Popcorn > Raisinets

Inequalities With Two Variables

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Grade Level	8th – 9th Grade	**Time Frame**	80-90 minutes
Subject	Mathematics	**Duration**	2 class periods
Course	Algebra 1		

Essential Question

How can two-variable inequalities be used to represent relationships?

Summary

This lesson is an extension of the "Pie > Everything" lesson series and adds a second variable to the equation. The goal of this lesson is for students to understand and find possible solutions for two-variable inequalities. Students will translate real-life problems into linear inequalities and make connections between the two. Students will also write and graph two-variable inequalities.

Snapshot

Engage

Students watch a video and discuss questions to begin thinking about variables.

Explore

Students consider a real-world scenario and find multiple solutions to the problem presented in the scenario.

Explain

Students resolve misconceptions about inequalities to gain a deeper understanding.

Extend

Students elaborate on their knowledge of inequalities by participating in an Amplify Classroom polygraph activity.

Evaluate

Students write a linear inequality represented by a given graph.

Standards

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

AF603: Interpret and use information from graphs in the coordinate plane

Oklahoma Academic Standards Mathematics (Algebra 1)

A1.A.2.1: Represent relationships using mathematical models with linear inequalities; solve the resulting inequalities, graph on a coordinate plane, and interpret the solutions.

Attachments

- Guided Notes—Popcorn Raisinets - Spanish.docx
- Guided Notes—Popcorn Raisinets - Spanish.pdf
- Guided Notes—Popcorn Raisinets.docx
- Guided Notes—Popcorn Raisinets.pdf
- Lesson Slides—Popcorn Raisinets.pptx
- Movie Snacks—Popcorn Raisinets - Spanish.docx
- Movie Snacks—Popcorn Raisinets - Spanish.pdf
- Movie Snacks—Popcorn Raisinets.docx
- Movie Snacks—Popcorn Raisinets.pdf

Materials

- Lesson Slides (attached)
- Movie Snacks handout (attached; one per student; print two-sided)
- Guided Notes handout (attached; one per student; print one-sided)
- Student devices with internet access

5 minutes

Engage

Introduce the lesson using the attached **Lesson Slides**. Briefly introduce the essential question on **slide 3**. Move to **slide 4** to identify the lesson's learning objectives. Review each of these with students to the extent you feel necessary.

Move to **slide 5** and show the short *Let's All Go to the Lobby* video.

Embedded video
https://youtube.com/watch?v=lm6IU6V-dE8

After showing the video, show **slide 6** and pose the following questions:

Would you rather...

- Have two boxes of candy and no drink, or a small popcorn and unlimited drinks?
- Invite two more friends to watch a movie with you and have no snacks, or go with one friend and have money to buy snacks?

Ask students to consider whether they would answer the questions the same way every time, or if they would answer differently depending on the circumstances.

20 minutes

Explore

Display **slide 7** and have students find an Elbow Partner. Have partners read and analyze the following scenario on the slide:

- **Scenario 1:** Your family goes to the movies. The snack bar is all out of large popcorn containers and large cups. The only size they have left is small. Your family has $30 to spend. How many orders of popcorn and drinks can your family buy if a small popcorn costs $6 and a small drink costs $5? Your family does not want any change.

Pass out one copy of the attached **Movie Snacks** handout to each student. Have students work with their Elbow Partners to determine how many different combinations of popcorn orders and drinks can be purchased for $30 without receiving change. Have them record their answers in the blank chart provided on "Part A" of the handout.

Once students think they have found all possible combinations, have them move to "Part B" to plot the points on the graph. After students plot their points, direct them to respond to the questions in "Part C," which have them connect the dots with a line, identify the type of graph, and explain their thinking.

Teacher Note: Blank Column Headers

The first two column headers on "Part A" of the Movie Snacks handout are left blank, giving students the freedom to label these as "Popcorn" and "Drinks." The results of their linear graphs will differ depending on the order they label the columns.

Their labeling choices will serve as a great discussion topic during the Explain portion of the lesson.

