problems the students want to see worked out. You can also have the students who get the correct answer put their work on the board. This activity is intended as a review activity.

**Resources and Materials**

* **Activity 2.4.1** Solving Problems Using the Distributive Property
* **Activity 2.4.2** Distributive Property with Algebra Tiles
* **Activity 2.4.3** Using the Distributive Property
* **Activity 2.4.4** Walk-A-Thon
* **Activity 2.4.5** Epic Win, Epic Fail
* **Activity 2.4.5a** Practice Solving Equations
* **Activity 2.4.6a** Pizza Party
* **Activity 2.4.6b** Pizza Party
* **Activity 2.4.7** Multi-Step Equation Challenge
* **Activity 2.4.8** Fraction Busters
* **Activity 2.4.9** Geometry and Sports
* **Activity 2.4.10** Arithmetic Sequences Revisited
* **Activity 2.4.11** Big Brain Contest
* **Exit Slip 2.4.1** Distribute!
* **Exit Slip 2.4.2** Let’s Solve!
* **Exit Slip 2.4.3** Saving for College
* Student Journals
* Graphing Calculators
* Algebra Tiles
* Pan Balance – Expressions applet at NCTM Illuminations. <http://illuminations.nctm.org/ActivityDetail.aspx?ID=10>
* Link to online practice for solving multi-step linear equations <http://www.algebralab.org/lessons/lesson.aspx?file=Algebra_OneVariableMultiStep.xml>
* Link to online videos and examples of solving multi-step 1-variable equations <http://www.onlinemathlearning.com/solving-multi-step-equations.html>and <http://www.yourteacher.com/algebra1/multistepequations.php>