Algebra I, Quarter 2, Unit 2.2

Use Data to Create and Interpret Linear Models

Overview

Number of instruction days: 8–10

(1 day = 53 minutes)

Content to Be Learned

- Create a linear function from the data of two quantitative variables.
- Determine when the regression line is appropriate.
- Interpret slope and intercept in context.
- Compute only with technology and interpret the correlation coefficient of a linear model.
- Distinguish between correlation and causation.

Mathematical Practices to Be Integrated

1 Make sense of problems and persevere in solving them.

- Interpret slope and y-intercept in context.

2 Reason abstractly and quantitatively.

- Describe the relationship between two quantitative variables on a scatterplot.
- Fit a function that describes the linear association of data points.

4 Model with mathematics.

- Create a linear equation from data that models the association between two variables.
- Calculate the correlation coefficient using technology to determine the strength of the linear association.

5 Use appropriate tools strategically.

- Use graphing technology to display the residuals plot for analyzing a linear model.
- Use graphing technology to calculate the correlation coefficient of a linear association.

Essential Questions

- How can you use scatterplots to investigate relationships among quantities?
- How can you use the line of best fit to make and evaluate predictions?
- What is the difference between causation and correlation?
- What does the correlation coefficient tell you about a linear fit?
Standards

Common Core State Standards for Mathematical Content

Statistics and Probability

Interpreting Categorical and Quantitative Data

Summarize, represent, and interpret data on two categorical and quantitative variables [Linear focus, discuss general principle]

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

b. Informally assess the fit of a function by plotting and analyzing residuals.

c. Fit a linear function for a scatter plot that suggests a linear association.

Interpret linear models

S-ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

S-ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.

S-ID.9 Distinguish between correlation and causation.

Common Core State Standards for Mathematical Practice

1 Make sense of problems and persevere in solving them.

Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, “Does this make sense?” They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.
2 **Reason abstractly and quantitatively.**

Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to *decontextualize*—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to *contextualize*, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.

4 **Model with mathematics.**

Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

5 **Use appropriate tools strategically.**

Mathematically proficient students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. For example, mathematically proficient high school students analyze graphs of functions and solutions generated using a graphing calculator. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data. Mathematically proficient students at various grade levels are able to identify relevant external mathematical resources, such as digital content located on a website, and use them to pose or solve problems. They are able to use technological tools to explore and deepen their understanding of concepts.

**Clarifying the Standards**

**Prior Learning**

In Grade 6, students developed understanding of statistical variability and summarized and described distributions of data. Grade 7 students used random sampling to draw inferences about population, drew informal comparative inferences about two populations, investigated chance processes, and developed, used, and evaluated probability models. In Grade 8, students used a linear equation to describe the
association between two quantities in bivariate data (such as arm span vs. height for students in a classroom). They fitted the model and assessed its fit to the data informally. Students constructed and interpreted scatterplots to investigate patterns between two quantities. They also described patterns such as clustering, outliers, positive and negative association, and nonlinear association. They used scatterplots to informally model a line of best fit by judging the closeness of the line to the data points.

**Current Learning**

This is a critical area for Algebra 1 students. Students create a linear function from the data of two quantitative variables. They determine whether the regression line is appropriate. In this course, they interpret slope and intercept in context. They use technology to compute and interpret the correlation coefficient of a linear fit. Last, they distinguish between correlation and causation. This unit builds on students’ prior experiences with data, providing students with more formal means of assessing how a model fits data. Students use regression techniques to approximately describe linear relationships between quantities. They use graphical representations and knowledge of the context to make judgments about the appropriateness of linear models.

**Future Learning**

In Algebra II, students will justify appropriate data sets when studying normal distributions. In AP Statistics, students will rewrite data to create an improved linear model.

**Additional Findings**

Students struggle with understanding that a line of best fit is not appropriate for all data. In this unit, students will deal with real data that may have a weak or no correlation. “When doing experiments or dealing with real data, students may encounter “messy data,” for which a line or a curve may not be an exact fit. They will need experience with such situations and assistance from the teacher to develop their ability to find a function that fits the data.” (*Principles and Standards for School Mathematics*, p.228)

### Assessment

When constructing an end-of-unit assessment, be aware that the assessment should measure your students’ understanding of the big ideas indicated within the standards. The CCSS for Mathematical Content and the CCSS for Mathematical Practice should be considered when designing assessments. Standards-based mathematics assessment items should vary in difficulty, content, and type. The assessment should comprise a mix of items, which could include multiple choice items, short and extended response items, and performance-based tasks. When creating your assessment, you should be mindful when an item could be differentiated to address the needs of students in your class.

The mathematical concepts below are not a prioritized list of assessment items, and your assessment is not limited to these concepts. However, care should be given to assess the skills the students have developed within this unit. The assessment should provide you with credible evidence as to your students’ attainment of the mathematics within the unit.

- Use the line of best fit to make and evaluate predictions.
- Fit a function that describes a linear relationship.
- Interpret slope and intercept within context.
- Analyze quantitative relationships using linear regression.
Use residuals to analyze the fit of the regression line.
Interpret the difference between causation and correlation within a context.
Use graphing technology to display the residuals plot for analyzing a linear model
Use graphing technology to calculate the correlation coefficient of a linear association

**Learning Objectives**

Students will be able to:
- Use a graphing calculator to collect data and investigate slope-intercept form.
- Write and graph linear equations in slope-intercept form.
- Model real-world data with equations in slope-intercept form.
- Investigate relationships between quantities by using points on scatter plots.
- Use lines of best fit to make and evaluate predictions.
- Explore the difference between correlation and causation.
- Write equations of best-fit lines using linear regression.
- Determine the fit of a function by using technology to plot and analyze residuals.
- Determine and interpret the correlation coefficient using technology in problem situations.
- Demonstrate understanding of concepts and skills learned in this unit.

