**Using Substitution to Solve**

**Section 1**

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| 00:00:00 | TEACHER: Our lesson question is, how do you solve a system |
| 00:00:03 | of equations using the substitution method? Well, we have just reviewed how to find the number of solutions to a system of equations by observing the slope and the y-intercept. Now we will determine the exact solution to a system of linear equations. |

**Section 2**

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| 00:00:00 | TEACHER: Here are the steps to solve a |
| 00:00:02 | system of linear equations. 1, we'll use substitution to create a one-variable linear equation. 2, we'll solve to determine the value of the unknown variable. 3, we will write the solution to the system of equations as an ordered pair. And 4, we want to know if we are correct. |
| 00:00:23 | We will verify the solution. Let us look at our system of equations. We have y equals 2x plus 3 and y equals 7. Now, as we observe these two equations, notice the slopes are different. In the first equation, the slope is 2. In the second equation, if we were to choose to rewrite it so we can identify the slope, notice the slope must be 0 for |
| 00:00:48 | there to be no term that has an x variable. Well, this means we expect to have one solution. Let's go to our first step. We will use substitution to create a one-variable linear equation. We will take the 7 and substitute it in for y. This gives us 7 is equal to 2x plus 3. Next, we will solve to determine the value of the |
| 00:01:13 | unknown variable, which in this case is x. We will subtract a 3 from both sides of the equation. And when we do, we now have the equation 4 is equal to 2x. The last step to solve is to divide both sides of the equation by 2. And we find that our unknown variable x equals 2. Now remember, we know y equals 7. So our very last step to solve is to write the solution to |
| 00:01:45 | the system of equations as an ordered pair. We have the ordered pair, 2 comma 7. |

**Section 5**

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| 00:00:00 | TEACHER: Let's use a system of equations from |
| 00:00:03 | the previous steps. Remember, step 4 was to verify the solution. Now, one way to do this is graphically. Look at the first equation. It's now graphed in orange. We have a slope of negative 1/4 and a y-intercept of negative 2. Our second equation is the vertical line x equals 4. |
| 00:00:22 | Well, let's sketch that right in. x equals 4 intersects with the orange line at this point right here, whose coordinates would be 4, negative 3. The solution to this system of linear equations is a intersection between the two lines. It occurs at 4, negative 3. |

**Section 6**

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| 00:00:01 | TEACHER: The lesson question is, how do you solve a system |
| 00:00:04 | of equations using the substitution method? Well, as you've learned, the substitution method for solving a system of linear equations involves substituting the value of one variable into the other equation to solve for the remaining variable. But what if the value of neither variable is known? You can use the exact same method. |

**Section 7**

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| 00:00:00 | TEACHER: Let us look at the steps for solving a system of |
| 00:00:02 | linear equations when the value of neither variable is known. The first step is to use substitution to create a one-variable linear equation. The second step is to solve to determine the unknown variable in the equation. The third step, and this is a new step, is to substitute the value of the variable into either original equation to |
| 00:00:26 | solve for the other variable. The fourth step is to write the solution to the system of equations as an ordered pair. Now the last step is just to reassure us that we're correct. We will verify the solution. Let us look at our system of equations. We have y is equal to 6x plus 1, y is equal to 2x plus 9, |
| 00:00:49 | and we will solve the system of equations using the substitution method. Notice we are not given the value of either variable. So what this means is that we want to begin by determining do we know the number of solutions we can expect? Well, the first equation has a slope of 6, and the second equation has a slope of 2. Since the slopes are different, we |
| 00:01:13 | can expect one solution. Let us begin. Step one, use substitution to create a one-variable linear equation. We will take 6x plus 1 and substitute it in for y in the second equation. This gives us 6x plus 1 is equal to 2x plus 9. Let us solve for our variable x. |
| 00:01:39 | First thing we'll do is we will subtract a 1 on both sides of the equation. We have 6x plus 1 minus 1 is equal to 2x plus 9 minus 1. This gives us 6x is equal to 2x plus 8. Now let's have the x's on the same side of the equation. We will subtract from both sides of the equation a 2x. We have 6x minus 2x is equal to 2x plus 8 minus 2x. This gives us 4x is equal to 8. |
| 00:02:14 | Our last step is to divide both sides of the equation by 4, and we find our variable x to be equal to 2. Next, since we have solved for x and found x to be 2 in the first two steps, we will substitute that value, the 2, into either original equation to solve for the other variable, which is y. So we will use the first equation, y is equal to 6x plus 1, and we will substitute for x the value |
| 00:02:52 | of x, which is 2. This means y is equal to 6 times 2 plus 1. This gives us y is equal to 13. So now we know y is 13, while x was 2. Notice we could have found that solution of y as being equal to 13 by substituting into the other equation as well. Our solution is written as an ordered pair, 2 comma 13. |

