Curve of Best Fit 2

Strand: Statistics

Topic: Determining a curve of best fit

Primary SOL: A.9 The student will collect and analyze data, determine the equation of the curve of best fit in order to make predictions, and solve practical problems, using mathematical models of linear and quadratic functions.

Related SOL: A.6, A.7

Materials

- Metric rulers
- Graph paper
- Graphing utility

Vocabulary

scatterplot, slope, y-intercept (earlier grades)
quadratic function (A.4)
coefficient, curve of best fit, determinate, line of best fit (A.9)

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

1. Distribute metric rulers, and have each student measure the length of his/her forearm (wrist to elbow) and the length of his/her foot without shoes (toe to heel) in centimeters. Record all students' data in a display table similar to the one below.

Student	Forearm in cm	Foot in cm
(Name)	30	25
(Name)	24	20
(Name)	26	22

2. Distribute graph paper and have students use it to graph these data points. Discuss what shape these data points make, and lead students to determine that it is a linear relationship: In general, the longer the forearm, the longer the foot.
3. Have students draw a line of best fit (linear curve of best fit) by connecting any two data points that seem to best represent the data. Tell them that an equal number of points should lie above and below this line.
4. Ask, *"If a baby has a forearm length of 9 centimeters, what would the length of her foot be?"* Have students predict the solution. Then, tell students that, to solve this problem, they can do the following:
    - Use the coordinates of any two points on the line of best fit to find the slope of the line (m).

- Use the formula $y = mx + b$ (the slope-intercept form for the equation of a line), the slope of the line (m), and the coordinates of a point on the line (x, y) to find the y-intercept of the line (b).
- Use the slope of the line (m), the y-intercept of the line (b), and the baby's forearm length of 9 cm (x), to solve for her foot length (y).

5. Ask, *"If Michael Jordan's foot length is 29.7 cm, what is his forearm length*?" Again, have students predict the solution and then use the method above to solve for forearm length (x).
6. Have students compare their predictions to their calculated answers. Ask why there is a discrepancy. Have students explain whether the discrepancy is significant or not.
7. Have students enter the class data into their graphing utilities or a spreadsheet program and find the linear-regression model for this data. Have them compare the linear-regression model to the equation of the line of best fit. Discuss what a correlation coefficient (R^2) is and how its proximity to 1 indicates how the regression line fits the data.
8. Give students the following data set and ask them to graph the points on a coordinate plane.

Speed (m/s)	Braking Distance (m)
0	0
2.8	0.7
5.6	2.8
8.3	6.2
11.1	11
13.9	17.2
16.7	24.8
19.4	33.8
22.2	44.1

9. Ask students what shape the data points seem to form. They will notice the data is not linear. Have them input the data into their graphing utility and find the correlation coefficient of a linear regression (R^2). Then have them find the correlation coefficient of a quadratic regression. What do they notice?
10. Ask students to write the quadratic regression equation, because the correlation coefficient is closer to 1 in the quadratic regression than the linear regression and because the data forms a curve. Have them predict the braking distance if a driver is driving a speed of 30 m/s.

Assessment

- **Questions**
  - Describe a practical data-collection situation that would lend itself to a linear relationship.
  - Describe a practical data-collection situation that would lend itself to a quadratic relationship.

 - Predict, using your quadratic regression equation found for speed and braking distance the braking distance if a driver is driving 20 m/s. Does this answer make sense with the given data?
 - How do you know whether a set of data is a linear function or quadratic function?

- **Journal/writing prompts**
  - Explain why two data samples would or would not be enough information to find an accurate curve of best fit. Then, explain why 200 data samples would or would not be enough information.
  - Describe the difference between making predictions from a graph and making predictions from an equation. When is a graph most helpful? When is an equation most helpful?
  - Explain the purpose of the R^2 value. How is it used to verify which regression equation is the best?

Extensions and Connections (for all students)

- Give students a linear graph and/or a linear equation. Do not indicate what *x* and *y* represent. Ask students to make up a practical situation to match this graph or equation. Have students write about the data and make predictions that extend beyond the data.
- Have students compare their forearm-foot equation data to data found in growth charts available on the internet. Does the class data mirror the data found on the internet? Why or why not?
- Have students test their equation using forearm-foot data gathered from adults at home. How does this compare to the growth charts found on the internet?
- Ask students to brainstorm ideas of practical situations that may encompass linear relationships. Have them use the internet to collect the data, graph it, and find the linear equation for it.
- Ask students to brainstorm ideas of practical situations that may encompass quadratic relationships. Have them use the internet to collect the data, graph it, and find the linear equation for it.

Strategies for Differentiation

- Review vocabulary from earlier grades, as needed.
- Provide class data for students who have trouble transferring information.
- Provide tables for students with x and y clearly labeled.
- Have students write main ideas on a graphic organizer with steps included on how to determine the curve of best fit in order to make predictions.
- If a graphing utility is used, provide students with steps for finding the curve of best fit.
- Hard spaghetti may be used for students who need help manipulating where the curve of best fit should lie for a linear regression equation.

- Highlight key data points from class data for students to graph in step 2 to limit the number of data points graphed.
- Allow students to participate in a think-pair-share when asked to discuss and/or make predictions.