Pollution and Curves of Best Fit

I. UNIT OVERVIEW & PURPOSE:
The purpose of this unit is to have students use curves of best fit to analyze data on pollution in the US.

II. UNIT AUTHOR:
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III. COURSE:
Mathematical Modeling: Capstone Course

IV. CONTENT STRAND:
Algebra

V. OBJECTIVES:
Students will use curves of best fit to analyze data on trash and recycling in the US and the air quality of different cities in the US. The students will use the equations for the curves of best fit to predict what could happen in the future if current trends continue.

VI. MATHEMATICS PERFORMANCE EXPECTATION(s):
MPE.2 Collect and analyze data, determine the equation of the curve of best fit, make predictions, and solve real-world problems using mathematical models. Mathematical models will include polynomial, exponential, and logarithmic functions.

VII. CONTENT:
Students will use the internet as a resource to find reliable data. Students will use graphing calculators to determine curves of best fit for data.

VIII. REFERENCE/RESOURCE MATERIALS:
PowerPoint on pollution in, computer lab with internet connections, graphing calculators, grading rubrics for the project and the presentation.

IX. PRIMARY ASSESSMENT STRATEGIES:
Students will be assessed through a rubric for the project and presentation.

X. EVALUATION CRITERIA:
Students will be evaluated through scoring on a rubric for the air quality project and a rubric for the group presentation. The project will be scored out of 50 points, and the group presentation will be scored out of 50 points. Both rubrics can be found at the end of the lessons.

XI. INSTRUCTIONAL TIME:
The unit will require four 90-minutes periods to cover the three lessons in this unit.

Lesson 1 – Pollution Discussion

Day 1

Warm Up

Students will answer the following questions to prepare for a class discussion:

1. What is pollution?
2. What types of pollutions are there?
3. What is polluted?
4. Why should we care about pollution?
5. How can pollution be prevented?
6. What can you do to prevent pollution?

Class Discussion

Students will share their answers to the warm up questions and the teacher will use the Pollution PowerPoint to help facilitate a class discussion on pollution. Use the link below to get to the Pollution PowerPoint.

Pollution PowerPoint

Scatter Plots Review

Review how to create scatter plots with students using the Scatter Plots Review below. Discuss how to label the x- and y-axis, plot the points, and determine the type of equation that will fit the data.

Homework

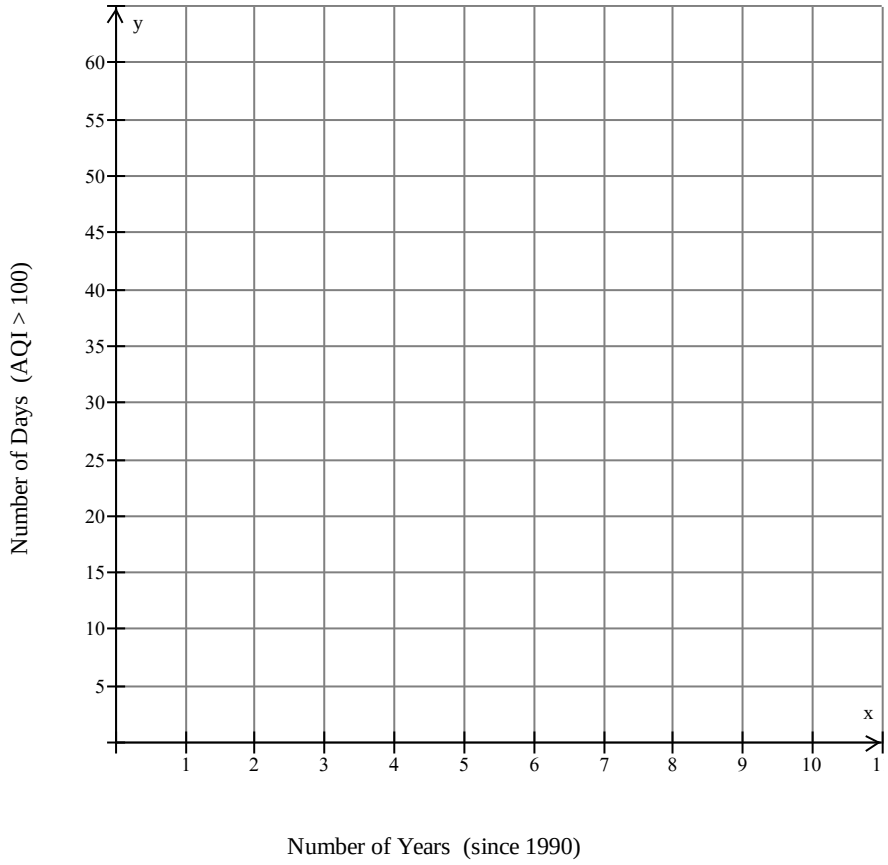
Students will discuss with their family how they are environmentally conscious at home.

