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Unit 3: Data Science Practices

Lesson 3.6: Linear Models with Story Builder

In this lesson, students will learn to create linear models in CODAP and use the Story Builder plugin to record their progress through a data investigation on Earthquakes.

Duration: 90 minutes

Objective: By the end of this lesson, students will know how to create linear models in CODAP, and use the Story Builder plugin to record their progress.

Lesson Walkthrough Video: [Unit 3 Lesson 6 - Teacher Walkthrough]

CSTA Foundational Standards in this Lesson

Identifier	Concept	Subconcept	Standards
HS-DAT-DC-23	Data & Analysis	Data Processing	Use a digital tool to clean and organize text-based data.

CSTA Data Science Specialty Standards in this Lesson

Identifier	Concept	Subconcept	Standards
S1-DSC-MI-07	Data Science	Interpreting Models, Problems, & Results	Interpret the results of data analyses to explain patterns, anomalies, and trends, and connect them back to the original problem or research question.
S1-DSC-CC-02	Data Science	Creation & Curation	Interpret metadata when using data collected by others.
S1-DSC-AM-04	Data Science	Analysis & Modeling Techniques	Apply appropriate analytic and visualization techniques for categorical and quantitative data.
S1-DSC-VZ-10	Data Science	Visualization	Create visualizations that communicate key findings to diverse audiences using appropriate chart types and formatting.

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Lesson activities

Warmup (10 min)

(CSTA standards in this activity: 3A-DA-11)

- From March 2, 2023: Train Derailments, consider the following questions:
  - What kind of graph is this?
  - What variable(s) do you see represented? Is there more than one?
  - What do you notice? What do you wonder?
  - What story does this graph portray?

Earthquake Magnitude Video (5 min)

- Students watch this video for a background on Earthquake magnitude.
  - Any questions?

Earthquake API Program (10 min)

(CSTA standards in this activity: 3A-AP-16)

- Students open this API page and modify this starter program to draw in data from the USGS earthquake dataset.

Intro to Story Builder (15 min)

(CSTA standards in this activity: 3A-AP-23)

- Review the slide on the Story Builder. Look at the "See an example" link, and note what happens when you click on each "Moment" in the Story.
- Students copy the output from their program into CODAP.
- Today, start the Story Builder ("Plugins" → "Story Builder.") This will allow students to save different stages of analysis in a multi-slide "story."
- Create a "Moment" in Story Builder.
  - Look over the data. How big is the sample?
  - Create any graphs you want to explore the data.
  - What do you notice? What do you wonder?
- Jot down any initial impressions of the data in the notes, then click the check button in Story Builder to save this Moment.

Initial Dotplot (15 min)

(CSTA standards in this activity: 3A-DA-11)

- Students create a graph with **magnitude** on the y-axis.
- Use the Ruler icon to show the **mean** and **standard deviation.**

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- Before saving the Moment in Story Builder, record the mean, SD, and the **variance** (the standard deviation squared) in your notes.
- Then, **save** the Moment using the Check button!

Does depth predict magnitude? (15 min)

(CSTA standards in this activity: 3A-DA-12)

- Now, create a new graph.
  - Put magnitude on the y-axis (again).
  - Put depth on the x-axis.
- Describe the association:
  - what is the direction?
  - what is the form?
  - what is the strength?
  - do you suspect any outliers?
- **Save** these notes in Story Builder and create a new Moment.
- Using the Ruler icon, add a line of best fit to the graph.
  - Interpret the slope and intercept of your line of best fit.
  - (Note: your parameters may be different than the ones in the picture to the right!)
- What magnitude would you predict for a depth of 40 miles?
- Save your interpretations.
- The r^2 value presented along with the line of best fit indicates how much variability in the y variable (magnitude) is explained by the x variable (depth).
  - r^2 can be as low as 0 and as high as 1.
  - Is a lot of variability in magnitude explained by depth in your model, or just a little?
- Now, go back to the Ruler icon and add confidence bands to the graph.
  - Think about the model as a tool to predict magnitude from depth.
  - Remember what you learned about confidence intervals, which give a range estimate for a mean.
  - What do confidence bands tell you?
- **Save** this in Story Builder and create a new Moment.

How "wrong" are our predictions? (10 min)

(CSTA standards in this activity: 3A-DA-12)

- Let's create a new attribute in our original data table.
  - This column of data will be predictions of magnitude based on depth.
  - To create these predictions, go to the top right of the table and click the + button.
  - Name the new attribute predictions, click on it, and go to "Edit Formula…"
  - In the Edit Formula window, type in: linRegrPredicted(depth, magnitude)
- This will fill the combo with predicted values for magnitude based on the line of best fit!
  - Compare these values to the actual values of magnitude.
- Create another new attribute using the + button on the table.
  - Name this one residuals.

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    - In the Edit Formula window, type in: magnitude - predictions
- What values does this produce?
    - We call these numbers residuals. What does a positive residual mean? What does a negative residual mean?
- Before moving into the next steps, save this Moment in Story Builder, with any notes on the two attributes (predictions and residuals) you just created.
- Then, create a new Moment.

How much variance is left? (10 min)

(CSTA standards in this activity: 3A-DA-12)

- Finally, create a new graph with residuals on the y-axis.
    - Using the Ruler icon, add the mean and the standard deviation to the graph.
    - Calculate the variance of this new graph (the standard deviation squared).
    - How does this variance compare to the original variance of magnitude?
- Divide the residuals variance by the magnitude variance.
    - What number does this give?
    - Do you see any relationship between this number and the r^2 value you had on your line of best fit?
- Take a note on this relationship and save this Moment in Story Builder.

Assessment:

Assess student understanding through participation in class discussions and class activities.

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