Trashketball: Part 2

Linear Inequalities

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Grade Level	9th Grade	**Time Frame**	3-4 class period(s)
Subject	Mathematics	**Duration**	180 minutes
Course	Algebra 1		

Essential Question

How can we compare different sets of data?

Summary

Students continue to work with data collected in "Trashketball: Part 1" (or the example data provided) to write inequalities to describe possible future outcomes.

Snapshot

Engage

Students work in pairs to interpret graphs and make conclusions involving inequalities

Explore

Students sketch several possible answers to linear inequalities in order to determine what region(s) of a graph describe solutions to the inequalities.

Explain

Students create and interpret new situations and explain their interpretations.

Extend

Students design and conduct an experiment that changes one of the control variables. They collect their data and create a line of best fit, based on that data.

Evaluate

Students create and share verbal descriptions to match given graphs of linear inequalities.

Standards

Oklahoma Academic Standards for Mathematics (Grades 9, 10, 11, 12)

A1.A.2.1: Represent relationships in various contexts with linear inequalities; solve the resulting inequalities, graph on a coordinate plane, and interpret the solutions.
A1.D.1.2: Collect data and use scatterplots to analyze patterns and describe linear relationships between two variables. Using graphing technology, determine regression lines and correlation coefficients; use regression lines to make predictions and correlation coefficients to assess the reliability of those predictions.

Attachments

- Graphing Stories - Spanish.docx
- Graphing Stories - Spanish.pdf
- Graphing Stories.docx
- Graphing Stories.pdf
- More Bowling with Jacob - Spanish.docx
- More Bowling with Jacob - Spanish.pdf
- More Bowling with Jacob.docx
- More Bowling with Jacob.pdf
- Trashketball Part 2 - Spanish.docx
- Trashketball Part 2 - Spanish.pdf
- Trashketball Part 2.docx
- Trashketball Part 2.pdf

Materials

- More Bowling with Jacob handout (attached)
- Trashketball: Part 2 handout (attached)
- Document camera
- Scissors (one pair per student)
- Colored pencils or marker (one set for the class)
- Index cards
- Graphing Stories handout (attached)

Engage

Pass out the **More Bowling with Jacob** handout. Have students complete this handout using a Think-Pair-Share strategy. After writing their own responses and sharing them with a partner, have three pairs share-out their thinking about part A. Compare and contrast these pairs' answers with your class. Continue to pick another two or three pairs to share their thinking about each of the parts B through E.

After everyone has shared, ask students why it might be useful for Jacob to know if he knocks down more or less pins than expected.

Explore

Hand each student a copy of the first page of the attached **Trashketball: Part 2** handout. Have students use their scissors to cut apart the six problems.

Explain to students the graph on each problem represents the shooting percentage of a class of 24 students. On each card is a statement made by one of the students about his or her individual shooting percentage. Tell students to use the statement to sketch a possible line of best fit for the shooting percentage of the student. Stress that many answers are possible, as long as the line of best fit they sketch makes the given statement true.

After students have sketched all six lines of best fit, divide the students into six groups. Assign one problem for each group to examine together. Ask the groups to create rules for the line of best fit in their problem. Some thoughts for them to consider: What are the possible values for the slope? The y-intercept? Are there any other restrictions on the line of best fit?

Once all groups have created their rules, ask the group that examined the problem about Ariana to display their lines of best fit on the document camera. Then have them share the rules they created.

Teacher's Note

Students should have created the rule that the line of best fit for Ariana's shooting percentage appears above the line of best fit for the class. If not, ask questions to guide them to this conclusion.

On your large copy of the graph, ask the students presenting to shade in, with a colored pencil or marker, the area of the graph that could contain Ariana's line of best fit . They should shade in the area above the class's line of best fit. Have the students label this area "Region 1" (or R1).

Ask the students in the group to describe the relationship between Ariana's shooting percentage and the class's shooting percentage. They should say something like "Ariana's shooting percentage was higher than the class shooting percentage." Have them label R1 with the words "higher than" or equivalent words they choose.

Next, have the group that examined the problem about Bethany present in the same manner as the Ariana group did above. On the same large copy of the graph that has already been shaded for Ariana, have this group use a second color to shade in the area where Bethany's line of best fit could be. Label this area R2.

Ask the students in this group to describe the relationship between Bethany's shooting percentage and the class's shooting percentage. They should say something like "Bethany's shooting percentage was less than the class shooting percentage." Have them label R2 with the words "less than" or equivalent words they choose.

Continue, having the group that examined the problem about Camila present. When they attempt to shade, the class should notice that they are shading the same area as that one that was shaded for Ariana. Ask the class to consider what the differences are, if any, between the statement about Camila's shooting percentage and the statement about Ariana's shooting percentage. Guide the class in a discussion until they reach the conclusion that Camila's shooting percentage could have been equal to the class's shooting percentage, whereas Ariana's was always higher.