Scatter Plots Review

The following data indicates the number of days in which the AQI (Air Quality Index) was greater than 100 in the city of Atlanta, Georgia. Let 0 represent 1990, 2 represent 1992, etc.

Year	1990	1992	1994	1996	1998	1999
Number of days AQI > 100, *n*	42	20	15	25	50	61

1. Sketch a scatter-plot of the data.



2. What type of equation best fits the data in the scatter plot?

Scatter Plots Review – Answer Key

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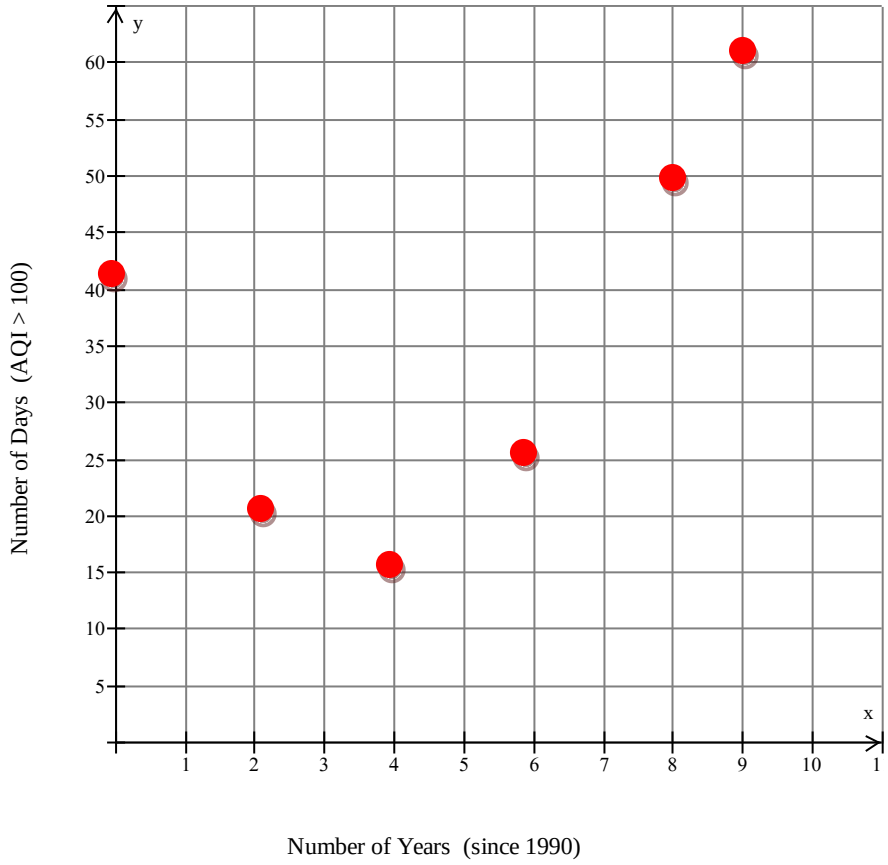

2. What type of equation best fits the data in the scatter plot?
   Quadratic Equation

Lesson 2 – Curves of Best Fit

Day 2

Warm Up

Students will use the trash and recycling data below to create two scatter plots using graph paper for the data.

Class Discussion

The class will discuss how their families are environmentally conscious at home. This should lead into a discussion of the data used in the warm up which describes trash and recycling in the United States.

Curve of Best Fit Review

The class will answer the questions on the Curve of Best Fit Review below using the data from the trash and recycling tables.

