Making Sense of Hurricane Havoc

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Objective: Students will be able to use hurricane data to construct best-fit mathematical models. They will use these models to solve problems and where appropriate, draw conclusions or make predictions.

Class: Algebra II

Standards:

NCSCOS Standards: 2.04 - Create and use best-fit mathematical models of linear, exponential, and quadratic functions to solve problems involving sets of data. 2.04b - Check the model for goodness-of-fit and use the model, where appropriate, to draw conclusions or make predictions.

NCTM Standards: Data Analysis and Probability Standard for Grades 9-12 - Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them. Select and use appropriate statistical methods to analyze data (for bivariate measurement data, be able to display a scatterplot, describe its shape, and determine regression coefficients, regression equations, and correlation coefficients using technological tools).

21st Century Skills: Learning and Innovation Skills (Communication and Collaboration); Core Subject; Information, Media, and Technology Skills

Introduction: Meteorologists use elementary data analysis and statistics in order to predict how many named storms are to make landfall in a season. Using these basic statistical and data analysis methods, including linear modeling, scientists can predict the number of named storms and their breakdown by intensity (i.e. the number of tropical storms, hurricanes, and major hurricanes) using data from past occurrences. In this activity students will have the chance to play the role of meteorologists, using different forms of graphs to display hurricane data and then using linear modeling/best-fit lines of the data to predict how many storms will make landfall in the U.S. Students will also use their mastery of best-fit lines to predict the number of hurricanes in a season based on the total number of storms, and to predict the amount of damage in billions of dollars that results from hurricane seasons of certain sizes (number of hurricanes).

Materials: Microsoft Office Excel, colored pencils, pencils, activity sheets

Instructional Activities:

Warm-Up: The warm-up is a review of displaying data using different forms of charts/graphs. Using Excel, students will create a bar graph and a pie chart that accurately represent provided hurricane data from the hurricane seasons between 2000 and 2006.

Whole Class Activity: (guided practice scaffolding for group work)
• Using Excel, students will make a scatterplot that represents the relationship between the number of hurricanes that make landfall in the U.S. and the year.
• Using the Excel tools, students will then find a best-fit line for the data, finding the equation and R-squared for the data. Then using the linear model students will make predictions for future hurricane seasons.
• They will then repeat the process for the data relating the number of tropical storms that make landfall in the U.S. to the year.
• Discussion: As a class, discuss if finding the best-fit line for this type of data is an accurate way to predict the number of hurricanes. Also, discuss which line fits best and using guided questions help students discover how it is possible to measure goodness of fit (R-squared).

Group Activity:
• In groups of 2-3 students will organize given hurricane data into a table.
• Using excel students will find the scatterplots and best-fit lines for the data.
• Based on the best-fit lines for the data students will make predictions.
• Finally students will compare the goodness of fit based on the R-squared numbers found using excel.
• Students will turn in completed group activity sheet.

Assessment: Students will be graded based on the completed group activity sheet. All members of the group will be given the same grade based on a randomly chosen paper from someone in the group. The grade will be based on accuracy of tables, graphs, and answers, as well as the quality of explanations.
Warm-Up: Reviewing Graphs

1. Enter the information given into an Excel document.

<table>
<thead>
<tr>
<th>Year</th>
<th>Tropical Storms</th>
<th>Hurricanes</th>
<th>Major Hurricanes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>7</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>2001</td>
<td>6</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>2002</td>
<td>8</td>
<td>2</td>
<td>2</td>
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<tr>
<td>2003</td>
<td>9</td>
<td>4</td>
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<tr>
<td>2004</td>
<td>6</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>2005</td>
<td>13</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>2006</td>
<td>5</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

2. Use the data to plot a bar graph. Sketch the result below.

3. Now choose one year from the table and construct a pie chart for that data. Sketch your result below.
Whole Class Activity: Scatterplots & Best-Fit Lines

<table>
<thead>
<tr>
<th>Year</th>
<th>Tropical storms making landfall in U.S.</th>
<th>Hurricanes making landfall in U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2001</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2002</td>
<td>7</td>
<td>1</td>
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<tr>
<td>2003</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2004</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>2005</td>
<td>2</td>
<td>5</td>
</tr>
</tbody>
</table>

1. Using the year 2000 as year 0, fill in the missing column and plot the data in a table in Microsoft Excel.

2. Plot the “Year” column as the independent variable (x-axis) and the “Hurricanes making landfall in U.S.” column as the dependent variable (y-axis). Sketch your results below.

3. Using excel, find the linear trendline (best-fit line). Choose to display the equation and r-squared value on chart and write below.

   Equation:

   R-squared value:

4. If this trend continued, how many hurricanes would you expect to make landfall in the U.S. in year 7 (year 2007)?
   - What about year 20 (year 2020)?

5. Would this be an appropriate conclusion to make? Why or why not?

6. Plot the “Year” column as the independent variable (x-axis) and the “Tropical storms making landfall in U.S.” column as the dependent variable (y-axis). Sketch your results below.

7. Using excel, find the linear trendline (best-fit line). Choose to display the equation and r-squared value on chart and write below.