**Resources**

In *Algebra I*, (Glencoe McGraw Hill) 2010
- Section 4.1 Graphing Technology Lab p. 213
- Section 4.1 pp. 214 to 221
- Section 4.5 pp. 245 to 251
- Section 4.5 Algebra Lab: Correlation and Causation p. 252
- Section 4.6 pp. 253 to 260
- *Chapter 4 Resource Masters* of corresponding sections
- *5-Minute Check Transparencies* for corresponding sections
Supplemental Units

- Transforming Relationships and Investigating Correlation activities can be found at education.ti.com. See the Supplementary Unit Materials section of this binder for the student and teacher notes for these activities.

- Residuals activity, created by Barbara Creati for PPSD. See the Supplementary Unit Materials section of the binder.


- Sections 4.3, 6.7, and 6.8 (Select problems based on Standards for this unit)
- Interactive Classroom CD - PowerPoint presentations (optional)
- Teacher Works Plus CD-ROM
- Teaching with Foldables (Dinah Zike; Glencoe McGraw Hill 2010)

Exam View Assessment Suite Software

Math Online, glencoe.com

Note: The district resources may contain content that goes beyond the standards addressed in this unit. See the Planning for Effective Instructional Design and Delivery and Assessment sections for specific recommendations.

Materials

Algebra tiles, graphing calculators, grid paper PowerPoint presentation

Instructional Considerations

**Key Vocabulary**

- Linear regression
- Causation
- correlation
- Correlation coefficient

**Planning for Effective Instructional Design and Delivery**

Reinforced vocabulary taught in previous grades or units: slope-intercept form, bivariate data, scatter plot, and line of fit.

Living word walls will assist all students in developing content language. Word walls should be visible to all students, focus on the current unit’s vocabulary, both new and reinforced, and have pictures, examples, and/or diagrams to accompany the definitions.

For planning considerations read through the teacher edition for suggestions about scaffolding techniques, using additional examples, and differentiated instructional guidelines as suggested by the Glencoe resource.

Students will use a graphing calculator to model linear regression.

Students can create a graph on large grid paper, relating their height to their shoe size, birth month to day of month, etc., and use the graph to start having conversations about trends and patterns.

As students observe data, ask them scaffolding questions. For example:
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- How would you find the equation of the line?
- If you had a graph that showed the number of VCRs sold each year for the last five years, what kind of slope would you expect to see? (Students may not know what VCR is, so some explanation may be required.)
- If you had a graph that showed the number of sales per month of mp3 players, what kind of slope would you expect to see?
- If the ratio of students to computers in the classroom is getting closer to a 1 to 1 ratio, what kind of correlation would you expect to see on a graph scatterplot of the situation and why?
- Is there only one line of fit for a set of data? Explain.

Have students do a mini-project. Start by collecting bivariate data, creating a scatterplot, and having them analyze the plot using what they have learned in this unit. Discuss the effects of outliers on the data’s correlation.

In Section 4-6, address only linear regression when determining the line of best fit. This applies also to the use of the Resource Masters.


The Transforming Relationships activity is available on the following website: http://education.ti.com/calculators/downloads/US/Activities/Detail?ID=11525&MICROSITE=TI%20Math. The activity can also be found by going to education.ti.com and searching for Transforming Relationships. However, you will need to download the tns file to your calculator. This activity will provide an opportunity for students to use technology to assess the strength of a linear relationship using a residual plot.

The Investigating Correlation activity is available on the following website: http://education.ti.com/calculators/downloads/US/Activities/Detail?ID=16928&MICROSITE=ACTIVITYEXCHANGE. The activity can also be found by going to education.ti.com and searching for Investigating Correlation. However, you will need to download the tns file to your calculator. This activity will provide an opportunity for students work in cooperative groups and investigate the connection between the scatterplot of bivariate data and the numerical value of the correlation coefficient.

In Extend Lesson 4-5, have students do the “From concrete to abstract problem” in the Teacher Edition.

Be sure to summarize different strategies for determining lines of best fit. Journal writing is an appropriate place for using a summarizing and note taking strategy. Also ask students to respond to the Essential Questions at appropriate times throughout the lessons of this unit.

Incorporate the Essential Questions as part of the daily lesson. Options include using them as a “do now” to activate prior knowledge of the previous day’s lesson, using them as an exit ticket by having students respond to it and post it, or hand it in as they exit the classroom, or using them as other formative assessments. Essential questions should be included in the unit assessment.

The 5-minute check transparencies can be used as a cue, questions, and advance organizers strategy as students will be activating prior knowledge. Some 5-minute checks may take longer than the allotted time, so consider choosing only problems that activate prior knowledge and use the rest for differentiation, to formatively assess student learning, as an exit ticket, or assigning for homework.

You may use the transparencies provided in the ancillary material as focus activities, review, or an exit activity. Additional activities and examples may be used for homework assignments.