Trash and Recycling Data

MSW (Municipal Solid Waste) Generation Rates, 1960 – 2010

Year	MSW generation (in million tons)
1960	88.1
1965	104.4
1970	121.1
1975	127.8
1980	151.6
1985	166.3
1990	208.3
1995	217.3
2000	242.5
2005	252.7
2010	249.9

MSW (Municipal Solid Waste) Recycling Rates, 1960 – 2010

Year	MSW recycling (in million tons)
1960	5.6
1965	6.5
1970	8.0
1975	9.3
1980	14.5
1985	16.7
1990	33.2
1995	55.8
2000	69.5
2005	79.9
2010	85.1

Scatter Plot Key

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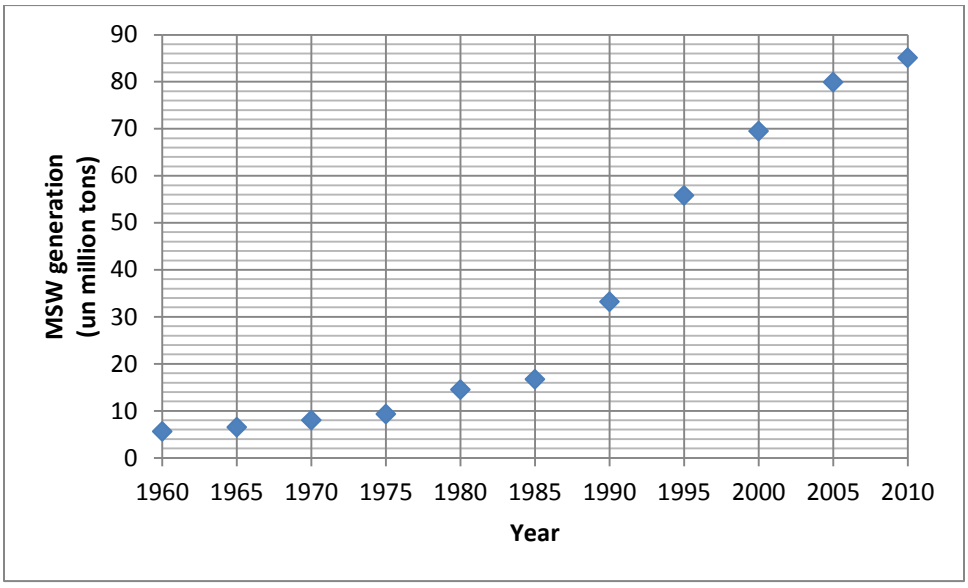
Answer scatter plot – students should create the scatter plot on their own graph paper



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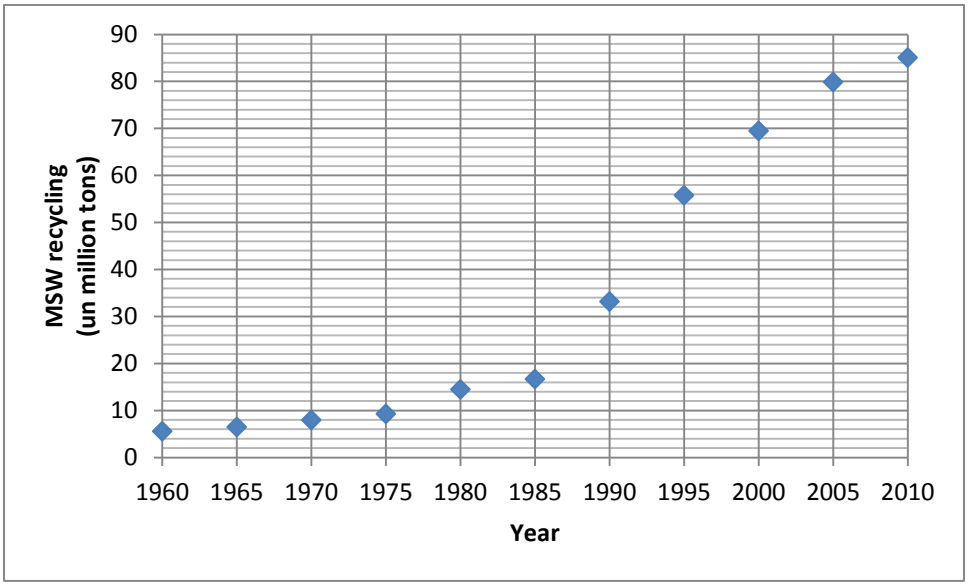

Curve of Best Fit Review

Use the MSW (Municipal Solid Waste) generation data to answer the following questions.

1. What is the equation for the curve of best fit for the MSW generation rates?

2. If the trend stays the same, how much waste will be produced in 2020?

3. If the trend stays the same, in what year will 300 million tons of waste be produced?

Use the MSW (Municipal Solid Waste) recycling data to answer the following questions.

