Math Objectives

- Students will discover that straight lines are widely used to model relationships between two quantitative variables.
- Students will informally fit a straight line and assess the model fit by judging the closeness of the data points to the line for scatter plots that suggest a linear association.

Vocabulary

- line of fit

About the Lesson

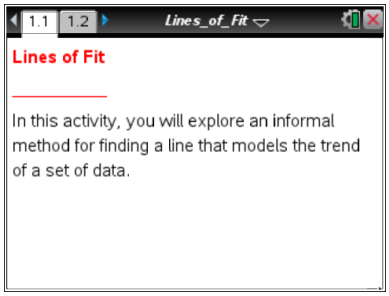
- This lesson involves informally fitting a straight line for a given data set that represents the mean verbal and mathematics scores on the SAT in 2004 across all 50 states and Washington, D.C.
- As a result, students will:
  - Rotate and translate a line to fit a linear model to the scatter plot of the given data set.
  - Discuss criteria for a good fit.
  - Use the line of fit to make estimations and predictions.

TI-Nspire™ Navigator™

- Send out the *Lines_of_Fit.tns* file.
- Monitor student progress using Class Capture.
- Use Live Presenter to spotlight student answers.

Activity Materials

- Compatible TI Technologies: TI-Nspire™ CX Handhelds, TI-Nspire™ Apps for iPad®, TI-Nspire™ Software



Tech Tips:

- This activity includes screen captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

Lesson Files:

Student Activity

- Lines_of_Fit_Student.pdf
- Lines_of_Fit_Student.doc

TI-Nspire document

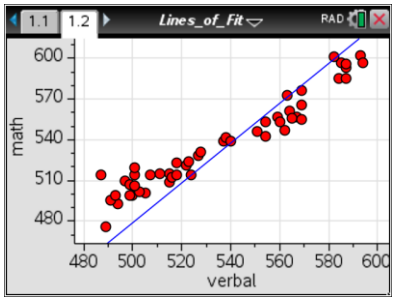
- Lines_of_Fit.tns
- Lines_of_Fit_Assessment.tns

Discussion Points and Possible Answers

Tech Tip: If students experience difficulty rotating a line, check to make sure that they have moved the cursor until it becomes ↻. If students have difficulty translating a line, check to make sure that they have moved the cursor until it becomes ✣. Then press ctrl to close the hand. Use the Touchpad to rotate or translate the line.

Tech Tip: To rotate the line, drag near the "end" of the line. To translate the line, drag near the "middle" of the line.

Move to page 1.2.



1. The scatter plot on page 1.2 displays the mean math SAT scores versus the mean verbal SAT scores received by U.S. high school students in 2004. Describe an association between the math and verbal SAT scores.

   Sample Answer: As the verbal scores increase, the math scores increase. This most likely demonstrates a positive linear association between math and verbal SAT scores.

   Tech Tip: Consider demonstrating how to rotate or translate the line.

2. Move your cursor near the "end" of the line. When you see ↻, press ctrl to grab and drag the line.
   a. What changes, and what remains the same?

      Sample Answer: The steepness of the line changes. The coefficient of *x* (the slope of the line) changes. The constant in the equation (the *y*-intercept) might change if the students grab the line on its far left. The data points remain the same.

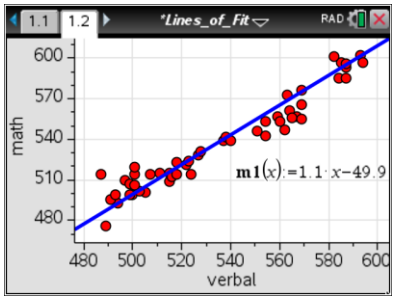
   b. Press or esc to release the line. Move to the other "end" of the line. Grab and drag the line. What changes, and what remains the same?

      Sample Answer: The same as 2a.

c. Press ctrl or esc to release the line. Move your cursor to what appears to be the middle of the line. When you see ✣, grab and drag the line. What changes, and what remains the same?

Sample Answer: The constant in the equation (the *y*-intercept) changes. The coefficient of *x* (the slope of the line) does not change. The data points remain the same.

3. Move the line until you find a line of fit that models the trend of the data.



a. What is the equation of your line?

Sample Answer: Answers will vary, e.g., *m1(x)* = 1.1*x* – 50. The slope is 1.1 and the *y*-intercept is approximately negative 50.

Teacher Tip: m1 refers to the movable line, not to the slope.

b. Compare your equation to your partner's equation. How are they alike or different?

Sample Answer: Both equations should have a positive slope and a negative *y*-intercept.

c. What criteria did you use to adjust the position of the line of fit in order to find the model for the given data set?

Sample Answer: The line is closest to the points; the distances from the points to the line are smallest.

TI-Nspire Navigator Opportunity: *Class Capture*
See Note 1 at the end of this lesson.

Teacher Tip: In this part of the lesson, encourage student discussion of how they selected their lines of fit. Students can demonstrate how they translated and rotated the lines while explaining the criteria they selected for the lines of fit.

4. The equation of your movable line is stored as the variable **m1.** You can use this equation to predict the math SAT score for a given verbal SAT score not included in the data set. You can also use the equation to predict the verbal score based on the math score.

a. What is the predicted math score if the verbal score is 600?

Sample Answer: Using the equation found in Question 3a, the math score is 610.

b. What is the predicted verbal score if the math score is 550?

