DAY 3: Graphing to Solve Systems

Materials

Copies:	3.1 Graph and Verify 3.2 Hats Off 3.3 White Board Review – teacher copy only Ticket out the Door – Day 3
Supplies:	rulers – one per student mini-whiteboards, markers, erasers – one set per pair
Word Wall Words:	no new words today

Objective

Students will discover that systems of equations can have one solution, no solution or infinitely many solutions by looking at the graphs of several different systems. Students will verify solutions by using substitution and continue to develop and understanding of how to write and solve word problems involving systems of equations.

Student Talk Strategy

Roundtable for activity 3.1 quick-write
Numbered Heads for activity 3.1 quick-write share out
Think-pair-share for activity 3.1

Academic Language Use

Linear Equation – An equation that makes a straight line when graphed, and is often written in the form $y = mx + b$.
Solution to a Linear Equation – A solution to a linear equation $y = mx + b$ is an ordered pair (c, d) with the property that when you substitute c for x and d for y in the equation, the equation is satisfied, or is *true.*
System of Equations – A system of equations involves the relationship between two or more equations and can be used to model a number of real-world situations.
Solution to a System of Linear Equations - A *solution* to a system of linear equations is the point(s) of intersection of the lines or the value of the variables that satisfy the equations. The number of *solutions* can vary from one, to none, to infinitely many solutions.

Activity Notes

20 minutes: Graph and Verify

As you are passing out activity sheet 3.1, write the following quick-write prompt on the board or elmo: From the activity we did yesterday, I learned (or remembered) that _____.

Instruct students to list as many ideas as they can recall from Day 2, and tell them it is okay to go back and look at their work. Allow for students to write for at least 2 minutes.

Have students get in to groups of 4 and use Roundtable to have students share their answers beginning with the student with the shortest hair and rotating to the right.

Have groups share for 2 minutes. While the students are sharing with each other, go around the class and number each student in the group 1-4. Use Numbered Heads to have groups share at least two items that they recalled from the prior day.

Allow students to silently read through question 1 and fill in the blank. After thirty seconds, randomly select students to read through the statement. It is hopeful that this fact will have already been reviewed in the quick-write activity.

Read the directions for problems 2 and 3 as a class and instruct students to work in their groups to finish problem 2 and fill in the sentence frame, which has been started for them. Ask students why we would want to verify if a solution is correct or not. After 2 minutes, have a volunteer come present their work to the class. Check for understanding by having students give thumbs up/down if they agree with the given solution. Give the class two more minutes to complete number 3, and ask for a volunteer to report their answer.

Randomly select a student to read through the directions for the next set of problems as you are passing out rulers to the class. Use think-pair-share to inquire what students think "verify by using substitution" means. Be sure to emphasize that they should graph several points for each equation and use a ruler to draw the line, as this will help ensure an accurate answer. Have the students begin solving the problems and set a timer for 10 minutes. The solutions for the problems are: 4) (1, 4); 5) (2, 0); 6) no solution; 7) infinitely many solutions.

Students will most likely be able to complete numbers 4 and 5 without difficulty, but may struggle with how to graph and prove that there is "no solution" to system of equations in problem 6. When most of the class has arrived at this point, stop the class and have a discussion about how we can graph problem 6, which has both equations written in standard form. Ask students to think about the ways in which an equation in standard form can be graphed: rewriting the equation into slope-intercept form or using the intercepts. Let students know that they can use either method; whichever they are most comfortable with. This is a review from Day 1. Students may also struggle with the idea that is difficult to verify that there is "no solution", or that a point may be true for one line but not the other (similar to #3 above). Thus, there is *no solution* for the system.

Have students continue on with number 7. Students may need to first write the second equation in slope-intercept form, unless they are familiar with graphing by using intercepts. (The same was true for number 6.) After students have graphed number 7, have a class discussion about what they think the solution is when the two equations are the same line. Make a list of the following coordinates, from the line, and assign each group a different coordinate to verify: (-1, 5); (0, 2); (1, -1); (2, -4); (3, -7). Once each group has determined if their coordinate is true or false, ask groups to come to the board and write true or false next to the coordinate they were assigned. Once the class can see that all of the coordinates are true, ask them what they think would happen if we continued trying to verify more points on the lines, as we kept extending the lines. The next question is, "how many solutions are there?" Have groups decide upon an answer and ask each group to report out how many they think there are. Agree upon the fact that we cannot pick a finite number, as we would need to include all of the fractional coordinates as well. Have the class agree that there could be many, or infinitely many solutions.

For the last few minutes of the activity, have groups read through the conclusion directions and sketch what the graphs of each of the three types of solutions would look like.

20 minutes: Solving a Systems Word Problem
Pass out activity sheet 3.2, and have students move out of groups of four and move next to a partner. Let them know that activity is going to continue to explore patterns in word problems to help write linear equations and solve them by graphing.

Ask for a volunteer to read through the problem, which is similar to the problems they completed on Day 1 and 2, but two different scenarios are now in the same problem. Let the class know that they will have 3 minutes to fill out the first table and answer the two questions and write the equation. If students are struggling, have them use activity sheet 1.3 from Day 1 or 2.2 from Day 2. At the end of 3 minutes, randomly select a pair to share their work with the class. Ask the class if anyone has anything different, and have them share their work. It is important that the class agrees on the structure of the problem, and to clear up any misconceptions before moving on. Allow partners 3 minutes to read through and complete the second table. At the end of three minutes, select a pair of students, whom you know did the work correctly, to present and explain their work to the class.

Give students about 2 minutes to fill out 2a and 2b and then stop to have a class discussion as to why the graph is set up in units of 2 and not 1 for the y-axis. It is important for students to notice: a) it affects the outcome of their graph if they are graphing using slope-intercept form. They cannot simply use rise/run as the graph is growing by increments of 2 vertically and b) if the graphed used the traditional increments of 1, it would have to be very large. Part of the difficulties students often have when graphing these types of problems is setting up the coordinate plane and not actually graphing and finding the intersection. In future days, students will be asked to come up with the increments on their own.

Have partners continue on with the remainder of the page, as you walk around and check for correctness and understanding. Allow about 5-6 minutes for them to

complete their work. At the end of the allotted time, or when most of the groups are finished, have a discussion about what the intersection really means in terms of the situation and when it is best to buy from each of the two companies.

15 minutes: White Board Review
Have students put away all of their belongings and pass out a mini-whiteboard, marker and eraser to each pair of students. Let them know that you will be writing a problem on the board (or putting it up on the elmo); they will have 2-minutes to solve the problem. At the end of the 2 minutes, each pair who holds up their whiteboard with the correct answer AND shows all of their work receives a point. Record points on the board. (If you have time, you can also have them shoot a basket, as done in the basketball review game.) The team with the most points after 5 questions is the winner. Let them know that you will subtract points if teams are too noisy. If students are struggling with any of the problems, be sure to stop and go over the problem before proceeding.
Answers:
1) Yes 2) (2, 1) 3) $y = 2.50x + 3$; $y = 2x + 4$

4) The two equations are the same. There are infinitely many solutions.

5) they do not intersect, or they are parallel

5 minutes: Ticket out the Door
Pass out the Ticket out the Door and collect it as soon as each student finishes (so that you can discuss mistakes with students as they turn it in).