Ask the group that examined the problem about Bethany to identify where in the graph a shooting percentage equal to that of the class world be. They should point to the class's line of best fit. Have this group highlight the class's line of best fit with a third color and then label it with R3 and "equal to." Explain to the class that if you want to show that this is strictly less than or greater than a given line, you make the line dotted, while a solid line implies that the values could also be equal to values on the line.

Now, have the Dante group present. This time, the whole graph has already been shaded. So, rather than asking Dante's group to shade, ask them where Dante's line of best fit could be. They should identify R2 and R3. Ask students to determine if R3 (the line of best fit) should be dotted or solid.

Have the remaining two groups present, describing where their lines of best fit would be.

Teacher's Note

The Elijah group should report that Elijah's line of best fit would start in R1 for small distances but fall into R2 for large distances. The Francisco group should report that Francisco's line of best fit would start in R2 for small distances and rise into R1 for large distances.

Point out to students that the class's line of best fit is labeled with its equation. In other words, R3 can be described mathematically using the equation y=-4.6627x+98.214. Ask students how they might mathematically describe R1 and R2. Have students work in pairs to try to write these descriptions.

Teacher's Note

If students are having difficulties, point out that R3 (the line of best fit) had been labelled with "equal to," and that R1 and R2 were both labeled. Tell students to consider the labels given to each region when writing the mathematical descriptions.

Students should conclude that R1 could be described by the inequality y >-4.6627x+98.214 and that R2 could be described using the inequality y<-4.6627x+98.214.

Ask students to work in pairs to write an inequality for at least four of the six students they just discussed (Ariana, Bethany, Camila, Dante, Elijah, and Francisco). After they have the opportunity to write these inequalities, as for a volunteer to share his or her inequality for Ariana. Make sure every pair of students agrees with this inequality.

Repeat this process for Bethany, Camila, and Dante. Be sure that students use the signs for greater than or equal to and less than or equal to for Camila and Dante, respectively.

Ask for a volunteer to share his or her results for Elijah. You should not receive any volunteers. Ask if anyone wrote an inequality for Elijah. Again, no one should respond. Ask students why they choose not to write an inequality for Elijah. Students should respond that it is impossible to write an inequality for Elijah, since his shooting percentage was greater than the class's shooting percentage for some values and less than the classes shooting percentage for others. Repeat this discussion for Francisco.

At the end of the discussion, emphasize that what students have found is that an inequality can only be written if it is true for all values of the independent variable.

Explain

If students completed the lesson Trashketball: Part 1, have them pull out their handouts for that lesson and examine the list of control variables. If not, have students quickly brainstorm a list of control variables that might impact or change shooting percentage. Note the number of control variables they list.

Have students form pairs, and then pass out two index cards for every control variable to each pair. Have pairs brainstorm ways the control variables could be changed. For each control variable, they should make a hypothesis about a way the control variable could be changed so shooting percentage is improved, and one way each control variable could be changed so that shooting percentage is decreased. Have students record each change made to the control variable on separate index cards. They do not need to write down their hypotheses. In other words, they should write down "make the basket bigger" rather than "make the basket bigger to improve shooting percentage." Be sure to instruct students to write big on the index cards. You want to be able to see their writing from across the room.

Teacher's Note

Students will claim that some of the control variables cannot be improved, which may be true (e.g., if the control variable was "ability to see the basket," this variable cannot be improved). As students begin to make these claims about different controls, stop the class and discuss them. If no group is able to brainstorm a way to improve the control variable, tell students to skip that hypothesis. You should still wind up with many different proposed changes for a variety of control variables.

Once groups have all written their changes, collect all of the students' index cards to make a deck of index cards. Create an area in which students can post their cards using Scotch tape. Divide this area into five columns and label the columns "less than," "less than or equal to," "equal to," "greater than or equal to," and "greater than."

Pick one student to draw the top card from the deck. Have that student read the card and post it in the column he or she feels is the most likely result. Then, have that student pick another student from the class to have the next turn. That next student needs to explain whether he or she agrees or disagrees with the placement of the first card. If the student disagrees, give both students an opportunity to explain their reasoning. Then poll the class to determine where the card should be posted. Move it to the appropriate column, if necessary.

Teacher's Note

Most of the disagreements will be about whether "equal to" should be part of the inequality. That is, students will disagree about whether the change will make the shooting percentage "greater than" or "greater than or equal to" the original shooting percentage. While students should carefully consider these differences—especially for very small distances (like zero) or very large distances (where the shooting percentage is likely to be zero no matter what)—there isn't necessarily a "right" answer. The value of this activity comes from engaging students in thinking about these questions.

The first student can now sit down, and the second student can draw the next card and repeat the above process.