Go to **slide 8** and direct students' attention to "Scenario 2" on their handout:

- **Scenario 2:** Your family decided it was too difficult to determine how many orders of popcorn and drinks to buy so that they wouldn't get any change back. They decided that they do not mind if they get change back. How many different combinations of popcorn orders and drinks can your family buy?

Have students figure out the new combinations based on this scenario and record them in the second blank chart on the handout. Once they have figured out all the new combinations, ask them to plot the points on the graph and complete the handout.

20 minutes

Explain

Teacher's Note: Meeting Your Students' Needs

Slides 9–19 cover how to graph linear inequalities and provide example problems. Feel free to add more problems if necessary.

Edit **slide 9** to meet the needs of your students. Step 1 for graphing linear inequalities in your classroom might look different for each class period. The slide is currently designed to meet the needs of any class, so you may leave the slide as is. This also applies to Step 1 on the **Guided Notes** handout. The first step of graphing linear inequalities is the same as the first step of graphing linear equations. Consider encouraging students to always start by making a table and writing the inequality in slope-intercept form. If you want to push students to become flexible with how they graph lines, guide them to recognize the given form and have them use that to determine how to start.

Use slide 9 to meet your students' needs, but be sure to tell students that there are many ways to begin graphing linear inequalities, just like linear equations. Have students record notes about Step 1 on their Guided Notes handout.

Pass out a copy of the **Guided Notes** handout to each student and transition through **slides 9–10**. Explain to students that graphing linear inequalities is much like graphing linear equations; the first step is the same for both processes, but when graphing linear inequalities, students must consider whether the line should be solid or dashed, and which area to shade on the graph.

Display **slide 11** and explain the difference between solid and dashed lines and when each line is used. Have students record when to use solid lines and when to use dashed lines on their handout by writing the ≥ and ≤ symbols in the table under the graph of the solid line and writing the < and > symbols in the table under the graph of the dashed line.

Show **slide 12** and define *test point* as any point that is not on the line, in the context of linear equations. Demonstrate how to use the test point by algebraically substituting the *x*- and *y*-values into the inequality to see if the test point makes the inequality true or false.

Move to **slide 13** and explain that if the test point makes the inequality true, then they should shade toward the test point. If the test point makes the inequality false, they should shade away from the test point.

Transition through **slides 14–15** and demonstrate to students how to shade toward the test point when it makes the inequality true and how to shade away from the test point when it makes the inequality false. Have students continue to complete their handouts.

Teacher's Note: Guiding the Lesson

Use slide 15 to help students understand the idea of shading toward and away from the test point. If students are still struggling, consider giving pairs of students different points and having them share their results with the class. These extra examples should help students see that no matter what point they select, as long as it is not on the line, points in the shaded region make the inequality true, while those not in the shaded region make it false. This approach can also help students gain a better understanding of the infinitely many solutions being represented by the shaded region, and the infinitely many points that are not solutions.

Avoid using language such as "above" and "below" the line, since a test point being true or false does not consistently determine whether one should shade above or below the line. Instead, use the language of shading "toward" or "away" from the test point, as this method always works.

Display **slide 16** and guide students through the process of graphing the example equation on the slide, $2y < 3x - 2$. Ask students the following prompting questions on the slide as you work:

- Will this be a solid or dashed line?
- What point will you use?

Check students' understanding using the challenge question on **slide 17**, which asks students to graph the equation $2y - 4x \geq 6$. Allow students to work in groups or pairs to graph the linear inequality.

Move to **slide 18** and have students reflect on Scenario 2, "Part B" from the Movie Snacks handout. Have groups or pairs share out their thought processes for creating the equation in Scenario 2. As they share, guide students to make connections between the activity and the rules of inequalities by asking them the following questions on the slide:

- Where are all the points located on the graph you created?
- Could you shade a region that would contain all your points?

