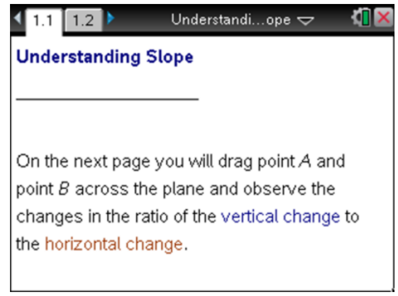

Math Objectives

- Students will identify positive and negative slope.
- Students will know that the sign of the ratio of the vertical and horizontal changes determines the sign of the slope.
- Students will recognize that a positive slope indicates a line is rising from left to right and a negative slope indicates a line is falling from left to right.
- Students will reason abstractly and quantitatively (CCSS Mathematical Practice).
- Students will construct viable arguments and critique the reasoning of others (CCSS Mathematical Practice).

Vocabulary

- slope
- vertical change
- horizontal change

About the Lesson

- This lesson involves helping students see the connections between the sign of the ratio of the vertical and horizontal change as they relate to the sign of the slope of a line. As a result, students will:
  - Move points in the coordinate plane
  - Observe how a line moves
  - Observe the relationships between the signs of the vertical and horizontal change.

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- Send out the *Understanding_Slope.tns* file.
- Monitor student progress using Class Capture.
- Use Live Presenter to spotlight student answers.

Activity Materials

- Compatible TI Technologies: TI-Nspire™ CX Handhelds, TI-Nspire™ Apps for iPad®, TI-Nspire™ Software

Tech Tips:

- This activity includes screen captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

Lesson Materials:

Student Activity

- Understanding_Slope.doc
- Understanding_Slope.pdf

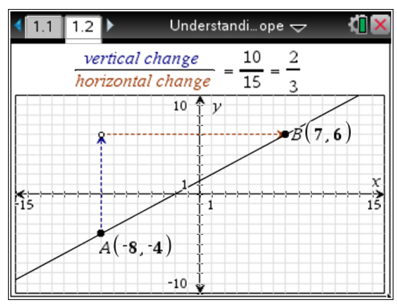
TI-Nspire document

- Understanding_Slope.tns

Discussion Points and Possible Answers

> **Tech Tip:** If students experience difficulty dragging a point, make sure they have not selected more than one point. Press esc to release points. Check to make sure that they have moved the cursor (arrow) until it becomes a hand ( ) getting ready to grab the point. Also, be sure that the word *point* appears. Then select ctrl to grab the point and close the hand ( ). When finished moving the point, select esc to release the point.
>
> **Tech Tip:** If you're moving point *P* and it gets "stuck" at one of the endpoints of the graph, tap once on the point to display the "select object" menu, and then select "point *P*." You can also select to undo your last move.

Move to page 1.2.



1. Following the arrows from point *A* to point *B*, what is the value of the vertical change? Of the horizontal change?

   <u>Answer:</u> The vertical change is the number of units counted up/down on the triangle (height of the slope triangle). The horizontal change is the number of units counted left/right on the triangle (length of the slope triangle).

> **Teacher Tip:** The main point here is to focus on the amount of the vertical and horizontal changes. Students can determine this by simply counting the number of units. Some students might say something about subtracting the coordinates. If so, this would be a good opportunity to discuss the slope formula. If students want to talk only about looking at the fraction at the top of the graph screen, emphasize counting to determine each change.

2. Move one or both points until the values for both the vertical and horizontal changes are positive. Describe the line.
   <u>Answer:</u> The graph rises (goes up) from left to right.

TI-Nspire™ Navigator™ Opportunity: Quick Poll and/or Class Capture
See Note 1 at the end of this lesson.

Teacher Tip: The main point of this question is to identify the characteristics of a positive slope. If any students want to talk about steepness, encourage the discussion, and then focus on the idea that no matter how steep the line is, it will rise from left to right.

Tech Tip: It is possible to move point *A* or point *B* outside of the grid of the coordinate plane. If this happens, simply move the point(s) back to the coordinate plane.

3. Write your answer to Question 2 in the first row of the table below. Move your points to match each pair of remaining conditions. For each case, describe what the line looks like.

   Answer: The completed table is below.