Sample Answer: Using the equation found in Question 3a, the verbal score is 545.

Tech Tip: Students can insert a Calculator page in order to complete calculations using the equation of the line stored as *m1*. In order to calculate the math score for the given verbal score, they can type **m1(600)** followed by enter to get an answer. Students can determine the verbal score for a given math score by typing **nsolve(m1(*x*)=550,*x*)** followed by enter (nsolve is the command *Numerical Solve*).

Note: Since the equation of the movable line shown on page 1.2 displays, at most, three digits, the results of computations with this equation may differ slightly from those obtained using the stored equation for *m1* on the Calculator page.

Tech Tip: Alternatively, students can use Scratchpad by selecting . In order to close Scratchpad and return to the document, select ☒ in the upper-right corner or select esc. If students use the Scratchpad, they do not have access to stored equations or variables, so they will have to type complete expressions in order to answer these questions.

Teacher Tip: Question 4a asks students to find the output given the input. This is equivalent to evaluating an expression given the value of the variable. Thus, all they need to do is the direct substitution of the value for the verbal score. Question 4b, however, asks students to find an input given an output. This is equivalent to solving a linear equation for an unknown. Thus, students can substitute a value for the output and solve the equation for the input, or algebraically change the equation to express the input in terms of output and then substitute the given output to evaluate the new expression. **Note:** In this set of data, verbal and math scores are positively associated but do not have causal relationship, thus avoid using terms “independent variable” and “dependent variable.”

TI-Nspire Navigator Opportunity: *Quick Poll*
See Note 2 at the end of this lesson.

c. How close is your prediction to the predictions of other students? Why do you think your predictions are different?

Sample Answer: The predictions are slightly different, but close, since all students used the same criteria that the line of fit should be close to the data points.

5. Would you want to use the line of fit or its equation to predict a math score for a verbal score of 900? Explain your reasoning.

   Sample Answer: Since SAT scores can have values only between 200 and 800, these are not valid scores, so the prediction has no meaning.

   Teacher Tip: Some students will substitute 900 into the equation and will predict that the math score is 940, for example. Help students understand that they can't make blind predictions without some knowledge about the source of the data. In this case, the data represent the SAT scores that can only have specific values between 200 and 800. This discussion is a pre-cursor to future understanding of domain and range.

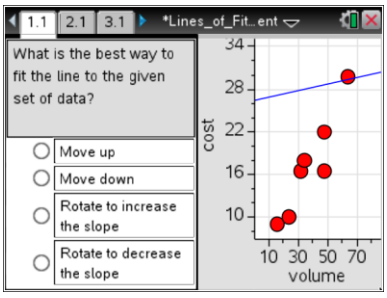
Wrap Up

Upon completion of the lesson, the teacher should ensure that students are able to understand:

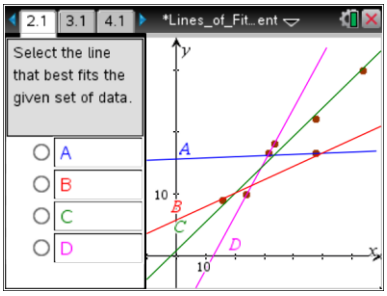
- How to rotate and translate a movable line to fit the graph of a given data set that suggests a linear association between two variables
- How to informally assess goodness of fit and develop criteria for a good linear fit
- How to use a linear model to make predictions

Assessment

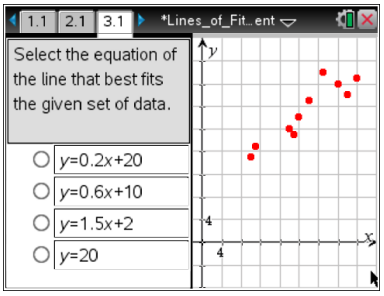
Use the provided TI-Nspire assessment document, Lines_of_Fit_Assessment.tns that has four multiple-choice questions to assess student understanding of the major concepts of this lesson. The file is set up to be Self-Check for those using the iPad or handheld users without the TI-Nspire Navigator. Teachers with TI-Nspire Navigator can use the questions as Quick Polls or change a question to Exam mode. Then they can send and collect the file. Explanations to the answers:



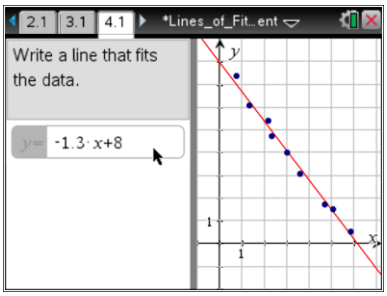
The best manipulation is rotating the left part of the line to increase the slope of the line.



The best fit line is line C as it is closest to all points in the data set.



The equation for the line that best fits the given set is $y = 0.6x + 10$. The line with equation $y = 0.2x + 20$ has a y-intercept that is too great, the line with equation $y = 1.5x + 2$ has a slope that is too great, and the line with equation $y = 20$ is a horizontal line.



This type of question allows students to see the graph immediately as the equation is entered. Answers can vary but will be approximately $y = -1.3x + 8$

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Note 1

Question 3, Class Capture

Use Class Capture to show students' lines of fit. Discuss how they are alike or different.

Note 2

Question 4, Quick Poll

Use an Open-Response Quick Poll question to collect students' answers to Questions 4a and 4b for class discussion.