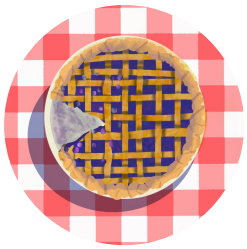

Pie > Everything, Part 2

Multi-Step Inequalities

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Grade Level	7th – 8th Grade	**Time Frame**	2 class periods
Subject	Mathematics	**Duration**	90–95 minutes
Course	Pre-Algebra		

Essential Question

How can we use inequalities to represent relationships?

Summary

This lesson focuses on the relationship between a set of numbers and the constraints of an inequality. Students write, graph, and identify solutions to inequalities, connecting them back to real-world scenarios when applicable.

Snapshot

Engage

Students match scenarios with inequalities in a Card Matching activity.

Explore

Students investigate solutions to inequalities using a T-chart and number lines.

Explain

Students formalize their understanding of solving multi-step inequalities and discover the rule for multiplying and dividing by a negative number.

Extend

Students match their given scenarios to inequalities and the corresponding algebraic and graphical solutions.

Evaluate

Students correct mistakes in solved inequalities to demonstrate understanding.

Standards

ACT College and Career Readiness Standards - Mathematics (6-12)

A405: Match simple inequalities with their graphs on the number line (e.g., x ≥ –3/5)
A503: Solve first-degree inequalities when the method does not involve reversing the inequality sign

Oklahoma Academic Standards Mathematics (8th Grade)

PA.A.4.2: Represent, write, solve, and graph problems leading to linear inequalities with one variable in the form px + q > r and px + q < r, where p, q, and r are rational numbers.

Attachments

- Exit Ticket—Pie_Everything, Part 2 - Spanish.docx
- Exit Ticket—Pie_Everything, Part 2 - Spanish.pdf
- Exit Ticket—Pie_Everything, Part 2.docx
- Exit Ticket—Pie_Everything, Part 2.pdf
- Lesson Slides—Pie_Everything, Part 2.pptx
- Linear Inequalities—Pie_Everything, Part 2 - Spanish.docx
- Linear Inequalities—Pie_Everything, Part 2 - Spanish.pdf
- Linear Inequalities—Pie_Everything, Part 2.docx
- Linear Inequalities—Pie_Everything, Part 2.pdf
- Pies and Inequalities Signs—Pie_Everything, Part 2.docx
- Pies and Inequalities Signs—Pie_Everything, Part 2.pdf
- Pies and Inequalities—Pie_Everything, Part 2 - Spanish.docx
- Pies and Inequalities—Pie_Everything, Part 2 - Spanish.pdf
- Pies and Inequalities—Pie_Everything, Part 2.docx
- Pies and Inequalities—Pie_Everything, Part 2.pdf
- Pies and Inequaltities (Teacher Guide)—Pie_Everything, Part 2.pdf
- What Numbers Work—Pie_Everything, Part 2 - Spanish.docx
- What Numbers Work—Pie_Everything, Part 2 - Spanish.pdf
- What Numbers Work—Pie_Everything, Part 2.docx
- What Numbers Work—Pie_Everything, Part 2.pdf

Materials

- Lesson Slides (attached)
- Linear Inequalities cards (attached; one set per pair; printed one-sided)
- What Numbers Work handout (attached; one per pair; printed two-sided)
- Pies and Inequalities Signs (attached; one per classroom; printed one-sided)
- Pies and Inequalities handout (attached; one per group; printed two-sided)
- Pies and Inequalities (Teacher Guide) document (attached)
- Exit Ticket handout (attached; one per student; printed one-sided)

10 minutes

Engage

Teacher's Note: Card Matching Preparation

Before you begin, print the attached **Linear Inequalities** cards (one copy per pair of students in your class). Consider printing on cardstock paper, especially if you plan to reuse these cards.

Once printed, cut out the cards. All of these cards are the same size for easy cutting.

Introduce the lesson using the attached **Lesson Slides**. Display **slide 3** and share the essential question: *How can inequalities represent relationships?* Then move to **slide 4** to outline lesson objectives.

Display **slide 5** and share the Card Matching strategy with the class. Have students find a partner or assign partners. Distribute one set of **Linear Inequalities** cards to each pair. Remind students to be kind and careful with the printed cards. Ask pairs to complete the card matching activity that involves matching various scenarios with one-variable inequalities. Give about five minutes for them to complete the matching activity, then have each pair join another pair to discuss their choices, using guiding questions like “Why did you match those cards?” or “How do you know the inequality symbol is correct?”

Optional Modification for Distance Learning

To make use of these activities in an online or distance learning environment, consider using the “card sort” feature of Desmos Classroom or the “matching game” option on Quizlet for online classes. You could also have students describe their thought processes for each pair of matched cards as part of an online discussion board. Download all attachments to use this lesson in Google Classroom.

20 minutes

Explore

Show **slide 6**. With students still in pairs, distribute a copy of the attached **What Numbers Work** handout to each pair. Ask them to list numbers that make the given inequality true, along with those that do not. Encourage pairs to discuss their reasoning. Students are to show the numbers that work on the number line (graphing the inequality). This activity allows students to visualize the solution set of the inequality. Students then answer the question: *Why do certain numbers not work?*

Display **slide 7** and direct students' attention to the back side of their handout. Have students reflect on their findings and write their "rule" (an explanation) for graphing inequalities. Ask a few volunteers to share their rules, then facilitate a class discussion about the relationship between the numbers from the table that worked with the values on the number line.