Display **slide 19** and see if students recognize the inequality from the Movie Snacks scenarios. Ask students what the numbers in the inequality represent. Repeat this process with **slide 20**. Ask students to raise their hand if their graph looked like the graph on slide 19. Then, ask students to raise their hand if their graph looked like the graph on slide 20. Lead a class discussion about why both responses are correct.

Sample Student Responses

- 5 represents the cost of a drink, 6 represents the price of the popcorn, and 30 is the total.
- I let x be the popcorn and y be the drinks.
- I let x be the drinks and y be the popcorn.

Assist students with academic language and encourage better understanding by having them use descriptions such as x represented the **number of** popcorn orders and y represented the **number of** drinks.

30 minutes

Extend

Teacher's Note: Desmos Classroom Polygraph Activity Preparation

The following directions were created for Desmos Classroom, which has since transitioned to Amplify Classroom. While the core functionality remains the same, the interface and navigation may look slightly different from what is shown in the instructions.

In this portion of the lesson, students complete an Amplify polygraph activity, which is similar to the games "Guess Who?" or "20 Questions" and encourages students to strengthen their academic vocabulary. For more information about how Amplify Classroom polygraphs work, go to the Polygraphs portion of the K20 Center's Desmos Classroom resources.

To use this Amplify Classroom activity, navigate to Polygraph: Linear Inequalities. Sign up to create an account or log in. Select the "Assign" dropdown button, and then select "Create single session code." Adjust the settings as desired, then select "Create Invite Code." Prepare this session invitation code for distribution to students during the learning experience. For more information about previewing and assigning a Desmos Classroom activity, navigate to the Using Activities portion of the K20 Center's Desmos Classroom resources.

Display **slide 21** and provide students with your session code. Then, have them go to student.amplify.com/join and enter the session code.

Once students enter the session code, explain how the polygraph activity works:

1. The first round is quick and intended to help them understand how the game works.
2. Students will be automatically assigned partners to complete the activity. If you have an odd number of students, consider logging in as a student to be someone's partner.
3. One student is assigned the role of "guesser" and the other is assigned the role of "picker." The picker selects one of the inequalities. Then, the guesser will ask the picker "yes" or "no" questions to try to determine which graph the picker selected.
4. Have students play the game two times and answer the prompted questions at the end of the game.

As students work, use the teacher dashboard to see what questions students are asking each other. Remind and encourage students to use the vocabulary they learned during the lesson.

Sample Student Responses

Students can ask a variety of questions. You may consider adding a competitive element by encouraging academic vocabulary, because that vocabulary should help the guesser more quickly guess the selected graph. For example, questions like the ones below encourage academic language:

- Does the graph have a solid line?
- Does the graph have a dashed line?
- Does the line have a positive slope?
- Does the line have a negative slope?
- Does the line have a positive *y*-intercept?
- Does the line have a negative *y*-intercept?
- Is the origin a solution?
- Is the origin part of the shaded region?
- Is (2,0) a solution?

5 minutes

Evaluate

Use the Exit Ticket instructional strategy to individually assess what students have learned from the lesson. Display **slide 22** and have students write the inequality that is represented by the given graph. Have students write their answers on an index card, sticky note, piece of paper, etc.

Use student responses to determine if they need additional practice with graphing or writing linear inequalities or if they are ready for the next topic.

Resources

- Burrns Luciano. (2021, May 15). *Let's all go to the lobby! Intermission bumper 4K update* [Video]. YouTube. https://www.youtube.com/watch?v=lm6IU6V-dE8
- Illichman. (n.d.). *Polygraph: Linear inequalities* [Interactive activity]. Desmos. https://teacher.desmos.com/activitybuilder/custom/560ad6907701c30306330601
- K20 Center. (n.d.). Bell ringers and exit tickets. https://learn.k20center.ou.edu/strategy/125
- K20 Center. (n.d.). Desmos classroom. Tech tools. https://learn.k20center.ou.edu/tech-tool/1081
- K20 Center. (n.d.). Elbow partners. https://learn.k20center.ou.edu/strategy/116