Linear rate of change: Steady growth

from the Esri GeoInquiries™ collection for Mathematics

MATH

Target audience – Algebra learners **Time required – 15 minutes**

Activity	While population growth is often associated with exponential functions, this activity explores a linear model for one Michigan county.
Math Standards	**CCSS: Math.Content.HSF.LE.A.1**. Distinguish between situations that can be modeled with linear functions and with exponential functions. **CCSS: Math.Content.HSF.LE.A.1.a**. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals. **CCSS: Math.Content.HSF.LE.B.5**. Interpret the parameters in a linear or exponential function in terms of a context.
Learning Outcomes	• Students will recognize a given population growth as linear change. • Students will estimate a future population based on the average rate of change (for example, slope).

Map URL: http://esriurl.com/mathGeoInquiry3

Engage

What is the population now?

- ➔ Click the link above to launch the map.
- ➔ With the Details button depressed, click the button, (Show) Contents.
- ? Which Michigan county looks like it has the highest population? *[Answers may include Macomb, Kent, Genesee, Oakland, or Wayne.]*
- ➔ Click a county with a high population in 2010 to see a pop-up.
- ➔ Scroll down the pop-up until you find the field, Population 2010.
- ? What is the population for that county?
- ➔ Do the same for two or three other high-population counties.

Explore

What was the population then?

- ? Which county do you think had the highest population 120 years ago? *[Answers will vary.]*
- ➔ Turn on the layer, Michigan Population, 1900.
- ➔ Turn off the layer, Michigan Population 2010.
- ➔ Read aloud: "This time, we will look at the table to see which one was highest."
- ➔ In the Contents pane, click the layer name, Michigan Population 1900. Click the table icon beneath the layer name.
- ➔ Click the column heading for the layer, 1900 Population. Choose Sort Descending.
- ? What are some of the counties with the highest population in 1900? *[Wayne, Kent, Saginaw, etc.]*
- ➔ Close the table. *(Click the "X" in upper right corner of table area.)*

more ▶

Explain

What was the rate of growth?

- Read aloud: "We will now look at Kent County, which had a particularly steady rate of growth over the last century."
- Turn on the Kent County layer.
- On the map, click Kent County to see a pop-up with populations from 1890 to 2010, along with a scatter-plot graph of that data.
- ? What is the average rate of growth (slope) for the years 1900 to 2000? *[(2000 population - 1900 population) / 100 years = 4,446 per year]*
- Starting with the population in 1900 (129, 714), add the product of the average growth rate multiplied by the number of years. (Example: For a population estimate for 1940: 129,714 + [4446 * 40] = 307,554)
- Based on the scatterplot, 1940 was below the value predicted; find the predicted values for 1920, 1950, 1980 and compare them to the actual populations.
- ? For which year is the linear model closest to the actual population? *[1920]*

Elaborate

Why did one increase and the other decrease?

- Turn off all (four) layers.
- Read aloud, "Some Michigan counties have declined in population since 1990."
- Turn on the layer, Change in Population, 1990 - 2010 - Michigan Counties.
- ? Which county has increased the most? Decreased the most? *[Macomb; Wayne]*
- ? What do you notice about where each is located? *[Next to each other]*
- ? Why do you think this has happened? *[Wayne has Detroit city and Macomb has Detroit suburbs.]*

Evaluate

Is there another county like Kent County?

- Linear population growth is unusual; try to find another county that shows approximate linear growth.
- View the Michigan Population 1900 table.
- Examine the population for Kalamazoo County, and use these values to justify whether you think that Kalamazoo experienced linear population growth. *[Yes, but not as linear as Kent County]*

VIEW A TABLE

- Tables are only available for certain map layers.
- In the Contents pane, point to a layer and click the Show Table icon that appears under the layer name.
- Click the field name and choose Sort Ascending or Sort Descending.

IDENTIFY A MAP FEATURE

- Click a feature on the map, and a pop-up window will open with information.
- Links and images in the pop-up are often clickable.
- An arrow icon in the upper right of the window indicates that multiple features have been selected.
- Click the button to scroll through the features.

Next Steps

DID YOU KNOW? ArcGIS Online is a mapping platform freely available to public, private, and home schools. A school subscription provides additional security, privacy, and content features. Learn more about ArcGIS Online and how to get a school subscription at http://www.esri.com/schools.

THEN TRY THIS...

• Change the Style of Michigan Population layer. Select a different field to show or combine two fields together in a comparison.

TEXT REFERENCES

This GIS map has been cross-referenced to material in sections of chapters from these high school texts.

- *Algebra Structure & Method, Book 1 by McDougal Littell — Chapter 8*
- *Algebra 1 by Prentice Hall Mathematics — Chapter 6*
- *Algebra & Trigonometry by Robert Blitzer — Chapter 2*

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