**Unit 6: Investigation 3 (3 Days)**

**SOLVING SYSTEMS OF LINEAR EQUATIONS BY ELIMINATION**

**CCSS:** A-REI #5

**Overview**

In this investigation, students will use the elimination method to solve systems of linear equations, identify the characteristics of a system of linear equations that lend themselves to the elimination method, and interpret the solution of a system of linear equations within the context of the problem.

**Assessment Activities**

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

* Students will use the elimination method to solve a system of equations.
* Students will explain the algebraic properties upon which the elimination method is based.
* Students will explain the relationship between the number of solutions to a system of equations and the relationship between the slopes and *y*-intercepts of the equations within a system.
* Students will identify the characteristics of systems of equations that lend themselves to the substitution and elimination methods.

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

* **Exit Slip 6.3.1** requires students to solve a system by elimination and identify the algebraic properties used.
* **Journal Entry 1** asks students to explain when the multiplication property must be used to solve a system by the elimination method.
* **Journal Entry 2** asks students to explain how graphical features correspond to algebraic solutions of simultaneous equations.
* **Exit Slip 6.3.2** requires students to compare different methods of solving systems and to explain their choice of method in solving a particular system.

**Launch Notes**

As a launch to this investigation you might show the 5 minute *Computer Problems* vignette. Go to <http://www.thefutureschannel.com/hands-on_math/computer_problems.php> from *The Futures Channel* which introduces students to the Dell Computers call center in Round Rock, Texas. The video shows the different facets involved in ordering and assembling a computer from component picking to shipping. Based on information in the video, you and the class may develop a number of simultaneous equation scenarios based around cost and time constraints to use as part of this investigation. For example, the shipping center produces 100,000 computers each day. Suppose some of them sell for $500 and the remainder sell for $800. If the total income for the day is $62,000,000 how many of each type were sold? You may pose this question and then answer it at the end of the first day of the investigation.

**Closure Notes**

The investigation culminates with students successfully demonstrating their ability to solve a system of equations, identify the method that they used, and explain why they chose that particular method. Students will identify the main characteristics of systems of equations that lend themselves to the substitution and elimination methods, respectively. This may be done with **Exit Slip 6.3.2**, followed by a class discussion.

**Teaching Strategies**

1. The focus of this investigation is the elimination method for solving systems of linear equations in two variables. Students should understand how this method utilizes the addition and multiplication properties of equality. Students should learn to recognize which method is most appropriate when solving a system.

Begin with an example that leads to a simple system such as: The sum of two numbers is 20. The difference between them is 2. Find the numbers. The following system can be written:

 *x* + *y* = 20

*x* – *y* = 2

where *x* is the larger of the two numbers and *y* is the smaller of the two numbers. Have students add the equations using the addition property of equality to see that the *y* variable is eliminated. Give further examples where the *x* or *y* variable is eliminated through simple addition, such as:

*x* + 2*y* = 5 and *x* – 2*y* = 7

 – *x* + *y* = 7 3*x* + 2*y* = 13.

Once students see the benefit of being able to eliminate one variable in a system of equations, supply examples where multiplication must be done to at least one equation in the system before the addition of the system results in the elimination of a variable. An example of this is the following system:

 5*x* – 2*y* = 19

3*x* + *y* = 7.

To help students develop an understanding of the sequence of steps involved in the elimination method, allow them to add a system like this before any changes are made and see that neither variable is eliminated. Ask students to explain why neither variable was eliminated and what is different about this system than the previous ones that cause this to happen. Emphasize during the discussion the idea that when solving an equation what is done to one side of an equation must be done to the other side for the equation to remain in balance and the solution of the equation to remain unchanged. Therefore, it is not possible to simply “insert” a coefficient of 2 in the second equation of this system. Students should recognize that the elimination method can be justified in terms of the multiplication property of equality in conjunction with the addition property of equality. Emphasize, as you did with the substitution method, that the values of both variables satisfy both equations, and thus provide the solution to the system.

You may use **Activity 6.3.1 Introduction to the Elimination Method** in class or for homework to help students learn the elimination method. Questions 5–7 are designed to help students see the role of the least common multiple when using the elimination method in cases where both equations need to be transformed and to make the connection to the addition of fractions with unlike denominators.

