

OH, HOW WE'VE GROWN!



People
and the
Planet

Lessons for a Sustainable Future

INTRODUCTION

Centuries ago, before people knew how to prolong life with modern medicine, better nutrition, and sanitation, the human population grew very slowly. While **birth rates** were high, **death rates** were also high, keeping the population from growing much. In modern times, we have greatly reduced death rates, but in some parts of the world, birth rates still remain relatively high. Because there are more births than deaths in the world each year, the human population grows. Even a small population growth rate can cause the population size to double in a short time.

MATERIALS

- Yarn or masking tape
- Counting Cards (provided)
- Roll of adding machine paper
- Meter sticks
- Markers
- Student Worksheet
- Poker chips (optional)

PART 1: POPULATION CIRCLE PROCEDURE

1. Before class, cut out the Counting Cards.
2. Using tape or yarn, create a circle on the floor about 10 feet in diameter. (If using yarn, measure 30 feet of yarn and tie the ends together.) Ask the class to form a circle around the outside of the yarn and explain that the circle represents the Earth. You will be looking at how the population of the Earth has changed during a 500 year span by simulating world population growth from 1525 to 2025.

CONCEPT

Over the past few hundred years, human population has grown exponentially, creating a "population explosion." The history of human population growth is a fitting real-world example of exponential growth.

OBJECTIVES

Students will be able to:

- Describe trends of human population growth.
- Prepare a timeline that graphically portrays population doubling through history.
- Explain the basic attributes of exponential growth (slow start, fast finish).

SUBJECTS

Social studies (history), math, science (Earth and environmental, life)

SKILLS

Modeling population growth, measuring in metric, multiplying, doubling numbers, scaling, identifying trends and patterns, critical thinking

METHOD

Students experience the changing pace of population growth by actively simulating the Earth's population growth over a 500-year span and then creating a timeline that visually depicts the population doubling through history.

3. Distribute the 32 counting cards. (If you have fewer than 32 students, you may use chairs or some other item to represent additional people.) Each card represents 250 million people. Explain the simulation by reading the following paragraph aloud:

"We will be counting out loud from 1 to 100 to see how our population has grown. As we count, each time we say a number, we are going to jump ahead five years into the future. We'll start in the year 1525 (with "0") and end in the year 2025 (with "100"). When we reach 100, all 500 years will have passed. Listen for the number in the middle of your card and when it's called, step into the circle. Each time someone steps into the circle, it represents 250 million people being added to the world's population."

4. Ask the two students holding cards with the number "0" to stand in the circle to represent the world's population in the year 1525. Explain that the two students represent everyone who lived on Earth in 1525, about 500 million people. Today, about 8 billion people live on Earth, and our population is expected to continue to grow rapidly through the end of the century.
5. Ask students to predict the number when they think the third person will enter the circle.
6. As a group, start counting at a comfortable pace with students entering the circle when their numbers are called. Stop when you reach 100.

PART 2: DOUBLING ON THE LINE

PROCEDURE

1. Divide the class into groups of 3-4. Distribute a meter stick, a 7-meter piece of adding machine paper, the Student Worksheet, and markers to each group.
2. Explain to the class that you are going to provide data showing how world population has been growing from the year 1525 to the present time. Display the World Population Growth Data chart.

World Population Growth Data Chart

YEAR	WORLD POPULATION
1525	500 million or $\frac{1}{2}$ billion
1804	1,000 million or 1 billion
1927	2,000 million or 2 billion
1974	4,000 million or 4 billion
2022	8,000 million or 8 billion



3. Explain that they will be creating a timeline where time is represented by length. Students will first calculate the number of years it took the population to double and then convert that number of years into a measurement.

The timeline scale used to convert years into metric measurements is as follows: 1 meter = 100 years, 1 decimeter = 10 years, and 1 cm = 1 year. If your students are not already familiar with linear metric measurements, explain to them the divisions on a meter stick (10 decimeters, 100 centimeters, 1,000 millimeters).

- Once the groups have used the scale to determine their doubling time measurements, have groups compare answers. They are then to construct a timeline on the adding machine paper. Starting with the year 1525, each group should determine where the next doubling mark will be made on the timeline. Students could use a different color marker to represent each doubling of the population.
- When they're finished, ask students to make observations about their timeline.

Note: To add a visual of the rapid population growth, put one timeline on the floor of the classroom and use poker chips to represent people (1 chip = 500 million people). Place one poker chip in the space between 1525 and 1804 to represent the 500 million people added to the Earth from 1525-1804. Place two poker chips between 1804 and 1927 to represent the additional 1 billion people added from 1804-1927. Place four poker chips between 1927 and 1974 (to represent the additional 2 billion people) and place eight poker chips between 1974 and 2022 (to represent the additional 4 billion people).