Teacher's Note: Student Conversations

As students work, walk around the room and listen for discussions that lead to steps for solving inequalities or that make connections to solving equations. Use what you hear to help guide the next phase of the lesson.

25 minutes

Explain

Display **slide 8** and share the steps for solving multi-step inequalities.

Transition to **slide 9** and solve the inequality ($-3 < 2x + 15$) together, keeping the variable on the right side of the inequality symbol. After finding the solution ($-9 < x$), ask students how they would solve the inequality if they instead moved the variable term to the left in the first step. This approach will lead students to encounter dividing both sides by a negative number. Remind them that regardless of which side the variable is on, the solution remains the same. Then ask the class which inequality symbol they should use and what rule they should use when they divide by a negative number. Use this example to facilitate a brief discussion about the reasoning behind "flipping the inequality symbol" when multiplying or dividing by a negative number.

Use hidden **slide 10** as a guide for walking students through this example.

Teacher's Note: A Little History

Share that early mathematicians avoided negative numbers, as they did not fit into their physical-world interpretations. Explain that today, we use the "flip the inequality symbol" rule to streamline calculations. The example on slides 9-10 gives insight into the complexity of negative coefficients and inequalities.

Display **slide 11** and ask the class to help you list the similarities and differences between solving equations and solving inequalities on the board. You can write or type their responses directly onto/into the slide.

Sample Student Responses

- **Similarity example:** completing inverse operations
- **Difference example:** flipping the inequality symbol when multiplying or dividing by a negative number

Display **slide 12** and have students try the given problem independently.

Move to **slide 13**. Use this challenge question to further their understanding. Clarify misconceptions as students are solving and graphing.

Teacher's Note: Guiding the Lesson

It is a common misconception that “the direction the inequality points” determines the direction the arrow points on the number line. Since this is only true when the variable is on the left side, encourage students to use the same reasoning as they did during the Explore portion of this lesson to test a number to determine which way the arrow points.

For example, when students solve the challenge problem, they should get $-12 \geq x$. If they test $x = 0$, they see that zero does not make the inequality true, so their arrow should point away from 0. If they picked $x = -20$ to test, –20 does make the inequality true, so their arrow would point towards –20. Consider using the language of “towards” and “away” instead of “left” and “right” so that students can use that language for all inequalities.

30 minutes

Extend

Teacher's Note: Activity Preparation

Before beginning this phase of the lesson, print the attached **Pies and Inequalities Signs** and cut them in half, creating 24 signs. Hang the signs randomly around the room. Students will use these signs to record their final answers. If limited on space, consider using the hallway to hang signs.

Use the attached **Pies and Inequalities (Teacher Guide)** document as needed. The first page shows what students' work may look like, while the second page shows which signs correspond to each problem. Print at least the second page, as you will use this page to quickly check students' work and give feedback.

Organize students into groups of 2–3 and give each group a copy of the attached **Pies and Inequalities** handout. Display **slide 14** and preview the activity. Inform students that they are to match their verbal descriptions of inequalities on their handout with the algebraic representations, algebraic solutions, and number line solutions that are hanging around the room. Each group is to look around the room for the inequality, solution, and number line that corresponds to the verbal description. Then they are to record the letter that is printed in the top-left corner of the sign on their handout.

Direct students' attention to the *Show Your Work* side of their handout. As they complete the front side of their handout, remind them to record the letters of the corresponding signs that are hung around the room. Each problem has three corresponding signs; encourage students to not visit a sign that has another group. All signs should be used exactly once. To ensure all group members participate, consider requiring each group member's distinct handwriting on the handout. This activity allows students to choose the order they complete their work.

Give students time to work at their own pace. Some may visit signs in order of their algebraic work; others might search for matching number lines first. Allow either approach to foster their engagement and problem-solving.

When a group finishes the *Your Results* side of their handout, have them bring you their handout. Use the second page of the attached **Pies and Inequalities (Teacher Guide)** document to quickly check their results and give feedback.

Teacher's Note: Giving Feedback

Consider student needs and class time as you provide feedback. If a group gets done with a lot of class time remaining and many errors, consider telling them how many are incorrect, but not which ones are incorrect. If a group has many errors, consider telling them which ones are correct. If only two letters are incorrect, consider pointing out which one is incorrect (but not both) and telling them that there is one more that is incorrect (that they will need to correct).

For example, if a group mixed up the numbers lines for problems 1 and 4, and you tell them that those are the two mistakes, then the group can mindlessly switch the letters and not think about their mistakes. Instead if you only share that the number line is incorrect for problem 1 and that there is one other mistake, then the group is required to critically think to correct their mistakes.

5 minutes

Evaluate

Display **slide 15** to introduce the Exit Ticket strategy. Distribute a copy of the attached **Exit Ticket** handout to each student. Here students are to analyze two solved inequalities and determine which was solved incorrectly, justifying the rationale behind their choice.

Have students correct the work and graph the solution on a number line. Collect the handouts to assess comprehension and identify any remaining misconceptions.

Resources

- K20 Center. (n.d.). Bell Ringers and Exit Ticket. Strategies. https://learn.k20center.ou.edu/strategy/125
- K20 Center. (n.d.). Card Matching. Strategies. https://learn.k20center.ou.edu/strategy/1837
- K20 Center. (n.d.). Desmos classroom. Tech Tools. https://learn.k20center.ou.edu/tech-tool/1081
- K20 Center. (n.d.). Google classroom. Tech Tools. https://learn.k20center.ou.edu/tech-tool/628
- K20 Center. (n.d.). Quizlet. Tech Tools. https://learn.k20center.ou.edu/tech-tool/666