**Section 10**

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| 00:00:01 | TEACHER: Remember, step five is to verify the solution. |
| 00:00:05 | Our solution is 2, 13. Now, one way to verify the solution is to graph the original system. This we did earlier. Another way to verify is to substitute x equals 2 and y equals 13 into both equations that make up our system. Let's do that. y equals 13. |
| 00:00:26 | This is equal to 6 times x, which is 2 plus 1. We have 13 equals 13. This is a true statement. Going to the second equation, y equals 2x plus 9, y is 13. This is equal to 2 times x, and x is 2, plus 9. This gives us 13 is equal to 13, which is true. We now have verified that the coordinate pair 2, 13 is a solution to the system of equations we were provided. |

**Section 11**

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| 00:00:00 | TEACHER: How do you solve a system of equations using the |
| 00:00:02 | substitution method? We've been using a substitution method to solve a system of linear equations when the slopes are different, both when the value of one variable is known and when the variables are completely unknown. Now, what we'll do is take a look at solving a system of linear equations when the slopes are the same. |

**Section 12**

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| 00:00:00 | TEACHER: Now let us look at a system of equations where the |
| 00:00:03 | slopes are the same and the y-intercepts are different. In our system of equations, for the first equation the slope is 3. For the second equation, the slope is 3. So we have the slopes are the same. But for the first equation, the y-intercept is negative 3. Second equation-- the y-intercept is 1. This means the y-intercepts are different. |
| 00:00:28 | So our orange line, which has a y-intercept of negative 3, is represented by the equation 3x minus 3, while our blue line, which has a y-intercept of 1, is represented by the equation y equals 3x plus 1. This is the case where these 2 lines, when graphed, are parallel. And our expectation is that we will have no solution. But what happens when we use substitution to solve the |
| 00:00:54 | system in the case where we have no solution? Well, here is our system. y equals 3x minus 3 and y equals 3x plus 1. Notice the value of neither variable is given. So we will take 3x minus 3, and we will substitute it into the second equation for y. This gives us 3x minus 3 is equal to 3x plus 1. Let's solve. |
| 00:01:23 | First step is we'll add a 3 to both sides of the equation. We have 3x minus 3 plus 3 is equal to 3x plus 1 plus 3. Well, simplifying this gives us 3x is equal to 3x plus 4. Our last step is to see if we can have the terms with x on the same side of the equation. We'll subtract a 3x from both sides of the equation. So we have 3x minus 3x is equal to 3x plus 4 minus 3x. Simplifying, we find 0 equals 4. |
| 00:01:59 | Now, 0 equals 4 does not give us a value of either variable, and the statement is false. So what this means is that we have no solution. Using the system of equations to solve in the case we have parallel lines is another way to verify that there is no solution to this system of equations. |

**Section 14**

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| 00:00:00 | TEACHER: Let us look at a system of equations where the |
| 00:00:03 | slopes and the y-intercepts are exactly the same. Look at our system. Notice, if you will, that the two equations are exactly the same. This means they represent the same line with a y-intercept of 2 and a slope of 1/2. Up 1, right 2. When this occurs, there are infinitely many solutions |
| 00:00:24 | because every point on the line, its coordinate pair is a solution. Let's see what happens when we try to solve this system using substitution. Again, notice that we have the exact same slopes and the same y-intercepts. This means both equations represent the same line, and we should expect infinitely many solutions. |
| 00:00:46 | The first step is to take 1/2 x plus 2 in the first equation and substitute it into y in the second equation. This gives us 1/2 x plus 2 is equal to 1/2 x plus 2. Now we'll proceed to solve. Let us subtract a 2 from both sides of the equation. This gives us 1/2 plus 2 minus 2 is equal to 1/2 x plus 2 minus 2. Simplifying, what do we get? |
| 00:01:14 | 1/2 x is equal to 1/2 x. Now let's get the terms with the x on the same side of the equation. We'll subtract 1/2 x from both sides of the equation. This gives us 0 equals 0. Now equals is a true statement. That means for any value of x you substitute in, you get back a true statement. |
| 00:01:39 | This tells us there are infinitely many solutions to this system of equations. |