Math TODAY™
Teacher Edition
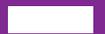
More of U.S.

By: Bob Tower
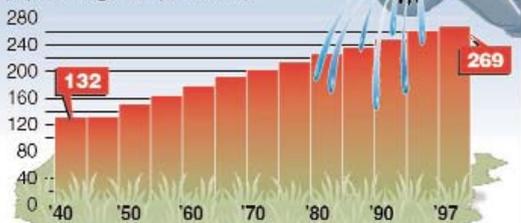
Activity Overview:

Students will investigate graphical representation of real-life data and determine the exponential regression model for the data set. Students will be presented with a problem situation and will use their problem-solving skills and their regression models to answer questions. Additionally, the students will determine the percent error in their estimations compared to the data in the USA TODAY Snapshot® "More of U.S."

Concepts:

- Exponential functions modeling population growth over time
- Comparing actual and estimated values using percent error

Objectives:

Students will:
- explore population data and create an exponential function to model the growth in the population data.
- use the model to estimate the population for a given year and will estimate the year for a given population.
- compare the estimated value to the given value by determining the percent error.

Activity at a Glance:

- Grade level: 9-12
- Subject: Pre-Calculus
- Estimated time required: 10-20 minutes

Materials:

- TI-83 Plus family or TI-84 Plus family handheld
- Overhead ViewScreen™ handheld for instruction/ demonstration
- Student handout
- Transparency

Prerequisites:

Students should:

- know how to create a scatterplot.

- have previous experience with exponential functions.

- have experience with the regression capabilities of the handheld.

- know how to determine percent error.

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Background:

In this activity students will investigate exponential functions and their graphs using real-life data. Students will analyze population data for the United States and create an exponential model for the scatterplot. Students will be using exponential functions to make predictions about population growth. The students will compare their estimated population to the population shown in the USA TODAY Snapshot "More of U.S." by calculating the percent error to demonstrate that models may not generate the original numbers. Mathematical models are used as a means to make predictions and look at trends in data.

Preparation:

- Provide one graphing handheld for each student.
- Each student should have a copy of the corresponding student activity sheet.

Classroom Management Tips:

- Exponential growth is unrestricted and populations usually have some limiting conditions to their growth. Space, food supply, and disease are a few factors that may limit the growth. This may be the time to talk about the characteristics of the logistic function.

- This activity may be used as an individual or group project.

- During this lesson you can discuss quadratic, exponential, and logistic functions using the same data set. This is an excellent opportunity for students to look at real-life data and think about that data mathematically.

- Students are asked to compare their estimate to the given value by finding the percent error. This activity will demonstrate that the regression model will find values that are close to the original data but may not give the exact values. This is a great time to talk to the class about limitations and benefits of using a model to make predictions about real-life data.

- You may want student handhelds to have the Diagnostics On and Expressions On settings active before starting this activity. This allows the students to see the coefficient of determination (r^2), correlation coefficient (r), and their expressions while using the handheld.

- Remind students that all the information they need in order to answer the percent error question is in the USA TODAY Snapshot.

- You can use this activity to have the students generate analytically the exponential function and then compare the handheld regression model to this analytical model.

Data Source:

U.S. Census Bureau

National Council of Teachers of Mathematics (NCTM) Standards*:

Numbers and Operations Standard
- Compute fluently and make reasonable estimates.

Algebra Standard
- Understand patterns, relations, and functions.

Measurement Standard
- Apply appropriate techniques, tools, and formulas to determine measurements.

Connections Standard
- Recognize and apply mathematics in contexts outside of mathematics.

Representation Standard
- Use representations to model and interpret physical, social, and mathematical phenomena.

*Standards are listed with the permission of the National Council of Teachers of mathematics (NCTM), www.nctm.org. NCTM does not endorse the content or validity of these alignments.

Additional Resources:

Student Handout

Transparency

TI Technology Guide, for information on the following:

- TI-83 Plus
- List Editor
- ScienceTools

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Activity Extension:

- Ask students to find the quadratic regression model for the same data set and answer the questions again using the quadratic model.
  Then, ask students to look at both models and explain what the data suggests was happening to the population before 1842.

- Encourage students to explore www.census.gov/main/www/popclock.html for the population clocks that show current facts about the population in the United States and World. Have the students use their models to predict the population and then compare their results with the information found at this Web site.

- The growth of populations has widespread applications. Exponential growth and decay are encountered in biology, chemistry, business and social sciences. Have students find five articles in USA TODAY that address the impact of population increase or decrease.

Curriculum Connections:

- US History

- Biology

- Chemistry

- Economics/Business

Assessment and Evaluation:

Q. **Assume that the population of the United States is growing exponentially. What is the exponential function that best models the data provided?**

```
ExpReg
 y=a*b^x
 a=80.37412008
 b=1.012911667
 r²=.994998783
 r=.9974962572
```

Q. **What was the projected population for 1997? What is the percent error in the estimated population compared to the actual population?**

A. Projected population for 1997 is 279 million (3 significant digits)

```
Y1=80.37412007201*1.01_




X=97          Y=278.97086
```
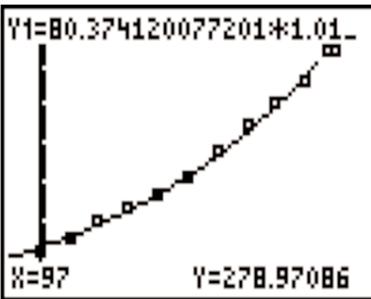
Percent error: Our estimate exceeded the actual by 10 million and created a 3.7% error.

Q. **Determine when the U.S. population reached 100 million.**

A. According to model, at the beginning of 1917 the U.S. reached 100 million.

```
Intersection
X=17.029978  Y=100    .
```