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| **Math Objectives**   * Students will explore the validation of a model constructed from a data set. * Students will be able to determine a regression equation. * Students will understand that a pattern in the graph of the residuals indicates that the model is not appropriate for the data set. * Students will look for and express regularity in repeated reasoning (CCSS Mathematical Practice). * Students will look for and make use of structure (CCSS Mathematical Practice).   **Vocabulary**   |  |  | | --- | --- | | * data set | * linear | | * residual | * exponential |   **About the Lesson**   * This lesson includes modeling a data set using linear and exponential regressions. * As a result students will:   + Observe a residual plot as well as a scatter plot of the data.   + Understand that a residual is the actual value of the data minus the predicted value from the regression equation.   + Conjecture and draw conclusions about the appropriateness of the model based on the residual plot.   **TI-Nspire™ Navigator™**   * Send the TI-Nspire document to students. * Use Class Capture to view and discuss the scatter plots and residual plots. * Use Quick Poll questions to adjust the pace of the lesson according to student understanding.   **Activity Materials**   * Compatible TI Technologies: Trail Blaszer:Users:ronblasz:Documents:WIP:CL947_Platform icons:Handheld_icon.png TI-Nspire™ CX Handhelds, Trail Blaszer:Users:ronblasz:Documents:WIP:CL947_Platform icons:Tablet_icon.png TI-Nspire™ Apps for iPad®, Trail Blaszer:Users:ronblasz:Documents:WIP:CL947_Platform icons:Software_icon.png 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/calcul](http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials) [ators/pd/US/Online-](http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials) [Learning/Tutorials](http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials)  **Lesson Files:**  *Student Activity*   * Residuals\_Student.pdf * Residuals\_Student.doc   *TI-Nspire document*   * Residuals.tns |

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| **Move to page 2.1.** | |
| **Part 1**  Use the following data set in Part 1.     |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | |  | –1 | 0 | 2 | 5 | 7 | 10 | |  | –7 | –4 | –1 | 6 | 8 | 16 | | | |
| 1. Enter the *x* values in the column labeled *xvalue.* Enter the *y* values in the column labeled *yvalue.* |  | |
| **Tech Tip:** Students must press enter or the down arrow after the last value is entered. | | | |
| Add a page by pressing /~. Select>Add Calculator. Press b . Select> Statistics> Stat Calculations, then Linear Regression (mx + b). For X List: select xvalue and for Y List: select yvalue. Press enter for OK..  What is your linear regression equation?  **Answer:** The linear regression equation is |  | |
| 1. Add a page by pressing /~. Select> Add Data & Statistics. Click in the lower gray region to select xvalue and click in the left gray region to select yvalue.   **Note:** To show the graph of the linear regression equation, press b. Select > Analyze> Regression, and Show Linear (mx + b). To hide the graph of the linear regression equation, press b. Select >Analyze>Regression, and Hide Linear (mx + b). |  | |
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| The residual is the actual value minus the predicated value. A regression model is justified as appropriate for a data set if the residuals of a regression, the residual plot, appear without pattern. To view the residual plot, click in the left gray region and select stat.resid.  Does your residual plot have a pattern? Would a linear regression be appropriate for this data set?  **Answer:** The residual plot does not have a pattern. A linear regression is appropriate for this data set. |  | | |
| 3.Add a page by pressing /~. Select> Add Calculator. To evaluate the predicted values, type *f*1(–1) and then calculate the residual when x is –1. Calculate *f*1(0) and then calculate the residual when x is 0. Notice that one residual value is negative and one is positive. What does this tell us about the predicted value as being an underestimate or an overestimate?    **Answer:**  f1(–1) = –6.68440367; Residual = –0.31559633  f1(0) = –4.680733945; Residual = 0.680733945  If the residual is positive, the predicted value is an underestimate. If the residual is negative, the predicted value is an overestimate.  **Note:** To view the residual list for all of the data points, press h and select stat.Resid. Scroll to the right to see more values. |  | | |
| **Teacher Note:** The graph of the scatter plot with the regression equation may be helpful to visualize the overestimate or underestimate. | | | |
| **Move to page 3.1.**  **Part 2**  Use the following data set in Part 2.     |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | |  | –1 | 0 | 1 | 2 | 4 | 5 | |  | 0.2 | 0.6 | 0.9 | 2.1 | 7.9 | 16.2 | | | | |
| 4. Follow the steps in Part 1. Enter the *x* values in the column labeled *xvalue.* Enter the *y* values in the column labeled *yvalue.*  Compute a linear regression, view the scatter plot, and view the residual plot. Does your residual plot have a pattern? Would a linear regression be appropriate for this data set?      **Answer:** The residual plot appears to have a pattern. A linear regression is not appropriate for this data set. |  | | |
| 5. Now compute an exponential regression. Add a page by pressing /~. Select > Add Calculator. Press b . > Statistics, >Stat Calculations, then \ Exponential Regression. View the residual plot. Does your residual plot have a pattern? Would an exponential regression be appropriate for this data set?    **Answer:** The residual plot does not appear to have a pattern. An exponential regression is appropriate for this data set. |  | | |

**Extensions**

1. Find a data set that models a quadratic and ask the students to follow the steps for a quadratic regression. Observe the scatter plot and the residual plot.

# Wrap Up

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

* How to input data and view scatter plots.
* How to compute linear, quadratic, and exponential regressions.
* How to plot residuals and determine if the residual plot has a pattern.