Continue drawing cards until you have several cards placed in each column or until you run out of cards.

Teacher's Note

If any student draws a card that has the same idea as an earlier card, feel free to let them skip the card and draw another.

You should now have several cards under in each column. For each column, discuss which modifications suggested can be feasibly and safely tested. Once ideas that are not feasible or safe are eliminated, let the class vote on one strategy from each column they wish to test.

Divide the class into five groups and assign the strategies chosen from each column to the groups.

Extend

Tell each group that they are responsible for designing and conducting an experiment that will allow them to create a line of best fit. Groups should write a procedure and create a method of organizing and recording their data. Be sure to have students get your approval of their plans before beginning their experiments. When you review their plans, make sure that they will be able to record the data they collect in a reasonable manner. However, do no correct any flaws in their design plan that you see. This will allow their peers to evaluate the design plans later.

Teacher's Note

You might be tempted to give your students an organizing structure, like a table, to use during this phase of the lesson. However, requiring students to create that structure themselves engages them more authentically in thinking about what data needs to be collected and how best to display the data.

Allow groups to take turns performing their experiments and collecting data. Once they have collected their data, they should plot the data and graph a line of best fit, either by hand or by using technology.

If they already completed Trashketball: Part 1, they should also plot the line of best fit they found for the class's shooting percentage. See Trashketball: Part 1 for methods of creating a line of best fit.

If they did not complete Trashketball: Part 1, a second option for this lesson is given below.

Teacher's Note

It may be helpful to have other work or a game for students ready, as some groups will likely have to wait for use of the wastebasket before they can perform their experiments.

Once every group has created their lines of best fit, have each group present their procedure and results. Encourage the other groups to give feedback, especially if there are design flaws. If no group is able to point out a design flaw, you may ask the presenting group about it yourself.

Teacher's Note

One common design flaw is having different students shoot from different distances. This does not control for the shooter. Groups should either have one volunteer make all the shots or have every student in the group shoot from every distance to find an average. You can (and should) discuss which of these designs make the resulting data more comparable to the original line of best fit for the whole class.

Option 1: Students have completed Trashketball: Part 1 Have students compare their results to the predictions made by the class. Was the new shooting percentage greater than or less than the original? Were they ever equal?

Option 2: Students have not completed Trashketball: Part 1 Have students graph all of their lines of best fit on the same coordinate axes. Tell them to compare their results to what might happen if none of these changes had been made. Are the results they found less or greater than they would expect, given "normal" circumstances? Could they be equal? Have them label each line of best fit with "less than," "less than or equal to," "equal to," "greater than or equal to," or "greater than."

Based on these labels, tell students to graph a line that could represent the line of best fit, given "normal" circumstances. This line of best fit should appear above the lines of best fit predicted to be less than the "normal" shooting percentage and below those that are predicted to be higher than the "normal" shooting percentage.

Evaluate

Tell students they have now seen an example in which inequalities helped to compare different people's athletic performances. Ask students to work with a partner to brainstorm other situations in which inequalities might be useful.

Common Example

Salaries: Person A earns a $1000 dollar raise every year, while person B always earns more (or always earns less) than person A. **Growth**: A tree grows a certain number of inches a year. A second tree is always taller or shorter as it grows. **Budget:** A customer needs to buy two items (x and y) but cannot afford to spend more than a certain amount. **Earnings**: You have two ways of earning money and want to earn at least a given amount of money. Errors: A musician makes fewer errors each time a piece is practiced. A second musician always makes more or fewer mistakes.

Have each pair of students share their ideas. Record each idea on the board or somewhere else the class can see it.

Pass out the **Graphing Stories** handout. Tell students that for each graph, they are to write a story that could be described using the linear inequality shown. They may use the list they brainstormed for ideas. They should consider the following:

- Whether the line is increasing or decreasing.
- Whether the line is solid or dashed.
- Whether the shading is above or below the line.

Teacher's Note

You may want to create the first story with them, as an example. The stories should be very simple. Something like, "An oak tree is planted when it is 4 feet tall and grows 2 feet every 3 years. A nearby elm tree is never any taller than the oak tree," describes the first graph well.

After they write out the story, they should also write an algebraic inequality to describe the graph shown.

Teacher's Note

Even if you write the first story with the students, have them write the inequality on their own. Check their answers before allowing them to complete the rest of the problems.

Resources

- K20 Center. (2014). Think-Pair-Share. Strategies. https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f5064b49
- Graphing Calculator Review. (2012, March 29). Find line of best fit on a TI-84: How to guide [Video]. YouTube. https://www.youtube.com/watch?v=HTFtogVoLiw
- computingboss. (2013, March 31). Microsoft Excel 2010 - line of best fit & equation [Video]. YouTube. https://www.youtube.com/watch?v=Ogx7CJ1JD9k