Vertical Change	Horizontal Change	Does the line rise or fall from left to right?
Positive	Positive	**Rise**
Positive	Negative	**Fall**
Negative	Positive	**Fall**
Negative	Negative	**Rise**

4. What patterns do you observe in your descriptions in the previous table?

   Answer: When the ratio is positive (same signs), the line rises from left to right. When the ratio is negative (opposite signs), the line falls from left to right.

Teacher Tip: Students might observe patterns in steepness. Direct discussion toward identifying whether the line is rising or falling from left to right.

5. Set point *A* to (–4, 1).
   a. Where must you place point *B* for the line to rise from left to right?

      Answer: Point *B* must be above and to the right of point *A* or below and to the left of point *A*.

b. Where must you place point B for the line to fall from left to right?

Answer: Point B must be below and to the right of point A or above and to the left of point A.

> **Teacher Tip:** You might also ask students to write inequalities for the conditions of the coordinates. For example, in the first question, in order for the line to rise, $x > -4$ and $y > 1$ (or $x < -4$ and $y < 1$) must be true for point B. Similarly, in order for the line to fall, $x > -4$ and $y < 1$ (or $x < -4$ and $y > 1$) must be true for point B.

6. Set point A to coordinates of your choice.

   a. Where must you place point B for the line to rise from left to right?

   Answer: Point B must be above and to the right of point A or below and to the left of point A.

   b. Where must you place point B for the line to fall from left to right?

   Answer: Point B must be below and to the right of point A or above and to the left of point A.

7. Ann says that her point B is above and to the right of point A. Elizabeth says that her point B is below and to the left of point A. Jessica says her point B is to the right of point A. Whose line must rise from left to right? Explain.

   Answer: Both Ann's and Elizabeth's lines rise from left to right. Jessica's line will sometimes rise from left to right, but not always (depending on whether point B is above point A).

> **Teacher Tip:** Although students might think point B being to the right of point A is sufficient to ensure a positive slope, it is important for them to understand it is not.

8. The slope of a line is defined as the ratio of the vertical change to the horizontal change for any two distinct points on the line.

   a. What relationships must exist between the vertical and horizontal changes to produce a positive slope?

Answer: Same signs produce a positive slope (rising from left to right).

b. To produce a negative slope?

Answer: Different signs produce a negative slope (falling from left to right).

> **Teacher Tip:** This is the main point of the lesson. Guide the discussion toward the ratio of the signs of horizontal and vertical change. Some students might still have trouble remembering the rules for division with two signed numbers. Remind them that when the signs are the same, the quotient is positive, and when they are opposite, the quotient is negative.

9. In each question so far, you have been following the arrows from point *A* to point *B.* If you started at point *B* and moved to point *A*, how would that change your previous answers?

   Answer: Each sign for the horizontal and vertical change would be the opposite, but the ratio of signs would still be the same (meaning the slope would still be the same whether you move from point *A* to point *B* or from point *B* to point *A*).

> **Teacher Tip:** Have students explain this in their own words. This is an important point for the students to realize, and many might not immediately make the connection.

Extension

10. What relationships exist between the coordinates of points *A* and *B* and the slope of the line passing through them?

    Answer: The coordinates can be used to determine the signs of the vertical and horizontal changes, and the ratio of the signs determines whether the slope will be positive or negative.

> **Teacher Tip:** This question is designed to look ahead at the formula for slope. Not all students will see how the values for change were calculated using the coordinates (for example, change in *y* over change in *x*).

TI-Nspire™ Navigator Opportunity: Quick Poll
See Note 2 at the end of this lesson.

Wrap Up

Upon completion of the discussion, the teacher should ensure that students understand:

- That the ratio of the signs of the vertical and horizontal changes determines the sign of slope of a line
- How to use the ratio of the vertical change to the horizontal change to determine whether the slope of a line is positive or negative
- That a positive slope indicates that a line rises from left to right and a negative slope indicates that a line falls from left to right

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Note 1

Question 2, Quick Poll and/or Class Capture: You might want to take Class Captures of student work to show the different possible lines with positive slopes. For example, ask the class to move point A to make a positive slope. Then press Take Screen Capture > Capture Class. Next ask them to move the points until they have a slope of zero. Refresh the Capture Class. Finally, move the points until you have a negative slope. Refresh.

Note 2

Questions 8, 9, and 10, Quick Poll: You might want to send a Quick Poll to determine whether students have reached the proper conclusions about lines with positive and negative slopes.