   Equation:

   R-squared value:

8. How well does this line fit the data? How can we tell if the line is a good-fit?
Group Activity: Using Models to Predict Hurricane Havoc

1. Using the following information fill in the table below:

- In 2002, there were 12 total tropical storms, 4 of which were classified as hurricanes. The total damage to the U.S. was 2.6 billion dollars.
- In 2003, there were 16 total tropical storms, 7 of which were classified as hurricanes. The total damage to the U.S. was 4.4 billion dollars.
- In 2004, there were 15 total tropical storms, 9 of which were classified as hurricanes. The total damage to the U.S. was 50 billion dollars.
- In 2005, there were 28 total tropical storms, 15 of which were classified as hurricanes. The total damage to the U.S. was 130 billion dollars.
- In 2006, there were 10 total tropical storms, 5 of which were classified as hurricanes. The total damage to the U.S. was 0.5 billion dollars.
- In 2007, there were 15 total tropical storms, 6 of which were classified as hurricanes. The total damage to the U.S. was 3 billion dollars.
- In 2008, there were 16 total tropical storms, 8 of which were classified as hurricanes. The total damage to the U.S. was 47.5 billion dollars.
- In 2009, there were 9 total tropical storms, 3 of which were classified as hurricanes. The total damage to the U.S. was 0.1 billion dollars.
- In 2010, there were 16 total tropical storms, 9 of which were classified as hurricanes. The total damage to the U.S. was 8 billion dollars.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total number of storms</th>
<th>Number of hurricanes</th>
<th>Total damage (in billions)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

2. Plot the “Total number of hurricanes” as the independent variable and the “Total damage” as the dependent variable. Sketch your results below. Make sure to label your title and axis’s appropriately.

3. Using excel, find the linear trendline (best-fit line).
   
   Equation:

   R-squared value:

4. If there were 20 hurricanes in a year, what could you predict the total damage in billions to be?

5. Is this a reasonable prediction? Why or why not?
6. Plot the “Total number of storms” as the independent variable and the “Number of hurricanes” as the dependent variable. Sketch your results below. Make sure to label your axis’s appropriately.

7. Using excel, find the linear trendline (best-fit line).

   Equation:

   R-squared value:

8. If there were 21 total storms in a year, what could you predict the number of hurricanes to be?

9. If there were 37 total storms in a year, what could you predict the number of hurricanes to be?

10. Are these reasonable predictions? Why or why not?

11. If you knew there were 26 total storms in a year, how much would you predict to be the total damage? Show your work. (Hint: The answer will have two steps using both linear models)

12. Which of these best-fit lines do you think would give a more accurate prediction? Why?
WARM-UP

WHOLE-CLASS ACTIVITY

1. Column should read “0, 1, 2, 3, 4, 5”
2. 
3. 

### Hurricanes making landfall in U.S.

- **Equation:** \( y = 1.1714x - 0.7619 \)
- **R²:** 0.8949

4. **7.4379**
5. **22.6661**
6. Just because the year is getting bigger, the number of hurricanes isn’t necessarily increasing as well.
7. 

### Tropical storms making landfall in U.S.

- **Equation:** \( y = -0.0857x + 5.0475 \)
- **R²:** 0.0055

8. The line is not a good-fit. The r-squared value needs to be close to 1 or -1 to be a good-fit.
Making Sense of Hurricane Havoc
Teacher Answer Key

GROUP ACTIVITY

1. | Year | Hurricanes | Storms | Total Damage in Billions |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>12</td>
<td>4</td>
<td>2.6</td>
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<tr>
<td>2003</td>
<td>16</td>
<td>7</td>
<td>4.4</td>
</tr>
<tr>
<td>2004</td>
<td>15</td>
<td>9</td>
<td>50</td>
</tr>
<tr>
<td>2005</td>
<td>28</td>
<td>15</td>
<td>130</td>
</tr>
<tr>
<td>2006</td>
<td>10</td>
<td>5</td>
<td>0.5</td>
</tr>
<tr>
<td>2007</td>
<td>15</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>2008</td>
<td>16</td>
<td>8</td>
<td>47.5</td>
</tr>
<tr>
<td>2009</td>
<td>9</td>
<td>3</td>
<td>0.1</td>
</tr>
<tr>
<td>2010</td>
<td>16</td>
<td>9</td>
<td>8</td>
</tr>
</tbody>
</table>

4. **165.106 billion dollars**

5. It is a reasonable prediction because the more hurricanes that occur in a season, the higher you can expect the total damage to be.

6. ![Graph](image1.png)

7. ![Graph](image2.png)

8. **10.9049**

9. **20.7961**

10. This data shows that roughly half of the storms each year reach hurricane status which is a reasonable prediction.

11. According to the second model, if there are 26 total storms in a year, you can predict that there will be 13.9959 hurricanes. According to the first model, if there are 13.9959 hurricanes in a year, you can predict the total damage to be 99.8054 billion dollars.

12. The second model will give a more accurate prediction because the r-squared value is closer to 1.