Math Objectives

- In this activity, students will graph the solution to simple inequalities in one variable and describe the solution using correct vocabulary and symbols.

Vocabulary

- boundary point
- open (non-inclusive) intervals
- closed (inclusive) intervals

About the Lesson

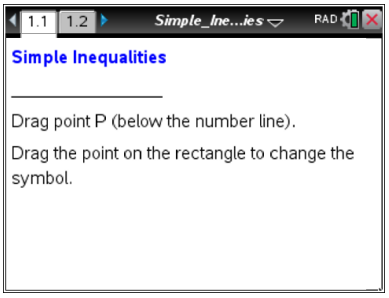
- This lesson involves observing the differences in the graphs when <, ≤, =, >, and ≥ are used. Students will make conjectures as to when to shade to the left, right, or not at all, as well as to whether the boundary point is shaded (included).
- As a result, students will:
  - Understand how to graph the solution to an inequality in one variable on the number line.
  - Describe the solution of a linear inequality in one variable, given the graph, using correct vocabulary and symbols.

TI-Nspire™ Navigator™ System

- Use Class Capture and Live Presenter to share students' explorations with the entire class during the formative lesson or as a review.
- Quick Polls may be used to assess students' progress and understanding of the concepts.
- Use Teacher Software to review student documents.

Activity Materials

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



Tech Tips:

- This activity includes screen captures 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 Apps. 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

- Simple_Inequalities_Student.pdf
- Simple_Inequalities_Student.doc

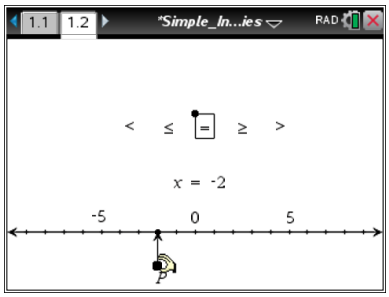
TI-Nspire document

- Simple_Inequalities.tns

Discussion Points and Possible Answers

Tech Tip: If students experience difficulty dragging a point, make sure that they have moved the cursor arrow until it becomes a hand (☜) getting ready to grab the point. Instruct students to press ctrl ☜ to grab the point and close the hand. After the point has been moved, they can press esc to release the point. **Note:** Point *P* can be moved from -9 to 9 inclusive.

Move to page 1.2.



1. Move point *P* to the location shown at the right (-2).
   a. Describe the changes that occur.

      Answer: As point *P* is moved, the number on the right side of the equals sign changes to -2.

   b. What stays the same as you move the point?

      Answer: The variable *x* and the equals sign stay the same.

   c. Make a conjecture about what would happen if you moved point *P* to the right of 0.

      Answer: The number on the right side of the equation will become positive.

TI-Nspire Navigator Opportunity: *Class Capture and/or Live Presenter*
See Note 1 at the end of this lesson.

2. Grab the point on the rectangle surrounding the equals sign. Move the rectangle so that an inequality symbol is selected.
   a. Describe the changes that occur as you move the rectangle.

      Sample Answer: The number line to the left of the circle becomes darker (or thicker) when < or ≤ is selected. The number line to the right of the circle becomes darker (or thicker) when > or ≥ is selected. The circle (boundary point) on the number line is not filled in when > or < (open interval) is selected. The circle (boundary point) is filled in when ≤ or ≥ (closed interval) is selected. There is no change to the number line, only a filled-in circle (closed interval), when the = sign is selected.

b. What stays the same as you move the rectangle?

Answer: The left- and right-hand side of the inequality stay the same.

Teacher Tip: Students might not make all of these observations at this point. The important points are to notice that the inequality records the values on the number line that correspond to the tip of the arrow and that the darkening of the number line represents the set of numbers described by the inequality.

TI-Nspire Navigator Opportunity: *Class Capture and/or Live Presenter*
See Note 2 at the end of this lesson.

3. a. Describe the solution set for the inequality $x < -3$. Indicate how it is shown on the graph.

Answer: The solution set is the set of all real numbers less than, or to the left of, −3 on the number line. These are represented by the dark portion of the number line.

b. How does the graph show that an equation, such as $x = 1$, has a *finite* number of solutions? How does it show that an inequality, such as $x > 1$, has an *infinite* number of solutions?

Answer: Only one point is circled and shaded (boundary point) on the number line for $x = 1$, so there is only one solution (a finite number of solutions). For $x > 1$, the graph on the number line has an open circle at 1 (boundary point) and is darker to the right of 1 (open interval) and continuing as shown by the arrow to include the set of all real numbers greater than 1. So it is impossible to list all of the values of x (infinite number of solutions).

Teacher Tip: Students might not make all of these observations at this point. Encourage students to read the inequality sentences forward and backward, using a phrase like "all the numbers" instead of saying "x".

Question 4 draws their attention to the open/closed circle and the darkening of the number line, which allows you to introduce the vocabulary terms *open* and *closed intervals*.

TI-Nspire Navigator Opportunity: *Quick Poll*
See Note 3 at the end of this lesson.

4. Describe the characteristics of the graph for each of the following expressions and equation.

Answer:

	$x < 2$	$x \leq 2$	$x = 2$	$x \geq 2$	$x > 2$
Open or closed circle?	Open	Closed	Closed	Closed	Open
Dark number line to the right or left?	Left	Left	Neither	Right	Right

TI-Nspire Navigator Opportunity: *Quick Poll*
See Note 4 at the end of this lesson.

5. a. Which symbol(s) will result in an open circle on the number line?

Answer: "Less than" (<) and "greater than" (>) result in an open circle (open interval).

b. Which symbol(s) will result in a closed circle?

