SIEMENS STEM DAY | Science Technology Engineering Math

GRADES 9–12

SIEMENS STEM DAY ACTIVITY

HOW DOES YOUR CITY GROW?

OBJECTIVES

Students will be able to:

- **Develop** an algebraic relationship between time and the population size of a city.
- **Predict** growth of the population size of a city using an algebraic relationship.
- **Create** a visual representation that summarizes their projection.

THIS LESSON FOCUSES ON

Engineering Design Cycle

- Defining the Problem

21st Century Skills

- Critical Thinking

OVERVIEW

As a city grows, its planners must project growth of the population to anticipate future needs, such as infrastructure expansion. Working in groups, students will select a city and then use U.S. government census data to develop an algebraic relationship between time and population size. Students will use their equations to predict growth of the city's population over the next decade. Groups can then create visual representations, such as graphs, that summarize the projection for their chosen city.

STEM incorporates Science, Technology, Engineering, and Mathematics to focus on real-world issues and problems guided by the engineering design process. This type of instruction supports students in developing critical thinking, collaboration, reasoning, and creative skills to be competitive in the 21st-century workforce.

Each Siemens STEM Day classroom activity highlights one or more components of the engineering design cycle and an essential 21st-century skill.

MATERIALS

- Computer with internet access
- **Web Search Student Handout**—one per group
- Visual presentation materials

HAVE YOU EVER WONDERED . . .

How a city figures out how quickly its population will grow?

MAKE CONNECTIONS!

How does this connect to students?

As a city's population grows, demands are made on all aspects of its infrastructure. For example, if new schools are not built, the class sizes of existing schools could become too large.

How does this connect to careers?

Economists model and explain economic trends using math and statistics.

Mathematical modelers help to solve problems by representing processes using mathematical models.

City Planners help design every aspect of a city such as the location and purpose of buildings and street layouts.

How does this connect to our world?

According to the UN, by 2050 two-thirds of the world's population will live in cities. To ensure an acceptable quality of life, city growth must be forecasted and planned so that future population needs can be adequately met.

BLUEPRINT FOR DISCOVERY

1. Introduce students to the idea of population growth by showing the following video: https://youtu.be/PUwmA3Q0_OE
2. Explain to students that they will be working in groups to use U.S. government census data to develop an algebraic relationship between time and population size and to predict growth.
3. Divide students into even groups that each choose a city. Ensure that the class chooses a variety of cities.
4. Distribute a Web Search Student Handout to each group and instruct students to follow the directions in order to gather their data.

   Note: In most cases, the population should increase from one year to the next. The data should comprise each year and its respective population size for the group's chosen city.
5. Challenge groups to develop an algebraic relationship between time and the city's population size.

   Note the following when facilitating:

   a. Assume growth follows an approximate straight line, so that P = mT+B (from y=mx + b, where P = population size and T = the year)

   b. The students should use their data to estimate the slope of the line. For each year, use the year as x and the population as y.

   c. These values should then be subtracted from the following year so that $x_1 - x_2$, and $y_1 - y_2$. For example, let us start with 2009. For 2009 and 2010, $x_1 - x_2$ = 2009 – 2010 = -1. The sign for one year to the next will always be negative.

d. Students should repeat the previous step for the population. For example, if the population in 2009 is 300,000 and in 2010 it increased to 305,000, then $y_1 - y_2 = -5000$. If the population had decreased, the sign would be positive.

e. Students will repeat the previous two steps for the following year, 2010 in the example. For the year, 2011–2010 = -1. Say the population increases by 5,000 again. For the population, 305,000 –310,000 = -5000.

f. With only two points, the slope can be calculated from $(y_1 - y_2)/(x_1 - x_2)$ to solve for the term m. That is,

$$m = \frac{y_2 - y_1}{x - x_1}$$

In this case, -5000/-1 = 5000. Therefore, the slope of the equation is 5000. The positive value indicates that the population size increased.

6. Students can use the slope to project a future population. *For example, in the case above, the slope indicates that the city's population increases by 5,000 a year. If population increase is constant, a projection simply multiplies the number of years projected by the value of the slope. In the example, in five years, the city population would be expected to grow by 5 x 5000 = 25,000.*

7. After groups complete their projections, invite them to brainstorm the changes or improvements needed to infrastructure. Types of infrastructure include housing, energy, transport, public safety, water, food supply, green space, health, education, and others.

8. Direct groups to create presentations illustrating their findings and featured infrastructure.

TAKE ACTION!

- Students can write to the city managers to compare their projections with the city's own estimates.
- Students can write to the managers of their featured infrastructure to evaluate the city's future needs for that type of infrastructure.
- Students can use the U.S. Census Bureau data to develop additional projections for different demographics, such as the increase in senior population or military veterans.

NATIONAL STANDARDS

Technology Education	**3.** Knowledge Constructor—Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others: a. Students plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits, d. Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions. **6.** Creative Communicator—Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals: d. Students publish or present content that customizes the message and medium for their intended audiences.
Mathematical Practice	HSA.CED.A.2: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. CCSS.MATH.CONTENT.HSA.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
English Language Arts	CCSS.ELA-LITERACY.SL.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on topics, texts, and issues, building on others' ideas and expressing their own clearly. CCSS.ELA-LITERACY.SL5 Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.

WEB SEARCH

Follow the steps below to gather your data and record it in the chart:

- ☐ Access the U.S. Census Bureau American FactFinder website: https://factfinder.census.gov.
- ☐ Click Advanced Search.
- ☐ Click "Show Me All."
- ☐ Enter: "Civilian Population" in the "topic or table name" field. Leave the "Topics" radio button checked.
- ☐ Enter the city name in the "state, county or place (optional)" field. The name of the city will show in a dynamic field. Select the name of the city from the dynamic field and click "Go."
- ☐ Select one of the tables indicating a multi-year estimate (e.g., "2017 ACS 5-year estimates"). The selected table will show the estimated population for the selected year (2017 is selected by default).
- ☐ Note the population for that year below.
- ☐ Repeat for each of the earlier years, noting the population for each year.

Year									
Population									