4. What is the equation for the curve of best fit for the MSW recycling rates?

5. If the trend stays the same, how much will be recycled in 2020?

6. If the trend stays the same, in what year will 100 million tons be recycled?

Curve of Best Fit Review – Answer Key

Use the MSW (Municipal Solid Waste) generation data to answer the following questions.

1. What is the equation for the curve of best fit for the MSW generation rates?

   y = 3.64x -7050.31 (using the years)

   y = 3.64x + 84.45 (using 0 for 1960, 5 for 1065, and so on)

2. If the trend stays the same, how much waste will be produced in 2020?

   302.49 million tons

3. If the trend stays the same, in what year will 350 million tons of waste be produced?

   2033

Use the MSW (Municipal Solid Waste) recycling data to answer the following questions.

4. What is the equation for the curve of best fit for the MSW recycling rates?

   $y = .04x^2 - .1x + 4.28$ (using 0 for 1960, 5 for 1065, and so on, does not work using the years)

5. If the trend stays the same, how much will be recycled in 2020?

   142.28 millions tons

6. If the trend stays the same, in what year will 200 million tons be recycled?

   In about 71 years from 1960, this would be 2031

Day 3

Air Quality Index Project

Students will look at the Air Quality Index (AQI) of different cities throughout the US.

Directions:

- Students should get into groups of no more than four.
- Each group should select a different US city to research
- The groups will go to the following website to collect data on the AQI in their city: http://www.epa.gov/airdata/ad_rep_aqi.html
    - On the site students will put in the year and the city and will be given the number of days that data was collected for that year, how many days the air quality was good, moderate, USG (unhealthy for sensitive groups), unhealthy and very unhealthy.
    - The groups should collect data in five year increments looking at ten different years.
- The groups will create a table listing the year, the number of days data was collected, and the number of days the air quality was good, moderate, USG, unhealthy and very unhealthy.
- The groups will create a scatter plot using the years and the number of days the air quality was healthy.
- The groups will create an equation of the curve of best fit for their data on the number of days the air quality was healthy.
- The groups will use the equation of the curve of best fit to determine the number of healthy days in five, ten and twenty years.
- The groups will create a presentation tool to help present their data to the class.
- The groups will prepare to discuss their findings with the class.

The rubric for the project is below.

Project Rubric

Category	Excellent	Moderate	Needs improvement	Check Off	Score
Data – Table	Table lists years, days of data collections and all days of different air quality levels.	Table does not meet all requirements.	No table was created.		____/10
Scatter Plot	A plot created with at least 10 data points for healthy air quality correctly plotted.	A plot was created with fewer than 10 data points, or not all points plotted correctly.	No plot was created.		____/10
Curves of Best Fit	Curve drawn and labeled on the scatter plot.	Curve drawn but not labeled on the scatter plot.	No curve drawn or labeled on any plot.		____/10
Predictions	Predictions for 5 years, 10 years and 20 years in the future.	Not all predictions done.	None of the predictions done.		____/15
Organization	Project is neat and easy to follow.		Project is not neat and easy to follow		____/5
				Total	____/50

Lesson 3 – Project Presentations

Day 4

Presentations

Groups will present their projects to the class. Groups will be graded using the presentation rubric below. Groups should discuss their findings for healthy air quality in different cities in the US and predictions for healthy air quality days in the future. Each presentation should last about 10 minutes.

Journaling

Students will write a journal entry to wrap up the topic of pollution and curves of best fit. Students will use the following questions to guide their journal entry.

1. What have you learned about pollution?
2. How does math help you to understand pollution in the world?
3. Do you feel the same or different about pollution as before the unit?
4. If your feelings have changed, why do you think that is?

Presentation Rubric

Category	Excellent	Moderate	Needs Improvement	Score
Organized	The presentation is organized and the discussion lasts for about 10 minutes.	The presentation is not organized or lasts for 5 minutes	The presentation is not organized and lasts for fewer than 5 minutes.	____/15
Professionalism	All members of the group act in a professional manner during the presentation and it is clear that all members contributed to the project.	Not all members of the group act in a professional manner or not all members contributed to the project.	The group does not act in a professional manner during the presentation and not all members contributed to the project.	____/10
On topic	The group stays on topic during the presentation.		The group does not stay on topic during the presentation.	____/10
Material	The group covers all the material from the project expectations		The group does not cover all of the material for the project expectations.	____/15
			Total	____/50