You may now return to the problem posed in the launch. Let *x* represent the number of $500 computers sold and *y* the number of $800 computers sold. The system of equations is:

*x* + *y* = 100,000

 500*x* + 800*y =* 62,000,000.

We can eliminate *x* by multiplying the first equation by –500 and adding the result to the second equation. We then find that *y* = 40,000 and *x* = 60,000.

You may use **Exit Slip 6.3.1** which asks students to solve a system of equations using the elimination method and explain the properties that are used in the solution.

**Journal Entry 1**

When solving a system of equations with the elimination method, how do you know whether it is necessary to multiply both sides of an equation by a number before adding it to the other equation?

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

Exploration and discussion of the elimination method should focus on both the process used as well as the algebraic principles that support the process. If students understand the algebra that supports the elimination method but have difficulty remembering and/or following the sequence of steps involved, you might have them work in pairs or small groups to develop a note card that describes the sequence of steps in their own words and includes one or more examples of how to implement the elimination method. Use simple equation pairs, such as *x + y =* 12 and *x – y =* 16, as examples.

1. Provide explorations that use the elimination method to solve systems of equations that have no solution, one solution, or many solutions (for example: 2*x +* 8*y =* 6 and *x +* 4*y =* 3). To emphasize the connection between the number of solutions to a system of equations and the number of intersections between the lines, write the two equations in the slope-intercept form and then graph the equations. By putting both equations in slope-intercept form, students can readily identify the slope and *y*-intercept of the lines, graph the lines as needed, and make connections between the graphical and algebraic nature of the lines. **Activity 6.3.2 Exploring the Number of Solutions** may be used to help students discover the connection between the number of solutions and the nature of the graphs.

At this point you may want to assign students some or all of the applications problems in **Activity 6.3.3 Applications of the Elimination Method.** Note that question 6 is open-ended and depends upon what students consider to be a “reasonable profit.”

**Differentiated Instruction (Enrichment)**

Assign students question 6 in **Activity 6.3.3** and then ask them to create one or more additional open ended problem that can be solved using a system of equations.

Have students complete **Exit Slip 6.3.2**, which requires that they explain graphical characteristics of systems of equations that have none, one, or an infinite number of solutions.

**Journal Entry 2**

Explain what happens when you solve a system of equations when the graphs of the equations are two parallel lines, when the graphs of the equations are two intersecting lines, and when the graphs of the equations are the same line.

1. Once students understand the algebraic principles that support the elimination method and can clearly describe the relationship between the number of solutions and the number of intersections of the graphs, you may lead students in an exploration of the characteristics of systems of equations that lend themselves to the substitution method versus the elimination method. You may use systems of equations students have already solved in **Investigations 1** and **2**, or additional examples from **Activity 6.3.3 Applications of the Elimination Method.**

Ask students to work independently, in pairs, or in small groups to identify characteristics of systems of equations that lend themselves to each method. When identifying common characteristics it is important to remind students that they may use either the elimination or substitution method. However, by looking at the characteristics of the equations within a system, one method might be easier to work with then the other. Students may design a graphic organizer to list the characteristics.

For practice using the elimination method, and for getting students to think about the steps that are required, you may use **Activity 6.3.4 Mechanics of the Elimination Method. Activity 6.3.5 Selecting an Algebraic Method** gives students practice choosing a method and explaining their choice.

**Group Activity**

Have students work in groups of three. Give each group a system of equations. Have one student solve the system by graphing, one by substitution, and one by elimination. Have them check each other’s work.

**Resources and Materials**

* **Activity 6.3.1** Introduction to the Elimination Method
* **Activity 6.3.2** Exploring the Number of Solutions
* **Activity 6.3.3** Applications of the Elimination Method
* **Activity 6.3.4** Mechanics of the Elimination Method
* **Activity 6.3.5** Selecting an Algebraic Method
* **Exit Slip 6.3.1** Elimination Method
* **Exit Slip 6.3.2** Solving Systems
* Bulletin board for key concepts
* Student journals