Answers to Student Worksheet

World Population Doubling Time

Doubling Time	Length of Tape
1525 – 1804: 279 years	2.79 m (2 meters + 7 decimeters + 9 centimeters)
1804 – 1927: 123 years	1.23 m (1 meter + 2 decimeters + 3 centimeters)
1927 – 1974: 47 years	0.47 m (4 decimeters + 7 centimeters)
1974 – 2022: 48 years	0.48 m (4 decimeters + 8 centimeters)

DISCUSSION QUESTIONS

- What did you observe about how our population has changed over time, in both parts of this activity?

In Part 1: Population Circle, it took a long time to add anyone to the circle (not until number 45!), but towards the end, at least one person was entering the circle for each number, meaning that the population was growing very fast. In Part 2: Doubling on the Line, the timeline shows that in our early history, it took a very long time for the population to double. Towards the end of the timeline, more recently, the population doubles in a fraction of the time it took during the first 279 years. This tells us that the population is now growing very quickly.

- Based on what you saw happening to the population, could you describe human population growth as **exponential growth**?

Yes, the slow start followed by a fast and sudden increase indicates that the population is increasing in size exponentially. Looking at Part 1: Population Circle, very few people joined the circle at the beginning of the counting; most people stepped into the circle after we got to numbers in the 80s (meaning 400 of the 500 years had passed). Growth started out very slowly but finished quickly, a sign of exponential growth. In Part 2: Doubling on the Line, the doubling time is very long in the early years and gets shorter as time goes on, indicating much faster population growth.

3. Population is projected to approach 10.5 billion by 2100. That's 2.5 billion more people than what is represented in this activity. How many more people would have to enter the circle in Population Circle to represent the population in 2100?

We would need 10 more people to enter the circle; four people for every billion.

4. What changes have occurred over the past 500 years that enabled people to live longer lives, and as a result, enabled our population to increase?

Answers may include: advances in food production have led to healthier nutrition, better sanitation and waste disposal has led to a reduction in the spread of disease, medical advancements have meant that people are living longer, healthier lives – we are now able to cure diseases that used to be deadly, new forms of transportation have been able to move these new technologies and new ideas at a faster pace.

5. What would happen if we continued to grow at the current rate? Can you think of any challenges that would be caused by a larger population?

The Earth would become more crowded. Encourage students to think of any social issues that might occur with a higher population and the resulting increase in resource use.

ASSESSMENT

Evaluate participation in the simulation and review students' timelines. Monitor responses to Discussion Questions to gauge understanding of population growth trends and exponential growth.

FOLLOW-UP ACTIVITY

Have students try out the following the activity illustrating the concept of doubling time: Give each student a cocktail napkin (unfolded) or paper towel (regular paper is too thin). Instruct them to fold the paper in half, then in half again, in half a third time, and then in half a fourth time. At this point, it should be about 1 cm or 0.4 inches thick. Ask students to count the layers in their folded napkins. Why can't we continue folding? The napkin is too thick to fold over again.

Ask them how thick the napkin would be if you folded it in half 29 more times (if this were possible). Estimates may vary widely.

Ask if students can see a pattern in the number of times they folded the napkin. Each time the napkin is folded, the number of layers doubles. We can find this out by multiplying the number of layers by 2. The layers of napkin grow exponentially every time we fold it in half again.

Doubling an amount will get you to large numbers rapidly. Tell them, "If we were to fold this napkin 29 more times, it would be 3,400 miles thick – the distance from Boston, Massachusetts to Frankfurt, Germany."

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COUNTING CARDS

0 (1525)	0 (1525)	45 (1750)	56 (1805)	65 (1850)
73 (1890)	77 (1910)	80 (1925)	83 (1940)	85 (1950)
86 (1955)	87 (1960)	88 (1965)	89 (1970)	89 (1970)
90 (1975)	91 (1980)	92 (1985)	92 (1985)	93 (1990)
93 (1990)	94 (1995)	94 (1995)	95 (2000)	96 (2005)
96 (2005)	97 (2010)	97 (2010)	98 (2015)	98 (2015)
99 (2020)	100 (2025)			

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STUDENT WORKSHEET

Name: _____

Date: _____

Scale

1 meter = 100 years

1 decimeter = 10 years

1 centimeter = 1 year

Year	World Population	Doubling Time (Number of Years Elapsed)	Length of Tape
1525	500 million or 1/2 billion		
1804	1,000 million or 1 billion		
1927	2,000 million or 2 billion		
1974	4,000 million or 4 billion		
2022	8,000 million or 8 billion		