Solve Multistep Inequalities and Graph the Solution

Strand: Patterns, Functions, and Algebra

Topic: Solving multistep inequalities and graphing the solution

Primary SOL: 8.18 The student will solve multistep linear inequalities in one variable with the variable on one or both sides of the inequality symbol, including practical problems, and graph the solution on a number line.

Related SOL: 6.13, 6.14, 7.12, 7.13, 8.17

Materials

- *Matching Problems to Inequalities* activity sheet (attached)
- *Solving and Graphing an Inequality – Example* activity sheet (attached)

Vocabulary

closed circle, inequality, inequality symbol/sign, inverse operation, like terms, number line, open circle, properties, reverse, solution, solution set (earlier grades)

Student/Teacher Actions: What should students be doing? What should teachers be doing?

Note: Students have solved one-step equations in Grade 6 along with represented practical problems as inequalities using addition and subtraction. In Grade 7, students solved two-step linear equations and solved one- and two-step inequalities using addition, subtraction, multiplication, and division. Students have also graphed the solution to inequalities on a number line (both open and closed endpoints). Using inequalities to solve practical problems is included in the standards for Grades 6 and 7. This standard extends the previous learning by expecting students to solve multistep inequalities with the variable on one or both sides of the inequality. It is advisable to have already worked with SOL 8.17 before this lesson, because concepts from it will be applied in this lesson. Throughout this lesson, remind students that they are using the properties of real numbers and the properties of inequality when solving.

1. Prepare a copy of the *Matching Problems to Inequalities* activity sheet (cut out) for each pair of four students. Each student is to randomly pick a problem and an inequality card. Have the students, one at a time, read the problem from his/her card. The student who thinks he/she has the solution will then read the inequality on his/her card. Group members will then discuss and confirm that the correct match has been found, and the problem and inequality cards are placed side-by-side on the table/desk. Another student reads his/her problem and the process continues until all matches are made.
2. Direct students to find and graph the solution set for each problem, starting with Alexa and progressing through Tim and Mark, Mrs. Smith, and Aaron. This will provide an opportunity for you to review previously learned content as well as informally assess students' current knowledge. Once the inequalities are graphed, ask students whether various values are in the solution set or not.

3. Distribute the *Solving and Graphing an Inequality – Example* activity sheet, which includes the inequality: $3(x-2)+5 < 6x-2$. In groups, have students discuss how this inequality is the same as and different from the inequalities previously solved. As groups share with the class, make sure that the students note there are variables on both sides of the inequality, and it looks like there are terms thus requiring more steps to solve.
4. Change the inequality symbol to an equals sign and have the students work to solve the equation. After most students have a solution, have a volunteer student (who has the correct answer of $x = \frac{1}{3}$ and, if possible, subtracted 6*x* from both sides of the equation when solving) present his/her problem-solving method. Thank the student and ask all students to graph this answer (a single point) on a number line.
5. Return the inequality symbol and ask students to discuss how this will change the answer. Students should indicate that there will be multiple solutions, not just one. If you want, you can ask students to predict whether the solution to the inequality will be shaded to the left (assuming most will predict as symbol is $\leq$) or right on the number line as well as determine whether $\frac{1}{3}$ will still be part of the solution set and why. Have students test a point from the predicted solution set.
6. Model for students the steps to solve the inequality and relate them to the steps the student used to solve the equation. Emphasize the need to reverse the sign of the inequality when dividing by a negative number and or when rewriting $\frac{1}{3} \leq x$ to $x \geq \frac{1}{3}$. Ask students to graph the solution. Were their predictions correct? Ask students to give two values that are in the solution set and two that are not. Explain why the inequality change directions when dividing by a negative.
7. Provide students with additional multistep inequalities to solve and graph the solution. Here is a sample list from the curriculum framework: $2x+1 > \frac{-x}{4}$; $-3(2x+7) \leq \frac{1}{2}x$; $2x+7-5x < 27$; $-5x-(x+3) > -12$.
8. Provide students with practical problems to solve and graph the solution set. For example, "You have $30 and earn $10 per week. A friend has $65 and earns $7 per week. After how many weeks will you have more money?"

Assessment

- **Questions**
  - Provide students with a multistep inequality with the variable on both sides to solve and graph.
  - Provide students with a practical problem to solve that requires setting up and solving a multistep inequality with the variable on both sides.
- **Journal/writing prompts**
  - Describe how solving multistep equations is the same as and different from solving multistep inequalities. How are the solutions the same or different?
  - Create, solve, and graph the solution to a practical problem that requires setting up and solving a multistep inequality with the variable on both sides.

- **Other Assessments**
  - Provide a solved inequality in which there are one or more errors. Have students review the work, find errors, and correctly solve and graph the inequality.
  - Provide a template for creating a multistep inequality. Have students create, solve, and graph the inequality.

Extensions and Connections

- Students can be provided a set of inequalities and graphed solutions. The task is to match each inequality with its graph.
- Arrange students in small groups of 3–4. Provide each student in the group a different inequality to solve. Each student is to complete the first step in the solution process. After that, the student passes his/her problem to the student on his/her left. With the new problem, the student reviews the work currently on the paper and adds the next step. This process is repeated until all inequalities are solved and graphed.

Strategies for Differentiation

- Have students look for situations where a specific number is not needed but rather a range of numbers. Have them model the situation with an inequality. An example would be, at the grocery store, there is a check-out line for 10 items or fewer ($x \leq 10$).
- The complexity of the inequality can be adjusted to meet the needs of the learners.

Note: The following pages are intended for classroom use for students as a visual aid to learning.

Matching Problems to Inequalities

Print on card stock and cut out.

Alexa needs to earn at least \$30 to go to the movies.	$x \geq 30$ 
Tim has some video games. Mark has twice as many video games as Tim. Together they have more than 20 video games. How many games could Tim have?	$x + 2x > 20$ 
Mrs. Smith charges \$30 per hour for tutoring services plus a one-time fee of \$10 for supplies. How many tutoring sessions can a student attend if the parent will spend, at most, \$2,500?	$30x + 10 \leq 2500$ 
Aaron wants to buy a new hockey stick that will cost at least \$220. He currently has \$50 and will earn \$30 each day at his part-time job. After how many days will he be able to buy the hockey stick?	$220 \leq 50 + 30x$ 

Solving and Graphing an Inequality – Example

$$3(x - 2) + 5 < 6x - 2$$

Changed to an Equation	As an Inequality
$3(x - 2) + 5 = 6x - 2$	$3(x - 2) + 5 < 6x - 2$