Answer: "Equals" (=), "less than or equal to" (≤), and "greater than or equal to" (≥) result in a shaded circle (closed interval).

Teacher Tip: Check to be sure that students understand that the open circle means that the number at which the arrow is pointing is not part of the solution. The closed circle means that the number at which the arrow is pointing is part of the solution.

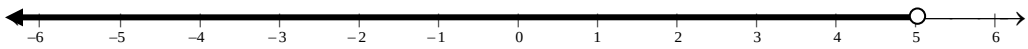
6. Mary says, "The graph of $x < 5$ would have an open circle and appear darker to the right on the number line." Is she correct? Why or why not?

Answer: Mary is partially correct. The < symbol would have an open circle (open interval). However, the number line would be darker to the left of 5 because numbers like 4, 3, and 1.5… are part of the solution, and numbers like 6, 8, 11, and 12.5 are not part of the solution.

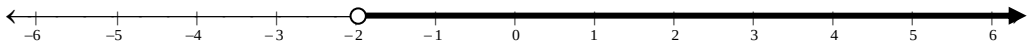
7. Sketch the graph of $x \geq 12$ on the following number line. Explain why you chose the characteristics of your graph. Be sure to label your number line.

Answer: The graph includes a shaded circle at $x = 12$ (closed interval) with the number line being darker to the right of 12. The numbers to the right are greater than 12.

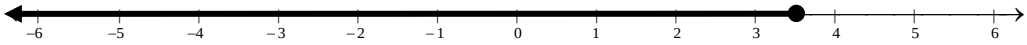
8. Write the inequalities that represent the graphs below.

a. 

Answer: $x < 5$

b. 

Answer: $x > -2$

c. 

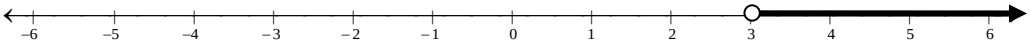
Answer: $x \leq 3.5$

Teacher Tip: This might be a good time to explain how the answers could be written with the variable on the right side of the inequality instead of the left. Suggest to students that when this is the case, read the inequality by focusing on the variable first, then the inequality sign, then the boundary number. Again, reading the sentence forward and backward may help understanding.
Depending on students' understanding, this might also be a good time to introduce interval notation to students: a. (- ∞, 5), b. (-2, ∞), c. (-∞, 3.5]. Note that parentheses ( ) are used for open intervals (non-inclusive) and brackets [ ] are used for closed intervals (inclusive).

9. The symbols ≤ and ≥ are referred to as *inclusive.* The symbols < and > are referred to as *non-inclusive.* Explain why these words are used.

Answer: The number is included as part of the solution for ≤ or ≥. Thus the circle is shaded. The number is not part of the solution for inequalities containing < or >. Thus the circle is not shaded.

10. Freda says that the graph below is of $x > 3$. Steve says it is of $3 < x$. Who do you think is correct, and why?



Answer: Both are correct. The inequality $x > 3$ can be interpreted as all of the numbers greater than 3 (non-inclusive) such as 3.1, 3.5, 4, 9 … and is darker to the right. The inequality $3 < x$ represents all of the numbers such that 3 is smaller than any of the numbers. That is, all of the numbers are greater than 3, but not including 3. The solutions to $x > 3$ and $3 < x$ are the same.

11. Sketch a graph of each of the following inequalities.
    a. $-3 \geq x$

    Answer: Sketch with a shaded circle (closed interval) at $x = -3$ and the number line darker to the left of –3.

    b. $x > 2$

    Answer: Sketch with an open circle (open interval) at $x = 2$ and the number line darker to the right of 2.

Move to page 1.3.

12. I have decided I need to reduce the number of soft drinks I consume in a month. I have determined that I should drink no more than 10 soft drinks in any particular month. Write an inequality representing this situation using **sd** as the variable to represent the number of soft drinks.

    Answer: $sd \leq 10$

TI-Nspire Navigator Opportunity: *Delete documents*
See Note 5 at the end of this lesson.

Wrap Up

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

- How to identify the solution to an inequality in one variable as a set of numbers that can be represented algebraically or graphically.

- How to recognize when the boundary point is part of the solution.
- Included symbols (≤, =, ≥) and non-included symbols (>, <).
- How to write a solution set for an inequality from a graph and how to graph a solution set given an inequality statement.

Assessment

Key places to assess students' understanding are after questions 8, 10, and 11. Have students describe an inequality. Ask the rest of the class to write the inequality using correct symbols.

TI-Nspire Navigator Opportunity

Note 1

Question 1, *Class Capture and/or Live Presenter*

Use Class Capture to monitor progress and students' understanding of using the document. Use Live Presenter to demonstrate the correct procedure for using the document.

Note 2

Question 2, *Class Capture and/or Live Presenter*

Use Screen Capture to monitor progress and students' understanding of changing the inequality symbol in the document. Use Live Presenter to demonstrate the correct procedure.

Note 3

Question 3, *Quick Poll*

Use Quick Poll for formative assessment. Use an Open Response poll to ask students to answer the following questions: "How many solutions are between 1 and 2 in the inequality $x > 1$?" "How many solutions are between 2 and 4 in the inequality $x > 1$?" Students might identify only integer solutions indicated by the arrow rather than solutions that are non-integer real numbers.

Note 4

Question 4, *Quick Poll*

Use Quick Polls to obtain students' responses to question 4. Discuss any discrepancies in their answers.

Note 5

Question 11, *Delete documents*

You might want to delete students' documents from their handhelds. If students share handhelds, you will have to resend the documents for your next class.